NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: Federal Energy Regulatory Commission (FERC)
US Army Corps of Engineers, New England District

Activity Considered: **Construction of new powerhouses at the Orono (2710) and Stillwater (2712) Projects;**
Fish passage improvements at the Orono, Stillwater and Milford (2534) Projects;
Species Protection Plan for the Orono, Stillwater, Milford, West Enfield (2600) and Medway (2666) Projects.

F/NER/2012/01568

Conducted by: National Marine Fisheries Service
Northeast Region

Date Issued: 8/31/12

Approved by: for
John Bullard

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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) approval of applications to amend the licenses for the construction of new powerhouses at the Stillwater (2712) and Orono (2710) Projects, as well as the incorporation of protection measures for Atlantic salmon and other listed species at the Orono, Stillwater, Milford (2534), West Enfield (2600) and Medway (2666) Projects.

By applications filed with FERC on May 18, 2011, Black Bear Hydro Partners, LLC (Black Bear) requested that its licenses for the Orono and Stillwater Projects be amended to authorize Black Bear to construct a second powerhouse at each project. In letters dated July 19, 2011 and September 14, 2011, the FERC designated Black Bear as their non-federal representative to conduct informal ESA consultation with us. These consultations would consider effects of actions proposed in the two amendment applications, as well as effects of applications to amend the licenses for its other licensed projects in the Penobscot River Basin (Milford, West Enfield and Medway) to incorporate protection measures to minimize effects to ESA-listed species as proposed in a Species Protection Plan (SPP).

This Opinion is based on information provided in the FERC's April 27, 2012 Biological Assessment and SPP, the updated SPP and study plan issued by FERC on June 27, 2012, as well as additional information provided in Black Bear's amendment applications for the Stillwater and Orono Projects. A complete administrative record of this consultation will be maintained at our Maine Field Office in Orono, Maine. Formal consultation was initiated on May 3, 2012.

In addition to FERC, another federal agency, the U.S. Army Corps of Engineers (ACOE), is taking action to authorize the construction of the new powerhouses at the Orono and Stillwater Projects. 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. Pursuant to the section 7 regulations (50 CFR §402.07), when a particular action involves 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.

1.1. Consultation History

- **July 2009 -** Black Bear submitted a letter to the USFWS and NMFS acknowledging the expanded listing for Atlantic salmon and confirming its commitment to work with the USFWS and NMFS to maintain compliance with the ESA with respect to the additional powerhouses at the Projects.

- **August/September/October 2009 -** Black Bear participated in various meetings with state resource agencies, NMFS and the USFWS regarding ESA compliance options including section 7 and section 10 of the ESA.

- **September 2009 to December 2011 -** Various consultation efforts on fishway designs at Stillwater and Milford Projects (see September 30, 2001 and November 30, 2011 filings, respectively, for additional documentation and details).

- **October 2009 -** NMFS responded to Black Bear's 17 July letter suggesting an early November meeting to discuss ESA compliance.

- **November 2009 -** Black Bear, NMFS, and the USFWS met at NMFS' Gloucester, MA office to discuss options for ESA compliance.

- **December 2009 -** Black Bear met with NMFS and the USFWS staff to discuss the outline and contents of a SPP and associated documents.

- **January/February 2010 -** Informal conversations between Black Bear, the USFWS, and NMFS took place regarding ESA requirements and the scope of supporting documents.

- **April 2010 -** Black Bear convened a meeting with the USFWS and NMFS to discuss ESA process, schedule, and development of a SPP. Black Bear provided an outline for a proposed SPP for discussion purposes.

- **April/May 2010 -** The USFWS and NMFS emailed various ESA documents to Black Bear in support of the Black Bear efforts to develop the content and format of an SPP.

- **June 2010 -** Black Bear convened a second meeting with the USFWS and NMFS to discuss the SPP. NMFS provided a revised SPP outline at the meeting.

- **June 2010 -** Black Bear emailed a revised SPP outline to the USFWS and NMFS.

- **October 2010** - Black Bear submitted a draft SPP to the USFWS and NMFS for review.

- **October 2010 -** NMFS provided certain documents to Black Bear to assist with completing the remaining section of the SPP.

- **December 2010 -** The USFWS and NMFS provided detailed comments on the draft SPP, including a request to include information on Penobscot River Atlantic sturgeon, a species under review as a candidate for ESA listing at that time.

- **February/March/April 2011 -** Informal conversations occurred between Black Bear, the USFWS and NMFS regarding the outline for the SPP, contents and consistency amongst projects within Maine, and schedule. Parties confirmed that the structure of the document would remain the same, but the SPP components would become Attachment A to the Biological Evaluation.

- **May 2011 -** Black Bear requested on May 18 that it be designated as the Commission's non-federal representative for the purpose of conducting informal consultation with USFWS and NOAA (the Services) pursuant to section 7 of the ESA with respect to:

  - the effects of the applications to amend the licenses for Orono and Stillwater on Atlantic salmon and other ESA-listed species; and
  - the effects of Black Bear's future applications to amend the licenses for Milford, West Enfield, and Medway to incorporate agreed-upon protective measures to aid Atlantic salmon and other ESA-listed species.

- **June 2011** - Black Bear provided draft Biological Evaluation with accompanying protective measures/SPP to the USFWS and NMFS.

- **July 2011** - FERC designated Black Bear as the Commission's non-federal representative for the purpose of conducting informal consultation with the Services pursuant to section 7 of the ESA for the Orono and Stillwater Projects on July 19. Subsequently, Black Bear called the Biological Evaluation a draft BA.

- **July 2011** - Black Bear met with the USFWS and NMFS to discuss the previously distributed draft BA with accompanying protective measures/SPP.

- **July/August 2011** - Black Bear continued consultation with the USFWS and NMFS on the draft BA and developed additional sections/information based on agency comments.

- **August 2011** - The USFWS and NMFS provided additional comments to Black Bear that resulted in revisions to the draft BA by Black Bear.

- **September 2011** - FERC designated Black Bear as the Commission's non-federal representative for the purpose of conducting informal consultation with the Services pursuant to section 7 of the ESA for the Milford, West Enfield, and Medway Projects on September 14.

- **October 2011** - Black Bear provided revised version of the preliminary draft BA to the USFWS and NMFS on October 11; met with USFWS and NMFS to discuss revised documents and performance standards on October 18 and 28.

- **November 2011** - Black Bear met with USFWS and NMFS to discuss SPP and performance standards on November 3. Black Bear provided USFWS and NMFS a revised SPP on November 17. Black Bear met with USFWS and NMFS to discuss SPP and performance standards on November 21. NMFS provided comments on the revised SPP on November 30.

- **December 2011** - Black Bear met with USFWS and NMFS to discuss SPP and performance standards on December 2, and 6, and 19. Black Bear provided revised version of the draft SPP to USFWS and NMFS on December 21.

- **January 2012** - NMFS provided comments on the revised SPP on January 4. Black Bear provided a revised version of the draft BA to USFWS and NMFS on January 4. Black Bear met with the PIN, USFWS, and NMFS to discuss SPP and performance standards on January 5. Black Bear, USFWS, and NMFS met with the Penobscot River

Restoration Trust and state agencies to provide an overview of the SPP efforts on January 18.

- **March 2012 –** Black Bear submitted draft license articles to FERC on March 8 to implement the provisions of the SPP and Sturgeon Handling Plan for the final license amendment applications for the Stillwater and Orono Projects. Included in Black Bear's submittal was the revised draft BA and SPP.

- **April 2012 –** FERC adopted the BA and SPP and submitted a letter to NMFS on April 27th requesting the initiation of formal consultation.

- **May 2012 –** NMFS submitted a letter to FERC on May 17th indicating that all of the information required to initiate a formal consultation for the project had been received. In this letter NMFS noted that the date that the initiation request was received (May 3, 2012) would serve as the commencement of the formal consultation process.

- **June 2012 –** Black Bear submitted final Species Protection Plan and Study Plan to FERC on June 7th. FERC issued the updated SPP and study plan on June 27th 2012.

- **July 2012 –** Black Bear convened a meeting with NMFS, USFWS and MDMR to review hydraulic modeling at the Orono Project.

1.2. Relevant Documents

The analysis in this Opinion is based on a review of the best available scientific and commercial information. Specific sources are listed in Section 13 and are cited directly throughout the body of the document. Primary sources of information include: 1) information provided in FERC's April 27, 2012 initiation letter and attached BA and SPP in support of formal consultation under the ESA; 2) the final SPP and study plan issued by FERC on June 27, 2012; 3)Black Bear's License Amendment Applications for the Orono and Stillwater Projects (May 2011); 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) Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States (Fay *et al.* 2006); 6) Designation of Critical Habitat for Atlantic salmon Gulf of Maine Distinct Population Segment (74 FR 29300; June 19, 2009); 7) Final Recovery Plan for Shortnose Sturgeon (December, 1998); and 8) Final listing determinations for the five distinct population segments of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). On February 6, 2012, we published notice in the *Federal Register* listing the Atlantic sturgeon as "endangered" in the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs, and as "threatened" in the Gulf of Maine DPS (77 FR 5880 and 77 FR 5914).

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

This section reviews the approach used in this Opinion in order to apply the standards for determining jeopardy and destruction or adverse modification of critical habitat as set forth in section 7(a)(2) of the ESA and as defined by 50 CFR §402.02 (the consultation regulations).

Additional guidance for this analysis is provided by the Endangered Species Consultation Handbook, March 1998, issued jointly by NMFS and the USFWS. In conducting analyses of actions under section 7 of the ESA, 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);
- Evaluates the relevance of climate change on environmental baseline and status of the species (Section 5);
- Determines whether the proposed action affects the abundance, reproduction, or distribution of the species, or alters any physical or biological features of designated critical habitat (Section 6);
- Determines and evaluates any cumulative effects within the action area (Section 7); and,
- Evaluates whether the effects of the proposed action, taken together with any cumulative effects and the environmental baseline, can be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the affected species, or is likely to destroy or adversely modify their designated critical habitat (Section 8).

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

The critical habitat analysis determines whether the proposed action will destroy or adversely modify designated or proposed critical habitat for ESA-listed species by examining any change in the conservation value of the primary constituent elements of that critical habitat. This analysis focuses on statutory provisions of the ESA, including those in section 3 that define "critical habitat" and "conservation", in section 4 that describe the designation process, and in section 7 that set forth the substantive protections and procedural aspects of consultation. Although some "properly functioning" habitat parameters are generally well known in the fisheries literature (e.g., thermal tolerances), for others, the effects of any adverse impacts are considered in more qualitative terms. The analysis presented in this Opinion does not rely on the regulatory definition of "adverse modification or destruction" of critical habitat at issue in the 9th Circuit Court of Appeals (Gifford Pinchot Task Force *et al.* v. U.S. Fish and Wildlife Service, No. 03-35279, August 6, 2004).

2. PROJECT DESCRIPTION AND PROPOSED ACTION

FERC is proposing to amend the licenses held by Black Bear for their Orono and Stillwater projects. The modifications to the licenses will authorize the construction of a second powerhouse at each project, as well as increase the length of the license term for each project to 2048. In addition, FERC is proposing to authorize the installation of new fishways at the Milford, Orono and Stillwater Projects and to modify the licenses for the Milford, Orono, Stillwater and West Enfield Projects to incorporate the provisions of a Species Protection Plan. . Although no new measures or structures are being proposed for the Medway Project, FERC is proposing to amend the license for the Medway project to require Black Bear to meet with NMFS every five years to ensure that operation of the project is consistent with the recovery objectives for Atlantic salmon and other listed fish species. This Opinion considers effects of the operation of Orono, Stillwater, Milford and West Enfield by Black Bear under the terms of the revised operating licenses as proposed by FERC, through the expiration of their licenses (see Table 1).

Table 1. License expiration dates for the projects considered in this Opinion. Dates in parentheses indicate the proposed extension of the license term.

Project	Expiration Date
Orono	2045 (2048)
Stillwater	2038 (2048)
Milford	2038
West Enfield	2024
Medway	2029

2.1. Orono Project - FERC No. 2710

2.1.1. Existing Hydroelectric Facilities and Operations

The Orono Project is located in the town of Orono, Penobscot County, Maine, on the Stillwater Branch of the Penobscot River. The Stillwater Branch is 10.5 miles long. It is not a true tributary of the Penobscot River, but is actually a channel of the Penobscot River that flows around the west side of Orson and Marsh Islands. The Orono Project is located at the downstream confluence of the Stillwater Branch where it rejoins the main stem of the Penobscot River (Figure 1).

The existing Orono Project consists of a concrete dam totaling 1,174 feet in length; an overflow spillway section with four foot high hinged flashboards; a non-overflow spillway section on the north end of the dam; a forebay intake supplying water to a single concrete penstock; a surge tank; a downstream fishway bypass; an upstream fishway for American eel; a powerhouse containing four turbine-generator units with a total installed capacity of 2.3 megawatts (MW) and a hydraulic capacity of 1,740 cubic feet per second (cfs); a 175-acre reservoir; and appurtenant facilities.

The Orono Project is operated as a run-of-river hydroelectric development with the discharge from the project turbines and spillway equivalent to inflow. The Orono Project includes a downstream fishway that discharges to a plunge pool located in the bypass reach. It also includes an upstream fishway located adjacent to the spillway abutment, which is designed to pass juvenile American eel into the headpond, although it is temporarily configured to trap migrant eels. There are currently no upstream passage facilities for other diadromous species. The Project provides a minimum flow to the bypass reach of 200 cfs through a combination of leakage through the flashboards and the discharge of the downstream bypass.

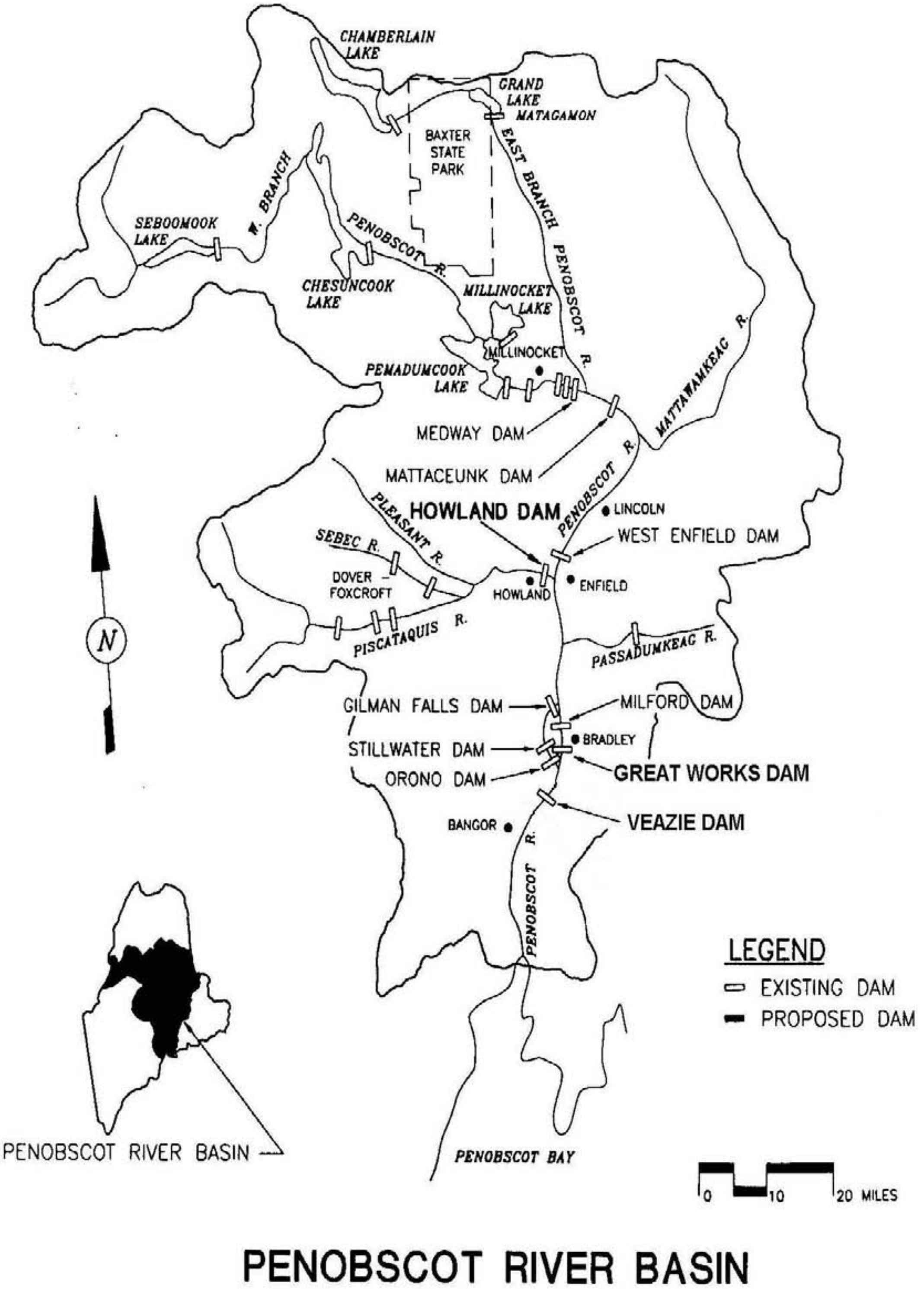

Figure 1. Penobscot River Watershed (Penobscot River Restoration Trust 2008)

2.1.2. Proposed Action

Black Bear filed an application with FERC on May 18, 2011 to amend the license for the Orono Project to include a second powerhouse, an additional downstream fish bypass and a new upstream fish trap. The license modification would also require Black Bear to adhere to the downstream fish passage measures proposed in the SPP, and would extend the term of the current license from 2045 to 2048.

2.1.2.1.New Powerhouse Construction

The proposed modifications at the Orono Project will consist of a new powerhouse and an expanded intake structure in line with the current trashracks and supplying water to a second penstock. This penstock will be located on the south shore of the bypass reach and generally adjacent to the existing penstock. The powerhouse will be situated in the bypass reach upon ledges. It will be located approximately 420 feet downstream of the existing dam in the existing bypass area, approximately 90 feet to the left of the existing penstock looking downstream. A tailrace will be constructed by removing some ledge from the existing channel to the main stem of the Penobscot River.

Active construction will occur below the mean high water (MHW) line of the Penobscot River for the construction of a new powerhouse at the Orono Project. Protection, mitigation and enhancement measures that address anticipated project effects to environmental resources at the Project have been proposed by Black Bear. Short-term effects to aquatic species and habitats anticipated from construction activities below the normal high water elevation in the project facility footprints are addressed by the following:

- Develop a soil erosion and sediment control plan prior to the start of any construction activity to prevent any short-term erosion or sedimentation effects in the river;
- Coordinate with fisheries management agencies to implement a fish passage plan for upstream migrating adult Atlantic salmon during the construction period including trap and truck from Veazie Dam to above the Milford Project;
- Maintain minimum bypass reach flows during construction activities to minimize effects to aquatic habitat;
- Conduct excavation and blasting activities in the dry to the extent possible; and
- Limit charge weights and delay individual blasts to keep detonation related sound pressures at a safe level for aquatic resources (less than an SPL of 206 dB re 1 uPa (3.6 psi), and below an SEL of 187 dB re 1 uPa sq.-sec) and implement blasting monitoring/reporting provisions.

New construction and alteration of the Orono Project will include the construction of a second powerhouse containing three Canadian Hydro Components (CHC) 1700 mm (5.6 feet) diameter vertical axial flow turbine-generating units having a nameplate capacity of 1,355 kW per unit. The new powerhouse will have a total rated capacity of approximately 3,738 kW and a total hydraulic capacity of 2,082 cfs. A new intake and 292 feet long by 25 feet wide by 12 feet high concrete box penstock will supply the powerhouse. A surge chamber measuring 60 feet long by

25 feet wide, flaring to 44 feet wide at the powerhouse by 32 feet high on three walls and 27 feet high on the spillway wall will be installed. Aerial transmission lines will be installed from the new powerhouse's generating step-up transformer unit (GSU) to the existing 12.5 kV, local substation near the existing powerhouse.

The new powerhouse will be a combination reinforced concrete structure with some corrugated tin walls and a beam and girder roof system measuring approximately 56 feet wide by 40 feet long by 60 feet high and housing the three, 1,246 kW generating units. The new units will have a combined maximum hydraulic capacity of 2,082 cfs and a minimum operating capacity of approximately 175 cfs, with a net head of 26.51 feet (under full station operation).

Once the second powerhouse is constructed, the Orono Project will have a total combined maximum hydraulic capacity of 3,822 cfs (1,740 cfs existing capacity at the existing powerhouse plus 2,082 cfs capacity at the new powerhouse) and a minimum operating capacity of approximately 100 cfs (minimum operating capacity of one unit at the existing powerhouse). In accordance with the existing Operation and Flow Monitoring Plan, the required minimum flow in the project bypass reach of 200 cfs will be handled by 153 cfs being routed through the proposed upstream/downstream fish passage facility and 47 cfs being leakage through the installed flashboards or an appropriate point source discharge.

The new powerhouse intake will be 84 feet wide by 20 feet high. It will be integral to the existing powerhouse intake via a singular trashrack. The trashrack will measure 156 feet wide by 20 feet high, and bars will be spaced at 1-3/8 inches on center (1 inch clear spacing), and situated at a 14.0 degree slope from vertical (1H:4V+/- slope). The new penstock transitions to an open surge chamber at the powerhouse, as discussed above. An overhead transmission line will extend from the GSU transformer at the new powerhouse to the existing substation that is within the existing project boundary. The transmission line is approximately 600 feet in length, will transmit at 12.5 kV, and will be interconnected with Bangor Hydro Electric Company's local, 12.5 kV distribution system. It is assumed that no interconnections are necessary with the use of the GSU. In addition to proposed structures for power generation, Black Bear is proposing to enhance generation output by increasing the normal impoundment level at the Orono Project by 0.6 feet, from 72.4 feet NGVD to 73.0 feet NGVD. The impoundment elevation will be accomplished by increasing the existing flashboard system height by 0.6 feet. The existing non-overflow section of the dam is at elevation 73.0 feet NGVD; the modified flashboards will be installed at the same elevation as the existing non-overflow section of the dam. This will allow for the normal headpond elevation increase while maintaining flood flow discharge capacity by not changing the existing spillway crest elevation. There will be no changes to minimum flows in the bypass channel reach.

Temporary Cofferdams

Three areas will be isolated for approximately a year at the Orono Project using solid fill cofferdams, in addition to a water diversion.

- Intake Cofferdam: A 300-foot long solid fill dam will be installed in the impoundment, upstream of the existing dam, to facilitate construction of the new intake structure. It will be constructed of clean, bank-run gravel, fill material. The top of the cofferdam will be approximately ten feet wide and it will have 2:1 side slopes. The footprint of the cofferdam will be approximately 20,000 square feet (0.5-acres) and the total volume of fill will be approximately 6,700 cubic yards (cy), of which 5,600 cy will be below the normal pond elevation of 72.4 feet NGVD.

- Powerhouse Isolation Cofferdam: A combination sheathing and solid fill cofferdam will be used to create a dewatered work environment to drill and blast bedrock in the new powerhouse area. The sheathing will be pinned to bedrock and will consist of typically 4 feet high flashboards. The footprint of the isolation cofferdam will be 3,870 square feet (0.09 acres) and the total volume of fill will be 653 cy, of which 437 cy will be below 42.0 feet NGVD, the normal tailwater elevation when the project is not operational.

- Tailrace Cofferdam: A 300-foot long earthen cofferdam will be placed across the naturally occurring alluvial deposits at the junction of the Stillwater Branch and the main stem of the Penobscot River to create a dewatered work environment to drill and blast bedrock. The downstream side of the dam will be selectively armored with rip-rap to minimize erosion. The footprint of the cofferdam will be approximately 18,000 square feet (0.41 acres) and the total volume of fill will be approximately 5,200 cy, of which 1,900 cy will be below 42.0 feet NGVD (the normal tailwater elevation when the Project is not operational).

- Water diversion: A pinned flashboard river flow control cofferdam structure will be erected to minimize, or eliminate, normal river flows from encroaching on the penstock and powerhouse construction work areas. The pinned flashboards will be attached to an existing concrete dam, as well as a new concrete sill that will be constructed on dry bedrock. Once complete the new sill will allow for a continuous pinned wooden flashboard system, approximately five feet tall, to be mounted from beneath the railroad trestle near the center pier to a high ledge outcropping near the right-hand end of the non-overflow dam forebay wall. The total length of the pinned flashboard system will be approximately 210 feet. Black Bear will retain the diversion wall (water diversion structure) from the dam to the existing low diversion wall just upstream of the railroad trestle. The diversion wall will have a stop log slot in it that will be removed at the end of construction to allow the approximate 153 cfs discharge from the new downstream fishway/upstream trapping facility (concentrating flow in the easternmost reach of the channel) to flow on into the mainstream of the Penobscot River.

Powerhouse Construction

Once the powerhouse isolation cofferdam is in place, construction of the powerhouse will occur. The overall footprint of the powerhouse is about 59.5 feet by 55.5 feet (3,300 square feet). However, as the entire footprint does not need to be excavated down to the same elevation, it will be excavated in steps to reduce the amount of excavation. The lowest area to be excavated is for the draft tube elbows and extensions and it is approximately 18 feet by 55 feet (990 square feet). This area will be excavated down to about 23.75 feet NGVD and then a concrete foundation slab placed. The total amount of ledge anticipated to be removed from the powerhouse area is approximately 1,900 cy. Ledge will be removed by drilling and blasting. Holes will be drilled into the bedrock down to a specified depth and then blast charges will be installed in the resulting cavities. Upon blasting the fractured bedrock will be removed by mechanical means such as an excavator or a crane.

After the site has been prepared, the powerhouse substructure can be constructed. The substructure is made of reinforced concrete with walls a minimum of two feet thick. The turbine floor is at 36.25 feet NGVD and the generator floor is at 63.9 feet NGVD. It is anticipated that the substructure would be constructed to about 63.9 feet NGVD and this includes setting the three steel square-to-round transition pieces, steel 90 degree elbows, and runners. Also placed would be the draft tube gate piers made of reinforced concrete to 53.0 feet NGVD. The draft tube gates could then be installed. The draft tube gates are approximately 15.4 feet wide by 19 feet high each and made of steel members. The head gate slots, head gates, and deck will also be installed immediately upstream of the square-to-round transitions. The three headgates will be 9.5 feet wide by 9 feet tall each and made of steel members. There will be a steel monorail hoist system installed on the deck to raise and lower the gates. The tailrace cofferdam can be removed at this point. With the turbidity curtain in place, removal of the earthen cofferdam will be done in sections by mechanical means, such as an excavator. Cofferdam removal will be timed with low inflows or will be conducted with flashboard removal.

The remaining powerhouse construction, which includes the setting of the units and the superstructure construction, will take place next. The powerhouse superstructure will be made of corrugated metal siding with four roof hatches for ease of generator and runner maintenance in the future.

Penstock and Surge Chamber Construction

A concrete box type penstock will be constructed from the new intake, passing under the railroad trestle down to an open surge chamber immediately upstream of the powerhouse. The reinforced concrete penstock is made from both cast-in-place concrete and pre-cast concrete roof panels. The base slab and walls will be cast-in-place concrete while the roof will be ten feet by 25 feet precast roof panels with concrete placed between the precast panels. The penstock has a clear width of 25 feet and inside height of 12 feet. The total length of the penstock is about 393 feet from the intake to the surge chamber. There is no excavation anticipated for the construction of the penstock.

The open surge chamber will be constructed at the downstream end of the penstock immediately upstream of the powerhouse. The footprint of the surge chamber is approximately 60 feet long with the width increasing from 25 feet at the penstock end to 44 feet at the powerhouse end. The surge chamber is made of reinforced concrete with an open top. The base slab is at EL 50.56 feet and the walls extend to EL 75.0 feet on the east side and EL 80.0 on the north and west sides. There is no excavation anticipated for the construction of the surge chamber.

Tailrace Excavation

The bedrock excavation will take place by drilling and blasting. The total amount of ledge removed for the project structures and tailrace is approximately 3,550 cy. This includes 1,900 cy for the powerhouse foundation, 50 cy for the intake structure, 1,100 cy for the tailrace, and 500 cy of additional bedrock removal to extend the permanent tailrace channel to re-enter the Penobscot River. Prior to excavation activities, site preparation will include mechanical removal of debris and overburden. Drilling will occur down to the specified elevation depending on the area being excavated. Blast charges will be installed into the drilled cavities. Upon blasting, the fractured bedrock will be removed by mechanical means such as an excavator or crane. The excavated rock will be repurposed as fill and/or shoreline stabilization where feasible and will otherwise be disposed of onsite to the extent possible. Blasting activities will be conducted in accordance with a blasting plan, which Black Bear will develop in consultation with the agencies.

Trashrack Installation and Intake Structure Completion

After the intake and gate structure is complete, the upstream cofferdam will be installed and the concrete portion of the existing dam upstream of the new powerhouse intake will then be demolished. This section is an existing non-overflow structure and it is essentially between the existing spillway abutment and the existing head works abutment. Once this is removed, the intake structure wall extensions can be finalized and the trashrack structure can be constructed. The intake walls are 3-feet-thick reinforced concrete with a large footing. The top of wall elevation is 78.3 feet and the walls extend west to meet the new trashrack structure. The new trashrack structure will be in the same alignment as the existing intake rack and rake structure. The sill of the trashracks will be EL 57.9 feet and the top of the deck will match the top of the intake walls at EL 78.3 feet. The trashracks will have one inch clear bar spacing from top to bottom and they will be supported by structural steel frames. The top of the structure will have an11.3 feet wide deck with rails installed, splicing the existing rails so the existing trash rake will be able to travel on the new deck and be utilized.

The new upstream fish trapping facility will be constructed adjacent to and below the new downstream fish passage facility. The upstream trapping facility will consist of a fixed brail system, a blocking screen, and an elevating hopper to retrieve the trapped fish. Black Bear will provide short distance trucking of trapped fish to a location upstream of the dam.

Cofferdam Removal

Once construction activities are complete, the powerhouse isolation and tailrace cofferdams will be removed by flooding the area by pumping or natural fill, to make the cofferdam water levels equal with the tailrace elevation. An excavator will travel on top of the cofferdams and remove the material in sections. The turbidity curtains will be in place and maintained during the removal of the cofferdams. Cofferdam removal will be timed with inflows to allow the maintenance of the normal pond elevation or lower to prevent spill in the tailrace during cofferdam removal activities.

The upstream cofferdam will be flooded and then removed by mechanical methods, such as an excavator. The upstream turbidity curtain will be in place and maintained during the removal of the cofferdam. Cofferdam removal will be timed with inflows to allow the maintenance of the normal pond elevation or lower to minimize erosion of the cofferdam as it is being removed. This will place the existing powerhouse back in service and initiate operation of the new powerhouse.

Minimum Flows

Minimum flows into the bypass reach will be maintained throughout the construction activities. The commensurate number of flashboards in the spillway section of the dam will be removed to provide the full 200 cfs minimum flow to the eastern channel of the bypass reach during construction activities to maintain aquatic habitat. In addition, during the period of time that the upstream cofferdam is in place, all flows will be passed over the spillway.

2.1.2.2.Upstream Fish Passage

There are currently no upstream fish passage facilities for Atlantic salmon or other anadromous species at the Orono Project. As part of the proposed action, Black Bear will install a fish trap and handling facility at the Orono Project spillway. The purpose of the fish trap is not to serve as a traditional fishway, but rather as an evacuation device that will remove fish that are attracted to the spillage in the Orono bypass reach. The new upstream fish trapping facility will be constructed adjacent to and below the downstream fish passage facility. A portion of the downstream fish passage flow (120 to 130 cfs) will be used for attraction flow for the upstream trapping facility. The upstream trapping facility will consist of a fixed brail system, a blocking screen and an elevating hopper to retrieve the trapped fish. In addition, the existing upstream fishway for American eels will be relocated immediately adjacent to its existing location.

Black Bear will be responsible for operating and maintaining the trap, and for short-distance transfer of trapped fish to mainstem locations approved by the MDMR. Trapped fish will not be released into the Orono headpond as there are no upstream passage facilities at the Stillwater Project, located 2.4-miles upriver. Black Bear will monitor the trap and notify the agencies of the species and numbers of fish trapped each year.

Management authorities, including state resource agencies and the Penobscot Indian Nation (PIN), will conduct long-distance transfer of trapped fish to upstream spawning habitat or to a hatchery. However, Black Bear will provide assistance to the agencies and PIN and will work cooperatively to achieve efficient handling procedures, which could include the sharing of trap and transport equipment.

In conformance with the respective project license requirements, Black Bear has also developed operating and maintenance procedures for various facilities that will accommodate the most effective fish passage operations in conjunction with project operations. In addition to maintaining fishway operations, the procedures, developed in consultation with the state and federal resource agencies and PIN, will include recommended unit sequencing to maximize fishway attraction (e.g., first on and last off operations for the powerhouse intake located closest to the upstream fishway entrance).

2.1.2.3.Downstream Fish Passage

As part of the refurbishment of the Orono Project in 2009, a downstream bypass facility was designed and installed to accommodate diadromous fish species. It includes reduced spacing of the trashracks (1-inch), and downstream fish passage that discharges up to 70 cfs into a plunge pool in the bypass reach immediately below the dam. The proposed project will incorporate the installation of full depth 1-inch-clear spacing trashracks along the entire new common intake. Black Bear will maintain and operate the downstream fish passage throughout fish migration periods defined as: April 1 to June 30 and November 1 to December 15 for Atlantic salmon; July 1 to December 31 for American shad and alewife; August to December 31 for blueback herring; and August 15 to November 15 (or other time periods determined when adequate information is available, and during any spring run that may occur) for American eel. Black Bear will perform all maintenance activities before each migratory period, such that the fishways can be tested, inspected, and operate effectively prior to and during the migratory periods.

The present downstream passage facility will need to be modified as a result of the construction of the new penstock and powerhouse. In addition, a new downstream fish passage facility will be constructed on the left side of the trashrack (looking downstream) at the intake of the powerhouse to allow for the downstream passage of fish. Based on preliminary designs, the downstream fish passage facility will consist of a four foot wide entrance into a 20 foot long by 8 foot wide sluice with a screened floor that narrows to three feet at the exit. Stoplogs will be used to control the level and flow of water at the entrance and exit. The new downstream fish passage facility will allow for a continuous flow of water of approximately 153 cfs, which is more than twice the flow through the current downstream passage facility and is equal to four percent of the combined intake capacity.

The fish will be passed into a plunge pool which will discharge into the bypass reach below the dam. The fish passage facility will also provide for downstream eel passage, which will consist of a two foot diameter downstream eel passage facility installed at the base of the trashrack with an invert at 60.0 feet NGVD extending to a weir controlled box structure which outlets to the downstream side of the new intake structure. The downstream fish passage facility will be designed to pass a combined flow of 153 cfs.

2.1.2.4. Species Protection Plan

Black Bear proposes to implement the protection measures and performance standards associated with their proposed SPP at the Orono Project. The SPP incorporates several components, including fishway enhancements, performance measures, efficiency and survival studies and a decision making process, to minimize the effects that the Project will have on listed species in the Penobscot River.

The performance standard for downstream migrating smolts and kelts at the Orono Project is a minimum of 96% survival, based on a 75% confidence interval. That is, no fewer than 96% of downstream migrating smolts and kelts approaching the dam structure must survive passing the dam structure, which would include from 200 meters upstream of the trashracks and continuing downstream to a point where delayed effects of passage can be quantified. Fish that stop moving prior to reaching the most downstream telemetry array or take longer than 24 hours to pass the Project will be considered to have failed in their passage attempt. The decision process on how to achieve this standard through project operation is described in Figure 2.

Atlantic salmon that are trapped at the new Orono trap and handling facility will be transported to habitat upstream of the Milford Project by Black Bear. There is no upstream performance standard for the Orono Project; however, monitoring will be conducted to determine if Atlantic salmon are being significantly delayed (greater than 48 hours) in either of the Orono tailraces or in the bypass reach.

Decision Making Process and Study Design

Following implementation of the fishway enhancements described above, Black Bear will evaluate smolt survival at the Orono Project for three years to determine whether the downstream survival performance standard is being met. In the event that the performance standard is not met, the first enhancement measure will be implemented (Figure 2). After the implementation of the new measure, another three year study period will be initiated. If this study determines that the standard has still not been met, the next measure will be implemented. This process will continue sequentially through three different enhancement measures, or until the performance standard is met. The enhancement measures are as follows:

1. Increase bypass flow up to the limit of the facility;
2. Increase spill to between 20% and 50% of river flow at station at night during the two-week smolt out migration period; and
3. Two weeks of 100% spill of river flow at night (except for one unit, which will be operated at its lowest possible setting as required for powerhouse startup), followed by two weeks of spill of 25% of river flow during day and night.

After the final measure, a one year study will be conducted to ensure that the standard continues to be met. If, after the final enhancement has been studied, the Orono Project is still not achieving the 96% performance standard, FERC will reinitiate formal consultation with NMFS. Once the 96% standard has been met, Black Bear will conduct a one year study every ten years to verify that the standard continues to be met.

The downstream passage monitoring will be conducted using radio tags. It is anticipated that 102 smolts, plus 45 to 60 paired release fish, will be evaluated at the Orono Project for each year of the study. The evaluation will use three release groups of 34 smolts each, along with 15 to 20 paired release fish, when river flows are within the 10-90th percentile for average May flows.

Ten years after completion of the final enhancements for smolt outmigration at the Orono Project, Black Bear proposes to conduct a downstream kelt study. The intent of this study is to verify that the 96% downstream performance standard is being met. The study will be a three year study that coincides with smolt monitoring and will use no more than 40 male kelts per project per year.

During the evaluation of the effectiveness of the upstream fish lift installed at the Milford Project, Black Bear will deploy telemetry receivers to monitor Atlantic salmon in the tailraces of the new and existing powerhouses at the Orono Project, as well as in the bypass reach, to evaluate if they are delayed significantly (greater than 48 hours) under study conditions by the presence and operation of the project. If significant numbers of salmon are being delayed at the

Project, Black Bear will coordinate with the Services to determine reasonable solutions.

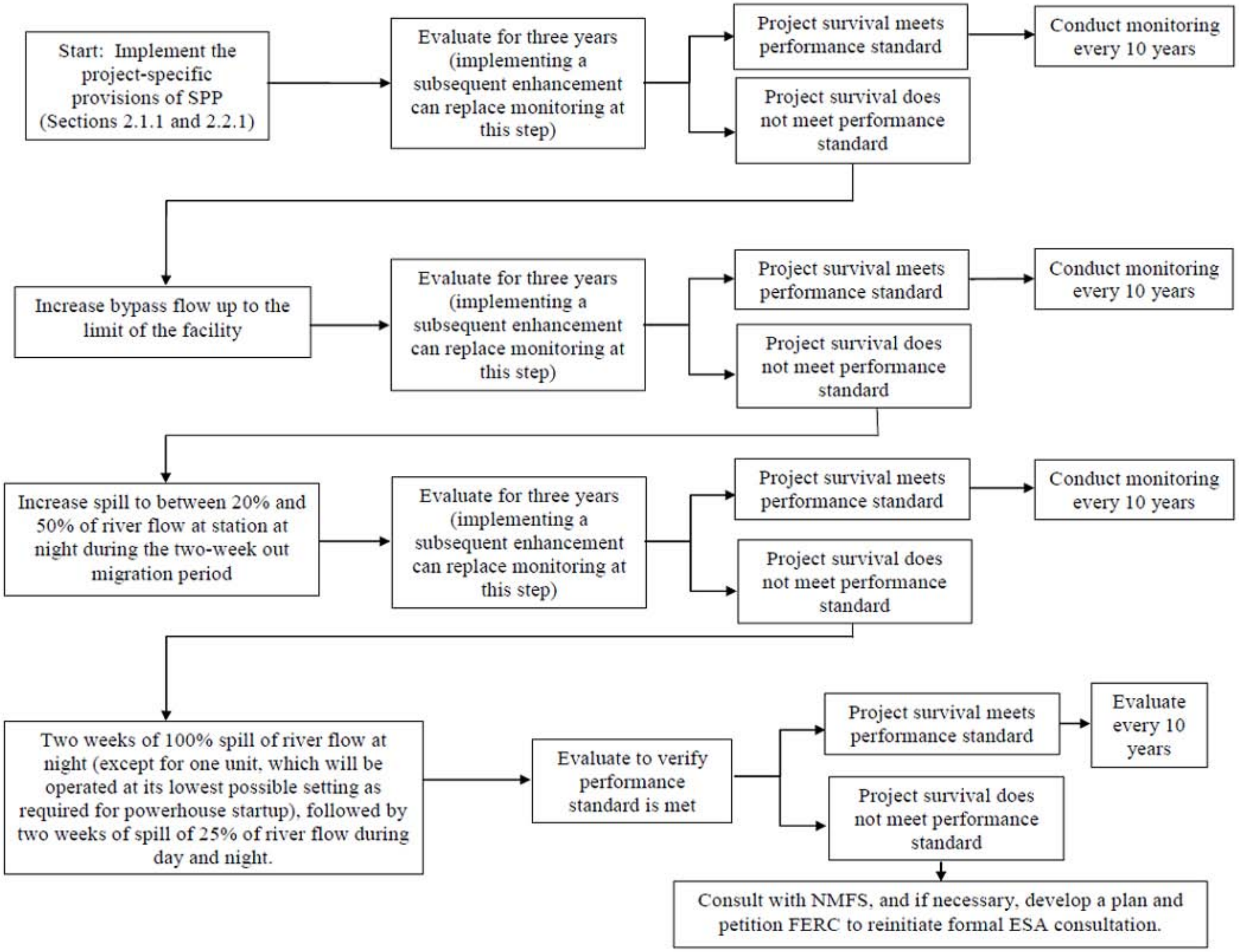

Figure 2. The proposed decision process for implementing the downstream performance standard described in the SPP.

2.1.2.5. Sturgeon Handling Plan

Following removal of the Veazie and Great Works dams, there will be no impediments to sturgeon reaching the Orono Project. Black Bear has committed to implementing a sturgeon handling plan to provide for safe handling of any sturgeon that are encountered during fish lift operations and in the event of stranding during flashboard replacement. FERC is proposing to require adherence to the handling plan as a condition of the amended operating license.

It is possible that sturgeon could be captured at the Orono fish trap and handled during the sorting process. The Sturgeon Handling Plan, which is incorporated into the license amendment proposed for approval by FERC, would require the release of any captured sturgeon back to the river below the project.

Annually, the impoundment of the Orono Project is lowered to a point where the flashboards can safely be replaced, resulting in a short period (a few hours) of receded flows downstream. During this time, fish could become stranded in isolated pools in the bypass reach. The handling plan includes measures to ensure safe handling of any sturgeon stranded during this period. If shortnose or Atlantic sturgeon become stranded, Black Bear will return them to the river downstream.

Fish Lift Operations

Atlantic and shortnose sturgeon will not be passed upstream of the Orono Project as the dam location is thought to be the historical limit of upstream migration for sturgeon on the Stillwater Branch (Houston *et al.* 2007), and because of concerns regarding the safety of downstream passage for shortnose and Atlantic sturgeon. The handling plan requires that if sturgeon are found in the fish lift, the following procedures will be implemented:

- For each sturgeon detected, Black Bear shall record the weight, length, and condition of the fish. Fish will also be scanned for PIT tags. River flow, bypass reach minimum flow, and water temperature will be recorded.
- If alive and uninjured, the sturgeon will be immediately returned downstream. A long handled net outfitted with non-abrasive knotless mesh will be used to place the sturgeon back into the river downstream of the dam. The fish should be properly supported during transport in the net to ensure that it is not injured.
- If any injured sturgeon are found, Black Bear shall report immediately to NMFS. Injured fish must be photographed and measured, if possible, and the reporting sheet must be submitted to NMFS within 24 hours. If the fish is injured, it should be retained by Black Bear, if possible, until transfer to a NMFS recommended facility for potential rehabilitation can be arranged.
- If any dead sturgeon are found, Black Bear will report immediately (within 24 hours) to NMFS. Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information should be recorded. Specimens should be stored in a refrigerator by the licensee until they can be obtained by NMFS for analysis.

Sturgeon Stranding

Following removal of the Veazie Dam sturgeon will have access to the Orono Project tailrace and bypass reach. When the flashboards are replaced at the Orono dam, or other operations cause no-spill or no-leakage conditions, there is a possibility that sturgeon may become stranded in pools below the dam. If this situation occurs, the license requires that Black Bear check these pools as soon as possible for the presence of sturgeon. The handling plan requires that Black Bear follow this protocol:

- Designated Black Bear employees and fish lift operation staff must monitor the pools below the dams while the flashboards at the project are replaced.
- For each fish removed from the pool, Black Bear will record the weight, length, and condition. Fish should also be scanned for PIT tags. River flow, bypass reach minimum flow and water temperature will be recorded.
- If stranded but alive and uninjured, the sturgeon will be moved to the river below the dam at a point that will provide for movement of the fish out of the area.
- If any injured sturgeon are found, Black Bear will report it immediately to NMFS. Injured fish must be photographed and measured, if possible, and the reporting sheet will be submitted to NMFS within 24 hours. If the fish is badly injured, the fish should be retained by Black Bear, if possible, until transfer to a NMFS recommended facility for potential rehabilitation can be arranged.
- Black Bear shall report any dead fish immediately (within 24 hours) to NMFS. Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information should be recorded. Specimens should be stored in a refrigerator by Black Bear until they can be obtained by NMFS for analysis.

2.2. Stillwater Project - FERC No. 2712

2.2.1. Existing Hydroelectric Facilities and Operations

The Stillwater Project is located in the City of Old Town, Penobscot County, Maine on the Stillwater Branch of the Penobscot River. The Stillwater Dam spans the Stillwater Branch 2.4 miles upstream of its confluence with the main stem of the Penobscot River in Orono (Figure 1).

The existing Stillwater Project works consist of a main concrete gravity dam, totaling about 1,720 feet long, with a maximum height of 22 feet at crest elevation 91.65 feet; a concrete and wooden powerhouse, about 83.5 feet long by 32 feet wide by 45 feet high; a downstream fishway bypass; four horizontal hydroelectric generating units, all totaling a rated capacity of 1,950 kilowatts (kW) and a hydraulic capacity of 1,700 cfs; an impoundment, about 3.1 miles long, having a surface area of about 300 acres; and appurtenant facilities. The Stillwater Project is operated as a run-of-river development with discharge from the project turbines and spillway equivalent to inflow. The Stillwater Project includes a downstream bypass that discharges to the tailrace. The Stillwater Project also includes two upstream fishways for juvenile American eel that are located at the east and west abutments of the spillway. The Project provides a minimum flow to the bypass reach of 195 cfs through weirs located near the west abutment (70 cfs) and near the center of the spillway (125 cfs).

2.2.2. Proposed Action

Black Bear filed an application with FERC on May 18, 2011 to amend the license for the Stillwater Project to include a second powerhouse and a new downstream fish bypass. Black Bear is also proposing that FERC extend the license term for this project by ten years to 2048. FERC is proposing to amend the license as requested by Black Bear and to authorize an additional ten years of project operations. FERC will require that Black Bear implement the protection measures and performance standards associated with their proposed SPP at the Stillwater Project. As there are no upstream anadromous fish passage facilities at the Stillwater Project, only the downstream performance standard will apply at this project. The project will include the construction of a new downstream fish bypass facility at the new powerhouse.

2.2.2.1.New Powerhouse Construction

The modifications proposed at the Stillwater Project consist of a new intake structure replacing the east abutment of the spillway and supplying water to a second powerhouse located integral to the dam. This powerhouse will be situated upon ledges located immediately downstream of the existing spillway abutment. The tailrace will discharge to the existing pool in the bypass reach.

Active construction will occur below the MHW line of the Penobscot River for the construction of a new powerhouse at the Stillwater Project. Protection, mitigation and enhancement measures that address anticipated project effects to environmental resources at the Project have been proposed by Black Bear. Short-term effects to aquatic species and habitats anticipated from construction activities below the normal high water elevation in the project facility footprints are addressed by the following:

- Develop a soil erosion and sediment control plan prior to the start of any construction activity to prevent any short-term erosion or sedimentation effects in the river;
- Maintain minimum bypass reach flows during construction activities to minimize effects to aquatic habitat;
- Conduct excavation and blasting activities in the dry to the extent possible; and
- Limit charge weights and delay individual blasts to keep detonation related sound pressures at a safe level for aquatic resources (less than an SPL of 206 dB re 1 uPa (3.6 psi), and below an SEL of 187 dB re 1 uPa sq.-sec) and implement blasting monitoring/reporting provisions.

New construction and alteration of the Stillwater Project will include the construction of a second powerhouse containing three 1700 mm (5.6 feet) diameter vertical axial flow CHC turbine-generating units having a nameplate capacity of 803 kW per unit. The new powerhouse will have a total rated capacity of approximately 2,229 kW and a total hydraulic capacity of approximately 1,758 cfs. The powerhouse will be located adjacent to the existing left buttress of the dam. A new 60-feet-wide forebay intake will supply the powerhouse. Aerial transmission lines will be installed from the new powerhouse's GSU to the existing adjacent 12.5 kV distribution system.

The proposed second powerhouse will be a reinforced concrete foundation with a steel-framed, metal-sided building and roof measuring approximately 55-feet-long by 40-feet-wide by 56-feet-high and housing the three generating units rated at 743 kW. The new units will have a minimum hydraulic capacity of 160 cfs and a maximum operating capacity of approximately 586 cfs, with a net head of 18.75 feet (under full station operation). Once the second powerhouse is constructed, the Stillwater Project will have a total combined maximum hydraulic capacity of 3,458 cfs (1,700 cfs existing capacity at the existing powerhouse plus 1,758 cfs capacity at the new powerhouse) and a minimum operating capacity of approximately 100 cfs (minimum operating capacity of one unit at the existing powerhouse).

The new powerhouse will include six generator leads, a 60 Hertz, 4.16 kV/12.5kV three phase transformer and appurtenant facilities including; (2) HPU's, (1) sump pump, air compressor, ventilation fans, switch gear and control cabinets, draft tube gate hoist, headgate gate hoist, overhead door and roof hatches. This new powerhouse will operate in conjunction with the existing powerhouse to enhance power production. The new powerhouse intake will be 22 feet high by 60 feet wide and will be integral to the powerhouse. The intake will feature a 60-feet-wide by 22-feet-high trashrack, spaced 1-3/8 inches on center, (1-in clear spacing), situated at a 14.0 degree slope from vertical (1H:4V± slope). A transmission line will extend from the GSU transformer at the new powerhouse to a local 12.5 kV distribution system that is located adjacent to the existing project boundary and along the south side of Stillwater Avenue. The transmission line is approximately 300 feet in length and will transmit at 12.5 kV. It is assumed that no interconnections are necessary with the use of the GSU.

Temporary Cofferdams

As part of the construction activities associated with the Stillwater Project, there will be two areas of limited cofferdamming and one dead-end causeway.

- Intake Cofferdam: A 215-foot long earthen cofferdam will be installed in the forebay of the Stillwater Project, running from the easterly bank to the spillway. The cofferdam will be constructed of washed gravel and will be 10-feet wide on the top. The footprint of the cofferdam will be 16,000 square feet (0.37 acres).

- Powerhouse Isolation Cofferdam: A similarly built 560-foot earthen cofferdam will be constructed downstream of the dam and will affect approximately 33,800 square feet (0.78-acres) of habitat. A turbidity curtain will be placed downstream of the cofferdam and the downstream slope will be selectively riprapped to prevent erosion of material into the river.

- Tailrace Causeway: To remove the downstream extent of ledge, a temporary causeway, of clean, bank-run gravel fill material will be placed upstream of the bedrock berm at the outlet to the eastern side channel. The lower end of the tailrace channel that requires bedrock removal begins approximately 160 feet downstream of the proposed powerhouse and covers a length of approximately 340 feet. The footprint of the causeway will be approximately 23,800 sq feet (0.55 acres).

Cofferdam Removal

Once construction activities are complete, the powerhouse/tailrace cofferdam will be removed by flooding the area by pumping or natural fill, to make the cofferdam water level equal with the tailrace elevation. An excavator will travel over the top of the cofferdam and remove the material in sections. The turbidity curtain will be in place and maintained during the removal of the cofferdam. Cofferdam removal will be timed with inflows to allow the maintenance of the normal pond elevation or lower to prevent spill in the tailrace during cofferdam removal activities. Minimum bypass reach flows will be temporarily suspended during cofferdam removal activities.

Once construction of the intake and powerhouse is complete and the dam is breached, the forebay will be flooded by pumping or by allowing natural refill through seepage. With the turbidity curtain in place, removal of the earthen cofferdam will be done in sections by excavator. Cofferdam removal will be timed with low inflows or will be conducted with flashboards removed to allow the passing of inflows above the capacity of the Project downstream.

The dead-end temporary causeway will be removed by mechanical means with an excavator. The berm at the entrance to the eastern side channel around the island in the tailrace will be lowered during egress by approximately 2.0 feet in elevation at a width of approximately 10ft to allow continued hydrologic input into this reach under the post-construction condition. This removal will occur behind a turbidity curtain and will occur under suspended minimum flows.

Minimum Flows

During construction activities in the powerhouse footprint and tailrace, the minimum flow of 70 cfs into the existing bypass reach will be maintained during installation of the upstream and downstream cofferdams, both of which will be installed behind a turbidity curtain to allow for maintenance of minimum flows. The minimum bypass reach flow may need to be temporarily suspended during some portions of the six to eight weeks of the downstream work. Some of the existing flashboards on the spillway outside of the cofferdam will be lowered in order to pass required minimum flows during construction, otherwise. The 35 cfs fish passage flow at the existing powerhouse downstream fish passage facility will continue throughout the construction process. Once the new powerhouse and tailrace channel excavation work is completed and the material removed, the required minimum bypass reach flow will resume.

The required minimum flows in the project bypass reach of 50 cfs in the east channel will be satisfied with the 70 cfs that will be routed through the proposed downstream fish passage facility at the new powerhouse, both during fish passage season and when it is off-line. Outside of fish passage season, operation of at least one unit of the new powerhouse will satisfy the 50 cfs requirement. The 20 cfs minimum flow will continue to be discharged to the west channel through the flashboard notch in the dam.

2.2.2.2.Upstream Fish Passage

There are currently no upstream fish passage facilities for Atlantic salmon or other anadromous species at the Stillwater Project; and none are proposed. Black Bear will provide short-distance trucking of fish that are captured at the downstream Orono Project, including transfers around the Stillwater dam.

A new upstream eel passage facility will be installed at the top of the forebay, adjacent to the new forebay retaining wall. This structure will consist of a textured climbing surface within a metal trough, similar to the existing upstream eel passage facilities currently installed at the Orono Project.

2.2.2.3.Downstream Fish Passage

The Stillwater Project currently includes a downstream bypass that includes one inch clear spacing of the trashracks and a bypass flume that discharges into the tailrace. As part of the redevelopment of the Stillwater Project, Black Bear will install a new downstream bypass. This will include a downstream fishway at the new powerhouse and refurbishing the existing downstream fishway and adding 1-inch trashracks for the full depth of the new and existing powerhouse intakes. Black Bear will maintain and operate the downstream fish passage throughout fish migration periods defined as: April 1 to June 30 and November 1 to December 15 for Atlantic salmon; July 1 to December 31 for American shad and alewife; August to December 31 for blueback herring; and August 15 to November 15 (or other time periods determined when adequate information is available, and during any spring run that may occur) for American eel. Black Bear will perform all maintenance activities before each migratory period, such that the fishways can be tested, inspected, and operate effectively prior to and during the migratory periods.

Based on preliminary designs, the downstream fish passage facility will be a combination of an opening in the flashboards in the forebay at the trashracks under normal pond conditions and a three foot wide and four foot deep opening in the forebay wall at invert elevation 87.65 feet NGVD (four feet below the permanent crest elevation of the dam) controlled by stoplogs, when the headpond elevation is generally at or below the permanent crest elevation of the dam. A two foot diameter downstream eel passage facility will be installed at the base of the trashrack with an invert at 79.0 feet NGVD extending to a weir controlled box structure which outlets to the tailrace of the powerhouse. The downstream fish passage facility will be designed to pass a combined flow of 70 cfs.

The fish will be passed into a plunge pool that discharges to the tailrace of the new powerhouse. Initial field investigations have shown the existing perched bedrock depression in the vicinity of the proposed downstream fish passage facility to be at least six feet in depth under minimum tailwater elevation conditions. If, during construction of the fish passage facility, the natural depth of the pool is discovered not to consistently be a minimum of six feet in depth, the naturally occurring perched plunge pool will be extended up with concrete walls to provide a minimum of six feet depth, concurrent with construction of the passage facility. The double-regulated unit nearest the downstream fish passage facility at the new powerhouse will be first on and last off to provide attraction to the downstream fish passage facility.

2.2.2.4.Species Protection Plan

Black Bear proposes to implement the protection measures and performance standards associated with their proposed SPP at the Stillwater Project. The SPP incorporates several components, including fishway enhancements, performance measures, efficiency and survival studies and a decision making process, to minimize the effects that the Project will have on listed species in the Penobscot River.

Performance Standards

The performance standard for downstream migrating smolts and kelts at the Stillwater Project is a minimum of 96% survival, based on a 75% confidence interval. That is, no fewer than 96% of downstream migrating smolts and kelts approaching the dam structure will survive passing the dam structure, which would include from 200 meters upstream of the trashracks and continuing downstream to a point where delayed effects of passage can be quantified. Fish that stop moving prior to reaching the most downstream telemetry array or take longer than 24 hours to pass the project will be considered to have failed in their passage attempt. The decision process on how to achieve this standard through project operation is described in Figure 2.

There are no upstream fish passage facilities at the Stillwater Project and, therefore, no upstream performance standard is being proposed.

Decision Making Process and Study Design

Following implementation of the fishway enhancements described above, Black Bear will evaluate smolt survival at the Stillwater Project for three years to determine whether the downstream survival performance standard is being met. In the event that the performance standard is not met, the first enhancement measure will be implemented (Figure 2). After the implementation of the new measure, another three year study period will be initiated. If this study determines that the standard has not been met, the next measure will be implemented. This process will continue sequentially through three different enhancement measures, or until the performance standard is met. The enhancement measures are as follows:

1. Increase bypass flow up to the limit of the facility;
2. Increase spill to between 20% and 50% of river flow at station at night during the two-week smolt out migration period; and
3. Two weeks of 100% spill of river flow at night (except for one unit, which will be operated at its lowest possible setting as required for powerhouse startup), followed by two weeks of spill of 25% of river flow during day and night.

After the final measure, a one year study will be conducted to ensure that the standard is being met. If, after the final enhancement has been studied, the Stillwater Project is still not achieving the 96% performance standard, FERC will reinitiate formal consultation with NMFS. Once the 96% standard has been met, Black Bear will conduct a one year study every ten years to verify that the standard continues to be met.

The downstream passage monitoring is expected to be conducted using radio tags. It is anticipated that 102 smolts will be evaluated at the Stillwater Project for each year of the study. Given the proximity of the two projects, the upstream release for the Orono Project study will be used as the downstream release for Stillwater Project study. The evaluation will use five release groups of 34 smolts each per year, when river flows are within the 10-90th percentile for average May flows.

Ten years after completion of the final enhancements for smolt outmigration at the Stillwater Project, Black Bear proposes to conduct a downstream kelt study. The intent of this study is to verify that the 96% downstream performance standard is being met. The study will be a three year study that coincides with smolt monitoring and will use no more than 40 male kelts per project per year.

2.3. Milford Project - FERC No. 2534

2.3.1. Existing Hydroelectric Facilities and Operations

The Milford Project consists of the 1,159-foot-long, 20-foot-high, concrete gravity Milford dam, topped with 4.5-foot-high flashboards, the 450-foot-long Gilman Falls dam, a 226-foot-long, 85-foot-wide, 78-foot high powerhouse containing four 1,600 kW turbine/generator units with an installed capacity of 6.4 MW, and a 235 acre reservoir with a gross storage of 2,250 acre-feet.

The project license includes approval for the installation of up to an additional 1,600 kW in empty turbine pits in the powerhouse. This additional unit will increase the installed capacity of the project to 8.0 MW.

2.3.2. Proposed Action

The Milford Project includes a four-foot Denil fishway located at the outboard side of the powerhouse tailrace and two American eel fishways located at the center of the spillway. Black Bear proposes to install a new fish lift and handling facility on the shore side of the powerhouse tailrace. The project is operated in a run-of-the-river mode.

2.3.2.1.Upstream Fish Passage

Black Bear proposes to install a fish lift and handling facility at the Milford Project. The fish lift is scheduled to be installed in 2012-2013. This facility will consist of:

- A shore-based fish lift with a single entrance immediately downstream from the powerhouse, an exit channel to include a fish counting station and facilities for sorting and trapping-and-trucking. The exit channel will pass through the basement of powerhouse. This fish lift will require an attraction flow of 210 cfs, an operation control center computer module, and a separate underground viewing facility for public use.
- A rubber dam at the spillway crest, installed on the 390-foot section of spillway between the mid-river ledge outcrop and the east abutment. This rubber dam will reduce flows that might attract upstream migrants, including Atlantic salmon, and will enhance passage at the fish lift.

Construction activities associated with installation of the new upstream and downstream fishways will take place on the easterly shore within the areas of the Milford forebay, powerhouse, tailrace, and parking lot. No work will be done on the spillway.

In order to create a dry work area in which to install the new fish lift, two cofferdams (bulkheads) will be concurrently installed in the tailrace and in the forebay. In the tailrace, this will be done by installing temporary anchors to the bedrock to support a sheetpile cofferdam that will be sealed prior to dewatering. This cofferdam will allow for the dewatering of 509 square feet of river bottom. The cofferdam in the forebay, however, will be constructed by placing prefabricated steel bulkhead panels over the area where the exit flume penetrates the forebay wall. The cofferdam will then be sealed and dewatered. There will not be any excavation or blasting associated with the construction at the Milford Project.

The Gilman Falls dam is a water control structure in the Stillwater Branch that has a breach section, approximately 75 feet wide, that provides passage to adult Atlantic salmon. No changes are proposed for this dam.

2.3.2.2.Downstream Fish Passage

The Milford Project currently operates a downstream bypass facility with interim measures to protect downstream migrating salmon. Black Bear will maintain and operate the downstream fish passage throughout fish migration periods defined as: April 1 to June 30 and November 1 to December 15 for Atlantic salmon; July 1 to December 31 for American shad and alewife; August to December 31 for blueback herring; and August 15 to November 15 (or other time periods determined when adequate information is available, and during any spring run that may occur) for American eel. Black Bear will perform all maintenance activities before each migratory period, such that the fishways can be tested, inspected, and operate effectively prior to and during the migratory periods.

As part of the proposed project, Black Bear will construct a new downstream fish bypass. The new fishway will incorporate the following changes:

- Reduce the clear bar spacing at the inner trashrack to one inch clear spacing over the full depth of rack;
- Install twin four foot wide (eight feet total) openings at the inner trashrack capable of passing up to 280 cfs; and
- Include a four foot by four foot gated bottom intake to the downstream migrant facilities to provide for the downstream passage of American eels. If so indicated by the results of initial effectiveness studies at Milford, evaluate restricted generation at night over a two-week period to enhance downstream passage of adult American eels.

Until the new downstream fish passage facilities are installed, Black Bear will continue to operate the existing surface weir bypass facilities at Milford.

2.3.2.3.Species Protection Plan

Black Bear proposes to implement a SPP to avoid and minimize impacts to Atlantic salmon related to the operation of the Milford Project on the Penobscot River. The SPP incorporates several components, including fishway enhancements, performance measures, efficiency and survival studies and a decision making process, to minimize the effects that Black Bear's hydroelectric projects will have on listed species in the Penobscot River.

Performance Standards

The performance standard for downstream migrating smolts and kelts at the Milford Project is a minimum of 96% survival, based on a 75% confidence interval. That is, no fewer than 96% of downstream migrating smolts and kelts approaching the dam structure will survive passing the dam structure, which would include from 200 meters upstream of the trashracks and continuing downstream to a point where delayed effects of passage can be quantified. Fish that stop moving prior to reaching the most downstream telemetry array or take longer than 24 hours to pass the project will be considered to have failed in their passage attempt. The decision process on how to achieve this standard through project operation is described in Figure 2.

The performance standard for upstream fish passage requires that 95% of upstream migrating Atlantic salmon pass the dam within 48 hours of approaching within 200 meters of the Project when the river temperature is at or below 23 degrees Celsius. The upstream migrants must not exhibit any trauma, loss of equilibrium, or descaling greater than 20% of the body surface. Trauma is defined as injuries including, but not limited to, hemorrhaging, open wounds without fungus growth, gill damage, bruising greater than 0.5 cm in diameter, etc. Fish displaying these injuries or signs of trauma will be categorized as not having passed safely and will be considered failures.

Decision Making Process and Study Design

Following implementation of the fishway enhancements described above, Black Bear will evaluate smolt survival at the projects for three years to determine whether the survival performance standard is being met. In the event that the performance standard is not met, the first enhancement measure will be implemented (Figure 2). After the implementation of the new measure, another three year study period will be initiated. If this study determines that the standard has not been met, the next measure will be implemented. This process will continue sequentially through three different enhancement measures, or until the performance standard is met. The enhancement measures are as follows:

1. Increase bypass flow up to the limit of the facility;
2. Increase spill to between 20% and 50% of river flow at station at night during the two-week smolt out migration period;
3. Two weeks of 100% spill of river flow at night (except for one unit, which will be operated at its lowest possible setting as required for powerhouse startup), followed by two weeks of spill of 25% of river flow during day and night.

After the final measure, a one year study will be conducted to ensure that the standard is being met. If, after the final enhancement has been studied, the Milford Project is still not achieving the 96% performance standard, FERC will reinitiate formal consultation with NMFS. Once the 96% standard has been met, Black Bear will conduct a one year study every ten years to verify that the standard continues to be met.

The downstream passage monitoring will be conducted using radio tags. It is anticipated that 102 smolts, plus 45 to 60 paired release fish, will be evaluated at the Milford Project for each year of the study. The evaluation will use three release groups of 34 smolts each, along with 15 to 20 paired release fish, when river flows are within the 10-90th percentile for average May flows.

Ten years after completion of the final enhancements for smolt outmigration at the Milford Project, Black Bear proposes to conduct a downstream kelt study. The intent of this study is to verify that the 96% downstream performance standard is being met. The study will be a three year study that coincides with smolt monitoring and will use no more than 40 male kelts per project per year.

At Milford, the 95% upstream passage performance standard will be evaluated before and after Veazie Dam is removed. Therefore, it is anticipated that efficiency will be evaluated in one season during which the new fish lift at Milford is in place and the Veazie Dam has not yet been removed. Passage effectiveness will be evaluated using radio tags or similarly accepted methods. Twenty to forty adult Atlantic salmon that are confirmed to have been released as juveniles upstream of the Milford Project, will be trapped at Veazie, radio tagged and released upstream of the Veazie Dam. Tagged fish that swim to within 200 meters downstream of the Milford Dam will be tracked to determine their success in using the upstream passage facility. Another one-year study will be conducted following the removal of Veazie Dam. At that point, if the project does not achieve the 95% performance standard, the facility will be modified to increase efficiency, and evaluated again and repeated as necessary to achieve the performance standard. Once the standard has been met, Black Bear will reevaluate upstream passage with a one-year efficiency study every ten years thereafter.

2.3.2.4.Sturgeon Handling Plan

Following removal of the Veazie and Great Works dams, there will be no impediments to sturgeon reaching the Milford Project. Black Bear has committed to implementing a sturgeon handling plan to provide for safe handling of any sturgeon that are encountered during fish lift operations and in the event of stranding during flashboard replacement. FERC is proposing to require adherence to the handling plan as a condition of the amended operating license.

It is possible that sturgeon could be captured at the Milford fish trap and handled during the sorting process. The Sturgeon Handling Plan, which is incorporated into the license amendment proposed for approval by FERC, would require the release of any captured sturgeon back to the river below the project.

Annually, the impoundment of the Milford Project is lowered to a point where the flashboards can safely be replaced, resulting in a short period (a few hours) of receded flows downstream. As the Milford Project lacks a true bypass reach that would be at risk of dewatering, it is not likely that any fish would become stranded. However, as a precautionary measure, Black Bear has proposed to follow the provisions of the Sturgeon Handling Plan at the Milford Project. The handling plan includes measures to ensure safe handling should any sturgeon become stranded during this period. If shortnose or Atlantic sturgeon become stranded, Black Bear will return them to the river downstream.

Fish Lift Operations

Atlantic and shortnose sturgeon will not be passed upstream of the Milford Project as the dam location is thought to be the historical limit of upstream migration for sturgeon on the Stillwater Branch (Houston *et al.* 2007), and because of concerns regarding the safety of downstream passage for shortnose and Atlantic sturgeon. The handling plan requires that if sturgeon are found in the fish lift, the following procedures will be implemented:

- For each sturgeon detected, Black Bear shall record the weight, length, and condition of the fish. Fish will also be scanned for PIT tags. River flow, bypass reach minimum flow, and water temperature will be recorded.
- If alive and uninjured, the sturgeon will be immediately returned downstream. A long handled net outfitted with non-abrasive knotless mesh will be used to place the sturgeon back into the river downstream of the dam. The fish should be properly supported during transport in the net to ensure that it is not injured.
- If any injured sturgeon are found, Black Bear shall report immediately to NMFS. Injured fish must be photographed and measured, if possible, and the reporting sheet must be submitted to NMFS within 24 hours. If the fish is injured, it should be retained by Black Bear, if possible, until transfer to a NMFS recommended facility for potential rehabilitation can be arranged.
- If any dead sturgeon are found, Black Bear will report immediately(within 24 hours) to NMFS. Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information should be recorded. Specimens should be stored in a refrigerator by the licensee until they can be obtained by NMFS for analysis.

Sturgeon Stranding

Following removal of the Veazie Dam sturgeon will have access to the area downstream of the Milford Project. When the flashboards are replaced at the Milford dam, or other operations cause no-spill or no-leakage conditions, there is a possibility that sturgeon may become stranded in pools below the dam. If this situation occurs, the license requires that Black Bear check these pools as soon as possible for the presence of sturgeon. The handling plan requires that Black Bear follow this protocol:

- Designated Black Bear employees and fish lift operation staff must monitor the pools below the dams while the flashboards at the project are replaced.
- For each fish removed from the pool, Black Bear will record the weight, length, and condition. Fish should also be scanned for PIT tags. River flow, bypass reach minimum flow and water temperature will be recorded.
- If stranded but alive and uninjured, the sturgeon will be moved to the river below the dam at a point that will provide for movement of the fish out of the area.
- If any injured sturgeon are found, Black Bear will report it immediately to NMFS. Injured fish must be photographed and measured, if possible, and the reporting sheet will be submitted to NMFS within 24 hours. If the fish is badly injured, the fish should be retained by Black Bear, if possible, until transfer to a NMFS recommended facility for potential rehabilitation can be arranged.

- Black Bear shall report any dead fish immediately (within 24 hours) to NMFS. Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information should be recorded. Specimens should be stored in a refrigerator by Black Bear until they can be obtained by NMFS for analysis.

2.4. West Enfield Project - FERC No. 2600

2.4.1. Existing Hydroelectric Facilities and Operations

The West Enfield Project is located on the main stem of the Penobscot River in the towns of Enfield and Howland, Penobscot County, Maine. The West Enfield Project is operated as a run-of-river facility with inflows equaling outflows either through the powerhouse/gates or via spillage over the dams/flashboards.

The West Enfield Project works consist of: a 39-foot high concrete dam with 7-foot high flashboards that are installed on a 363-foot long overflow spillway; a 194-foot long non-overflow spillway; a 107-foot long gated spillway with three radial gates; and a 200-foot-long, 15-foot-high earth dam located on the west bank of Merrill Brook. The earthen dam on Merrill Brook controls flow from the project reservoir to the Piscataquis River using three steel gates. The 1,125-acre project reservoir has a normal maximum water surface elevation of 156.1 feet mean sea level (msl). The powerhouse contains two pit turbine-generator units with a total rated capacity of 13,000 kW, and appurtenant facilities. No changes are proposed to the physical components of the Project as part of this action.

The upstream fishway at West Enfield is a vertical slot fishway with three entrances. The first entrance is located on the west side of the powerhouse near the dam and is eight feet wide and capable of passing up to 130 cfs. The second entrance is located on the west side of the powerhouse on the downstream side and is five feet wide and capable of passing up to 110 cfs. The third entrance is located on the east side of the powerhouse on the downstream side and is seven feet wide and capable of passing up to 160 cfs. The entrances combine into a single gallery that runs along the downstream width of the powerhouse to the diffusion chamber. The diffusion chamber has six pumps that are capable of passing up to 40 cfs each with a total capacity of 280cfs. Historically, not all the pumps or entrances have been continually used. The fishway conveyance flow is approximately 30cfs. The fishway is constructed with 32 vertical slots with approximately a 0.75 foot drop per slot. A crowder and counting window are constructed about midway up the fishway. The counting window is no longer used. Just downstream of the counting window is a “pike jump”. The pike jump is constructed to prevent pike from continuing up the fishway. The exit channel has one foot center to center spaced trashracks and conveys fish to the headpond some distance upstream of the powerhouse. No changes to the upstream fishway are proposed as part of this project.

New downstream fish passage facilities integral to the intake structure were installed at West Enfield in 1988 when the hydropower project was redeveloped. The downstream passage facilities were designed in accordance with DOI/USFWS criteria and specifications. The Project has five surface fish bypass weirs along the top of the turbine intake. Two of these four foot wide fish bypass weirs are used to pass the fish bypass flow. Fish are collected in a collection gallery that runs across the length of the intake to a three foot diameter pipe that is capable of passing up to 100 cfs. The project includes bar racks across the intake that have two inch spacing for the first two feet followed by three inch spacing for the remaining depth. No changes to the downstream bypass are proposed as part of this action. Black Bear maintains and operates the downstream fishway at West Enfield between November 1 and June 15.

2.4.2. Proposed Action

2.4.2.1. Species Protection Plan

Black Bear has proposed to implement an SPP to identify enhancements to avoid and minimize impacts to Atlantic salmon related to the operation of the West Enfield Project on the Penobscot River. The SPP incorporates several components, including fishway enhancements, performance measures, efficiency and survival studies and a decision making process, to minimize the effects that Black Bear's hydroelectric projects will have on listed species in the Penobscot River.

Performance Standards

The performance standard for downstream migrating smolts and kelts at the West Enfield Project is a minimum of 96% survival, based on a 75% confidence interval. That is, no fewer than 96% of downstream migrating smolts and kelts approaching the dam structure will survive passing the dam structure, which would include from 200 meters upstream of the trashracks and continuing downstream to a point where delayed effects of passage can be quantified. Fish that stop moving prior to reaching the most downstream telemetry array or take longer than 24 hours to pass the project will be considered to have failed in their passage attempt. The decision process on how to achieve this standard through project operation is described in Figure 2.

The performance standard for upstream fish passage requires that 95% of upstream migrating Atlantic salmon pass the dam within 48 hours of approaching (within 200 meters) the Project. The upstream migrants must not exhibit any trauma, loss of equilibrium, or descaling greater than 20% of the body surface. Trauma is defined as injuries including, but not limited to, hemorrhaging, open wounds without fungus growth, gill damage, bruising greater than 0.5 cm in diameter, etc. Fish displaying these injuries or signs of trauma will be categorized as not having passed safely and will be considered failures.

Decision Making Process and Study Design

Following implementation of the fishway enhancements described above, Black Bear will evaluate smolt survival at the West Enfield Project for three years to determine whether the survival performance standard is being met. In the event that the performance standard is not met, the first enhancement measure will be implemented (Figure 2). After the implementation of the new measure, another three year study period will be initiated. If this study determines that the standard has not been met, the next measure will be implemented. This process will continue sequentially through three different enhancement measures, or until the performance standard is met. The enhancement measures are as follows:

1. Increase bypass flow up to the limit of the facility;
2. Increase spill to between 20% and 50% of river flow at station at night during the two-

week smolt out migration period; and
3. Two weeks of 100% spill of river flow at night (except for one unit, which will be operated at its lowest possible setting as required for powerhouse startup), followed by two weeks of spill of 25% of river flow during day and night.

After the final measure, a one year study will be conducted to ensure that the standard is being met. If, after the final enhancement has been studied, the West Enfield Project is still not achieving the 96% performance standard, FERC will reinitiate formal consultation with NMFS. Once the 96% standard has been met, Black Bear will conduct a one year study every ten years to verify that the standard continues to be met.

The downstream passage monitoring will be conducted using radio tags. It is anticipated that 102 smolts, plus 45 to 60 paired release fish, will be evaluated at the West Enfield Project for each year of the study. The evaluation will use three release groups of 34 smolts each, along with 15 to 20 paired release fish, when river flows are within the 10-90th percentile for average May flows.

Ten years after completion of the final enhancements for smolt outmigration at the West Enfield Project, Black Bear proposes to conduct a downstream kelt study. The intent of this study is to verify that the 96% downstream performance standard is being met. The study will be a three year study that coincides with smolt monitoring and will use no more than 40 male kelts per project per year.

Black Bear has not proposed an initial upstream passage study at West Enfield. The upstream fishway at West Enfield was modified in 2006 to prevent passage of northern pike in response to state invasive species management. At that time, a "jump" was installed in the fishway that would preclude northern pike passage but would continue to allow Atlantic salmon to pass upstream at the project. The University of Maine is currently evaluating upstream passage effectiveness at the West Enfield Project. Preliminary results of the studies indicate the jump may be having some affects to salmon passage. The jump was modified in the spring of 2012 to improve Atlantic salmon passage. It is anticipated that the issues involving northern pike and Atlantic salmon passage will be resolved at the West Enfield Project within ten years, therefore, Black Bear will not be conducting upstream fish passage monitoring at the Project until 2023.

A one-year efficiency study will be conducted every ten years at the West Enfield Project after the license is amended, to verify that the 95% standard is being met. Passage effectiveness will be evaluated using radio tags or similarly accepted methods. Twenty to forty adult Atlantic salmon that are confirmed to have been released as juveniles upstream of the Milford Project, will be trapped at Milford, radio tagged and released upstream of the Milford Dam. Tagged fish that swim to within 200 meters downstream of the West Enfield Dam will be tracked to determine their success in using the upstream passage facility. At that point, if the project does not achieve the 95% performance standard, the facility will be modified to increase efficiency, and evaluated again and repeated as necessary to achieve the performance standard. Once the standard has been met, Black Bear will reevaluate upstream passage with a one-year efficiency study every ten years thereafter.

2.5. Medway Project - FERC No. 2666

2.5.1. Existing Hydroelectric Facilities and Operations

The Medway Project is located on the West Branch of the Penobscot River, just upstream of the confluence with the East Branch of the Penobscot River. The Project consists of a 343-foot-long concrete gravity dam with wooden flashboards, a 64-foot-long concrete gravity forebay wall, a 120-acre impoundment, a powerhouse containing five generating units with a total installed capacity of 3.44 MW, an approximate 144-foot-long underground transmission line, and appurtenant facilities. The Medway Project includes upstream and downstream American eel fishways that are located at the north abutment of the spillway. There are no other upstream or downstream fish passage facilities at this project. The project is operated in a run-of-the-river mode.

2.5.2. Proposed Action

Black Bear is not proposing any changes to the physical components of the Project as part of the proposed action. As there are no fish passage facilities at the project, Black Bear is not proposing that upstream and downstream performance standards be met at the Medway Project. Rather, in a submittal to FERC on May 15, 2012, Black Bear proposed that FERC amend the license for the Medway Project to incorporate the following language as a license article:

"The Licensee shall consult with the National Marine Fisheries Service once every five years regarding the status of Atlantic salmon and other Endangered Species Act-listed fishery species in the Penobscot River to ensure that operation of the Medway Project is consistent with the listing determinations for such species and with the then-current recovery objectives for such species".

2.6. 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.

Operation of the Milford, West Enfield, Medway, Stillwater and Orono Projects pursuant to the revised licenses proposed to be approved by FERC, will affect much of the Penobscot River watershed, its estuary, and associated waters. In addition, short-term, construction related effects associated with powerhouse and fishway construction will occur in the lower Penobscot River in the vicinity of the Milford, Orono and Stillwater Projects. Therefore, the Penobscot River watershed represents the action area for this consultation (Figure 1).

3. STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT

NMFS has determined that the following endangered or threatened species may be affected by the proposed action:

Fish	
Gulf of Maine DPS of Atlantic salmon	Endangered

Shortnose sturgeon	Endangered
New York Bight DPS of Atlantic sturgeon	Endangered
Gulf of Maine DPS of Atlantic sturgeon	Threatened
Chesapeake Bay DPS of Atlantic sturgeon	Endangered
South Atlantic DPS of Atlantic sturgeon	Endangered
Carolina DPS of Atlantic sturgeon	Endangered

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

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

3.1. Gulf of Maine DPS of Atlantic Salmon

3.1.1. Species Description

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

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

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

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

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

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

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

Beland 1981). The female then continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel.

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

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

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

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

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

Some salmon may remain at sea for another year or more before maturing. After their second winter at sea, the salmon over-winter in the area of the Grand Banks before returning to their natal rivers to spawn (Reddin and Shearer 1987). Reddin and Friedland (1993) found immature adults located along the coasts of Newfoundland, Labrador, and Greenland, and in the Labrador and Irminger Sea in the later summer and autumn.

3.1.2 Status and Trends of Atlantic Salmon in the GOM DPS

The abundance of Atlantic salmon within the range of the GOM DPS has been generally declining since the 1800s (Fay *et al.* 2006). Data sets tracking adult abundance are not available throughout this entire time period; however, a comprehensive time series of adult returns to the GOM DPS dating back to 1967 exists (Fay *et al.* 2006, USASAC 2001-2012) (Figure 3). It is important to note that contemporary abundance levels of Atlantic salmon within the GOM DPS are several orders of magnitude lower than historical abundance estimates. For example, Foster and Atkins (1869) estimated that roughly 100,000 adult salmon returned to the Penobscot River alone before the river was dammed, whereas contemporary estimates of abundance for the entire GOM DPS have rarely exceeded 5,000 individuals in any given year since 1967 (Fay *et al.* 2006, USASAC 2010).

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

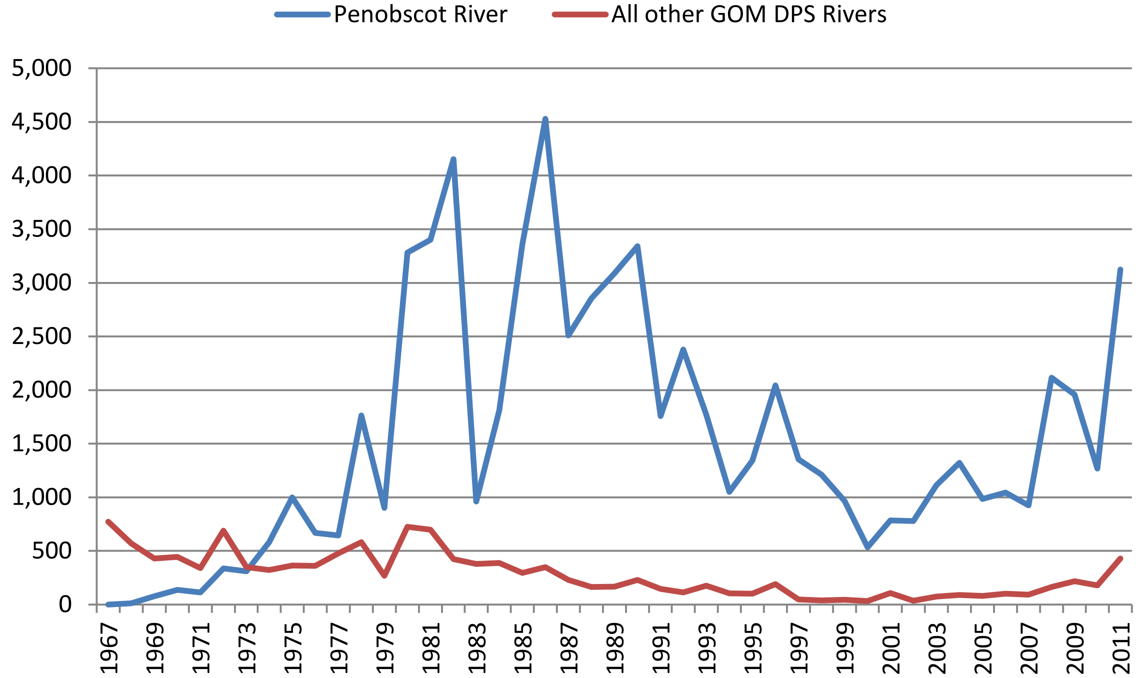

Figure 3. Adult returns to the GOM DPS Rivers between 1967 and 2011(Fay *et al.* 2006, USASAC 2001-2012).

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

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

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

3.1.3. Status of Atlantic Salmon in the Action Area

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

Upstream migrating adults

All adults returning to the Penobscot River are collected at the Veazie Dam fishway. Adults captured at the fishway are either taken to CBNFH for captive breeding or returned to the river upstream of the Veazie Dam. Since the initial listing of the GOM DPS of Atlantic salmon in 2000, the number of returning adults (both naturally-reared and conservation hatchery stocked) captured at the fishway trap at the Veazie Dam has ranged from as low as 534 in 2000 to as many as 3,123 in 2011(USASAC 2012). The majority of adult returns to the Penobscot River are of hatchery origin (Fay *et al.* 2006). In 2011, 92% of adult Atlantic salmon returns were of hatchery smolt origin, and the balance (8%) originated from fry stocking or natural reproduction (USASAC 2012).

The Veazie fishway trap is operated each year from May 1 to October 31 (MDMR, MDIFW 2009). The majority of the adult salmon captures at Veazie occur in June, with the median capture date occurring around the last week of June (MDMR 2008). Use of the rubber dam system at the Veazie spillway has led to improved, and earlier captures of adult salmon in the river (MDMR 2007). Although the overall size of the salmon run differs from year to year, the monthly breakdown and median capture dates are similar (Table 2)(MDMR 2007, MDMR 2008, Dube *et al.* 2011).

Table 2. Monthly total and median capture dates of Atlantic salmon collected at the Veazie Trap during 2007-2010.

	2007		**2008**		**2009**		**2010**		
Month	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**Mean Distribution**
May	48	5%	267	13%	173	9%	344	26%	13%
June	458	50%	1465	69%	1382	71%	782	59%	65%
July	268	29%	236	11%	370	19%	141	11%	16%
August	79	9%	111	5%	14	1%	18	1%	4%
September	45	5%	18	1%	11	1%	27	2%	2%

October	18	2%	15	1%	8	0%	4	0%	1%
Total Run	**916**	**100%**	**2112**	**100%**	**1958**	**100%**	**1316**	**100%**	**100%**
Median Capture Date	23-Jun-07		26-Jun-08		18-Jun-09		9-Jun-10		

According to current broodstock management plans, 650 adult salmon are typically collected each year at Veazie Dam for transport to the federal salmon hatcheries in Maine (MDMR 2007). Because of the goal of providing an equal ratio of male and female spawners for hatchery, as well as a proportion of 1-sea winter returns (“grilse”), the goal of 650 spawners is rarely achieved. Table 3 below presents broodstock targets and number of broodstock collected at the Veazie Dam since 2000.

Table 3. Atlantic salmon broodstock collected at the Veazie Trap during (2000-2011).

Year	**Broodstock Target**	**Total Broodstock Collected**
2000	600	328
2001	600	502
2002	600	377
2003	600	605
2004	600	606
2005	600	475
2006	650	537
2007	650	590
2008	650	650
2009	650	679
2010	650	700
2011	650	739

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

Post-spawned adults

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

Downstream migrating smolts

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

Rotary screw traps (RSTs) were used by NMFS during 2000-2005 to monitor downstream migrating smolts in the Penobscot River (Figure 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.

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

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

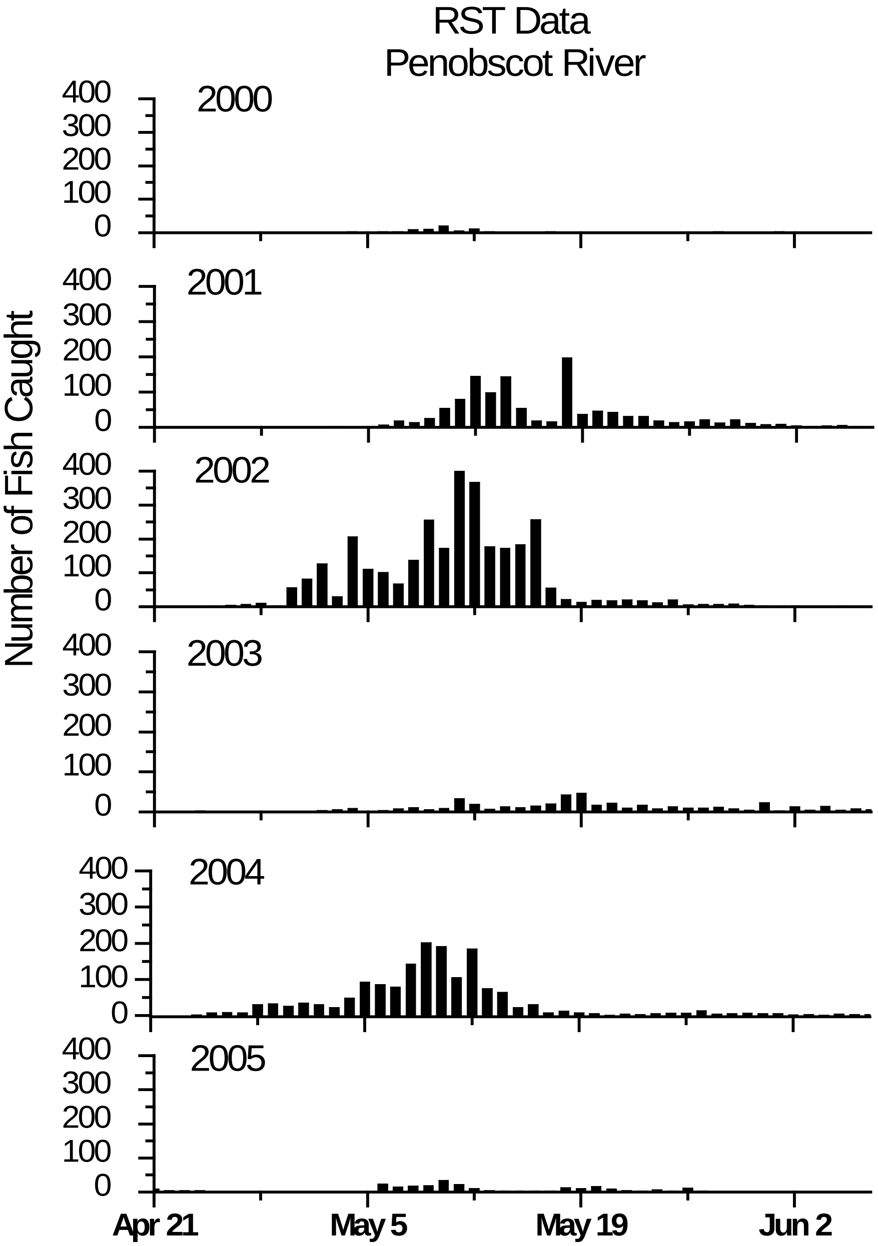

Figure 4. Total number of smolts collected using rotary screw traps in the Penobscot River from 2000 to 2005.

3.1.4. Factors Affecting Atlantic Salmon in the Action Area

3.1.4.1.Hydroelectric Facilities

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

Habitat Alteration

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

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

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

Habitat Connectivity

Pre-spawn adults

Among rivers within the range of the GOM DPS with hydropower dams that have one or more formal passage facility, most of the current understanding of fish passage efficiency comes from studies on the Penobscot River. Radio telemetry and other tracking studies by the MDMR and various hydropower project licensees have shown wide variation in site-specific upstream passage success, depending on the dam location and the environmental conditions (e.g., temperature, hydrology) during the year of study. For example, at the Veazie Dam, the percentage of radio tagged Atlantic salmon adults using the fishway ranged from 44% in 1990 to 89% in 1992, and averaged 68% over five years of study in the late 1980s and early 1990s (Dube 1988, Shepard 1989b, Shepard and Hall 1991, Shepard 1995). Shepard (1995) hypothesized that warm water temperatures during certain study years contributed to some of the low passage success rates observed at Veazie.

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

At Milford Dam, upstream passage success ranged from 86% in 1987 to 100% in 1990, and averaged 90% (56 of 62) over five years of study using Carlin and radio tags (Dube 1988, Shepard 1995). Similarly, a three year study that was conducted between 2002 and 2004 that looked at migratory movements of adult Atlantic salmon using PIT tags indicated passage success at Milford ranging between 86% and 94% (Beland and Gorsky 2004, MASC unpublished data). In 2005 and 2006, Holbrook *et al.* (2009) conducted acoustic telemetry studies to assess upstream passage of adult salmon in the Penobscot River from the Veazie Dam upstream to the Howland and West Enfield Dams. Passage at Milford was 100% in 2005 (3 of 3) and 67% in 2006 (2 of 3). Based on all of these studies, Holbrook *et al.* (2009) calculated that passage at the Milford Project ranged between 67% and 100%, with an average of 90% and a median passage rate of 93%.

Upstream passage efficiency ranged between 85% and 100% over four years of study at the West Enfield and Howland Projects, 20 miles upriver from Milford. Based upon radio telemetry studies conducted from 1989-1992, Shepard (1995) estimated pooled upstream passage rates for adult Atlantic salmon at the Howland and West Enfield at 88% for fish released below the

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

Migratory Delay

Early migration is an adaptive trait that ensures adult Atlantic salmon have sufficient time to effectively reach spawning areas despite the occurrence of temporarily unfavorable conditions that naturally occur within rivers (Bjornn and Reiser 1991). Gorsky (2005) found that migration in Atlantic salmon was significantly affected by flow and temperature conditions in the Penobscot River. He found that high flow led to a decrease in the rate of migration and that rates increased with temperature up to a point (around 23 degrees C) where they declined rapidly. To avoid high flows and warmer temperatures in the river, Atlantic salmon have adapted to migrating in the late spring and early summer, even though spawning does not occur until October and November. Between 2007 and 2010, 78% of migrating Atlantic salmon migrated past the Veazie Dam in May and June. According to USGS temperature data from Eddington, Maine, the 12-year median daily temperature in the Penobscot River exceeds 23 C in the first week of July.

To access high quality summer holding areas close to spawning areas in the Penobscot River watershed, Atlantic salmon must migrate past multiple dams. Delay at these dams can, individually and cumulatively, affect an individual’s ability to access suitable spawning habitat within the narrow window when conditions in the river are suitable for migration. In addition, delays in migration can cause overripening of eggs, increased chance of egg retention, and reduced egg viability in pre-spawn female salmonids (deGaudemar and Beall 1998). It is not known what level of delay at each of these dams would significantly affect a migrant’s ability to access suitable spawning habitat, as it would be different for each individual, and would vary from year to year depending on environmental conditions. We believe that 48 hours provide adequate opportunity for pre-spawn adult Atlantic salmon to locate and utilize well-designed upstream fishways at hydroelectric dams.

Available empirical data indicate a wide range in time needed for individual adult salmon to pass upstream of various dams in the Penobscot River once detected in the vicinity of a spillway or tailrace. The yearly pooled median passage time for adults at Milford Dam ranged from 1.0 days to 5.3 days over five years of study, while the total range of individual passage times over this study period was 0.1 days to 25.0 days. The yearly pooled median passage time for adults at the West Enfield or Howland Dam ranged from 1.1 days to 3.1 days over four years of study, while the total range of individual passage times over this study period was 0.9 days to 61.1 days (Shepard 1995).

Adult migrating salmon are attracted to the discharge of the existing powerhouse at the Orono Project, where they can be significantly delayed (greater than 48 hours). The Orono Project is in the Stillwater Branch, but the powerhouse discharges into the mainstem of the river, adjacent to the confluence with the Stillwater. Over a two year period (1988-1989), Shepard (1995) indicated that 46% (56% in 1988 and 37% in 1989) of tagged salmon were attracted to this discharge and delayed for a median of 8.30 hours in 1988 and 2.18 hours in 1989, prior to continuing upstream migration in the mainstem. The duration of the delay in 1988 ranged between 0.3 hours to 247.4 hours. Of the fish attracted to the discharge in that year, 33% were recorded spending more than 48 hours in the tailrace of the Project (S. Shepard, personal communication, 2012). Some of the salmon entered the Orono tailrace several times or were found to have migrated upstream prior to being attracted to the discharge at Orono. This behavior may be partially attributable to the fact that a proportion of the fish (56% in 1988 and 28% in 1989) were hatchery fish that were stocked as smolts in the mainstem of the Penobscot, rather than in the upper watershed. These fish may not have imprinted on upriver habitat and, therefore, may not have been highly motivated to continue migrating upstream. This would suggest that the proportion of Atlantic salmon that were attracted to the discharge at Orono may be greater than what would be expected for just wild fish. However, this study provides the best available information regarding what proportion of Atlantic salmon migrating through the Penobscot River could be attracted to, and delayed by, the discharge of the powerhouse at the Orono Project.

Outmigrating smolts

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

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

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

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

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

Alden Research Laboratory, Inc. (Alden Lab 2012) has modeled current smolt survival rates at 15 dams on the Penobscot River, based on turbine entrainment, spill mortality estimates and bypass efficiency. Alden Lab conducted a literature review to estimate survival rates based on passage route. Based on that review, it was estimated that mortality through a properly designed bypass would not exceed 1%, whereas mortality via spillage would not exceed 3%. The estimates of mortality due to passage through the turbines was calculated based on the characteristics of individual turbines (such as type of turbine, number of blades and the speed of rotation) and were therefore project specific. In addition to these route-specific estimates, Alden Lab estimated a 5% indirect mortality rate (due primarily to predation and sublethal injuries during passage), regardless of passage route (Alden Lab 2012, Appendix A). Using these assumptions, Alden Lab estimated that the mean survival rates of all 15 dams ranged between 86% and 92% (Table 6).

Table 6. Modeled smolt survival rates under current conditions at May flows for 15 dams on the Penobscot River (Alden Lab 2012) . Black Bear's projects on the Penobscot River are in bold.

Project	Mean	Min	Max
Veazie	89.7%	82.7%	91.3%
Great Works	86.1%	77.7%	89.6%
Milford	**91.6%**	**75.6%**	**92.0%**
West Enfield	**92.5%**	**92.3%**	**93.6%**
Mattaceunk	86.0%	77.2%	89.8%
Orono	**90.1%**	**81.6%**	**91.5%**
Stillwater	**91.9%**	**90.5%**	**92.1%**
Medway	**91.2%**	**88.4%**	**91.9%**
Howland	91.5%	89.6%	92.7%
Brown's Mill	86.5%	61.5%	91.8%
Lowell Tann.	88.7%	84.7%	94.9%
Moosehead	87.9%	66.0%	91.0%
Milo	89.0%	85.2%	90.9%
Sebec	88.7%	83.4%	90.9%
Frankfort	92.0%	90.8%	94.4%

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

Outmigrating kelts

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

Alden Lab (2012) has modeled the current survival rates of kelts at the dams on the Penobscot River, based on turbine entrainment, spill mortality estimates and bypass efficiency (Table 7). Alden Lab's analysis accounted for both immediate and delayed mortality associated with dam passage. Through the three months of outmigration, Alden Lab indicates that mean survival rates at 14 of the dams (Medway is excluded) on the Penobscot range between 61% and 93%.

Table 7. Modeled kelt survival rates under current conditions at May flows for Black Bear's projects on the Penobscot River (Alden Lab 2012). Black Bear's projects are indicated in bold.

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

Moosehead	92.2%	92.2%	92.2%	82.3%	0.0%	92.2%	76.3%	0.0%	92.2%
Milo	64.5%	43.6%	82.0%	66.8%	43.6%	83.2%	61.6%	0.0%	89.5%
Sebec	89.7%	86.0%	94.1%	89.8%	86.0%	92.3%	89.7%	86.0%	94.1%
Frankfort	68.4%	53.5%	90.8%	70.9%	53.5%	94.1%	71.6%	53.5%	94.1%

Delayed Effects of Downstream Passage

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

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

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

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

Given the difficulty in estimating this type of mortality at the present time, we do not have sufficient data to specifically assess the effect of hydrosystem-related mortality in the Penobscot River. Thus, we have not attempted to quantify the delayed (or delayed) loss of smolts or kelts attributed to Black Bear’s projects in this Opinion. Nevertheless, considering that there are presently 15 FERC licensed hydroelectric projects in the Penobscot River watershed, it can be assumed that practically all smolts and kelts in the river must pass at least two hydroelectric dams during the downstream migrations and the resulting loss of endangered Atlantic salmon could be significant. According to a model developed by NMFS (2012; Figure 5), even a small cumulative mortality rate (1-10%) could have a significant effect on the number of returning 2 SW female Atlantic salmon in the Penobscot River watershed. It should be noted, however, that removal of the Veazie and Great Works Projects and decommissioning the Howland Project should significantly reduce the hydrosystem-related mortality of smolts and kelts in the river.

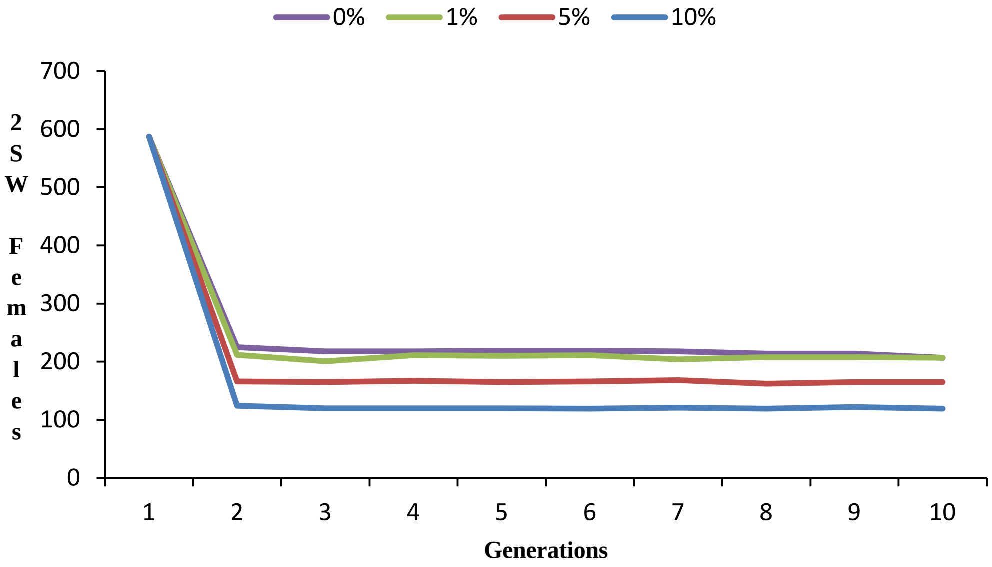

Figure 5. The potential effects of cumulative delayed mortality on the abundance of returning 2SW female Atlantic salmon over ten generations (NMFS 2012).

3.1.4.2.Predation

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

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

Smallmouth bass and chain pickerel are each important predators of Atlantic salmon within the range of the GOM DPS (Fay *et al.* 2006). Smallmouth bass are a warm-water species whose range now extends through north-central Maine and well into New Brunswick (Jackson 2002). Smallmouth bass are very abundant in the Penobscot River—smallmouth bass inhabit the entire main stem migratory corridor as well as many of the juvenile Atlantic salmon rearing habitats such as the East Branch Penobscot River and the Piscataquis River. Smallmouth bass likely feed on fry and parr though little quantitative information exists regarding the extent of bass predation upon salmon fry and parr. Smallmouth bass are important predators of smolts in main stem habitats, although bioenergetics modeling indicates that bass predation is insignificant at 5°C and increases with increasing water temperature during the smolt migration (Van den Ende 1993).

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

1993). Chain pickerel feed actively in temperatures below 10°C (Van den Ende 1993, MDIFW 2002). Smolts were, by far, the most common item in the diet of chain pickerel observed by Barr (1962) and Van den Ende (1993). However, Van den Ende (1993) concluded that, "daily consumption was consistently lower for chain pickerel than that of smallmouth bass", apparently due to the much lower abundance of chain pickerel.

Northern pike were illegally stocked in Maine, and their range now includes Pushaw Lake which drains to the Lower Penobscot River (Fay *et al.* 2006). Northern pike have expanded their range in the Penobscot River to include the Pushaw Stream outlet, nearby Mud Pond and probably portions of the main stem Penobscot River, since there are no barriers to their movement. Northern pike are ambush predators that rely on vision and thus, predation upon smolts occurs primarily in daylight with the highest predation rates in low light conditions at dawn and dusk (Bakshtansky *et al.*1982). Hatchery smolts experience higher rates of predation by fish than wild smolts, particularly from northern pike (Ruggles 1980, Bakshtansky *et al.* 1982).

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

3.1.4.3.Contaminants and Water Quality

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

3.1.5. Summary of Factors Affecting Recovery of Atlantic Salmon

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

Threats to the Species

The recovery plan for the previously designated GOM DPS (NMFS and USFWS 2005), the latest status review (Fay *et al.* 2006), and the 2009 listing rule all provide a comprehensive assessment of the many factors, including both threats and conservation actions, that are currently affecting the status and recovery of listed Atlantic salmon. The Services are writing a new recovery plan that will include the current, expanded GOM DPS and its designated critical habitat. The new recovery plan provides the most up to date list of significant threats affecting the GOM DPS. These are the following:

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

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

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

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

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

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

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

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

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

Efforts to Protect the GOM DPS of Atlantic salmon

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

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

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

3.2. Critical Habitat for Atlantic Salmon in the GOM DPS

Coincident with the June 19, 2009 endangered listing, NMFS designated critical habitat for the GOM DPS of Atlantic salmon (74 FR 29300; June 19, 2009) (Figure 6). The final rule was revised on August 10, 2009. In this revision, designated critical habitat for the expanded GOM DPS of Atlantic salmon was reduced to exclude trust and fee holdings of the Penobscot Indian Nation and a table was corrected (74 FR 39003; August 10, 2009).

Primary Constituent Elements of Atlantic Salmon Critical Habitat

Designation of critical habitat is focused on the known primary constituent elements (PCEs), within the occupied areas of a listed species that are deemed essential to the conservation of the species. Within the GOM DPS, the PCEs for Atlantic salmon are: 1) sites for spawning and rearing, and 2) sites for migration (excluding marine migration[1]). NMFS chose not to separate

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

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

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designated.2 For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

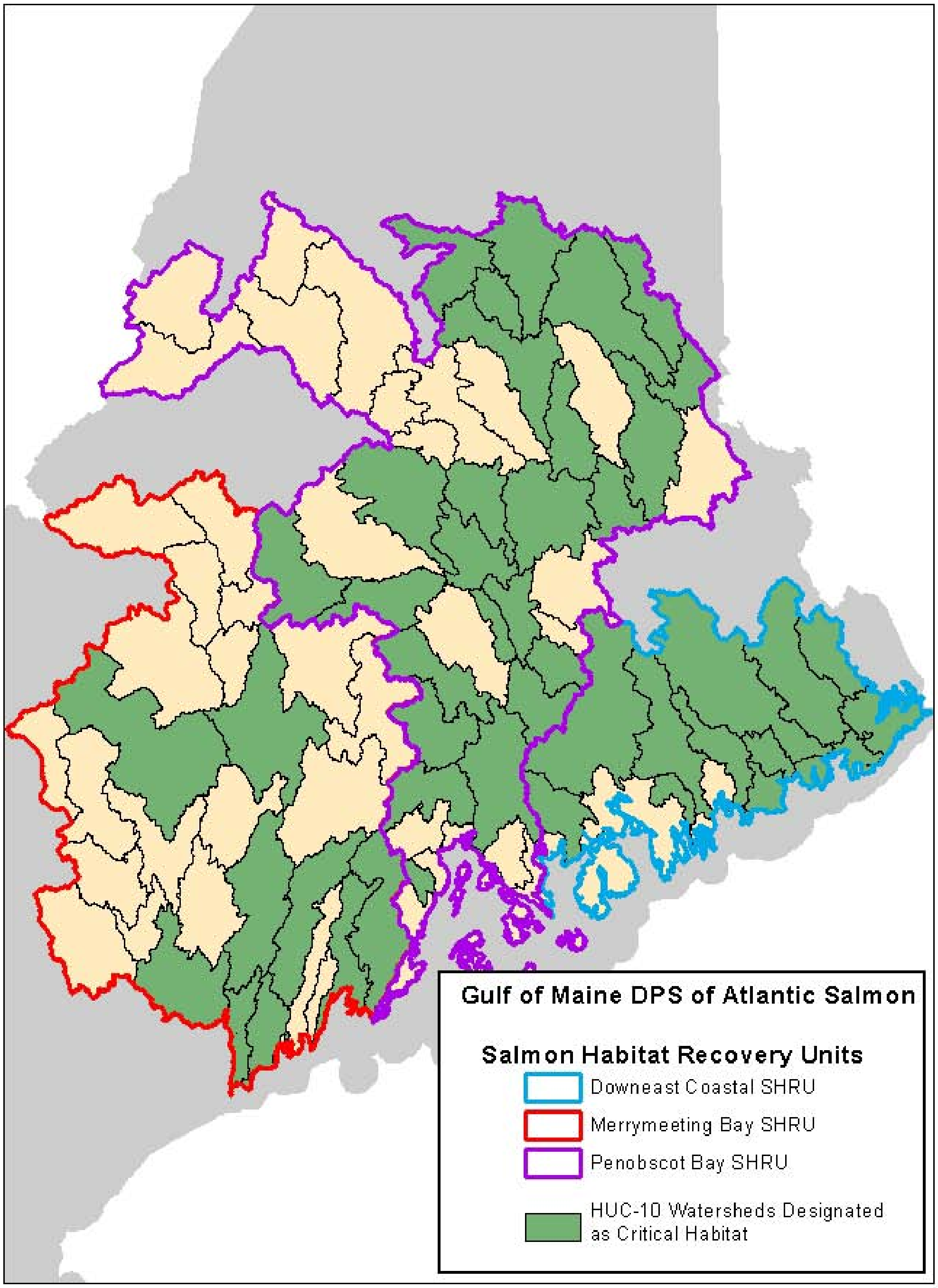

Figure 6. HUC-10 Watersheds Designated as Atlantic Salmon Critical Habitat within the GOM DPS.

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

Physical and Biological Features of the Spawning and Rearing PCE

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

Physical and Biological Features of the Migration PCE

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

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

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

Salmon Habitat Recovery Units within Critical Habitat for the GOM DPS

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

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

Downeast Coastal SHRU

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

Penobscot Bay SHRU

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

Merrymeeting Bay SHRU

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

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

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

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

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

As discussed previously, critical habitat for Atlantic salmon has been designated in the Penobscot River, as well as in the Stillwater Branch. Both PCEs for Atlantic salmon (sites for spawning and rearing and sites for migration) are present in the action area as it was described in Section 2.6 of this Opinion (the entirety of the Penobscot River watershed). PCEs consist of the physical and biological elements identified as essential to the conservation of the species in the documents designating critical habitat. These PCEs include sites essential to support one or more life stages of Atlantic salmon (sites for spawning, rearing, and migration) and contain physical or biological features essential to the conservation of the species, for example, spawning gravels, water quality and quantity, unobstructed passage, and forage.

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

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

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

TABLE 4 continued…

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

TABLE 4 continued…

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

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

Pathway/Indicator	Life Stages Affected	PCEs Affected	Effect	Population Viability Attributes Affected
Passage/Access to Historical Habitat	Adult, juvenile, smolt	Freshwater migration	Upstream passage delays and inefficiencies limit access to spawning habitat. Poor downstream passage causes direct and delayed mortality of smolts and kelts.	Adult abundance and productivity,
Habitat Elements, Channel Dynamics, Watershed Condition	Adult, incubating eggs, juvenile, smolt	Freshwater migration, spawning, and rearing	Impoundments degrade spawning and rearing habitat, increase predation, limit productivity, and delay migrations.	Adult abundance and productivity Juvenile growth rate
Water Quality	Adult, juvenile, incubating eggs	Freshwater spawning and rearing	Impoundments degrade spawning and rearing habitat.	Adult abundance and productivity Juvenile growth rate

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

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

Threats to Critical Habitat within the GOM DPS

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

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

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

3.3. Shortnose sturgeon

3.3.1. Species Description

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley 1963, Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell *et al.* 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at five to ten years, while females mature between seven and thirteen years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers)[2] when the freshwater temperatures increase to 8-9ºC. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse *et al.* 1987, Crowder *et al.* 1994, Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

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

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

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

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and

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2 For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

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

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

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell *et al.* 1984, Hall *et al.* 1991). 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 (Flournoy *et al.* 1992, Rogers *et al.* 1994, Rogers and Weber 1995, Weber 1996).

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

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6 meters is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30 meters but are generally found in waters less than 20 meters (Dadswell *et al.* 1984, Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert

1980, Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973). McCleave *et al.* (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989). Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973.

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

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NMFS has not formally recognized distinct population segments (DPS)[3] of shortnose sturgeon under the ESA. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998).

Studies conducted since the issuance of the Recovery Plan have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh *et al.* (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width,

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[3] 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.

interorbital width and dorsal scute count, left lateral scute count, right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and Kennebec rivers drain into a common estuary, these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

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

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

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

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

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

3.3.2. Status and Trends of Shortnose Sturgeon Rangewide

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the Saint John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. The species is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while northern populations are amphidromous (NMFS 1998). Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) and Merrimack Rivers (~100 adults; M. Kieffer, United States Geological Survey, personal communication), while the largest populations are found in the Saint John (~100,000; Dadswell 1979) and Hudson Rivers (~61,000; Bain *et al.* 1998). As indicated in Kynard (1996), adult abundance is less than the minimum estimated viable population abundance of 1000 adults for five of 11 surveyed northern populations and all natural southern populations. Kynard (1996) indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the Saint John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species or the shortnose sturgeon population in the northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed; however, overall the species trend is considered to be stable.

3.3.3. Status and Distribution of Shortnose Sturgeon in the Action Area

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

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

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

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

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

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

Currently, shortnose sturgeon are limited to the area below Veazie Dam. Existing fish passage facilities at the Veazie Dam are not used by shortnose sturgeon, and no shortnose sturgeon are known to occur upstream of the dam. Historically, the first natural obstacle to sturgeon migration on the Penobscot River may have been the falls at Milford, approximately rkm 70 (L. Flagg, MDMR, pers. comm 1998, Houston *et al.* 2007). If sturgeon were able to ascend the falls at Milford, they could have migrated without obstruction to Mattaseunk (rkm 171). The currently available information on the distribution of shortnose sturgeon in the Penobscot River is summarized below.

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

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

The preliminary telemetry data collected by UM suggests that sub-adult and adult shortnose sturgeon move extensively within the river system during spring and early summer and often can be found over mudflats outside the main river channel (Fernandes *et al.* 2008b).

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

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

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

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

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

Research has been conducted by the New York University School of Medicine involving mitochondrial DNA (mtDNA) analysis of shortnose sturgeon populations, including fish caught in the Penobscot River (Wirgin *et al.* in progress). Information available to date for the Penobscot samples indicates that haplotype frequencies in this population were almost identical to that in the Kennebec River system. Additionally, the Penobscot River samples did not exhibit any haplotypes that were not seen elsewhere. It is unknown at this time whether shortnose sturgeon in the Penobscot River are the descendants of recent migrants from the Kennebec River, migrants themselves or whether they represent a remnant naturally reproducing Penobscot River population. It is possible that the adults captured to date are representatives of all three scenarios. As the sample size is very small and as mtDNA represents only a fraction (less than 1%) of the genetic material and is maternally inherited, it is difficult to make conclusive statements regarding the potential for fish in the Penobscot River to be genetically distinct from other fish in the Kennebec complex. However, as there were no unique haplotypes in the Penobscot River fish and unique haplotypes are seen in almost every other population, the best available information suggests that fish occurring in the Penobscot River are not genetically unique and are not genetically distinct from other fish in the Kennebec River. Nuclear DNA analysis (King *et al.* 2001) finds that the Kennebec, Androscoggin, and Penobscot Rives form a metapopulation that are genetically indistinguishable from each other; reflecting a panmictic population.

3.3.4. Factors Affecting Shortnose Sturgeon in the Action Area

3.3.4.1.Dams and Hydroelectric Facilities

As noted above, the range of shortnose sturgeon in the Penobscot River has been restricted by the Veazie Dam. In rivers where shortnose sturgeon have free access (*i.e.*, there are no dams), the species typically has a 100-200 kilometer range. In the Penobscot River, this range is restricted to only 40 kilometers of mainstem river, with an additional 32 kilometers of estuary available below the mouth of the river. The Veazie Dam and Great Works dam prevent shortnose sturgeon from accessing historically available habitat above the dams, which is thought to have extended to at least Milford Falls (approximately rkm 70). These dams have also likely prevented the species from spawning at their preferred spawning habitat, which is likely located upstream of the Veazie Dam. The lack of accessibility to this habitat has likely had a significant negative effect on shortnose sturgeon in this river system and will continue to delay recovery of this species in the Penobscot River. Because no shortnose sturgeon are known to occur upstream of any hydroelectric projects in the Penobscot River, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in the action area. The extent that shortnose sturgeon are affected by operations of hydroelectric facilities in the Penobscot River is currently unknown. Additionally, to the extent that upstream hydroelectric projects affect conditions below Veazie Dam, shortnose sturgeon are affected by the operation of these projects as well. The Veazie Dam is slated for removal within the timeframe of this action.

3.3.4.2.Contaminants and Water Quality

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

3.3.4.3.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 rangewide. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979, Dovel *et al.* 1992, Collins *et al.* 1996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are taken, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with re-suspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to water quality which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989, Sinderman 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and

Henry 1992, Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

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

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

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28ºC. Flournoy *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 (Flournoy *et al.*,1992, Rogers and Weber 1995, Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

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

3.4. Atlantic Sturgeon

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

3.4.1. Species Description

The Atlantic sturgeon *(Acipenser oxyrinchus oxyrinchus)* is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA (Scott and Scott 1988, ASSRT 2007, T. Savoy, CT DEP, pers. comm.). We have delineated U.S. populations of Atlantic sturgeon into five DPSs (77 FR 5880 and 77 FR 5914). These are: the Gulf of Maine (GOM), New York Bight (NYB), Chesapeake Bay, Carolina, and South Atlantic DPSs (Figure 7). The results of genetic studies suggest that natal origin influences the distribution of Atlantic sturgeon in the marine environment (Wirgin and King 2011). However, genetic data as well as tracking and tagging data demonstrate sturgeon from each DPS and Canada occur throughout the full range of the subspecies. Therefore, sturgeon originating from any of the five DPSs can be affected by threats in the marine, estuarine and riverine environment that occur far from natal spawning rivers.

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

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

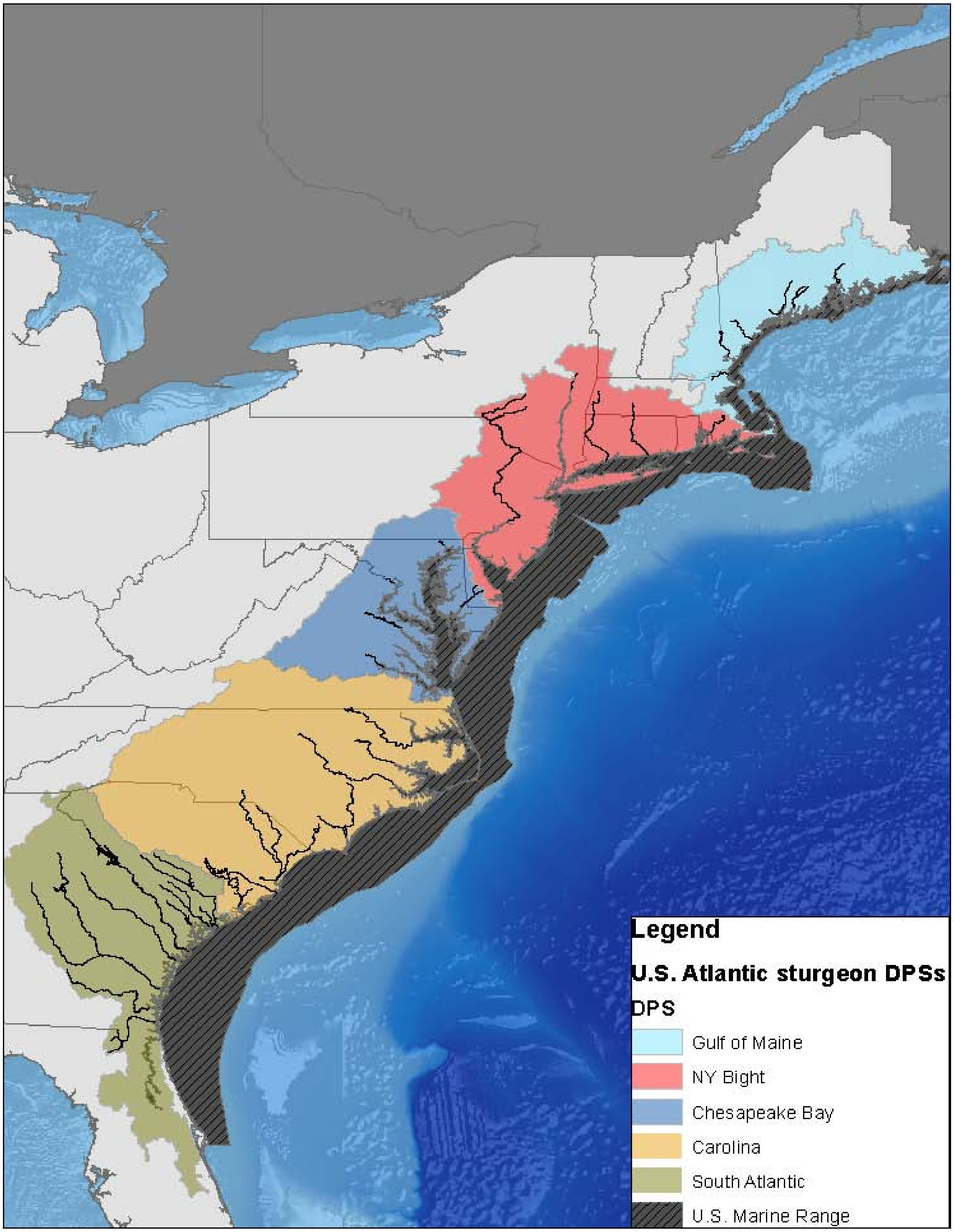

Figure 7. Map Depicting the Boundaries of the five Atlantic sturgeon DPSs

Atlantic sturgeon life history

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

Table 8. Descriptions of Atlantic sturgeon life history stages (adapted from Mohler 2003, Atlantic Sturgeon Status Review Team 2007).

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

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

Rate of maturation is affected by water temperature and gender. In general: (1) Atlantic sturgeon that originate from southern systems grow faster and mature sooner than Atlantic sturgeon that originate from more northern systems; (2) males grow faster than females; (3) fully mature females attain a larger size (i.e., length) than fully mature males; and (4) the length of Atlantic sturgeon caught since the mid-late 20th century have typically been less than three meters (Smith *et al.*1982, Smith *et al.* 1984, Smith 1985, Scott and Scott 1988, Young *et al.* 1998, Collins *et al.* 2000, Caron *et al.* 2002, Dadswell 2006, ASSRT 2007, Kahnle *et al 2*007, DFO 2011). The largest recorded Atlantic sturgeon was a female captured in 1924 that measured approximately

4.26 meters (Vladykov and Greeley 1963). Dadswell (2006) reported seeing seven fish of comparable size in the St. John River estuary from 1973 to 1995. Observations of large sized sturgeon are particularly important given that egg production is correlated with age and body size (Smith *et al.* 1982, Van Eenennaam *et al.* 1996, Van Eenennaam and Doroshov 1998, Dadswell 2006). However, while females are prolific with egg production ranging from 400,000 to 4,000,000 eggs per spawning year, females spawn at intervals of two to five years (Vladykov and Greeley 1963, Smith *et al.* 1982, Van Eenennaam *et al.* 1996, Van Eenennaam and Doroshov 1998, Stevenson and Secor 1999, Dadswell 2006). Given spawning periodicity and a female's relatively late age to maturity, the age at which 50 percent of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman 1997). Males exhibit spawning periodicity of one to five years (Smith 1985, Collins *et al.* 2000, Caron *et al.* 2002). While long-lived, Atlantic sturgeon are exposed to a multitude of threats prior to achieving maturation and have a limited number of spawning opportunities once mature.

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

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

Larval Atlantic sturgeon (i.e. less than four weeks old, with total lengths (TL) less than 30 mm; Van Eenennaam *et al.* 1996) are assumed to undertake a demersal existence and inhabit the same riverine or estuarine areas where they were spawned (Smith *et al.* 1980, Bain *et al. 2*000, Kynard and Horgan 2002, ASMFC 2009). Studies suggest that age zero (i.e., young-of-year), age one, and age two juvenile Atlantic sturgeon occur in low salinity waters of the natal estuary (Haley 1999, Hatin *et al.* 2007, McCord *et al.* 2007, Munro *et al.* 2007) while older fish are more salt tolerant and occur in higher salinity waters as well as low salinity waters (Collins *et al.* 2000*).* Atlantic sturgeon remain in the natal estuary for months to years before emigrating to open ocean as subadults (Holland and Yelverton 1973, Dovel and Berggen 1983, Waldman *et al.* 1996, Dadswell 2006, ASSRT 2007).

After emigration from the natal estuary, subadults and adults travel within the marine environment, typically in waters less than 50 meters in depth, using coastal bays, sounds, and ocean waters (Vladykov and Greeley 1963, Murawski and Pacheco 1977, Dovel and Berggren 1983, Smith 1985, Collins and Smith 1997, Welsh *et al.* 2002, Savoy and Pacileo 2003, Stein *et al.* 2004, USFWS 2004, Laney *et al.* 2007, Dunton *et al.* 2010, Erickson *et al.* 2011, Wirgin and King 2011). Tracking and tagging studies reveal seasonal movements of Atlantic sturgeon along the coast. Satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight at depths greater than 20 meters during winter and spring, and in the northern portion of the Mid-Atlantic Bight at depths less than 20 meters in summer and fall (Erickson *et al.* 2011). Shirey (Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC 2009) found a similar movement pattern for juvenile Atlantic sturgeon based on recaptures of fish originally tagged in the Delaware River. After leaving the Delaware River estuary during the fall, juvenile Atlantic sturgeon were recaptured by commercial fishermen in nearshore waters along the Atlantic coast as far south as Cape Hatteras, North Carolina from November through early March. In the spring, a portion of the tagged fish reentered the Delaware River estuary. However, many fish continued a northerly coastal migration through the Mid-Atlantic as well as into southern New England waters where they were recovered throughout the summer months. Movements as far north as Maine were documented. A southerly coastal migration was apparent from tag returns reported in the fall. The majority of these tag returns were reported from relatively shallow near shore fisheries with few fish reported from waters in excess of 25 meters (C. Shirey, Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC 2009). Areas where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy (e.g., Minas and Cumberland Basins), Massachusetts Bay, Connecticut River estuary, Long Island Sound, New York Bight, Delaware Bay, Chesapeake Bay, and waters off of North Carolina from the Virginia-North Carolina border to Cape Hatteras at depths up to 24 meters (Dovel and Berggren1983, Dadswell *et al.*1984, Johnson *et al.* 1997, Rochard *et al.* 1997, Kynard *et al.* 2000, Eyler *et al.* 2004, Stein *et al.* 2004, Wehrell 2005, Dadswell 2006, ASSRT 2007, Laney *et al.* 2007). These sites may be used as foraging sites and/or thermal refuge.

3.4.2. Determination of DPS Composition in the Action Area

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

3.4.3. Status and Trends of Atlantic Sturgeon Rangewide

Distribution and Abundance

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

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

3.4.4. Threats Faced by Atlantic sturgeon throughout their range

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

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

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

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

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

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

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

3.4.5. Gulf of Maine DPS of Atlantic sturgeon

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

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

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

Bigelow and Schroeder (1953) surmised that Atlantic sturgeon likely spawned in Gulf of Maine Rivers in May-July. More recent captures of Atlantic sturgeon in spawning condition within the Kennebec River suggest that spawning more likely occurs in June-July (Squiers *et al.* 1981, ASMFC 1998, NMFS and USFWS 1998). Evidence for the timing and location of Atlantic sturgeon spawning in the Kennebec River includes: (1) the capture of five adult male Atlantic sturgeon in spawning condition (i.e., expressing milt) in July 1994 below the (former) Edwards Dam; (2) capture of 31 adult Atlantic sturgeon from June 15,1980, through July 26,1980, in a small commercial fishery directed at Atlantic sturgeon from the South Gardiner area (above Merrymeeting Bay) that included at least four ripe males and one ripe female captured on July 26,1980; and, (3) capture of nine adults during a gillnet survey conducted from 1977-1981, the majority of which were captured in July in the area from Merrymeeting Bay and upriver as far as Gardiner, ME (NMFS and USFWS 1998, ASMFC 2007). The low salinity values for waters above Merrymeeting Bay are consistent with values found in other rivers where successful Atlantic sturgeon spawning is known to occur.

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

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

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot and Merrimack Rivers. While there are also dams on the Kennebec, Androscoggin and Saco Rivers, these dams are near the site of natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the Gulf of Maine region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. The extent that Atlantic sturgeon are affected by operations of dams in the Gulf of Maine region is currently unknown; however, as noted above, the documentation of an Atlantic sturgeon larva downstream of the Brunswick Dam in the Androscoggin River suggests that Atlantic sturgeon spawning may be occurring in the vicinity of at least that project and therefore, may be affected by project operations. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Veazie and Great Works Dams. Together these dams prevent Atlantic sturgeon from accessing approximately 29 km of habitat, including the presumed historical spawning habitat located downstream of Milford Falls, the site of the Milford Dam. While removal of the Veazie and Great Works Dams is anticipated to occur in the near future, the presence of these dams is currently preventing access to significant habitats within the Penobscot River. While Atlantic sturgeon are known to occur in the Penobscot River, it is unknown if spawning is currently occurring or whether the presence of the Veazie and Great Works Dams affects the likelihood of spawning occurring in this river. The Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River, but spawning has not been documented. Like the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning occurring in this river.

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

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

Summary of the Gulf of Maine DPS

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

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

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

3.4.6. New York Bight DPS of Atlantic sturgeon

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

Taunton Rivers as part of their overall marine range (ASSRT 2007, Savoy 2007, Wirgin and King 2011).

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

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

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

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

The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800's is unknown but, has been conservatively estimated at 10,000 adult females (Secor 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor 2002, ASSRT 2007, Kahnle *et al.* 2007). As described above, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007). Kahnle *et al.* (1998, 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment. All available data on abundance of juvenile Atlantic sturgeon in the Hudson River Estuary indicate a substantial drop in production of young since the mid 1970's (Kahnle *et al.* 1998). A decline appeared to occur in the mid to late 1970's followed by a secondary drop in the late 1980's (Kahnle *et al.* 1998, Sweka *et al.* 2007, ASMFC 2010). Catch-per-unit-effort data suggest that recruitment has remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980's (Sweka *et al.* 2007, ASMFC 2010). In examining the CPUE data from 1985-2007, there are significant fluctuations during this time. There appears to be a decline in the number of juveniles between the late 1980s and early 1990s and while the CPUE is generally higher in the 2000s as compared to the 1990s, given the significant annual fluctuation it is difficult to discern any trend. Despite the CPUEs from 2000-2007 being generally higher than those from 1990-1999, they are low compared to the late 1980s. There is currently not enough information regarding any life stage to establish a trend for the Hudson River population.

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

Historical records from the 1830's indicate Atlantic sturgeon may have spawned as far north as Bordentown, just below Trenton, NJ (Pennsylvania Commission of Fisheries 1897). Cobb (1899) and Borodin (1925) reported spawning occurring between rkm 77 and 130 (Delaware City, DE to Chester City, PA). Based on recent tagging and tracking studies carried out from 2009-2011, Breece (2011) reports likely spawning locations at rkm 120-150 and rkm 170-190. Mature adults have been tracked in these areas at the time of year when spawning is expected to occur and movements have been consistent with what would be expected from spawning adults.

Based on tagging and tracking studies, Simpson (2008) suggested that spawning habitat also exists from Tinicum Island (rkm 136) to the fall line in Trenton, NJ (rkm 211). To date, eggs and larvae have not been documented to confirm that actual spawning is occurring in these areas. However, as noted below, the presence of young of the year in the Delaware River provides confirmation that spawning is still occurring in this river.

Sampling in 2009 that targeted YOY resulted in the capture of more than 60 YOY in the Marcus Hook anchorage (rkm 127) area during late October-late November 2009 (Fisher 2009, Calvo *et al.* 2010). Twenty of the YOY from one study and six from the second study received acoustic tags that provided information on habitat use by this early life stage (Calvo *et al.* 2010, Fisher 2011). YOY used several areas from Deepwater (rkm 105) to Roebling (rkm 199) during late fall to early spring. Some remained in the Marcus Hook area while others moved upstream, exhibiting migrations in and out of the area during winter months (Calvo *et al.* 2010, Fisher 2011). At least one YOY spent some time downstream of Marcus Hook (Calvo *et al.* 2010, Fisher 2011). Downstream detections from May to August between Philadelphia (rkm 150) and New Castle (rkm 100) suggest non-use of the upriver locations during the summer months (Fisher 2011). By September 2010, only three of 20 individuals tagged by DE DNREC persisted with active tags (Fisher 2011). One of these migrated upstream to the Newbold Island and Roebling area (rkm 195), but was back down in the lower tidal area within three weeks and was last detected at Tinicum Island (rkm 141) when the transmitter expired in October (Fisher 2011). The other two remained in the Cherry Island Flats (rkm 113) and Marcus Hook Anchorage area (rkm130) until their tags transmissions also ended in October (Fisher 2011).

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

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

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

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

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

Summary of the New York Bight DPS

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

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

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

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

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

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

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

3.4.7. Factors Affecting Atlantic Sturgeon in Action Area

3.4.7.1.Dams and Hydroelectric Facilities

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot River. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Veazie and Great Works Dams. Together these dams prevent Atlantic sturgeon from accessing approximately 29 km of habitat, including the presumed historical spawning habitat located downstream of Milford Falls, the site of the Milford Dam. While removal of the Veazie and Great Works Dams is anticipated to occur in the near future, the presence of these dams is currently preventing access to significant habitats within the Penobscot River. While Atlantic sturgeon are known to occur in the Penobscot River, it is unknown if spawning is currently occurring or whether the presence of the Veazie and Great Works Dams affects the likelihood of spawning occurring in this river. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the Penobscot River, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in the action area. The extent that Atlantic sturgeon are affected by operations of hydroelectric facilities in the Penobscot River is currently unknown.

3.4.7.2.Contaminants and Water Quality

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

3.5 Summary of Information on Listed Species and Critical Habitat in the Action Area

3.5.1. Summary of Information on Atlantic Salmon in the Action Area

Adult returns for the GOM DPS remain well below conservation spawning escapement (CSE). For all GOM DPS rivers in Maine, current Atlantic salmon populations (including hatchery contributions) are well below CSE levels required to sustain themselves (Fay *et al.* 2006), which is further indication of their poor population status. The abundance of Atlantic salmon in the GOM DPS has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is very small (approximately 6% over the last ten years) and is continuing to decline. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to halt the decline of the naturally reared component of the GOM DPS.

3.5.2. Summary of Information on Critical Habitat in the Action Area

A number of activities within the Penobscot Bay SHRU will likely continue to impact the biological and physical features of spawning, rearing, and migration habitat for Atlantic salmon. These include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-crossings and other instream activities (such as alternative energy development), mining, dams, dredging, and aquaculture. Dams, along with degraded substrate and cover, water quality, water temperature, and biological communities, have reduced the quality and quantity of habitat available to Atlantic salmon populations within the Penobscot Bay SHRU. The removal of the two lowermost dams on the Penobscot is anticipated to significantly improve upstream passage and downstream survival, and will likely lead to an increase in the abundance of returning Atlantic salmon.

3.5.3. Summary of Information on Shortnose Sturgeon in the Action Area

As noted above, several population estimates have been made for the Penobscot River, ranging from several 602-1654 adult shortnose sturgeon (Fernandes 2008, Fernandes *et al.* 2010, Zydlewski *et al.* 2010 in MDMR 2010). Telemetry studies indicate that while shortnose sturgeon are present in the river and estuary throughout the year, their movements vary by season in response to water temperature and flow. From mid-October to mid-April most tagged shortnose sturgeon concentrate in a relatively small section of river in the Bangor area. Following this overwintering period they move downstream into the estuary, until returning upstream in summer during low flows. Tagged fish were observed to move as far upstream as two 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). 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, we believe 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 five of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting healthy populations are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

While no reliable estimate of the 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, we believe 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.

3.5.4. Summary of Information on Atlantic Sturgeon in the Action Area

Atlantic sturgeon adults and subadults are likely to be present in the action area in the spring as they move from oceanic overwintering sites to upstream foraging and resting sites and then migrate back out of the area as they move to lower reaches of the estuary or oceanic areas in the late summer. During other times of the year, individuals are likely migrating within the marine environment or transitioning from and to overwintering and foraging areas within larger rivers along the coast (e.g., Kennebec and Androscoggin). Tracking data from tagged Atlantic sturgeon indicates that during the spring and summer, individuals are most likely to occur within rkm 21-24.5 (Fernandes *et al.* 2010). During this time, most Atlantic sturgeon are located between a 1.5 km stretch from rkm 23 to rkm 24.5. During the winter months, subadult Atlantic sturgeon are most likely to occur over a two km stretch around rkm 36.5 (Fernandes *et al.* 2010). However, in 2011 the overwintering site moved further upstream into the Bangor headpond area within Ecozone one at approximately rkm 43. As explained above, Atlantic sturgeon in the action area are likely to have originated from the GOM DPS and NYB DPS with the majority of individuals originating from the GOM DPS, and all of those individuals originating from the Kennebec River.

4. ENVIRONMENTAL BASELINE OF THE ACTION AREA

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

4.1. Formal or Early Section 7 Consultations

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

On April 25, 2012, we issued an Opinion to the NMFS Northeast Fisheries Science Center, Maine Field Station on the impacts to listed species from the proposed Penobscot Estuarine Fish Community and Ecosystem Survey. The NEFSC is continuing to develop and refine a long term study plan to evaluate the feasibility of various capture methods with the goal of establishing a comprehensive ecosystem survey to document the distribution and relative abundance of aquatic species in estuarine and nearshore environments of the Penobscot River. The purpose of the proposed research survey is to develop consistent sampling methods and test efficacy of a variety of sampling techniques and gear types at numerous sites to measure estuary fish communities with a focus on diadromous fish species. We concluded that the proposed action was not likely to jeopardize the continued existence of listed Atlantic salmon, shortnose sturgeon or Atlantic sturgeon. The ITS accompanying the Opinion exempted the incidental take of up to 15 Atlantic sturgeon juveniles and/or subadults (4 St. John River (Canada), nine GOM DPS and two NYB DPS) and up to 32 shortnose sturgeon juveniles and/or adults. We hold an ESA section 10 (a)(l)(A) research permit (ESA permit 697823) from the USFWS. As all effects to Atlantic salmon resulting from the estuary study will be considered and authorized under this permit, take of Atlantic salmon was not exempted as part of the consultation.

Penobscot River Restoration Project

On December 23, 2009, we issued an Opinion to FERC on the surrender of licenses for the Veazie, Great Works and Howland Projects. The projects were decommissioned and purchased by the Penobscot River Restoration Trust. The Trust's intent is to restore migratory access and habitat for multiple species of diadromous fish in the Penobscot River. 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. The Opinion considered take associated with the 6-year interim period prior to the dam removals, during which time listed fish would be affected by the presence of the dams. In the Opinion, we 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 not more than 5.8% of Atlantic salmon smolts in the Penobscot River would be delayed[4], injured, or killed during interim operations of the Great Works Project for 2-years. At Veazie and Howland, we anticipated 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, we expect 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. The proposed action is also 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, since they will not be able to access the upriver extent of their historic range near Milford. 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.

The dam removals associated with the PRRP will occur at the beginning of the term covered by the proposed action (likely between 2012 and 2014). The removal of the Great Works Dam is already underway. Therefore, the condition of the river after the removal of the dams will be considered as the Environmental Baseline for this consultation. The schedule for the implementation of the dam removals is 1) removal of the Great Works Project will be completed by November 2012, 2) the Veazie Project will be removed in 2013 or 2014, and 3) the bypass around the Howland Dam will be constructed in 2014, at the earliest.

Once the Veazie and Great Works Projects are removed, the Milford Project, located on the eastern side of Marsh Island in Milford, will be the lowermost dam on the mainstem Penobscot River (Figure 1).

The removal of the dams associated with the PRRP is anticipated to have significant effects on the survival of Atlantic salmon migrating in the mainstem of the Penobscot River. Two modeling efforts have been undertaken, one by USFWS and one by us, to predict the effect of this project on Atlantic salmon in the Penobscot River. The models only considered the effect of the components of the PRRP that have already undergone section 7 consultation (i.e. the removal of the Great Works and Veazie Dams, and a new upstream fish bypass at the Howland Project).

NMFS's Northeast Fisheries Science Center (NEFSC) has constructed a Dam Impact Analysis (DIA) model that will facilitate the determination of the effects of the proposed action on Atlantic salmon survival and recovery in the Penobscot Bay SHRU (NMFS 2012; Appendix C). Using estimates of smolt survival at dams provided by Alden Lab (2012) (Table 6), the DIA model estimates survival (both survival of downstream migrating smolts, as well as passage success of upstream migrants) at the West Enfield, Milford, Orono and Stillwater Projects under current operations, post-PRRP (the dam removals and fishway around Howland), and under the proposed action (new powerhouses, improved fish passage facilities and upstream and downstream passage performance standards); in addition to relating the results to survival and recovery of Atlantic salmon in the Penobscot Bay SHRU. The model's predictions for the

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

environmental baseline (both before and after the dam removals) condition are considered here; whereas the analysis that addresses the result of the proposed action will be considered in Section 6 and Section 8.

According to the DIA model (NMFS 2012), the removal of the dams will increase both the proportion of outmigrating smolts surviving to Verona Island at the mouth of Penobscot Bay, and the proportion of returning 2SW females. The model predicts that the dam removals will lead to a 68% relative reduction in the proportion of outmigrating salmon smolts that are killed prior to reaching the estuary when compared to the existing conditions. The DIA model also predicts a 79% relative increase in the number of returning 2SW female Atlantic salmon when compared to existing conditions (Figure 8).

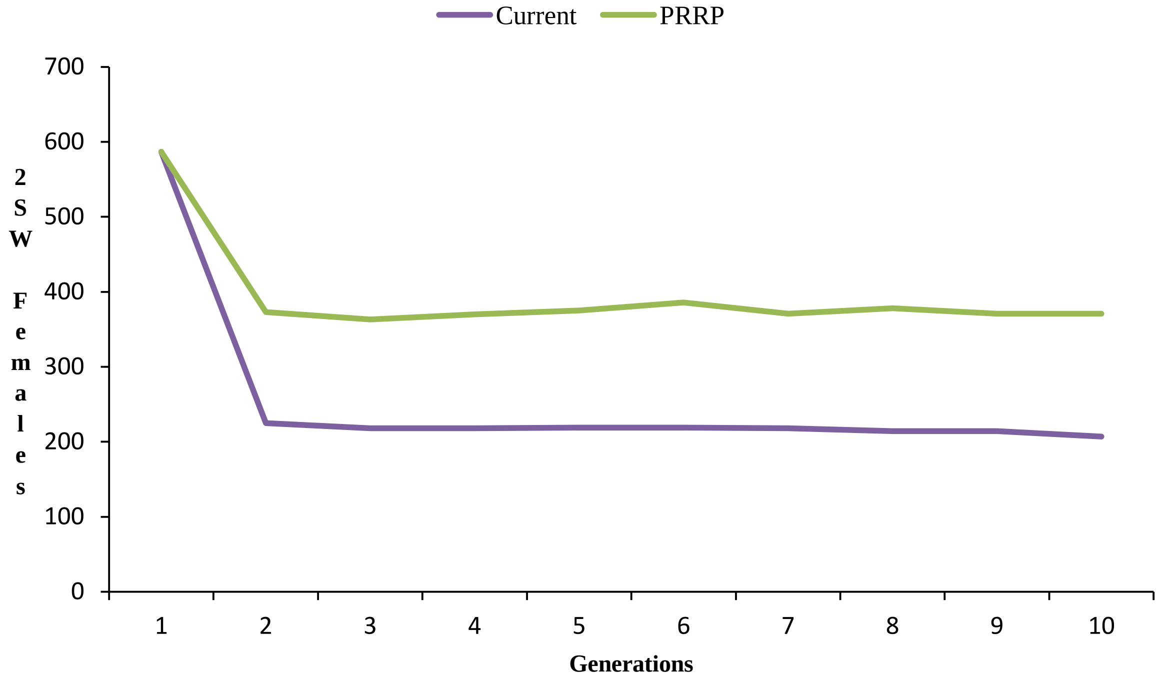

Figure 8. Comparison of the simulated number of returning 2SW female Atlantic salmon over ten generations according to the DIA model under existing conditions and conditions expected after the removal of the Veazie and Great Works Dams, as well as the construction of a bypass around the Howland Dam (PRRP).

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

The DIA model (NMFS 2012) also predicted the effect that the dam removals will have on the distribution of Atlantic salmon in the Penobscot River. The metric used for distribution was the proportion of Atlantic salmon runs where at least one 2SW female successfully migrated past the West Enfield Project in the mainstem of the Penobscot, or the Howland Project in the Piscataquis River. These landmarks were chosen as 92% of high quality spawning and rearing habitat in the Penobscot River watershed occurs upriver of these locations (NMFS 2009). Access to this habitat is critical to the survival and recovery of the species in the Penobscot Bay SHRU. The model indicates that after ten generations under existing conditions only 64% of runs will have individuals accessing the habitat in the Upper Penobscot and the Piscataquis Rivers. After the dam removals have been completed, however, the DIA model predicts that the proportion of successful runs could increase to 90%, a 41% relative increase over existing conditions (Table 9).

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

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

Given the results of the NMFS and USFWS models, it is anticipated that the PRRP could significantly decrease the mortality of downstream migrating smolts, as well as increase the proportion of pre-spawn Atlantic salmon that can successfully migrate to suitable spawning habitat in the upper Penobscot River and Piscataquis River. Both models also indicate a corresponding increase in the population growth rate over the next several generations due to the dam removal activities associated with the PRRP.

Atlantic and shortnose sturgeon

In addition to the anticipated effects on listed Atlantic salmon, it is expected that the dam removals associated with the PRRP will restore a significant amount of habitat to Atlantic and shortnose sturgeon in the Penobscot River. Currently, shortnose and Atlantic sturgeon are limited to the area below Veazie Dam. Existing fish passage facilities at the Veazie Dam are not used by sturgeon, and no 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 the existing location of the Milford Project (L. Flagg, MDMR, pers. comm. 1998). Therefore, the removal of the Veazie and Great Works Projects will allow both shortnose and Atlantic sturgeon to access habitat all the way up to the base of the Milford Dam, fourteen river kilometers upstream of Veazie on the mainstem, and the Orono Dam at the mouth of the Stillwater Branch. It is anticipated that the removal of the dams will provide natural passage to all historic spawning and rearing habitat for sturgeon downriver of these two projects.

4.2. Scientific Studies

Atlantic salmon

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

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

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

Shortnose sturgeon

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

Atlantic sturgeon

The MDMR, in collaboration with scientists at UM and others, proposes to conduct studies on the Atlantic sturgeon population in the GOM DPS. The research proposed to be conducted through a scientific research permit (NMFS No. 16526) would include determining movement patterns and rate of exchange between coastal river systems, characterizing the population structure (i.e., sex ratios and aging), and generating estimates of population abundance. The proposed action would involve several major river systems in Maine, including the Penobscot, Kennebec, Androscoggin and Sheepscot rivers. Smaller coastal rivers throughout Maine would also be targeted. The applicant would use gill nets to capture up to 975 juvenile and adult Atlantic sturgeon, and D-nets to sample 200 early life stage (ELS) annually. Atlantic sturgeon captured by gill nets, trammel nets, trawls, and beach seines would be measured, weighed, photographed, PIT tagged, Floy/T-bar tagged, tissue sampled, boroscoped, apical spine sampled, blood sampled, anesthetized, fin ray sectioned, and implanted with an acoustic telemetry tag. The applicant would use MS-222 as an anesthetic or on occasion, electronarcosis; see the application for further details. Not all Atlantic sturgeon would undergo all procedures. In total, up to 200 ELS, plus two annual incidental mortalities of juvenile Atlantic sturgeon and up to one adult Atlantic sturgeon over the life of the permit would be anticipated as the result of research. Research conducted prior to issuance of this permit has demonstrated a low mortality rate using similar gear types; approximately 120 Atlantic sturgeon were captured over a five year study with four incidental mortalities occurring to juvenile fish. This research would take place concurrently with authorized shortnose sturgeon research conducted in the Penobscot River under current Permit No. 1595.

4.3. Other Federally Authorized Activities in the Action Area

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

4.4. State or Private Activities in the Action Area

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

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

4.5. Impacts of Other Human Activities in the Action Area

Other human activities that may affect listed species and critical habitat include direct and indirect modification of habitat due to hydroelectric facilities and the introduction of pollutants from paper mills, sewers, and other industrial sources. Pollution has been a major problem for this river system, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons). Hydroelectric facilities can alter the river's natural flow pattern and temperatures. In addition, the release of silt and other fine river sediments during dam maintenance can be deposited in sensitive spawning habitat nearby. These facilities also act as barriers to normal upstream and downstream movements, and block access to important habitats. Passage through these facilities may result in the mortality of downstream migrants.

5. CLIMATE CHANGE

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

5.1. Background Information on Global climate change

The global mean temperature has risen 0.76ºC (1.36°F) over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007) and precipitation has increased nationally by 5%-10%, mostly due to an increase in heavy downpours (NAST 2000). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. Ocean acidification resulting from massive amounts of carbon dioxide and other pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007); these trends are most apparent over the past few decades. Information on future impacts of climate change in the action area is discussed below.

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

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

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the Penobscot River, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the U.S. Warming is very likely to continue in the U.S. over the next 25 to 50 years regardless of reduction in GHGs, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that the rate of change will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

A warmer and drier climate is expected to result in reductions in stream flows and increases in water temperatures. Expected consequences could be a decrease in the amount of dissolved oxygen in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch *et al.* 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants other than heat currently degrade water quality (Murdoch *et al.* 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer *et al.* 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development may experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer *et al.* 2008).

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

5.2. Species Specific Information on Climate Change Effects

5.2.1. Effects to Atlantic Salmon and Critical Habitat

Atlantic salmon may be especially vulnerable to the effects of climate change in New England, since the areas surrounding many river catchments where salmon are found are heavily populated and have already been affected by a range of stresses associated with agriculture, industrialization, and urbanization (Elliot *et al*. 1998). Climate effects related to temperature regimes and flow conditions determine juvenile salmon growth and habitat (Friedland1998). One study conducted in the Connecticut and Penobscot rivers, where temperatures and average discharge rates have been increasing over the last 25 years, found that dates of first capture and median capture dates for Atlantic salmon have shifted earlier by about 0.5 days/ year, and these consistent shifts are correlated with long-term changes in temperature and flow (Juanes *et al*. 2004). Temperature increases are also expected to reduce the abundance of salmon returning to home waters, particularly at the southern limits of Atlantic salmon spatial distribution (Beaugrand and Reid 2003).

One recent study conducted in the United Kingdom that used data collected over a 20-year period in the Wye River found Atlantic salmon populations have declined substantially and this decline was best explained by climatic factors like increasing summer temperatures and reduced discharge more than any other factor (Clews *et al*. 2010). Changes in temperature and flow serve as cues for salmon to migrate, and smolts entering the ocean either too late or too early would then begin their post-smolt year in such a way that could be less optimal for opportunities to feed, predator risks, and/or thermal stress (Friedland 1998). Since the highest mortality affecting Atlantic salmon occurs in the marine phase, both the temperature and the productivity of the coastal environment may be critical to survival (Drinkwater *et al.* 2003). Temperature influences the length of egg incubation periods for salmonids (Elliot *et al*. 1998) and higher water temperatures could accelerate embryo development of salmon and cause premature emergence of fry.

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

The productivity and feeding conditions in Atlantic salmon’s overwintering regions in the ocean are critical in determining the final weight of individual salmon and whether they have sufficient energy to migrate upriver to spawn (Lehodey *et al*. 2006). Survival is inversely related to body size in pelagic fishes, and temperature has a direct effect on growth that will affect growth-related sources of mortality in post-smolts (Friedland 1998). Post-smolt growth increases in a linear trend with temperature, but eventually reaches a maximum rate and decreases at high temperatures (Brett 1979 in Friedland 1998). When at sea, Atlantic salmon eat crustaceans and small fishes, such as herring, sprat, sand-eels, capelin, and small gadids, and when in freshwater, adults do not feed but juveniles eat aquatic insect larvae (FAO 2012). Species with calcium carbonate skeletons, such as the crustaceans that salmon sometimes eat, are particularly susceptible to ocean acidification, since ocean acidification will reduce the carbonate availability necessary for shell formation (Wood *et al*. 2008). Climate change is likely to affect the abundance, diversity, and composition of plankton, and these changes may have important consequences for higher trophic levels like Atlantic salmon (Beaugrand and Reid 2003).

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

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

It is anticipated that these climate change effects could significantly affect the functioning of the Atlantic salmon critical habitat. Increased temperatures will affect the timing of upstream and downstream migration and make some areas unsuitable as temporary holding and resting areas. Higher temperatures could also reduce the amount of time that conditions are appropriate for migration (<23 degrees Celsius), which could affect an individual's ability to access suitable spawning habitat. In addition, elevated temperatures will make some areas unsuitable for spawning and rearing due to effects to egg and embryo development.

5.2.2. Shortnose sturgeon

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

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

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

5.2.3. Atlantic sturgeon

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

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

6. EFFECTS OF THE ACTION

This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). The trapping of Atlantic salmon broodstock by MDMR will occur at the Milford and Orono fish traps after the proposed action has occurred. This activity would not occur but for the construction of the fish traps. However, as this activity has already been authorized under a research and recovery blanket permit with USFWS (permit number 697823); its effects will not be addressed in this Opinion. We have not identified any other interrelated or interdependent actions.

These activities will affect the GOM DPS of Atlantic salmon, shortnose sturgeon, the GOM DPS of Atlantic sturgeon and the New York Bight DPS of Atlantic sturgeon as well as critical habitat designated from the GOM DPS of Atlantic salmon. The sections that follow present our analysis of the following: (1) construction of new powerhouses and fish passage facilities; (2) hydroelectric operations under the terms of the revised licenses; and (3) implementation of upstream and downstream fish passage efficiency and survival studies required by the licenses.

6.1. Effects of Powerhouse and Fishway Construction

Effects of the construction of powerhouses and fishways at the Orono, Stillwater and Milford Projects are likely to be restricted to the area between the Milford and Veazie Dams on the mainstem, and the Stillwater Branch downstream of the Stillwater Dam. As shortnose and Atlantic sturgeon do not use the fish passage facilities at Veazie, they are restricted to habitat below the Veazie Dam. The Veazie Dam is approximately 4.5 miles downriver from the Orono Project and nearly 9 miles downriver of Milford Dam. The Veazie Dam is proposed for removal in 2013-2014. The Great Works Dam which is the next dam on the river is in the process of being removed. After Veazie and Great Works are removed, sturgeon will be able to reach the Orono project on the Stillwater Branch and the Milford Project on the Penobscot River mainstem. Powerhouse and fishway construction at Orono is scheduled to be completed in 2013, prior to the removal of the Veazie Dam. Fishway construction at Milford is scheduled to be completed in 2012, also prior to removal of the Veazie Dam. Effects of powerhouse and fishway construction will not be experienced below the Veazie Dam; as such, no shortnose or Atlantic sturgeon will be exposed to effects of any of the proposed powerhouse and fishway construction.

The mainstem Penobscot River serves as an important migratory corridor for adult Atlantic salmon migrating upriver to spawning habitat between May and October, as well as to outmigrating smolts between April and June and outmigrating kelts in early winter and spring. The potential effects associated with the construction of powerhouses at Orono and Stillwater and fishways at Orono and Milford include inhibiting fish passage during construction, increasing noise and suspended sediment levels, causing direct injury and mortality during construction, and potentially spilling toxic substances (e.g., equipment leaks). The effects of construction on Atlantic salmon are considered below.

6.1.1. Fish Passage

Activities associated with the construction of new powerhouses at the Orono and Stillwater Projects, as well as the fishway improvements at the Milford, Orono and Stillwater Projects, have the potential to affect Atlantic salmon in the lower Penobscot River by increasing turbidity and noise levels. To minimize exposure, in-water construction activities have been timed to avoid smolt and kelt outmigration periods. As such, no Atlantic salmon smolts or kelts are expected to be affected by these activities. Therefore, only passage of upstream migrating Atlantic salmon adults could be affected by construction activities.

Construction is anticipated to commence in late summer of 2012, and will be completed by the end of 2013. The majority of in-water construction is anticipated to occur in 2012. The Penobscot River Restoration Trust (PRRT) has arranged for MDMR to trap and truck migrating adult Atlantic salmon that have been trapped at the Veazie Dam upriver of the Milford Project during the removal of the Great Works Dam, which began in June 2012. However, it is likely that trucking will have ceased by late summer when construction at the Orono, Stillwater and Milford Projects is expected to commence. At that point all upstream migrants will be released into the Veazie headpond. Based on Atlantic salmon returns between 2007 and 2010, 7% of the run passes the Veazie Project between August and October. Therefore, it is expected that at least 7% of the Atlantic salmon run in the Penobscot could be migrating through the project area during construction activities in the late summer and fall of 2012. As Great Works Dam will have been breached, and the Denil fishway at Milford will be operational, it is anticipated that these fish will be able to migrate successfully through the River.

In 2013, the Great Works Dam will have been removed and trucking of Atlantic salmon upriver of Milford will not be conducted. Therefore, the entirety of the salmon run will be migrating through the mainstem of the Penobscot River and could be exposed to the effects of the remaining in-water construction activities (primarily cofferdam removal).

Adult migrating salmon are attracted to the discharge of the existing powerhouse at the Orono project, where they can be significantly delayed. The powerhouse discharges into the mainstem of the River, adjacent to the confluence with the Stillwater Branch. Shepard (1995) determined that 46% (56% in 1988 and 37% in 1989) of tagged salmon were attracted to this discharge and delayed for a median of 8.30 hours in 1988 and 2.18 hours in 1989. The duration of the delay in 1988 ranged between 0.3 hours to 247.4 hours. Shepard (1995) indicated that all of these fish eventually continued their upstream migration in the mainstem. Of the fish attracted to the discharge, only 33% were recorded spending more than 48 hours in the tailrace of the Project (S. Shepard, personal communication, 2012). Many of the salmon tracked during this study were originally stocked in the mainstem, and, therefore, may not have been motivated to migrate any further upriver. This would suggest that the proportion of Atlantic salmon that were attracted to the discharge at Orono may be larger than what would be expected for wild fish, or for fish that were stocked as smolts further upriver. However, this study provides the best available information regarding what proportion of Atlantic salmon migrating through the Penobscot River could be attracted to the discharge of the powerhouse in Orono. Therefore, the level of delay observed by Shepard (1995) is a conservative estimate of what would be expected at the Orono Project during the 2012 construction season.

While the intake cofferdam is in place in 2013 (July to October) Black Bear proposes to pass all flows over the spillway, which will temporarily eliminate the discharge from the existing powerhouse. Therefore, salmon will be attracted to spillage in the bypass rather than to discharge from the powerhouse during this stage of construction. Based on Atlantic salmon returns between 2007 and 2010, 23% of the run passes the Veazie Project between July and October. As the spillway is more than 800 feet from the confluence with the mainstem, it is possible that the decrease in attraction to the river will lead to increased delay at the Orono Project during construction. However, it is impossible to predict what level of increased delay would occur. Therefore, it is assumed that 33% of the salmon that are attracted to the increased spillage will be significantly delayed during the period when the intake cofferdam is in place in 2013. This equates to approximately 3% of the entire run in 2013 (23% of the run between July and October x 46% attracted to discharge x 33% of the fish delayed by more than 48 hours= 3%).

As there is no upstream passage into the Stillwater Branch, it is anticipated that very few Atlantic salmon will be able to access the construction area between the Orono and Stillwater Projects. However, a proportion of Atlantic salmon are known to drop back in the river during their upstream migration. In 2002-2004 and 2010, the proportion of Atlantic salmon that were released into the Veazie headpond that dropped downriver and were recaptured in the Veazie trap ranged between 0.8% and 9.4%, with an average of 5.9% (Holbrook *et al.* 2009, MDMR unpublished data). Fall back over Veazie is a conservative estimate of fall back into the Stillwater Branch; however, it is the best available information of fall back rates in the lower Penobscot River. Therefore, based on this recapture rate, and assuming that the fish fall back into the mainstem Penobscot and Stillwater Branch in equal proportion, it can be estimated that no more than 0.3% (7% of the salmon run x maximum 9.4% fall back x 50% split between Stillwater and mainstem) of the salmon run in 2012 will fall back into the Stillwater Branch and, therefore, could be exposed to effects associated with construction at the Stillwater Project.

6.1.2. Cofferdam Construction

As discussed previously, construction activities will likely commence between August and October in 2012, when approximately 7% of the salmon run could be expected to be migrating through the mainstem of the Penobscot River. In this timeframe, enclosed cofferdams will be constructed at the Orono, Stillwater and Milford Projects to create a dry work area for construction of the new powerhouses, tailraces and fishways. The construction of cofferdams can entrap fish within the cofferdam, and expose fish to elevated sediment and noise levels. The cofferdams at the Stillwater and Orono Projects will temporarily isolate a combined 2.6 acres of habitat in the Stillwater Branch of the Penobscot River. In addition, the Milford Dam will require the isolation of approximately 500 square feet of habitat in the mainstem Penobscot River for the construction of the new fishways.

Isolation of a work area within a cofferdam minimizes the overall adverse effects of construction activities on Atlantic salmon and their habitat because it reduces exposure to in-water construction activities. However, isolating the work area within a cofferdam could lead to negative impacts on fish if any are trapped within the isolated work area. Given the level of instream activity associated with setting up the cofferdams and other construction-related activities along the stream banks, any adult salmon present in the project area are expected to move away from the work zone. Given that the majority of construction activity is in the Stillwater Branch and not in the mainstem, which is the primary migratory corridor, this movement away from the construction area is not likely to halt or hinder migration through the Penobscot. However, it is still possible that salmon could become entrapped within the cofferdams, if they are constructed in the wet. Therefore, in order to minimize the probability of entrapping an adult Atlantic salmon within the work area, a visual survey of these areas will be conducted by qualified personnel to verify that there are no salmon within the project area prior to and during the installation and removal of any in-water bypass structure, including cofferdams. If Atlantic salmon are found within a cofferdam, they will be removed and returned to the River prior to dewatering. The implementation of such an evacuation plan will minimize the effect so that entrapped fish would not be anticipated to be injured or killed by the construction and dewatering of the proposed cofferdams.

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

6.1.3. Water Quality Effects

Sediments and Turbidity

Construction of new powerhouses, fishways and associated features would require the use of extensive heavy equipment in the Penobscot River. Construction activities associated with the proposed project, including cofferdam construction and removal and access road construction, will temporarily introduce sediment and increase turbidity in the Penobscot River. While Black Bear will employ erosion and sedimentation BMPs to prevent and minimize erosion and sedimentation during construction, some release of fine materials and turbidity is likely to occur as a result of these in-water activities.

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

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

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

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

In-water work will primarily be conducted on ledge within dewatered bypass reaches or within the confines of dewatered cofferdams; therefore, sediment releases are only anticipated during the installation and removal of these cofferdams. Single day TSS levels in excess of 50 mg/l are not anticipated during these activities because: 1) BMPs for erosion and sedimentation control will be employed throughout construction; 2) flow will be managed at the Projects to minimize flow into the work area; and, 3) the majority of excavation will occur on ledge. Therefore, we do not expect any Atlantic salmon to be injured or killed due to exposure to elevated TSS or sediments during construction activities. Atlantic salmon may experience behavioral avoidance of turbid waters during construction, which could cause a change in migratory route. As there is ample space available in the river for migration, a minor change in route should not adversely affect upriver migration for salmon. It is unlikely that any significant number of parr would be present below each project during construction since the area is not stocked with fry or parr and natural reproduction in these areas is not known to occur. Construction will occur outside of the smolt outmigration period so it is not anticipated that any smolts will be affected by sediments released by construction.

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, Black Bear 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 as a result of contaminants from heavy equipment in the action area would be discountable.

6.1.4. Ledge Removal Effects

Ledge removal is proposed to occur in the tailraces of the new powerhouses at the Orono and Stillwater Projects (Table 10). Ledge will be removed by drilling and blasting. Holes will be drilled into the bedrock down to a specified depth and then blast charges will be installed in the resulting cavities. Upon blasting the fractured bedrock will be removed by mechanical means such as an excavator or a crane.

Table 10. Volume of ledge that will be removed via drilling and blasting at the Orono and Stillwater Projects.

	Blasting Impacts (cy)	
	Orono	Stillwater
Powerhouse	1900	1500
Forebay	50	0
Tailrace 1	1100	590
Tailrace 2	500	2320
Total	3550	4410

Blasting

The use of explosives in or near water produces a post-detonation compression shock wave with a rapid rise to a peak pressure followed by a rapid decay to below ambient hydrostatic pressure (Wright and Hopky 1998). This final pressure deficit causes most of the known adverse effects to fish from blasting by damaging the swim bladder, kidney, liver, spleen, and circulatory system (sinus venous). Any of these organs may rupture or hemorrhage as a result of blasting, with the swim bladder being the most sensitive. The effects on fish are variable and relate to the type of explosive; size and pattern of charges; method of detonation; distance from the point of detonation; water depth; and species, size and life stage of fish. Small fish, including juvenile salmon, are more likely to be injured by an explosion than large fish (ADFG 1991). Shock waves generated by in-water explosions generally have more adverse effects on fish than underground explosions, in part because some energy is reflected and lost at the ground-water interface. Underwater explosions that are contained (e.g., explosive placed within a pier for demolition by drilling and covering), however, reduce the capacity of the water-borne shock wave to cause fish mortality when compared to an unconfined underwater explosion (Keevin 1998).

In 2010, monitoring was conducted in association with the installation of the Old Town Fuel and Fiber plant water intake structures on the Penobscot River in Old Town, Maine. As part of the project blasting was conducted within a dry earthen and portable fabric cofferdam to remove rock from the river bottom. No other means of noise mitigation (passive or active) were addressed or employed. Based on SPL waveform measurements taken ten meters from the source, unmitigated sound levels ranged from < 196.8 dB re: 1 μPa $_{PEAK}$ to 221.5 dB re: 1 μPa $_{PEAK}$. This is a similar technique to what Black Bear is proposing for the work at the Orono and Stillwater Projects; however, as the blasting will be occurring more than ten meters from the river the noise levels are anticipated to be lower.

Wright (1982) has demonstrated that effects on fish from blasting occur when the overpressure exceeds 100 kPa (kilopascals), or 14.5 pounds per square inch (which is equivalent to approximately 220 dB re: 1 μPa). This is the pressure limit used in guidelines developed by the Canadian Department of Fisheries and Oceans to protect fishery resources from explosions in or near water bodies (Wright and Hopky 1998). Black Bear has proposed to keep noise levels in the river below 187 dB$_{SEL}$ re: 1 μPa and 206 dB $_{PEAK}$ re: 1 μPa. They have proposed to do this by limiting charge weights, delaying individual blasts to reduce detonation related sound pressures, and by blasting within a dewatered cofferdam (Black Bear Amendment Applications 2011). These noise thresholds are based on the Fisheries Hydroacoustic Working Group (FHWG 2008) thresholds for injury to fish due to pile driving noise. The extent to which these thresholds apply to blasting is unknown; however, when compared to the threshold for blasting reported by Wright and Hopky (1998), the FHWG guidelines appear to be conservative.

As blasting will occur at the end of the adult salmon migration period (August to October), only 7% of the salmon run could be exposed to this activity. The blasting will occur in the dry within an earthen cofferdam that has been dewatered, and fish will not be able to get any closer to blasting and drilling activities than approximately 30 meters due to the location of the new tailraces within the cofferdams. Given the distance from the source, as well as the other minimization techniques proposed by Black Bear (blasting in the dry, limiting charge weights, delaying individual blasts, sound monitoring) we anticipate that no Atlantic salmon will be injured or killed due to the activities associated with tailrace excavation at the Orono and Stillwater Projects. However, it is anticipated that construction noise will lead to avoidance behavior in Atlantic salmon in the vicinity that may lead to minor migratory delays (less than 48 hours). As delay is anticipated to be brief, the noise effects associated with the construction of the powerhouses and tailraces will be insignificant.

As described above, adult Atlantic salmon may be exposed to changes in water quality and increased underwater noise associated with certain construction activities. In the worst case, Atlantic salmon in the project area will be exposed to increases in sediment and noise that could lead to an avoidance response, which could potentially lead to a minor delay in migration. As Black Bear has proposed several minimization techniques to keep noise levels from blasting and drilling below thresholds for injury to fish, no injuries or mortalities are anticipated from these activities. In addition, erosion and sedimentation control BMPs will be implemented to minimize the amount of sediment that enters the river, and will therefore, not lead to any lethal or injurious effects to fish. Therefore, all effects associated with the construction of new powerhouses and fishways at the Orono, Stillwater and Milford Projects are anticipated to be insignificant.

Drilling

Drills generate noise and vibrations when in operation as a result of friction between the drill bit face and the material it is boring through (i.e., rock is denser than sand or silt, so there is greater friction resulting in higher noise and vibration levels than for softer materials) (Transit Link Consultants 2008). The generated noise and vibration from the drill produces sound waves that transverse the substrate. Detailed data on the underwater noise associated with the exact drill to be used is not available, but information on underwater noise from geotechnical drills is available. As these drills work in the same fashion, it is reasonable to use the source levels associated with geotechnical drills as a surrogate for the specific drill to be used for this project. Unmitigated sound levels from underwater geotechnical drills have been estimated at 118-145 dB re 1uPa at 1 meter, with noise decreasing to 101.5 dB re 1uPa at 150 meters, 97.0 dB re 1uPa at 250 meters, and 94.1 dB re 1uPa at 350 meters. As noise produced by drilling in water is relatively low, and the proposed activity will occur within a dewatered cofferdam, it is expected that drilling will have an insignificant effect on Atlantic salmon.

6.1.5. Atlantic Salmon Critical Habitat

Proposed construction activities will temporarily reduce the status of several habitat indicators relative to Atlantic salmon critical habitat. We expect these activities to cause temporary adverse effects to the migratory PCE of critical habitat by reducing water quality due to increased noise and turbidity and the filling of habitat. The habitat in the Stillwater Branch does not currently function for upstream migration of pre-spawn adult Atlantic salmon due to the lack of fish passage facilities at both the Stillwater and Orono projects. However, the habitat does function as a migration corridor for outmigrating smolts and kelts in the spring as they make their way to the estuary. In addition, temporary effects (turbidity and noise) of the construction at the Orono and Stillwater Projects are anticipated to extend into the mainstem of the Penobscot River, which functions as migratory habitat for both pre-spawn adults and outmigrating smolts and kelts. Construction has been timed so that in-water effects to the habitat (turbidity, noise and the presence of temporary fill) will not coincide with the smolt outmigration period. However, construction effects may still reduce the functioning of the habitat for adult Atlantic salmon in the mainstem for short intervals.

The construction of the new powerhouses will place temporary and permanent fill below the ordinary high water (OHW) line in the Stillwater Branch of the Penobscot River (Table 11). The total temporary fill is 2.6 acres (115,470 square feet), while the permanent fill (new penstocks, powerhouses and site work) will eliminate 0.66 acres (28,999 square feet) of migratory habitat. As previously indicated, the majority of the temporary fill will be placed and removed in the Stillwater Branch outside of the spring outmigration period. Therefore, the placement of this fill is anticipated to have an insignificant effect on the migration PCE. However, the placement of permanent fill will negatively affect the functioning of the habitat in the bypass reach at both projects by precluding the use of the habitat for migration. However, as the permanent fill associated with the new structures will only occupy 0.02% of the migratory habitat in the Stillwater Branch, it is not anticipated that it will substantially alter the functioning of the habitat for Atlantic salmon.

There will be no permanent fill associated with the new fishway at Milford, although a small area (509 square feet) will be temporarily cofferdammed in the tailrace during construction. The cofferdam will be placed on ledge, so it is not anticipated that there will be a significant sediment release when it is removed. There will be no blasting or excavation associated with the project at Milford. As the Denil fishway at Milford will be maintained and operated during construction, it is anticipated that the effect of construction activities on these fish would be insignificant.

Table 11. Areas of effect associated with construction at the Orono, Stillwater and Milford Projects.

		Temporary (sf)	**Permanent (sf)**
Orono	Cofferdams	41,870	
	Penstock		10,985
	Site Work		7,607
	Powerhouse		3,300
	Total	**41,870**	**21,892**
Stillwater	Cofferdams	73,600	
	Site Work		2,982
	Powerhouse		4,125
	Total	**73,600**	**7,107**
Milford	Cofferdams	509	0
	Total	**509**	**0**

Construction of the new powerhouses without pass-through upstream fishways will continue to impair critical habitat for adults in the Stillwater branch. The installation of a fish trap at the Orono project will help to minimize these effects to critical habitat but will not completely eliminate them. If it is found that a significant number of adult Atlantic salmon are attracted to the Stillwater Branch, Black Bear will develop reasonable solutions for minimizing the effects to the PCE.

6.2. Effects of Hydroelectric Operations

Hydroelectric dams can impact Atlantic salmon, shortnose sturgeon and Atlantic sturgeon through habitat alteration, fish passage delays, entrainment in turbines and impingement on screens and/or racks. Currently, the Medway, West Enfield, Milford, Stillwater and Orono Projects are operated pursuant to the terms and conditions of existing FERC licenses. Existing FERC license articles require the projects to be operated in a run-of-river mode with minimal impoundment fluctuations. The license amendments will not alter the run-of-river requirement.

6.2.1. Atlantic salmon

The modified licenses proposed by FERC implement protection measures described in the SPP to achieve specified performance standards (96% downstream survival of smolts and 95% upstream passage efficiency) in order to minimize the effect of operations of Black Bear's hydroelectric facilities on migrating Atlantic salmon. The SPP involves the sequential implementation of three protective measures, interspersed with monitoring studies. Once the performance standards have been met no further measures will need to be implemented. However, it is possible that all three of the measures will need to be implemented and studied prior to the performance standards being achieved. Therefore, it is possible that there will be a ten year period between when the licenses are amended and the final study year where the performance standards are achieved. Since we cannot accurately predict the survival of Atlantic salmon achieved through each of the individual protection measures, it will be assumed that survival and passage efficiency at these projects will be maintained at existing levels throughout this period. Thereafter, it will be assumed that the performance standards have been achieved.

6.2.1.1.Upstream Passage Effects

To complete their upstream migration, all pre-spawn Atlantic salmon in the Penobscot River must navigate past numerous hydroelectric projects via fishways. Fishways collect motivated fish into human-made structures that allow them to proceed in their migration. These fish are necessarily crowded together into a narrow channel or trap, which exposes them to increased levels of injury and delay, as well as to stress from elevated water temperatures, energetic exhaustion and disease. Forcing fish to alter their migratory behavior and potentially exposing them to the corresponding stress and injury negatively affects 100% of the Atlantic salmon motivated to migrate past a hydroelectric project.

Atlantic salmon are known to successfully utilize upstream fishways at the Milford and West Enfield Projects. However, none of the fishways are 100% effective at passing Atlantic salmon. At Milford Dam, 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). Upstream passage efficiency ranged between 85% and 100% over four years of study at the West Enfield and Howland Projects, 20 miles upriver from Milford. Based upon radio telemetry studies conducted from 1989-1992, Shepard (1995) estimated pooled upstream passage rates for adult Atlantic salmon at the Howland and West Enfield from 88-89%.

The amended project licenses will require Black Bear to enhance fish passage through the lower Penobscot River by constructing new fish lifts at the Milford and Orono Projects. The new lift at the Milford Project will replace the existing Denil fishway and is intended to lead to higher upstream passage rates. The Denil may be deactivated while the fish lift is functioning, but can be reactivated if there are problems with the lift, or to provide volitional passage for Atlantic salmon in the future. The construction of the new fish trap at the Orono Project, where none has previously existed, should provide passage for Atlantic salmon that are attracted to the Orono bypass reach. As no passage will be provided at the Stillwater Project, salmon trapped at the Orono fish trap will be trapped and trucked upriver of the Milford Project. It is anticipated that a portion of the annual run of Atlantic salmon will be attracted to the spill at the Orono Dam, but that most individuals will migrate through the mainstem.

Adult salmon that are not passed at the Milford and West Enfield Projects will either spawn in downstream areas, return to the ocean without spawning, or die in the river. These salmon are significantly affected by the presence of fishways at the Milford and West Enfield Projects. Although no studies have looked directly at the fate of fish that fail to pass through upstream fish passage facilities on the Penobscot River, we convened an expert panel in 2010 to provide the best available information on the fate of these fish. The panel was comprised of state, federal, and private sector Atlantic salmon biologists and engineers with expertise in Atlantic salmon biology and behavior at fishways. The group estimated a baseline mortality rate of 1% for Atlantic salmon that fail to pass a fishway at a given dam on the Penobscot River (NMFS 2011, Appendix B). Dams that do not have fishways were not considered to have baseline mortality. Additional mortality was assumed based on project specific factors, such as predation, fish handling, high fall back rates, lack of thermal refugia, etc. The panel assumed an additional 1% mortality due to fall back at the Veazie Project caused by handling associated with the trapping and handling facilities. The proposed project includes the construction of a similar facility at the Milford Project. Therefore, the proposed project will increase the mortality rate of fish that fail to pass the Milford fishway by 1%. Therefore, it is assumed that under SPP conditions (post fishway construction) 2% of the Atlantic salmon that fail to pass the Milford Project will die; 1% due to baseline mortality and 1% due to increased fall back. Likewise, it is assumed for both the environmental baseline and SPP conditions at West Enfield that 2% of the Atlantic salmon that fail to pass the Project will be killed; 1% due to baseline mortality and 1% due to high fallback rates at that dam. The mortality rate at West Enfield is not expected to change after the implementation of the proposed project as there are no structural changes proposed to the Project. Under the baseline conditions, there is no mortality associated with attempted passage at the Orono Project as no upstream fish passage facilities currently exist. However, after the proposed fish trap has been constructed, it is assumed that 1% of the fish that enter the bypass reach and fail to find the fish trap may be killed.

Migratory Delay

In addition to documenting passage success, past studies at Milford and West Enfield have documented delays in upstream migrations for Atlantic salmon. The yearly pooled median passage time for adults at Milford Dam ranged from 1.0 days to 5.3 days over five years of study, while the total range of individual passage times over this study period was 0.1 days to 25.0 days. The yearly pooled median passage time for adults at the West Enfield or Howland Dam ranged from 1.1 days to 3.1 days over four years of study, while the total range of individual passage times over this study period was 0.9 days to 61.1 days (Shepard 1995).

To access high quality spawning and rearing habitat in the Penobscot River watershed, Atlantic salmon must migrate past multiple dams. Delay at these dams can, individually and cumulatively, affect an individual's ability to access suitable spawning habitat within the narrow window when conditions in the River are suitable for migration. In addition, delays in migration can cause overripening of eggs, increased chance of egg retention, and reduced egg viability in pre-spawn female salmonids (deGaudemar and Beal 1998). It cannot be known what level of delay at each of these dams would significantly affect a migrant's ability to access suitable spawning habitat, as it would be different for each individual, and would vary from year to year depending on environmental conditions. NMFS believes that 48 hours provide adequate opportunity for pre-spawn adult Atlantic salmon to locate and utilize well-designed upstream fishways at hydroelectric dams. Once the Veazie and Great Works Dams have been removed, keeping delay at each individual project below 48 hours would ensure a cumulative delay of under a week due to dams in the River (four days for fish migrating to the Piscataquis and Mattawamkeag Rivers, and six days for fish migrating to the East Branch of the Penobscot). Passage times in excess of 48 hours per project would result in unnatural delay for migrants that could make the suitable spawning habitat to which the salmon is migrating inaccessible. Therefore, we consider any adult salmon documented to take longer than 48 hours to pass an upstream passage facility to have been significantly delayed.

Performance Standard

Exact upstream fish passage efficiency and survival rates are not known at the Milford and West Enfield Projects under all operational and environmental conditions. However, based on the minimum passage rate cited in the available empirical studies, NMFS expects that the Milford and West Enfield Projects are at least 86% and 85% effective, respectively, at passing adult Atlantic salmon that are homing to areas in the Penobscot River above each facility. Under the performance standards described in the SPP, operations of the projects pursuant to the amended licenses will require Black Bear to achieve an upstream performance standard of 95% at both of these facilities. Studies will be conducted to evaluate that the performance standard has been met. If the project does not achieve the 95% performance standard, the facility will be modified to increase efficiency and/or survival, and evaluated again and repeated as necessary to achieve the performance standard.

The increase in passage efficiency associated with the performance standard will benefit the species by allowing more individuals to locate suitable spawning habitat and successfully spawn. Currently, the range of passage efficiencies for existing and future conditions (under the SPP) overlap, meaning that in years with higher passage success, the performance standard is already being met. However, in years where passage success is low under current conditions, it is expected that Black Bear will need to alter operations in order to meet the performance standard of 95%. Therefore, in the years where passage rates would otherwise be low, the performance standard would increase passage rates at both the Milford and West Enfield Projects by approximately 10% by increasing passage rates from 85-86% to 95%. Increasing passage rates at the Milford and West Enfield Projects to 95% will increase cumulative passage through both dams from 73% (based on minimum passage rates of 86% and 85%, respectively) to 90%.

Upstream Impediments to Passage

Stillwater Branch of the Penobscot River

The Projects on the Stillwater Branch, the Orono and Stillwater Projects, currently lack upstream passage facilities for diadromous fish. Although a fish lift and trap are proposed for the Orono Project, the amended licenses will not require Black Bear to release any trapped fish into the headpond. The Stillwater Branch runs along the west side of Orson and Marsh Islands before flowing back into the mainstem. The Stillwater primarily functions as a migration corridor for outmigrating smolts and kelts, and would be used by Atlantic salmon migrating to upstream spawning habitat if there weren't any barriers.

A proportion of the annual Atlantic salmon run in the Penobscot migrate to the base of the Orono Project every year. Shepard (1995) determined that in 1988 and 1989, 46% of adult salmon that were passed upriver of the Veazie Dam were attracted to the existing powerhouse discharge at the Orono Project for a median of 8.30 hours in 1988 and 2.18 hours in 1989. The duration of the delay in 1988 ranged between 0.3 hours to 247.4 hours. As there was still attraction flow to the mainstem Penobscot at this location, however, 100% of the delayed fish eventually continued their migrations in the mainstem. Although the Orono Project may not cause migration to cease, delay hinders the timing for reaching suitable spawning habitat and may eventually result in a 'dead end' where fish stop migrating. In addition, it may lead to spawning in unsuitable habitat, increased predation and an inefficient expenditure of energetics (Glebe and Leggett 1981, Larinier 2000, Schilt 2007). Given the location of the proposed powerhouse, it is expected that fish attracted to the new powerhouse will need to travel the additional 250 to 300 feet up the proposed tailrace channel, which dead ends at the draft tube discharge. At this location, unlike at the existing powerhouse, there will be less attraction back to the mainstem Penobscot River. In addition, Black Bear is proposing to route more water down the Stillwater Branch (up to 10%) and concentrate the flow with additional generating facilities. This change in flow characteristics will increase attraction flow, and will likely increase the delay of upstream migrating Atlantic salmon, as well. Fish that are attracted to the bypass reach are expected to be drawn to the proposed fish trap and trucked upstream; however, there are no provisions for trapping fish attracted to the existing or proposed powerhouse tailraces. Therefore, it is likely that some proportion of Atlantic salmon will be significantly delayed (more than 48 hours) at the powerhouses at the Orono Project. In 1988, Shepard (1995) determined that 33% (three out of nine) of the fish that were delayed by the discharge of the powerhouse at the Orono Project were in the tailrace for more than 48 hours. As we consider delay of more than 48 hours as significant, this equates to 15% of upstream migrating adults currently being significantly delayed (33% x the 46% of Atlantic salmon attracted to the discharge of the Orono powerhouse=15%) by the powerhouse discharge at the Orono Project.

According to Black Bear, fish migrations in the lower Penobscot River will not be affected by the new flow reallocation between the Stillwater Branch and mainstem river (BBHP October 7, 2011 letter to FERC). While we believe that the flow reallocation and installation of an additional powerhouse at the Orono Project may increase delay for upstream migrating adults in the lower Penobscot River, we do not have any information to validate this assumption. Therefore, we will assume that significant delay of adults following construction of the new powerhouse at the Orono Project will continue at existing levels. Therefore, we assume that no more than 15% of Atlantic salmon will be delayed significantly (more than 48 hours) by the discharge of the powerhouses at the Orono Project.

Black Bear will deploy telemetry receivers in the tailrace of the new Orono powerhouse, as well as in the bypass reach, to evaluate levels of significant delay. If information is collected during upstream passage studies that indicates that more than 15% of upstream migrating Atlantic salmon are being significantly delayed by the powerhouse discharge at the Orono Project, and Black Bear cannot effectively and expeditiously remedy the situation, then consultation will need to be reinitiated.

As there is no upstream passage into the Stillwater Branch it is anticipated that very few Atlantic salmon will be able to access the area downstream of the Stillwater Project. However, a proportion of Atlantic salmon are known to drop back into the river during their upstream migration. In 2002-2004 and 2010, the proportion of Atlantic salmon that were released into the Veazie headpond that dropped downriver and were recaptured in the Veazie trap ranged between 0.8% and 9.4%, with an average of 5.9% (Holbrook *et al.* 2009, MDMR unpublished data). As much of this fall back may be associated with the handling effects at Veazie, it is a conservative estimate of the proportion of the run that falls back during migration. As there are no upstream passage facilities at Stillwater, all of the salmon that fall back over the Project will need to navigate downstream past the Orono Project in order to either continue their upstream migration in the mainstem, or drop out of the River. Due to the delay associated with the attraction to the discharge at both the Stillwater and Orono Projects, as well as with having to swim down the Stillwater Branch prior to continuing upstream migration in the mainstem, it is expected that 100% of the fish that fall over the Stillwater Project will be significantly delayed (more than 48 hours).

West Branch of the Penobscot River

The West Branch of the Penobscot River is currently inaccessible to anadromous fish because there is no fish passage at the four lowermost dams. This unoccupied watershed is not designated as critical habitat for Atlantic salmon as it was not deemed essential for the recovery of the species (50 CFR Part 226). However, the impassable dams exclude Atlantic salmon from approximately 80,000 units of spawning and rearing habitat within the West Branch (NMFS 2009), or 25% of the potential rearing habitat within the Penobscot drainage. The lower-most of the dams on the West Branch is the Medway Project, which is operated by Black Bear and is one of the projects considered in this Opinion. No upstream passage facilities exist at the Medway Dam, and Black Bear is not proposing to incorporate any into this project as part of this action. Rather, Black Bear has proposed to incorporate a new license article that requires them to meet with us every five years "to ensure that operation of the Medway Project is consistent with the listing determinations for such species and with the then-current recovery objectives for such species" (Filed with FERC on May 15, 2012).

The West Branch above the Medway Project is managed by the State of Maine for resident fishes and catadromous eels. The East Millinocket Dam is 2.9 kilometers upriver of the Medway Project and is the next upstream barrier to migrating fish. The approximately 0.46 square kilometers of habitat between the two projects has been made inaccessible to Atlantic salmon by the lack of passage at the Medway Dam. The habitat is impounded and is, therefore, not currently suitable as rearing or spawning habitat. This reach of river is not currently stocked with Atlantic salmon so there should be no homing of salmon to it. The presence of the dam forces any migrating Atlantic salmon approaching the dam to stray into downstream habitat. NMFS (2012) estimated that approximately 7% of the Atlantic salmon that are returning to their natal habitat in the East Branch of the Penobscot will stray into the West Branch. Due to the lack of upstream passage facilities at the Medway Project, 100% of these fish will be forced to stray back into the East Branch or into the segment of the mainstem between the Medway and Mattaceunk Projects. Between 2002 and 2011, the number of Atlantic salmon passed at the Mattaceunk Project ranged between 37 and 345 (USASAC 2010, 2008, 2005, 2004, 2003). Although no studies exist, some proportion of these fish are attracted to the flow coming out of the West Branch, and will, therefore be subject to some amount of delay downstream of the Medway Project prior to dropping back downriver. Based on the level of delay measured by Shepard (1995) at the Orono Project, it can be estimated that approximately 33% of the fish that approach within 200 meters of the Medway Project may be delayed significantly. Therefore, it can be estimated that 2% (33% x 7%=2%) of the Atlantic salmon that successfully pass the Mattaceunk Project will be delayed significantly in the tailrace of the Medway Project. Black Bear will deploy telemetry receivers at the Medway Project to evaluate levels of significant delay.

While the loss of connectivity to the West Branch is important from the perspective of production potential, the fact that an entire major sub-drainage has been eliminated may further elevate the significance of this loss when viewed from the metapopulation perspective. As with many major tributaries of the Penobscot, the West Branch likely represented a unique combination of watershed level factors (e.g., topography, hydrology, basic water chemistry, and nutrient supply) that distinguished it from the East Branch, Piscataquis, or Mattawamkeag. The importance of having the West Branch available to the GOM DPS metapopulation of salmon, while unknown, could be significant at this broader scale.

6.2.1.2.Downstream Passage Effects

The projects currently affect outmigrating juvenile salmon and kelts by: 1) injury and mortality associated with entrainment through project facilities, 2) delayed outmigration influencing outmigrating timing, 3) potential to increase predation on outmigrating juveniles in project reservoirs, and 4) increasing stress levels, which leads to a subsequent decrease in saltwater tolerance. Under the proposed action, the projects would continue to cause some mortality and injury to downstream migrating smolts and kelts. Although the measures described in the SPP are anticipated to improve downstream fish passage conditions compared to the current conditions, fish mortality and injury would still be lower if the river was free flowing. Reservoirs that are part of the projects alter the conditions that juvenile salmon face as compared to a free flowing condition. The reservoirs alter water quality, eliminate stream channel migratory routes, and alter timing and behavior of outmigrating fish.

The West Enfield, Milford, Stillwater and Orono Projects all operate with some form of downstream fish passage and protection for outmigrating smolts and kelts, including reduced spacing of the trashracks for protection against turbine entrainment and sluice gates or other openings for downstream passage. Since none of the fishways are 100% effective, turbine entrainment, impingement and migratory delays of Atlantic salmon are expected at each dam (Section 3). Therefore, continuing to operate the West Enfield, Milford, Stillwater and Orono Projects will affect downstream movements of Atlantic salmon in the Penobscot River watershed.

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

Estimates of downstream passage efficiency and survival for smolts and kelts through all of the dams on the Penobscot have been modeled by Alden Lab (2012) (Tables 6 and 7). Survival rates were calculated for the range of possible flow conditions. Mean smolt survival rates at Milford, West Enfield, Orono and Stillwater were 91.6%, 92.5%, 90.1% and 91.9%, respectively. Alden Lab also reported minimum smolt survival rates at these projects as 75.6%, 92.3%, 81.6% and 90.5%, respectively. Through the three months of outmigration, Alden indicates that mean survival rates of kelts at all four dams are between 82% and 91%, with the lower values occurring in the month of November. However, kelt survival rates at three of the projects (all except West Enfield) are predicted to fall as low as 65-69%.

Performance Standard

Exact downstream survival rates for smolts and kelts are not known at the Milford, West Enfield, Stillwater and Orono Projects under all operational and environmental conditions. However, the survival rates calculated by Alden Lab (2012) provide an estimate of baseline mortality at these projects under a variety of flows. Under the performance standards described in the SPP, Black Bear will need to achieve a downstream performance standard of 96%, based on a 75% confidence interval, for both smolts and kelts at each of these facilities. In order to be considered to have met the performance standard, downstream passage of a smolt or kelt must occur within 24 hours of approaching within 200 meters of a project's trashracks. Studies will be conducted to evaluate that the performance standard has been met. If the project does not achieve the 96% performance standard, the facility will be modified to increase efficiency, and evaluated again and repeated as necessary to achieve the performance standard. It is assumed that the standard will not be met immediately and that it may take several years before it can be achieved. Therefore, it is assumed that the existing survival rates will persist for a period, not to exceed ten years.

The improvement in survival rates associated with the performance standard will benefit the species by increasing the number of smolts and kelts surviving their outmigration, which in turn will increase the number of adult returns in future years. Meeting the performance standard will increase the minimum survival rate of both smolts and kelts considerably at each individual project (Table 12). The standard will also have a corresponding effect on the total survival of smolts and kelts that migrate through multiple dams in the system (either West Enfield-Stillwater-Orono if the Stillwater Branch path is chosen; or West Enfield-Milford if the mainstem path is chosen). Meeting the performance standard will increase total survival for smolts and kelts swimming through multiple Black Bear Projects by 37.87% and 68.20%, respectively.

Table 12. Anticipated changes in smolt and kelt minimum survival rates due to the implementation of a downstream performance standard. The differences are relative to existing mortality, rather than absolute differences. The mortality rate for fish that swim through multiple dams is based on a median split between the Stillwater Branch and the mainstem Penobscot of 19.7%/80.3% (NMFS 2012, based on Holbrook *et al.* 2011). Existing kelt survival is based on data from Alden Lab (2012), but has been weighted based on 80% of outmigration occurring in the spring and 20% in the fall (Lévesque *et al.* 1985, Baum 1997).

Project	**Smolts**			**Kelts**		
	Existing	*SPP*	*Difference*	*Existing*	*SPP*	*Difference*
Milford	75.60%	96.00%	26.98%	68.59%	96.00%	39.97%
West Enfield	92.30%	96.00%	4.01%	90.18%	96.00%	6.45%
Orono	81.60%	96.00%	17.65%	72.00%	96.00%	33.34%
Stillwater	90.50%	96.00%	6.08%	65.84%	96.00%	45.82%
All 4 Dams	**66.15%**	**91.20%**	**37.87%**	**54.22%**	**91.20%**	**68.20%**

As mentioned previously, a proportion of adult pre-spawn Atlantic salmon are known to drop back into the river during their upstream migration. In 2002-2004 and 2010, the proportion of Atlantic salmon that were released into the Veazie headpond that dropped downriver and were recaptured in the Veazie trap ranged between 0.8% and 9.4%, with an average of 5.9% (Holbrook *et al.* 2009, MDMR unpublished data). As much of this fall back may be associated with the handling effects at Veazie, 9.4% represents a conservative estimate of the proportion of the run that falls back during migration. Although Black Bear has not proposed a downstream performance standard for upstream migrants that fall back over a project, it is assumed that the mortality rates associated with downstream passage (Table 12) for the Milford, West Enfield, Stillwater and Orono Projects will apply to these salmon, as well.

6.2.2. Atlantic Salmon Critical Habitat

As discussed in Section 3.2, critical habitat for Atlantic salmon has been designated in the Penobscot River including the sections of river in the vicinity of the Orono, Stillwater, Milford and West Enfield Projects. Within the action area of this consultation, the PCEs for Atlantic salmon include: 1) sites for spawning and rearing; and, 2) sites for migration (excluding marine migration). The analysis presented in the environmental baseline shows several habitat indicators are not properly functioning, and biological requirements of Atlantic salmon are not being met in the action area. We expect that the proposed project would continue to harm these already impaired habitat characteristics. We expect the continued operations of these projects to cause 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, designated critical habitat in the Penobscot River watershed is anticipated to improve for Atlantic salmon with the implementation of the performance standards outlined in the proposed SPP. Operation of the projects pursuant to the amended licenses is expected to achieve these performance standards by 2023. At this time, effects of hydroelectric operations to the migration PCE will be reduced by improving survival rates and reducing delay for both upstream and downstream migrating Atlantic salmon.

The Stillwater Branch has been designated as critical habitat for the GOM DPS of Atlantic salmon. It runs along the west side of Orson and Marsh Islands before flowing back into the mainstem. Although there is a small amount of spawning and rearing habitat in this branch of the river, the Stillwater primarily functions as a migration corridor for outmigrating smolts and kelts, and would be used by Atlantic salmon migrating to upstream spawning habitat if there weren't any barriers. Therefore, the continuation of the impassable conditions at the Orono and Stillwater Projects significantly affects the migratory PCE within the Stillwater Branch. Although migration upriver is not halted, the lack of passage facilities contributes to migratory delay by forcing migrating salmon attracted to the flow out of the Stillwater Branch to drop back into the mainstem before continuing their migration.

The lack of upstream passage at the Orono Project prevents access to the Stillwater Branch, not only for Atlantic salmon, but also for other diadromous fish species, such as alewives, blueback herring and shad. One of the essential features that is described for the migration PCE refers to the need for diverse native fish communities that serve as a protective buffer against predation. Thus, the lack of upstream passage for these species at the projects on the Stillwater Branch diminishes the functioning of the habitat within the Stillwater Branch of the River. The proposed project will not reduce this effect.

6.2.3. Shortnose and Atlantic Sturgeon

It is believed that, historically, prior to dam construction, shortnose and Atlantic sturgeon ranged only as far as the site of the Orono Project on the Stillwater Branch and the Milford Project on the mainstem Penobscot River (L. Flagg, MDMR, personal communication 1998, Houston *et al*. 2007). Since historical data on sturgeon habitat use in the river is lacking, NMFS assumes that Penobscot River sturgeon have migration patterns and habitat uses consistent with other northeastern rivers. As such, spawning would occur at the most upstream accessible area, which in the Penobscot will be Milford Falls. 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. Atlantic sturgeon are more tolerant of salinity and, thus, overwinter in the lower estuary or coastal ocean, while the juveniles tend to occur in low salinity waters of the natal estuary.

6.2.3.1. Upstream Passage

As explained above, the Veazie Dam currently represents the first barrier to upstream migration to shortnose and Atlantic sturgeon. After the removal of the Veazie and Great Works Projects, the Milford Dam, on the mainstem, and the Orono Dam, on the Stillwater Branch, will be the lowermost dams on the Penobscot, and will be accessible to sturgeon. Some proportion of

Atlantic and shortnose sturgeon are anticipated to be trapped at the new fish lifts being constructed at these projects. Pursuant to the requirements of the amended operating licenses, all shortnose and Atlantic sturgeon that are trapped will be handled according to Black Bear's sturgeon handling plan, and will be released downstream of the projects.

Limited information is available on the use of fish passage facilities by sturgeon generally. Ladders are installed at several hydroelectric facilities in the northeast where shortnose and Atlantic sturgeon are known to occur, including the Brunswick Dam on the Androscoggin River, Cabot Station on the Connecticut River and the Veazie Dam on the Penobscot River. Despite extensive monitoring programs at these facilities, no shortnose or Atlantic sturgeon have ever been documented using the ladders. The only documented use of a fish ladder by a sturgeon in the northeast is one shortnose sturgeon that was documented in the Denil ladder at the DSI dam on the Deerfield River, a tributary to the Connecticut River.

Fish lifts may be more successful at passing sturgeon. The fish lift at the Holyoke Dam on the Connecticut River passed 127 shortnose sturgeon over a 31- year period (1980-2011) (Ducheney *et al.* 2006, R. Murray, Holyoke Gas and Electric, personal communication, 2012). Between 0 and 16 shortnose sturgeon were trapped per year throughout that period, averaging approximately four fish per year. As many more shortnose sturgeon were observed annually downriver of the Holyoke Dam, the trapping of so few fish indicates poor passage efficiency and/or a lack of motivation to move upriver. As spawning habitat in the Connecticut River occurs upriver of the Holyoke Dam, the fish are likely more motivated to move upriver of the dam than they would be in a river where they have full access to their historic spawning habitat. Comparatively, shortnose sturgeon have never been trapped at the lowermost dam (Lockwood) in the Kennebec River where sturgeon have access to the entirety of their historic habitat.

Given sturgeon capture rates at fish lifts on the Kennebec and Connecticut Rivers, it is anticipated that very few shortnose sturgeon will be trapped at the Milford and Orono Projects. An average of four fish per year were trapped at the Holyoke Dam over a thirty-one year period. As shortnose sturgeon population estimates for the lower Connecticut River and the Penobscot River are similar (Connecticut: 1000 (Savoy 2005); Penobscot: 602-1654) it is anticipated that a similar number of fish will be captured at the Milford and Orono Dams. Four shortnose sturgeon a year is a conservative estimate given that, unlike in the Connecticut, sturgeon in the Penobscot will have access to their historic range in the Penobscot River after the removal of the Great Works and Veazie Dams and, thus, may be less motivated to move upriver. As sturgeon prefer deeper water for their migrations most will likely stay in the mainstem, rather than enter the Stillwater Branch. Therefore, it is expected that three of the four sturgeon captured every year would become trapped in the Milford fish trap, whereas only one per year would be expected to be trapped at the Orono Project.

Similar to shortnose sturgeon, Atlantic sturgeon are rarely found to use fishways. In the 31 years that records have been kept at the Holyoke Project, only a single Atlantic sturgeon has ever been trapped in the fishway. This may not be representative of what would occur at the proposed Orono and Milford fish traps, because, unlike in the Penobscot, it is not thought that Atlantic sturgeon would spawn in the Connecticut River. However, the fact that no Atlantic sturgeon have ever been trapped at the Lockwood Project on the Kennebec River, where there is a spawning population, would support the conclusion that few would be caught in fish traps on the Penobscot River. Given the low usage of fish traps by Atlantic sturgeon in the northeast, it is anticipated that no more than one Atlantic sturgeon will be trapped at the Milford and Orono Projects per project per year, which equates to 25 and 35 fish, respectively, over the term of the existing licenses.

As sturgeon do not occur in the vicinity of the Stillwater, West Enfield and Medway Projects, operations at these projects will not affect upstream movements of either species of sturgeon.

6.2.3.2.Downstream Effects

With the removal of the Veazie and Great Works Dams, the range of shortnose and Atlantic sturgeon in the Penobscot River will extend to the foot of the Milford Dam, on the mainstem, and the Orono Dam, on the Stillwater Branch, which are likely the historic upstream limits for both species. Sturgeon will not be passed upstream of these projects; therefore, there will be no effects to the species associated with downstream passage. However, the operations of these projects could affect sturgeon occurring downstream of these facilities.

While spawning by shortnose and Atlantic sturgeon in the Penobscot River has not been confirmed, it is possible. Thus, it is thought that with the removal of the two lowermost dams, these species will regain access to their historic spawning grounds in the river. Optimal shortnose sturgeon spawning habitats are in freshwater, but usually within areas of tidal influence, in deep water where the predominate substrate type is a combination of gravel, rubble, and cobble and water velocities are between 30 and 76 centimeters per second (cm/s) (Crance 1986). In the Merrimack River, telemetry studies revealed that spawning males occurred in water 2.3-5.8 m deep (Kieffer and Kynard 1996) and in the Connecticut River, radio-tagged females used spawning depths of 1.2-10.4 m deep (Buckley and Kynard 1985, Kynard 1997). Spawning for Atlantic sturgeon is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers, when and where optimal flows are 46-76 cm/s and depths are 3-27 meters (Borodin 1925, Dees 1961, Leland 1968, Scott and Crossman 1973, Crance 1987, Shirey *et al.* 1999, Bain *et al.* 2000, Collins *et al.* 2000, Caron *et al.* 2002, Hatin *et al.* 2002, ASMFC 2009).

The habitat downstream of the Orono Project consists primarily of ledge with a relatively high gradient and relatively shallow water depths (one to two feet). Given these characteristics the bypass reach is an unlikely location for sturgeon spawning. Due to the presence of deeper water and more variable substrate types, however, portions of the habitat downriver of the Milford Project may be more suitable. Both the Milford and Orono Projects operate as run of river facilities, which will minimize the scouring of habitats and the likelihood of pulsed discharges that could result in the stranding of adult or early life stage Atlantic and shortnose sturgeon. Based on this, we do not expect that operations of Milford or Orono will affect the ability of shortnose or Atlantic sturgeon to spawn successfully in the vicinity of these projects or that the operation of these projects will affect the successful development of early life stages of shortnose or Atlantic sturgeon that may be present in the action area.

Once a year, the impoundments of Orono and Milford are lowered to a point where the flashboards can safely be replaced, resulting in a short period (a few hours) of receded flows downstream. This typically occurs in the month of June. Although minimum flows will still be maintained, there is potential during these low flow periods for sturgeon to become stranded in pools. The Milford Project does not have a bypass reach, which means that although water levels may decrease during this period there aren't any areas that are anticipated to dry out entirely and few pools, if any, are anticipated to become isolated. Therefore, no shortnose and Atlantic sturgeon are expected to become stranded at the Milford Project.

The Orono Project has a bypass reach that could become partially dewatered during flashboard replacement, which could result in the stranding of a small number of sturgeon. As the flashboards are typically replaced in June, and sturgeon spawning generally occurs between March and May, it is anticipated that no pre-spawn sturgeon are likely to be stranded. As sturgeon tend to move downstream once spawning is complete, very few adults are likely to be in the area when the flashboards are being replaced. Given that the habitat in the Orono bypass reach is not suitable for spawning, it is not expected that any sturgeon eggs or juveniles will occur in the affected area. However, it is possible that a small number of adult Atlantic and shortnose sturgeon could be attracted to the flow out of the Stillwater Branch and make their way into the Orono bypass reach, where they could potentially become stranded during flashboard replacement. It is expected that no more than one shortnose sturgeon or Atlantic sturgeon per year (equates to 35 individuals per species over the term of the license), will be affected by stranding. To minimize this effect, qualified staff from Black Bear will conduct surveys and will carefully transport any stranded sturgeon downriver as described in their proposed sturgeon handling plan. These fish would be subject to stress from stranding and handling similar to the sturgeon trapped in the proposed fish trap and lift at Orono; however, any injuries experienced are expected to be minor and consist of scrapes and abrasions. No significant injuries or mortalities are anticipated.

6.3. Effects of Fish Handling

6.3.1. Trapping and Handling of Atlantic Salmon

Trapping, handling and trucking fish causes them stress. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on Atlantic salmon increases rapidly from handling if the water temperature is too warm or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps that are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis.

With the removal of the fish trapping and handling facility at the Veazie Project, the majority of Atlantic salmon migrating upriver in the Penobscot River will swim through the upstream passage facilities at the Milford Project. These fish will be trapped and then released upstream of the Milford Project, or will be taken to Green Lake National Fish Hatchery to be used as broodstock. The handling and trucking of these fish will be conducted by MDMR, which holds a section 10(a)(1)(A) research permit under the USFWS's regional endangered species blanket permit (No. 697823) which authorizes the handling of listed Atlantic salmon. Therefore, the effects of handling and transporting are not considered as part of the proposed action. However, all migrating adult Atlantic salmon in the mainstem will be affected by the Project as they will be trapped and potentially delayed by the dam and its fish passage facilities.

Migrating Atlantic salmon are anticipated to be trapped at both the Milford and Orono Projects. The vast majority of migrating adult Atlantic salmon is anticipated to migrate up the mainstem and, thus, get trapped and passed at the Milford Project. However, we anticipate that a small proportion of the Atlantic salmon run will be attracted to and trapped within the proposed fish trap at the Orono Dam. The salmon trapped at Orono will be placed into trucks and transported upriver of the Milford Project on the mainstem. Black Bear is responsible for the handling and transport of fish over short distances. Long-distance transport, such as to the hatchery, will be conducted by MDMR. In either case, it is anticipated that Black Bear will be responsible for the operation and maintenance of the new fish lift, which is anticipated to affect every Atlantic salmon that enters the lift or that is delayed in its migration by the Project. MDMR maintains a database of adult Atlantic salmon mortalities attributable to trapping and trucking from the Veazie fish trap. Between 1978 and 2011, the median mortality rate for adult Atlantic salmon trapped at the Veazie Dam was 0.07%. In a typical year, between zero and four salmon are killed during trapping and transportation at the Veazie Project. Similar levels of mortality are anticipated at the Milford Project, while fewer are likely to be killed at the Orono Project. Although there are no records of injuries in the MDMR database, it is assumed that a larger proportion of trapped and trucked Atlantic salmon suffer from injuries than mortality and that some of these injuries may lead to delayed mortality.

6.3.2. Trapping and Handling of Sturgeon

Atlantic and shortnose sturgeon could be trapped in the fish lifts at the Milford and Orono Projects. Although the location of spawning habitat in the Penobscot is unknown, it is assumed that it would occur downriver of the Milford and Orono projects as these are the historic upstream limits for both species. As the spawning habitat in the Penobscot is anticipated to be below the Milford Falls (the site of the Milford Project), it is unlikely that sturgeon will be motivated to pass the projects. However, it is possible that a few sturgeon per year will be attracted to flow from the spillway at Orono, or the powerhouse discharge at Milford, and become trapped. These fish will be handled as proposed in the sturgeon handling plan (Sections 2.1.2.5 and 2.3.2.4), and will be released downriver of the projects as soon as possible. They will not be transported in trucks and the handling will be minimized to the extent possible.

As described above, when flashboards are replaced at the Orono and Milford Projects, or other operations cause no-spill or no-leakage conditions, there is a possibility that sturgeon may become stranded in pools below the dams. When these activities occur trained Black Bear staff will survey isolated pools downstream and transport trapped fish back into the river. Handling time is anticipated to be minimal; therefore, it is anticipated that all sturgeon will be moved back to the river without significant injury or mortality.

6.3.3. Effects of Aquatic Monitoring and Evaluation

Under the proposed action, numerous measures will be implemented to minimize project effects on Atlantic salmon passage in the Penobscot River. These measures include the construction of upstream and downstream fish passage facilities and performance standards that were incorporated in a SPP. In order to determine the effectiveness of the performance measures, Black Bear proposes to conduct downstream survival studies at the Orono, Stillwater, Milford and West Enfield Projects, as well as upstream effectiveness studies at the Milford and West Enfield Projects.

Proposed Studies

The downstream smolt survival studies will involve obtaining Atlantic salmon smolts from GLNFH, surgically implanting radio transmitter tags, and then conducting paired releases in groups up and downriver of each of the projects. The handling and implantation of radio tags will injure all of the fish used in the studies, and a small proportion will likely be killed.

Upstream passage efficiency studies will be conducted using adult Atlantic salmon trapped either at the Veazie Dam (prior to its removal) or at the Milford Dam. The adult fish will be gastrically implanted with a radio telemetry tag prior to being placed downstream of the project. The handling and implantation of radio tags will injure all of the fish used in the studies.

Under the SPP, Black Bear will monitor and evaluate the effectiveness of various measures outlined in the SPP to determine if performance standards for upstream and downstream passage have been met. Studies on outmigrating smolts will be conducted after each measure in Figure 2 is implemented. The study period after each measure is three years. An initial three-year study will be conducted, potentially followed by the sequential implementation of three different performance measures if the standard has not been met. This means that there is the potential for smolt studies to be conducted for ten consecutive years at the Orono, Stillwater, Milford and West Enfield Projects. After the downstream performance standard has been achieved at each project, a one year verification study will be conducted every ten years thereafter. Given the license terms of these projects, these verification studies will add an additional study year to Milford (license expires in 2038), and two more years to both the Stillwater and Orono Projects (license expires in 2048). After the first or second year of each three year study, Black Bear may decide to implement the next measure in the sequence, rather than completing the three year study. Therefore, it is anticipated that ten to twelve years represents a conservative estimate of the number of years under which the projects will be studied for downstream smolt passage. Table 13 shows the anticipated number of smolts used at each project per year of study. In addition to the fish being used in the survival studies, Black Bear has proposed to conduct tag life and retention studies on 40 smolts each year that monitoring occurs. Including these additional fish, it is conservatively estimated that 7,050 smolts will be tagged and released as part of monitoring downstream passage success at all four of the projects.

Table 13. The number of salmon smolts that are anticipated to be affected by downstream survival studies conducted to test the performance measures described in the SPP.

Project	Smolts Per Year	# Years	Total

	Experiment	*Control*		
Milford	102	60	11	1782
West Enfield	102	60	10	1620
Orono	0	60	12	720
Stillwater	102	102	12	2448
Tag life/Retention	40		12	480
Total				**7050**

During upstream monitoring of fishways at the Milford and West Enfield projects, 20 to 40 pre-spawn adults a year will have radio tags gastrically implanted prior to release downstream of Milford. The initial study (two years) will only test the Milford Project, however, a verification study will be conducted at both the Milford and West Enfield Projects every ten years after the project licenses have been amended until the expiration of their current licenses. Therefore, Milford (license expires in 2038) will be tested for four years (2013, 2014, 2024, 2034) during the term of this consultation, whereas, West Enfield (license expires in 2024) will only be tested for one year (2023). As a maximum of 40 fish will be used to study passage efficiency in four different years over the term of this consultation, it is expected that as many as 200 adult Atlantic salmon could be trapped, handled and tagged as part of the proposed studies.

Ten years after completion of the final enhancements for smolt outmigration outlined in the SPP, Black Bear will conduct a study to provide verification that kelts moving downstream meet the 96% downstream performance standard. Black Bear indicates that the study would coincide with smolt monitoring, would involve using tagged male kelts, and would evaluate monitoring passage at the Orono, Stillwater, Milford, and West Enfield Projects. We believe that a maximum of 40 post-spawn Atlantic salmon should be used per project per year over three years in order to verify that the performance standard has been achieved. Although a larger sample size would provide for a more statistically sound result, adult salmon are a critically valuable resource for restoring salmon populations and, therefore, the number of affected individuals should be minimized to the extent possible. The three year study would require the use of a maximum of 480 post-spawn male Atlantic salmon (four projects x 40 fish x three years = 480 fish). No follow-up studies have been proposed at this time.

Tagging

Techniques such as PIT tagging, coded wire tagging, fin-clipping, and the use of radio transmitters are common to many scientific research efforts using listed species. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. Radio telemetry will be used as the primary technique for the proposed studies.

There are two techniques used to implant fish with radio tags and they differ in both their characteristics and consequences. First, a tag can be inserted into a fish’s stomach by pushing it past the esophagus with a plunger. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways. This is the technique that Black Bear proposes to use on adult Atlantic salmon for the upstream passage studies.

The second method for implanting radio tags is to surgically place them within the body cavities of (usually juvenile) salmonids. These tags do not interfere with feeding or movement. However, the tagging procedure is difficult, requiring considerable experience and care (Nielsen 1992). Because the tag is placed within the body cavity, it is possible to injure a fish's internal organs. Infections of the sutured incision and the body cavity itself are also possible (Chisholm and Hubert 1985, Mellas and Haynes 1985). This is the technique that Black Bear proposes to use on Atlantic salmon smolts for the downstream passage studies.

Fish with internal radio tags often die at higher rates than fish tagged by other means because radio tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982, Matthews and Reavis 1990, Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance.

All fish used in the proposed studies will be subject to handling by one or more people. There is an immediate risk of injury or mortality and a potential for delayed mortality due to mishandling. Those same fish that survive initial handling will also be subject to tag insertion for identification purposes during monitoring activities. It is assumed that a 100% of the fish that are handled and tagged will suffer injury, and some of these will die due to immediate and long term effects of being trucked, handled and tagged.

All 7,050 Atlantic salmon smolts used in the downstream survival studies will be harassed and injured. In addition, a proportion of the smolts are anticipated to be killed due to handling and tagging, as well as to the direct and indirect effects associated with dam passage. There is some variability in the reported level of mortality associated with tagging juvenile salmonids. NMFS did not document any immediate mortality while tagging 666 hatchery reared juvenile Atlantic salmon between 1997 and 2005 prior to their release into the Dennys River. After two weeks of being held in pools, only two (0.3%) of these fish were subject to delayed mortality. Over the same timeframe, NMFS surgically implanted tags into wild juvenile Atlantic salmon prior to their release into the Narraguagus River. Of the 679 fish tagged, 13, or 1.9%, died during surgery (NMFS, unpublished data). It is likely there were delayed mortalities as a result of the surgeries, but this could not be quantified because fish were not held for an extended period. In a study assessing tagging mortality in hatchery reared yearling Chinook salmon, Hockersmith *et al.* (2000) determined that 1.8% (20 out of 1,133) died after having radio tags surgically implanted. Given this range of mortality rates, it is anticipated that no more than 2% of Atlantic salmon smolts will be killed due to handling and tagging during the proposed downstream monitoring over ten years of study. The proportion of smolts anticipated to be injured and killed due to the effects of downstream passage is addressed in Section 6.2.1.2.

All adult salmon used in the upstream and downstream passage studies will be harassed and injured due to handling and tagging. However, long term effects of handling and tagging on adult salmon appear to be negligible. Bridger and Booth (2003) indicate that implanting tags gastrically does not affect the swimming ability, migratory orientation, and buoyancy of test fish. The primary disadvantage of gastrically implanted tags is that fish are often unable to feed while the tags are in their stomachs. As pre-spawn adult Atlantic salmon do not feed (Fay *et al.* 2006), this should not significantly affect the tagged individuals. Due to handling and tag insertion, it is possible that a small proportion of the study fish will be killed due to delayed effects. In a study of adult sockeye salmon in Alaska, it was determined that 2% (one out of 59 fish) of adults tagged with esophageal radio tags died within 33-days of tagging (Ramstad and Woody 2003). Assuming a similar rate with Atlantic salmon, it can be anticipated that 2% of the 200 study fish (or four fish) could be subject to mortality due to upstream passage monitoring activities at the West Enfield and Milford Projects over several years of study. Likewise, it is anticipated that 2% of the, at most, 480 kelts used in the downstream study (approximately three fish per project) could die due the effects of handling and tagging. Mortalities are expected to be minimized by having trained professionals conduct the procedures using established protocols.

7. CUMULATIVE EFFECTS

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

The effects of future state and private activities in the action area that are reasonably certain to occur are continuation of recreational fisheries, discharge of pollutants, and development and/or construction activities resulting in excessive water turbidity and habitat degradation.

Impacts to shortnose sturgeon, Atlantic 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 these species. There have been no documented takes of shortnose sturgeon from fisheries in the action area although one Atlantic sturgeon was captured by an angler in 2005. The operation of these hook and line fisheries and other fisheries could result in future sturgeon or Atlantic salmon mortality and/or injury.

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

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

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

Industrialized waterfront development will continue to impact the water quality in and around the action area. Sewage treatment facilities, manufacturing plants, and other facilities present in the action area are likely to continue to operate. Excessive water turbidity, water temperature variations and increased shipping traffic are likely with continued future operation of these facilities. As a result, shortnose and Atlantic 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, we have no information to suggest that the effects of future activities in the action area will be any different from effects of activities that have occurred in the past.

8. INTEGRATION AND SYNTHESIS OF EFFECTS

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

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

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

We have determined that the proposed action will result in harm or harassment to Atlantic salmon, shortnose sturgeon and Atlantic sturgeon in the action area. While lethal injuries and/or mortalities are being reduced by adhering to construction BMPs and the provisions of the SPP, it is anticipated that some Atlantic salmon will be injured or killed as a result of the continued operations of the five hydroelectric projects considered in this Opinion. Whereas, no Atlantic sturgeon or shortnose sturgeon are expected to be injured or killed by the action.

8.1. Atlantic Salmon

GOM DPS Atlantic salmon currently exhibit critically low spawner abundance, poor marine survival, and are confronted with a variety of additional threats. The abundance of GOM DPS Atlantic salmon has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is extremely low (approximately 6% over the last ten years) and is continuing to decline. The conservation hatchery program assists in slowing the decline and helps stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to halt the decline of the naturally reared component of the GOM DPS.

We recognize that the operation of the Orono, Stillwater, Milford, West Enfield and Medway Projects pursuant to amended licenses that incorporate the proposed SPP and its associated performance measures will lead to an improvement in upstream and downstream passage for Atlantic salmon as compared to current operations. However, the projects will continue to affect the abundance, reproduction and distribution of salmon in the Penobscot River by delaying, injuring and killing upstream migrating pre-spawn adults, as well as outmigrating smolts and kelts. While FERC will require that Black Bear implement several measures to reduce adverse impacts of project operation, all Atlantic salmon in the Penobscot River watershed will be adversely affected by continued operations of these facilities.

Summary of Construction Effects

The construction of new powerhouses at the Stillwater and Orono Projects, as well as new fish lifts at the Orono and Milford Projects, will cause short-term impacts to Atlantic salmon when exposed to increased suspended sediments concentrations and increased underwater noise levels in the action area. The proposed action includes certain measures that should reduce the adverse effects of instream work on listed species and critical habitat; including erosion and sedimentation control BMPs, noise minimization techniques, and the timing of in-water work to avoid the smolt migration.

The isolation of riverine habitat within a cofferdam minimizes the overall adverse effects of construction activities on Atlantic salmon and their habitat because it reduces exposure to in-water construction activities. However, isolating the work area within a cofferdam could lead to negative impacts on fish if any are trapped within the isolated work area. In order to minimize the probability of entrapping an adult Atlantic salmon within the work area, a visual survey of these areas will be conducted by qualified personnel to verify that there are no salmon within the project area prior to and during the installation and removal of any in-water bypass structure, including cofferdams. If Atlantic salmon are found within a cofferdam, they will be removed and returned to the River prior to dewatering. As the cofferdams will be 1) constructed at the end of the upstream migration period in 2012 when only a small proportion of the salmon run will still be migrating through the mainstem of the Penobscot, and 2) constructed within the Stillwater Branch where very few salmon are likely to occur, it is expected that no more than one adult salmon per project will be harmed due to capture and handling at the Orono and Stillwater Projects. Capturing and handling salmon causes physiological stress and can cause physical injury although these effects can be kept to a minimum through proper handling procedures. The fish evacuation plan should minimize such stresses by requiring minimal handling time; minimal time that fish are held out of the water; and using transfer containers with aerated stream water of ambient temperature. Impacts to Atlantic salmon will be further minimized by requiring that only qualified biologists handle the fish. Given these minimization efforts, it is not expected that there will be any injury or mortality associated with cofferdam construction.

Summary of Upstream Passage Effects

Atlantic salmon are known to successfully utilize upstream fishways in the Penobscot River. However, even when operated pursuant to the amended licenses, none of the projects will be 100% effective at passing all Atlantic salmon that are motivated to access habitat upriver. Adult salmon that are not passed at the Milford and West Enfield Projects will either spawn in downstream areas, return to the ocean without spawning, or die in the river. These salmon are significantly affected by the stress, injury and mortality associated with locating and successfully passing fishways at the Milford, Orono and West Enfield Projects. Although no studies have looked directly at the fate of fish that fail to pass through upstream fish passage facilities on the Penobscot River, we convened an expert panel in 2010 to provide the best available information on the fate of these fish. The panel was comprised of state, federal, and private sector Atlantic salmon biologists and engineers with expertise in Atlantic salmon biology and behavior at fishways. The group estimated a baseline mortality rate of 1% for Atlantic salmon that fail to pass a fishway at a given dam on the Penobscot River (NMFS 2011, Appendix B). Dams that do not have fishways were not considered to have baseline mortality, as fish are not subject to the stresses of upstream passage (although they may be subjected to significant delays). Additional mortality was assumed based on project specific factors, such as predation, fish handling, high fall back rates, lack of thermal refugia, etc. Based on these assumptions, the panel estimated existing mortality rates for Atlantic salmon that fail to pass the Milford, West Enfield and Orono Projects of 1%, 2% and 0%, respectively. Due to the proposal to install a handling facility at Milford and a trap at Orono, the proposed project is anticipated to increase those rates to 2% and 1%, respectively.

Based on the expert panel's conclusions, it is anticipated that a small proportion of pre-spawn Atlantic salmon that currently approach the Milford and West Enfield Projects are killed while attempting passage. It is assumed for this analysis that the existing passage rates will be maintained until the achievement of the performance standard has been demonstrated through passage studies. Therefore, the projects will be considered to operate under two conditions: the current condition, and the SPP performance standard condition (i.e., operations pursuant to the amended licenses). The upstream performance standard, once achieved, is anticipated to significantly decrease the proportion of salmon killed in their passage attempt, as proportionally more salmon are passed.

As they currently lack upstream fish passage facilities, it is assumed that 100% of Atlantic salmon that approach the Stillwater, Medway and Orono Projects experience significant adverse effects due to delay or alteration in spawning behavior. As no upstream passage facilities are proposed at the Stillwater or Medway Projects, these conditions will continue to be experienced even when FERC issues amended licenses. Therefore, these adverse effects will continue during the entirety of the period that the Stillwater and Medway Projects will operate. The construction of a new fish trap may minimally alleviate these effects in the Orono Project's bypass reach. However, the purpose of the Orono fish trap is not to serve as a traditional fishway, but rather as an evacuation device that will remove fish that are attracted to the spillage in the Orono bypass reach. We will consider the Orono trap to be effective if 95% of the Atlantic salmon that enter the bypass reach are either trapped by the new fish trap or migrate volitionally out of the bypass reach within 48 hours. As described above, up to 1% of the fish that fail to exit the bypass reach within 48 hours will die. The remaining fish will suffer from the effects of significant delay, but are expected to eventually drop down into the mainstem and will either continue their upstream migration or will drop downriver and spawn in potentially less suitable habitat.

The existence of all of Black Bear's projects in the Penobscot River results in a certain amount of delay in upstream migration. Numerous 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 Milford Dam ranged from 1.0 days to 5.3 days over five years of study, while the total range of individual passage times over this study period was 0.1 days to 25.0 days. The yearly pooled median passage time for adults at the West Enfield or Howland Dam ranged from 1.1 days to 3.1 days over four years of study, while the total range of individual passage times over this study period was 0.9 days to 61.1 days (Shepard 1995). When the projects are operating pursuant to the amended licenses, delay at the Milford and West Enfield projects should be reduced. When operating in compliance with the upstream performance standard, 95% of salmon will pass these projects within 48 hours of approaching within 200 meters of either of these projects; thus, only 5% will experience significant delays (*i.e.*, greater than 48 hours).

There is no upstream performance standard proposed for the Orono Project on the Stillwater Branch. As addressed previously, Shepard (1995) determined that in 1988 and 1989, 46% of adult salmon that were passed upriver of the Veazie Dam were attracted to the existing powerhouse discharge at the Orono Project for a median of 8.30 hours in 1988 and 2.18 hours in 1989. The duration of the delay in 1988 ranged between 0.3 hours to 247.4 hours. This delay is not expected to be reduced when project operations are modified under the terms of the amended license. In fact, the construction of a new powerhouse and tailrace, as well as an increase in the amount of flow being channeled through the Stillwater Branch, may lead to both an increase in the proportion of fish delayed, and in the duration of that delay. This will be caused by the potential additive effects of multiple discharges (*i.e*,. a fish is attracted to and delayed by the existing powerhouse, and is subsequently attracted to and delayed by discharge from the new powerhouse). The proposed fish trap at the Orono Project is intended to minimize the amount of delay in the bypass reach by providing a method for the removal of Atlantic salmon and transport back to the mainstem. However, as the trap will be located in the bypass reach and not at either of the powerhouses, we do not know how effective it will be at reducing the overall delay experienced by Atlantic salmon at the Project. Under current conditions, it is estimated that 33% of the Atlantic salmon that are attracted to the discharge of the existing powerhouse will be harassed due to significant delay (in excess of 48 hours) in migration. We believe that a delay in migration of more than two days per project could affect a salmon's ability to migrate successfully to suitable spawning habitat. Black Bear will monitor delay at the Orono Project and if a significant number of fish are delayed for more than 48 hours they will discuss solutions with state and federal fisheries agencies.

It is not known how many adult Atlantic salmon are attracted to the West Branch of the Penobscot and are delayed due to the lack of passage at the Medway Project. Likewise, the duration of the delay is not known. As there is currently no spawning in the West Branch, it is not anticipated that salmon will be motivated to migrate into the river to spawn. However, it is anticipated that some proportion of the Atlantic salmon that are homing to the East Branch will stray into the West Branch. These fish will be delayed for some amount of time prior to dropping back into the East Branch or the mainstem Penobscot. Based on the work conducted by Shepard (1995) at the Orono Project, it is estimated that 33% of the Atlantic salmon that are attracted to the discharge of the powerhouse at the Medway Project will be harassed due to significant delay (in excess of 48 hours) in migration. We believe that a delay in migration of more than two days per project could affect a salmon's ability to migrate successfully to suitable spawning habitat. Black Bear will monitor the number of salmon that come within 200 meters of the Medway Project, and will assess the level of delay that is resulting due to project operations. FERC is proposing to implement a license article requiring Black Bear to meet with us every five years to discuss the operation of the project in relation to listed species. If significant delay is occurring, possible solutions will be discussed at that time.

Upstream Distribution Effects

Of the surviving Atlantic salmon that fail to pass the upstream fishways at Milford, Orono and West Enfield, the vast majority are assumed to stray to other habitat and spawn. The expert panel convened by us in 2010 addressed this issue, and determined that the presence of the dams would cause the majority of straying Atlantic salmon to spawn in habitat downriver of the dam that halted their migration. For Milford and Orono, this would mean that 100% of the fish that stray would fall back into the habitat upriver of Verona Island, and would potentially spawn in the lower mainstem Penobscot, or in one of its tributaries. Of the Atlantic salmon that failed to pass West Enfield, the expert panel assumed that 60% would spawn in the Piscataquis River and that the remaining 40% would spawn either in the Passadumkeag River or in the mainstem Penobscot upriver of the Milford Project. This forced straying of a small proportion of migrating Atlantic salmon may lead to a gradual shift downriver in the distribution of the species in the Penobscot. The PRRP and the proposed performance standards are anticipated to reduce this effect, however, by increasing the proportion of fish that can migrate successfully in the Penobscot River watershed.

As noted previously, no upstream fish passage facilities are proposed for the Orono and Stillwater Projects, which will prevent Atlantic salmon from using the Stillwater Branch as a migratory corridor. Habitat is available and accessible to migrating adults in the mainstem of the river and all of the Atlantic salmon that were attracted to the discharge from the Stillwater Branch in 1988 and 1989 eventually strayed back to the mainstem where they continued their upstream migration (Shepard 1995). Therefore, while the continued blockage of the Stillwater Branch will continue to alter the distribution of migratory behavior, it will not preclude pre-spawn adults from accessing high quality spawning habitat upriver.

The Medway Project prevents Atlantic salmon from accessing approximately 80,000 habitat units in the West Branch of the Penobscot (NMFS 2009). This habitat represents approximately 25% of the potential spawning and rearing habitat within the Penobscot drainage. The Medway Project itself only prevents passage to the next upstream barrier, the East Millinocket Dam about two miles upriver and, on its own, is not preventing access to a significant quantity of habitat. However, the lack of passage at Medway does force all Atlantic salmon that are attracted to the flow in the West Branch to stray downriver into the East Branch, or into the mainstem. This straying leads to increased energy expenditure and delay, which could prevent salmon from accessing suitable spawning habitat.

Summary of Downstream Passage Effects

A significant proportion of Atlantic salmon smolts and kelts are injured or killed while passing dams during their downstream migration. It is assumed for this Opinion that the existing downstream passage rates will be maintained until the achievement of the performance standard has been demonstrated through passage studies. Therefore, over the life of the project licenses, we consider that the projects will operate under two conditions: the current condition and the conditions once the SPP performance standards are met. Once the projects are operating pursuant to the downstream performance standard, there will be a decrease in the proportion of salmon killed while attempting downstream passage.

Atlantic salmon smolts outmigrate to the estuary in the spring after rearing in freshwater streams. Under current operations, which may continue for up to ten years, Alden Lab (2012) reports that, due to the direct and indirect effects of dam passage, between 6.40% and 24.36% of smolts outmigrating through the Penobscot River are killed annually by the individual dams considered in this Opinion (Table 14). Therefore, cumulatively, between 15.3% and 32.9% of smolts migrating through the Projects in the lower Penobscot (West Enfield, Milford, Stillwater and Orono) will be subject to direct mortality associated with dam passage (assuming a median split of 80.3%/19.7% between the mainstem Penobscot and the Stillwater Branch (NMFS 2012, based on Holbrook *et al.* 2011). Pursuant to the terms of the proposed license amendments and consistent with the he SPP, we anticipate that the performance standard of 96%, based on a 75% confidence interval, will be met at all four projects no later than spring of 2023. At that point, the mortality rate is expected to be 4%, which will reduce the cumulative mortality rate through all four dams to 8.7%. This is a relative reduction of between 43% and 74%, when compared to the maximum and minimum survival rates reported by Alden Lab (2012).

Atlantic salmon kelts outmigrate in the fall after spawning, or in the spring after overwintering in freshwater. They are subject to the same challenges associated with dam passage as smolts but, due to their greater length, are more likely to be struck by a turbine blade (Alden Lab 2012). Under current operations, which may persist for up to ten years, Alden Lab (2012) reports that, due to the direct and indirect effects of dam passage, between 7.91% and 34.17% of kelts will be killed annually by the individual dams considered in this Opinion. Therefore, between 19.3% and 43.9% of kelts migrating past the West Enfield, Milford, Stillwater and Orono Projects in the lower Penobscot will be subject to mortality associated with dam passage (assuming that outmigrating kelts split between the Stillwater Branch and the mainstem Penobscot at the same rate as smolts). It is anticipated that the performance standard of 96%, based on a 75% confidence interval, will be met at all four projects no later than spring of 2023. At that point, the mortality rate is expected to be 4%, which will reduce the cumulative mortality rate through all four dams to 8.7%, which is a relative reduction of between 55% and 80%, when compared to the maximum and minimum survival rates reported by Alden Lab.

Table 14. The proportion of Atlantic salmon smolts and kelts that are anticipated to be killed annually due to direct and indirect effects due to present and future operations at the Milford, West Enfield, Orono and Stillwater Projects based on survival estimates provided by Alden Lab (2012), and a median split between the Stillwater Branch and the mainstem Penobscot of 19.7%/80.3% (NMFS 2012, based on Holbrook *et al.* 2011). Existing kelt survival numbers are based on Alden Lab's data, but has been weighted to account for 80% of outmigration occurring in the spring and 20% in the fall (Lévesque *et al.* 1985, Baum 1997).

	Project	**Smolts**		**Kelts**		
		Max	*Min*	*Max*	*Min*	*Duration*
Environmental Baseline	Milford	24.4%	8.0%	31.4%	10.8%	2013-2022
	West Enfield	7.7%	6.4%	9.8%	7.9%	
	Orono	18.4%	8.5%	28.0%	10.0%	
	Stillwater	9.5%	7.9%	34.2%	9.9%	
	All Four	**32.9%**	**15.3%**	**43.9%**	**19.3%**	
SPP Performance Standards	Milford	4.0%		4.0%		2023-2038
	West Enfield	4.0%		4.0%		2023-2024
	Orono	4.0%		4.0%		2023-2048
	Stillwater	4.0%		4.0%		2023-2048
	All Four	**8.7%**		**8.7%**		

Similar to migrating pre-spawn adults, outmigrating smolts and kelts are subject to delay by the presence of hydroelectric dams. While these delays can lead to 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).

We expect that 24 hours provides adequate opportunity for smolts and kelts to locate and utilize well-designed downstream fishways at hydroelectric dams. A 24-hour period would allow these migrants an opportunity to locate and pass the fishway during early morning and dusk, a natural diurnal migration behavior of Atlantic salmon. Passage times in excess of 24 hours would result in unnatural delay for migrants leading to increased predation and reduced fitness in the freshwater to saltwater transition. Therefore, any smolt or kelt documented to take longer than 24 hours to pass a downstream passage facility will be considered to have failed in their passage attempt. Therefore, under the downstream performance standard, 96% of salmon smolts and kelts are expected to be passed within 24 hours of approaching within 200 meters of any of these projects; thus, only 4% will be potentially subjected to significant delays.

In addition to the direct and indirect mortality associated with dam passage for smolts and kelts, there is also the possibility of additional dam-related mortality occurring in the early marine phases of the salmon's life history. For Pacific salmon species, this concept is known as the hydrosystem-related delayed-mortality hypothesis (Budy *et al.* 2002, Schaller and Petrosky 2007). This delayed mortality is thought to be attributable to physiological stress associated with dam passage that affects smolts and post-smolts experiencing the challenges of transitioning to the marine environment (osmoregulation, novel predators, etc.). Very recently, Haeseker *et al.* (2012) provide clear evidence supporting this hypothesis for Snake River Chinook salmon and steelhead. At this time, it is impossible to quantify how much (if any) early marine mortality of Atlantic salmon may be attributable to similar mechanisms in the Penobscot River watershed. However, it is reasonable to assume that some level of delayed (and as yet undocumented) early marine mortality of Atlantic salmon is ultimately due to earlier hydrosystem experience.

8.1.1. Survival and Recovery Analysis

Jeopardy is defined as "an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, to determine if the proposed action will jeopardize the GOM DPS of Atlantic salmon, we conduct an analysis of the effects of the proposed action on survival and recovery.

The first step in conducting this analysis is to assess the effects of the proposed action on the survival of the species. Survival is defined as the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter (USFWS and NMFS 1998).

There are three criteria that are evaluated under the survival analysis: reproduction, numbers and distribution. The number of returning adult Atlantic salmon, particularly 2SW females, to the Penobscot River is a measure of both the reproduction and numbers of the species. We consider the proportion of runs where pre-spawn Atlantic salmon are able to access high quality spawning and rearing habitat in the upper Penobscot watershed as a reasonable and appropriate measure of distribution. As 92% of high quality habitat in the Penobscot River exists upriver of the West Enfield Project on the mainstem, and the Howland Project on the Piscataquis River, we consider improved access past these locations to be critical to the survival and recovery of the species. The survival analysis assumes that the following conditions are maintained over the time period considered in this consultation: existing passage rates at all the dams in the Penobscot River, estimations of existing freshwater and marine survival rates, and existing hatchery stocking rates.

The second step in conducting this analysis is to assess the effects of the proposed project on the recovery of the species. Recovery is defined as the improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the ESA (50 CFR 402.02). As with the survival analysis, there are three criteria that are evaluated under the recovery analysis: reproduction, numbers and distribution. In the recovery analysis, the same measures are used to evaluate these criteria as are used in the survival analysis. However, unlike with survival, the recovery analysis requires an adjustment to the existing freshwater and marine survival rates to allow for a population that has a positive growth rate, so that it can be determined how the proposed project will affect the species ability to achieve recovery. Such an analysis could not be conducted under existing freshwater and marine survival conditions, since they do not allow a population trending towards recovery. The recovery condition includes existing dam passage rates, but does not include hatchery supplementation as it is assumed that in a recovered population, stocking will not be necessary to sustain a viable population.

The proposed construction activities and passage studies are only anticipated to kill, injure, harm and harass a small number of Atlantic salmon and are, therefore, not anticipated to result in changes in abundance, reproduction and distribution that would reduce appreciably the likelihood of both the survival and recovery of the species. Therefore, this analysis only addresses the effects of future operations of Black Bear’s hydroelectric facilities under the terms of the proposed SPP.

To facilitate this analysis, NMFS and USFWS have independently constructed models to determine how dams affect the GOM DPS of Atlantic salmon (NMFS 2012, Appendix C; USFWS 2012, Appendix D). The models utilize life history characteristics and estimated passage and survival rates at dams in the Penobscot River to determine how the proposed project will affect survival and recovery of Atlantic salmon. Both models use multiple inputs in their analyses that are documented and described in detail in Appendix C and D.

The NMFS Dam Impact Assessment (DIA) model evaluates the relative effect that changes in various inputs could have on the abundance of returning 2SW female Atlantic salmon to the Penobscot River under the survival and recovery conditions. The DIA model uses the following inputs in its analysis:

- Initial number of 2SW females spawners
- Eggs per female
- Freshwater Survival (Egg to smolt)
- In-River Survival (Outmigration)
- Smolt production caps
- Hatchery Stocking Levels and Location
- Downstream passage estimates (Alden)
- Downstream passage estimate correlation
- Path choice
- Hatchery discount
- Marine Survival
- Broodstock collection
- Natural Straying Rate
- Dam mortality
- Dam-induced Straying Rate
- Pre-spawn adult upstream passage efficiencies

The model compares baseline survival and recovery conditions to what would be anticipated with the implementation of the performance standards outlined in Black Bear's SPP. As described previously, dam passage rates, marine and freshwater survival, and hatchery supplementation are adjusted according to the condition (Table 15).

Table 15. The conditions considered in the NMFS's DIA model for the Penobscot River watershed, based on the proposed action of implementing upstream and downstream performance standards.

	Survival		**Recovery**	
	Baseline	*Proposed*	*Baseline*	*Proposed*
Dam Passage Rates	Existing+PRRP	SPP	Existing+PRRP	SPP
Hatchery	Stocking	Stocking	No stocking	No stocking
Marine Survival	Post-regime shift	Post-regime shift	Pre-regime shift	Pre-regime shift
Freshwater Survival	Contemporary	Contemporary	Improved	Improved

Survival Analysis

Abundance and Reproduction

Our DIA model compares baseline conditions with the conditions of the river once the proposed action has been implemented. The baseline condition of the Penobscot River in this comparison assumes the following: that the removal of the Veazie and Great Works Projects, as well as the new bypass around the Howland Project has occurred; that all remaining dams are functioning at their current passage rates; that stocking of hatchery smolts is occurring; and that marine survival is at contemporary levels. The project condition alters the passage rates at the West Enfield, Milford, Stillwater and Orono Projects to 96% downstream and 95% upstream. The baseline assumes a starting population in the Penobscot River that approximates current conditions. For the model, we calculated that the ten year (2002-2011) average of returning 2SW females is 587 individuals.

The model results indicate that the downstream performance standard is anticipated to reduce the proportion of salmon smolts that are killed by hydroelectric operations on the Penobscot by 52% when compared to baseline conditions, which includes completion of the PRRP. Similarly, the DIA model indicates that the standards will lead to an increase in the annual return rate of 2SW female Atlantic salmon by 11% in the tenth generation over the baseline conditions when the PRRP is completed (Figure 9). As the metric being assessed is the change in the abundance of pre-spawn 2SW female Atlantic salmon, we assume that the increase in abundance corresponds with an increase in reproduction.

As illustrated in Figure 9, the model indicates a significant decline in 2SW female returns between the first and second generations prior to leveling out for the next nine generations. Although in generation one the model allows for 587 females to spawn in the system, the majority of their progeny do not survive to the adult stage due to freshwater and marine mortality factors. As such, they have very little effect on the subsequent adult returns and generations two through ten are primarily being driven by the return rate for the stocked smolts. In short, the 'wild' spawners in generation one are providing very little benefit to the subsequent adult returns under the baseline survival conditions and any benefit provided quickly dissipates as the generations progress.

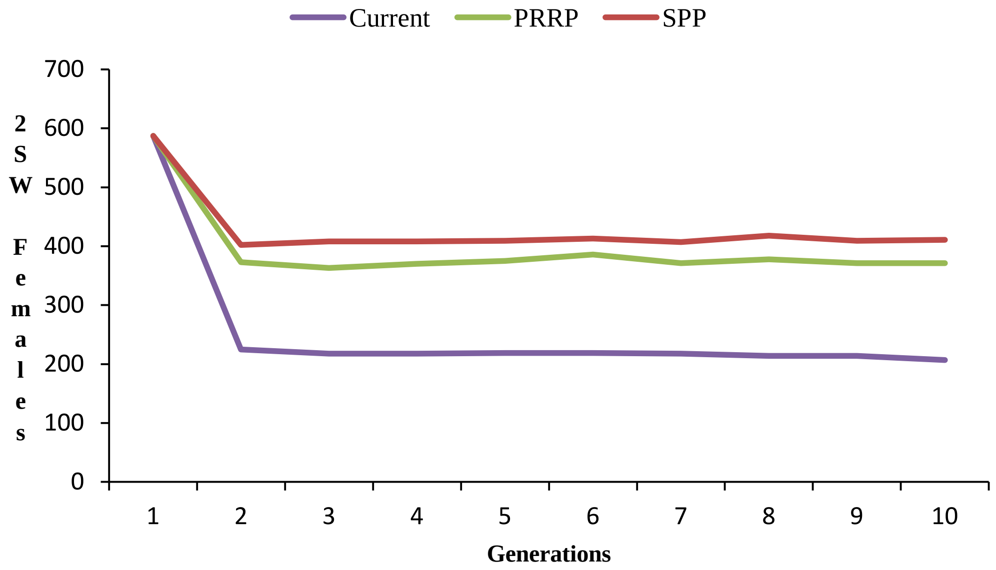

Figure 9. Comparison of the simulated number of returning 2SW female Atlantic salmon over ten generations according to the DIA model under current, environmental baseline (PRRP), and SPP passage conditions (NMFS 2012).

As mentioned above, USFWS (2012) constructed an independent life history model to assess how operations of the projects pursuant to the SPP would affect total smolt survival and adult returns in the Penobscot River (Appendix D). The USFWS (2012) model shows similar results to our DIA model, indicating that operations of the projects pursuant to the SPP's performance standards would result in a relative increase in cumulative smolt survival of 7% over the baseline conditions (which include the PRRP). Additionally, the model predicts that operations pursuant to the SPP will result in an increase in cumulative upstream passage success through the Penobscot River dams of 2%. The USFWS model also calculated a population growth rate (λ) for the various scenarios, and determined that the proposed performance standards will increase λ in the Penobscot River from 0.82 to 0.85, assuming existing marine survival rates are maintained over this period. A population that has a λ below 1 is a declining population that is below the replacement rate; however, the USFWS model indicates that under conditions where the projects operate pursuant to the SPP and under existing marine survival conditions, there will be an increase of 3.5% in the population's rate of growth.

Based on the results of the two models, it can be concluded that, although the Atlantic salmon population is still declining, the proposed project will lead to a slight increase in the abundance of returning 2SW female Atlantic salmon to the Penobscot River and the GOM DPS of Atlantic salmon. As the metric being measured is pre-spawn females, this increased abundance corresponds with an equal increase in reproduction.

Distribution

We conducted a separate analysis using the DIA model to assess the effects of project operations pursuant to the SPP on the distribution of Atlantic salmon in the Penobscot River watershed. In this analysis, the proportion of runs where salmon access habitat upstream of the West Enfield Project in the mainstem of the Penobscot and the Howland Dam on the Piscataquis River, is compared between the baseline condition and the condition after the implementation of the SPP. The DIA model indicates that the operation of the projects in a manner that achieves the performance standards in the SPP leads to a small increase in the proportion of runs where salmon pass the West Enfield or Howland Projects (Table 16). The model indicates that after ten generations the implementation of the SPP there will be a 2% relative increase when compared to baseline conditions. Therefore, the proposed project is anticipated to lead to a small improvement in the distribution of Atlantic salmon in the Penobscot River, and GOM DPS as a whole.

Table 16. The proportion of runs anticipated where 2SW female Atlantic salmon are able to access high quality habitat in the upper Penobscot River (above West Enfield) and in the Piscataquis River (above Howland) over ten generations.

	Upper Penobscot			**Piscataquis**		
Generation	**Current**	**PRRP**	**SPP**	**Current**	**PRRP**	**SPP**
1	100%	100%	100%	100%	100%	100%
2	68%	91%	92%	68%	91%	92%
3	64%	90%	92%	65%	90%	92%

4	64%	90%	92%	65%	91%	92%
5	63%	90%	92%	64%	90%	92%
6	64%	90%	92%	65%	90%	92%
7	64%	91%	92%	64%	91%	92%
8	63%	90%	92%	64%	91%	92%
9	64%	91%	92%	65%	91%	92%
10	64%	90%	92%	64%	90%	92%

The model results for the survival analysis indicate that the operation of Black Bear's Projects in the Penobscot River, under the terms of the proposed SPP, will lead to a slight increase in the abundance, reproduction and distribution of Atlantic salmon in the Penobscot River watershed, as well as the GOM DPS as a whole. Therefore, the proposed action will not appreciably reduce the likelihood that the GOM DPS of Atlantic salmon will survive.

Recovery Analysis

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

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

At existing freshwater and marine survival rates (the medians have been estimated by NMFS as 1.1% and 0.4%, respectively), it is unlikely that Atlantic salmon will be able to achieve recovery. As indicated in the survival analysis above, at current survival rates wild spawners are having a very small effect on the number of returning salmon. If hatchery supplementation were to cease, the population would decline rapidly, and recovery would not be possible. Therefore, a significant increase in either freshwater or marine survival (or a lesser increase in both) will be necessary to achieve recovery. The Atlantic Salmon Recovery Team (ASRT) created a conceptual model to indicate how marine and freshwater survival rates would need to change in order to recover Atlantic salmon (ASRT 2010). In Figure 10, the red dot represents current marine and freshwater survival rates; the blue line represents all possible combinations of marine and freshwater survival rates that would result in a stable population with a growth rate of zero. If survival conditions are above the blue line, the population is growing, and, thus, trending towards recovery (lambda greater than one). The red lines indicate the rates of freshwater survival that have been historically observed (Legault 2004). This model indicates that there are many potential routes to recovery; for example, recovery could be achieved by significantly increasing the existing marine survival rate while holding freshwater survival at existing levels, or, conversely, by significantly increasing freshwater survival while holding marine survival at today's levels. Conceptually, however, the figure makes clear that an increase in both freshwater and marine survival will lead to the shortest and, therefore, most likely to occur, path to achieving a self-sustaining population that is trending towards recovery.

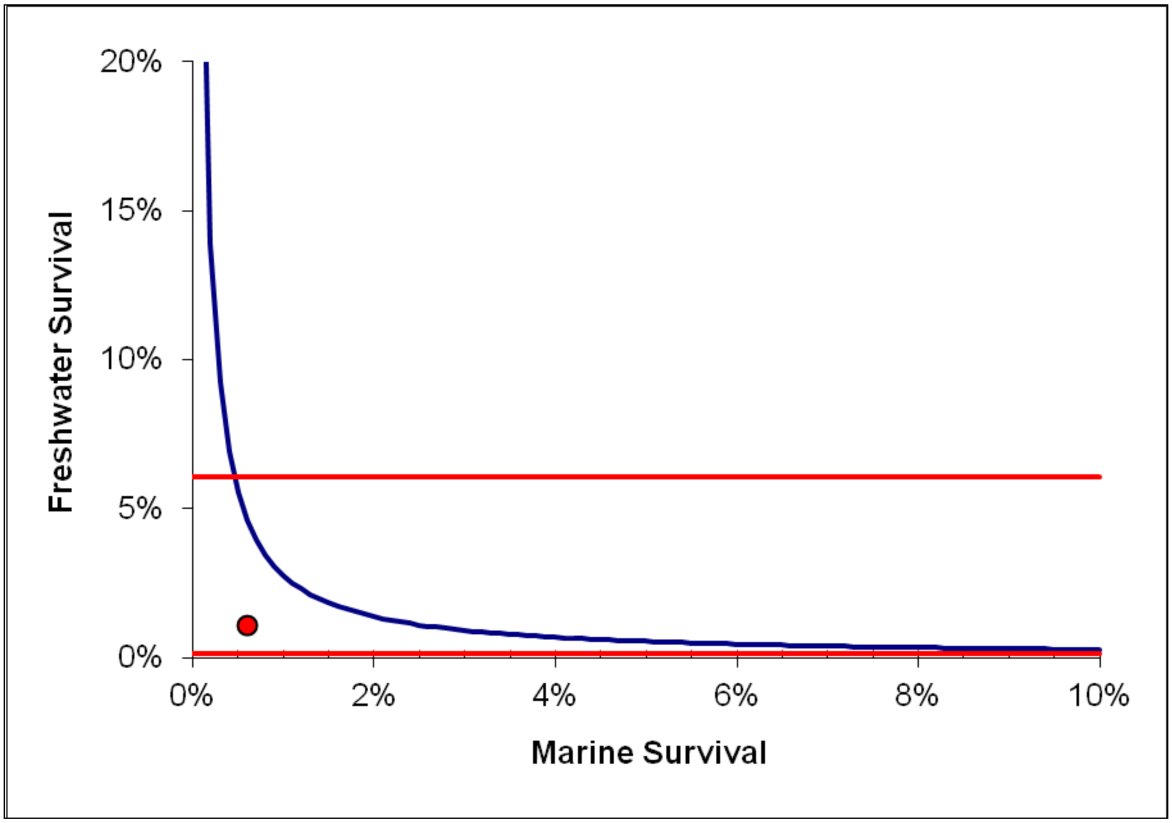

Figure 10. A conceptual model constructed by ASRT (2010) that demonstrates how changes in marine and freshwater survival will be necessary to recover the GOM DPS of Atlantic salmon. The red dot represents current conditions, the blue line represents recovery, and the red lines are the historic maximum and minimum freshwater survival.

In order to model the effect that the proposed action would have on recovery, marine and freshwater survival rates are increased to a point that will allow for the recovery of the species. To do this, assumptions are made about what constitutes a realistic increase in these parameters. In the mid-1980's to early 1990's there was a 50% to 70% decline in Atlantic salmon marine survival rates. This event is referred to as the regime shift (Chaput *et al.* 2005); the causes for which are unknown at this time (Windsor *et al.* 2012). Based on the smolt to adult return rate for wild fish in the Narraguagus River, USFWS (2012) estimated that the pre-regime shift marine survival rate ranged between 0.9% and 5.2%, with an average of 3.0%. A four-fold increase in the current median marine survival rate (from 0.4% to 1.7%) will allow for a rate that is within the range estimated to have existed prior to the regime shift.

Freshwater survival rates have historically ranged between 0.1% and 6.0%, with an average of

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

This recovery analysis looks at two scenarios; one that sets the starting population at existing levels, and another that starts at an already recovered population. Using these scenarios, the analysis will address whether the proposed project will preclude or slow the existing population from achieving recovery (Scenario #1), as well as whether an already recovered population can sustain recovery under the conditions created by the proposed action (Scenario #2).

Recovery Scenario #1

Abundance and Reproduction

Like in the survival analysis, the baseline population under this scenario assumes a starting population in the Penobscot River that approximates current conditions. For the DIA model, NMFS calculated that the ten year average (2002-2011) of returning 2SW female Atlantic salmon is 587 individuals. As described above, in order to achieve recovery an increase in freshwater and marine survival will be necessary. We have determined that a doubling of freshwater survival and a quadrupling of marine survival will allow for a population that is increasing at a slow but steady rate, although other scenarios could be used to achieve the same increase in population growth rate.

To conduct the scenario #1 recovery analysis, we used the DIA model to compare the recovery baseline condition with the condition anticipated once the proposed action has been implemented. The current baseline condition of the Penobscot River in this comparison assumes that the PRRP (removal of the Veazie and Great Works Projects, as well as the new bypass around the Howland Project) has occurred; that all remaining dams, including Black Bear’s projects, are functioning at their current passage rates; that stocking of hatchery smolts has been discontinued; and, as indicated above, that marine and freshwater survival has been increased to a point that recovery is achievable. The SPP condition improves the downstream and upstream passage rates at the West Enfield, Milford, Stillwater and Orono Projects to 96% and 95%, respectively. For comparison, the model also incorporated a hypothetical full passage condition, where all of Black Bear’s projects in the Penobscot River, except for Medway, had their upstream and downstream passage rates set to 100%. The DIA model analysis predicts that operations of the projects pursuant to the SPP will lead to a relative increase in the number of returning 2SW female Atlantic salmon of 41% after ten generations. However, as anticipated, the proposed project will lead to 35% fewer returns than what would be expected under the full passage scenario (Figure 11).

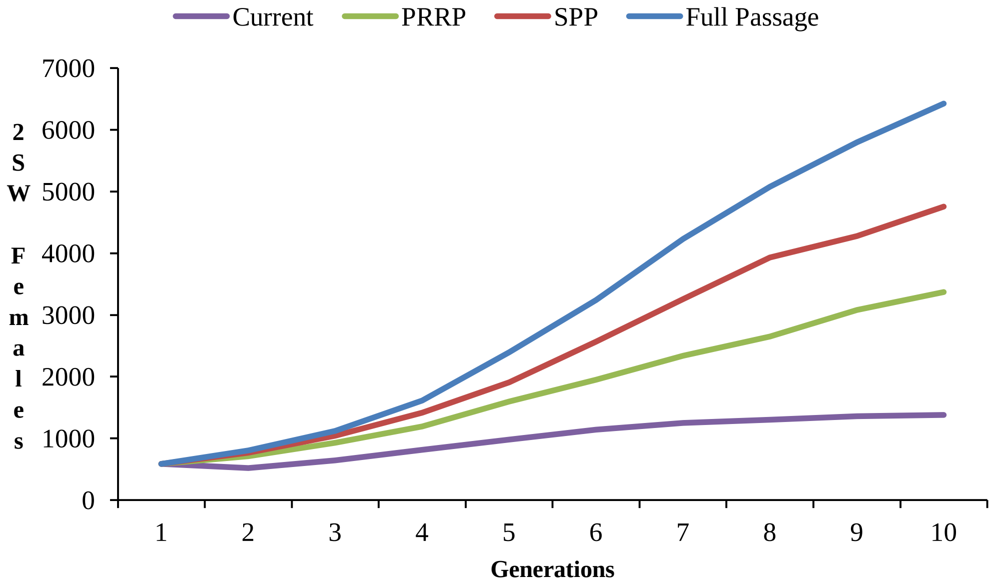

Figure 11. Comparison of the simulated number of returning 2SW female Atlantic salmon over ten generations under the first recovery scenario according to the DIA model under current, environmental baseline (PRRP), SPP and full passage conditions (NMFS 2012).

The draft Atlantic Salmon Recovery Plan, which is currently being developed by the Services, indicates that 2,000 wild adult returning salmon in each of the three SHRUs will be necessary for the species to achieve recovery. Two thousand adult returns equate to approximately 1,000 wild 2SW female Atlantic salmon. As can be seen in Table 17, both the SPP and the Full Passage condition achieve this threshold by the third generation under these survival rates. Although these numbers would vary under different freshwater and marine survival rates, this output suggests that under improved survival conditions the operation of the projects pursuant to the SPP likely does not appreciably reduce the rate of recovery. Therefore, this analysis indicates that the proposed action will likely not preclude the species from growing in a way that leads to recovery and that the action will not significantly reduce the rate at which it can occur should marine and freshwater survival rates increase sufficiently to allow for recovery.

Table 17. The simulated number (median) of returning 2SW female Atlantic salmon returns estimated by the DIA model under the recovery scenario #1 that incorporates a starting population that estimates the ten year (2002-2011) average return rate (NMFS 2012).

Generation	Current	PRRP	SPP	Full Passage
1	587	587	587	587
2	517	710	766	807
3	645	930	1045	1120
4	814	1195	1414	1613
5	980	1597	1908	2396
6	1144	1953	2569	3239
7	1253	2338	3256	4230

8	1303	2651	3929	5076
9	1360	3079	4280	5796
10	1378	3373	4755	6425

USFWS's (2012) life history model also assessed how the proposed SPP would affect the Penobscot Bay SHRU if marine survival was increased to pre-regime levels (Appendix D). The model calculated a population growth rate (λ or lambda) under this condition, and determined that the proposed performance standards will increase λ in the Penobscot River under the recovery scenario from 1.07 to 1.10. A population that has a λ greater than 1 is an increasing population trending towards recovery. The USFWS model indicates that the SPP, under increased marine survival conditions, would lead to an increase of 2.7% in the population's rate of growth.

Distribution

Under scenario #1 (starting population at existing levels), the DIA model was used to conduct a separate analysis to assess the effects of the SPP on the distribution of Atlantic salmon in the Penobscot River watershed under the baseline recovery conditions (hatchery off and increased freshwater and marine survival). In this analysis, the proportion of runs where salmon access habitat upstream of the West Enfield Project in the mainstem of the Penobscot and the Howland Dam on the Piscataquis River, is compared between the baseline condition and the condition after the implementation of the SPP. The DIA model indicates that with improved marine and freshwater survival the proportion of runs where individual 2SW female salmon access habitat upriver of the West Enfield and Howland Projects is between 97% and 100% regardless of dam passage rates. The model indicates that the SPP condition will allow 100% of salmon runs to have access to the upper Penobscot and Piscataquis after ten generations, which is essentially the same as the environmental baseline condition, where 99% and 100% of successful runs can access the habitat in the mainstem Penobscot and Piscataquis, respectively.

Recovery Scenario # 2

Abundance and Reproduction

The baseline for this analysis assumes that the population has achieved a sustainable level approximately at the threshold for recovery. The draft Atlantic Salmon Recovery Plan, which is currently being developed by the Services, indicates that 2,000 wild adult returning salmon in each of the three SHRUs will be necessary for the species to achieve recovery. Two thousand adult returns equates to approximately 1000 2SW female Atlantic salmon, which is the metric that was used in the DIA model. As described above, in order to achieve and sustain a recovery an increase in freshwater and marine survival will be necessary. We determined that a doubling of freshwater survival and a quadrupling of marine survival will allow for a population that is increasing at a slow but steady rate, although other scenarios could be used to achieve the same increase in population growth rate.

To conduct the scenario # 2 recovery analysis, we used the model to compare the recovery baseline condition with the conditions anticipated once the proposed action has been fully implemented. The baseline condition of the Penobscot River watershed in this comparison assumed that the removal of the Veazie and Great Works Projects, as well as the new bypass around the Howland Project, has occurred; that all remaining dams, including Black Bear's projects, are functioning at their current passage rates; that stocking of hatchery smolts has been discontinued; and, as indicated above, that marine survival has been increased to a point that recovery is sustainable. The post project implementation condition alters the downstream and upstream passage rates at the West Enfield, Milford, Stillwater and Orono Projects to 96% and 95%, respectively. For comparison, the model also incorporated a full passage condition, where all of Black Bear's projects in the Penobscot River, except for Medway, had their upstream and downstream passage rates set to 100%. Our analysis addressing the effect of the project on the abundance of returning adults indicates that the SPP will lead to an increase in the number of returning 2SW females of approximately 39% after ten generations (Figure 12). However, as anticipated, the proposed project will lead to 27% fewer returns than what would be expected under the full passage condition.

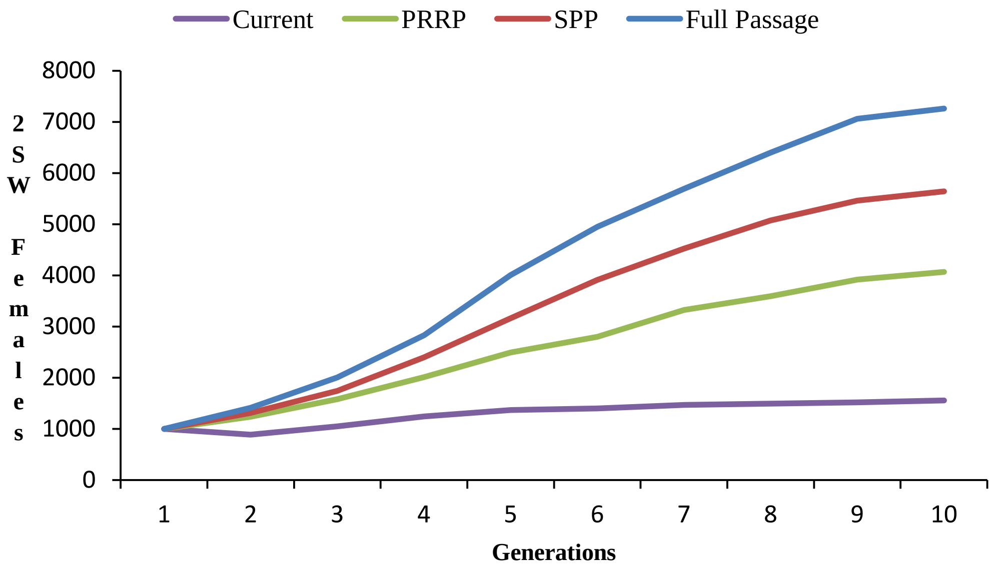

Figure 12. Comparison of the simulated number of returning 2SW female Atlantic salmon over ten generations under the second recovery scenario according to the DIA model under current, environmental baseline (PRRP), SPP and full passage conditions (NMFS 2012).

The intent of this analysis is to indicate whether or not a recovered Atlantic salmon population can sustain recovery (stay above the threshold) once the proposed action has been implemented. The results suggest that although the number of returning salmon is somewhat smaller under the SPP condition than under the full passage scenario, neither condition allows the population to drop below 1000, and both show a population growth rate that is increasing into the foreseeable future.

Distribution

Under scenario #2 (starting population at recovery threshold), the DIA model was used to conduct a separate analysis to assess the effects of the SPP on the distribution of Atlantic salmon in the Penobscot River watershed under the baseline recovery conditions (hatchery off and increased freshwater and marine survival). In this analysis, the proportion of runs where salmon access habitat upstream of the West Enfield Project in the mainstem of the Penobscot and the Howland Dam on the Piscataquis River, is compared between the baseline condition and the condition after the implementation of the SPP. The DIA model indicates that with improved marine and freshwater survival the proportion of runs where individual 2SW female salmon access habitat upriver of the West Enfield and Howland Projects is between 97% and 100% regardless of dam passage rates. The model indicates that the SPP condition will allow 100% of salmon runs to have access to the upper Penobscot and Piscataquis after ten generations, which is essentially the same as the environmental baseline condition, where 99% and 100% of successful runs can access the habitat in the mainstem Penobscot and Piscataquis, respectively.

Summary of Effects of the Proposed Action to Atlantic Salmon

In this section, we summarize the effects of the proposed action on the GOM DPS of Atlantic salmon in conjunction with the environmental baseline. Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for Atlantic salmon in the wild (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). Although the population growth rate of Atlantic salmon will still have a downward trend after the implementation of the proposed project, the increase in upstream and downstream passage rates as described in the SPP will lead to a slight improvement of the baseline condition of the species, and will make recovery more likely should other parameters, such as marine and freshwater survival, improve in the future. While juvenile and adult Atlantic salmon mortality associated with dam passage at the Milford, West Enfield, Orono, Stillwater and Medway Projects will continue to have an adverse effect on Atlantic salmon in the Penobscot River, the NMFS DIA (2012) and USFWS (2012) models indicate that the loss will not be sufficient to appreciably diminish the species ability to achieve recovery. As such, there is not likely to be an appreciable reduction in the likelihood of survival and recovery in the wild of the Penobscot River population or the species as a whole.

The proposed action will not affect Atlantic salmon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent Atlantic salmon from completing their entire life cycle, including reproduction, sustenance, and shelter. The above analysis predicts that the proposed project will lead to an improvement in the numbers, reproduction and distribution of Atlantic salmon. This is the case because: 1) the proposed performance standards result in an increase in the abundance of pre-spawn adult Atlantic salmon returning to the Penobscot River, 2) the increase in the number of returning Atlantic salmon due to the improved downstream survival and upstream passage rates at Black Bear’s facilities will lead to an increase in reproduction in high quality spawning habitat in the upper Penobscot and Piscataquis Rivers, and 3) the increase in the number of returning Atlantic salmon due to the improved downstream survival and upstream passage rates at Black Bear’s facilities will lead to a higher distribution of Atlantic salmon in the upper Penobscot watershed.

Despite the threats faced by individual Atlantic salmon inside and outside of the action area, the proposed action will not increase the vulnerability of individual Atlantic salmon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action.

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

8.2. Atlantic Salmon Critical Habitat

Critical habitat for Atlantic salmon has been designated in the Penobscot River including the sections of river in the vicinity of the Orono, Stillwater, Milford and West Enfield 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). Although there is a small amount of spawning and rearing habitat in the mainstem of the Penobscot and the Stillwater Branch, the habitat in the proposed project area primary functions as a migration corridor for migrating pre-spawn adults, as well as for outmigrating smolts and kelts

Summary of Construction Effects

The construction of the powerhouses and fishways on the Stillwater Branch will temporarily reduce the functioning of critical habitat in the vicinity of the Orono and Stillwater Projects between 2012 and 2013. These areas will be made unsuitable for Atlantic salmon migration due to elevated turbidity and noise levels associated with construction activities. The effects will be of short duration and, as all work will occur within dewatered cofferdams, it is expected that exposure to the effects will be minimal. It is expected that temporary construction effects will cause fish to avoid the project area for short periods of time.

The total temporary fill associated with the proposed project is 2.6 acres (115,470 square feet), while the permanent fill (new penstocks, powerhouses and site work) will eliminate 0.66 acres (28,999 square feet) of migratory habitat. The majority of the temporary fill will be placed and removed in the Stillwater Branch outside of the spring outmigration period. As the Stillwater does not function as an upstream migratory corridor due to a lack of passage facilities, the placement of this fill is anticipated to have an insignificant effect on the migration PCE. However, the placement of permanent fill will negatively affect the functioning of the habitat in the bypass reach at both projects by precluding the use of the habitat for migration. As the permanent fill associated with the new structures will only occupy 0.02% of the migratory habitat in the Stillwater Branch, it is not anticipated that it will substantially alter the functioning of the habitat for Atlantic salmon.

There will be no permanent fill associated with the new fishway at Milford, although a small area (509 square feet) will be temporarily cofferdammed in the tailrace during construction. The cofferdam will be placed on ledge, so it is not anticipated that there will be a significant sediment release when it is removed. There will be no blasting or excavation associated with the project at Milford. As the Denil fishway at Milford will be maintained and operated during construction, it is anticipated that the effect of construction activities on these fish would be insignificant.

Summary of Upstream Passage Effects

The proposed upstream performance standard will improve migratory conditions in the action area by allowing more Atlantic salmon to successfully migrate past the Milford and West Enfield Projects. As 95% of salmon will have to migrate past these dams within 48 hours of approaching within 200 meters of the tailrace, it is expected that the proposed standards will also reduce levels of significant delay associated with dam passage. It is expected that the operation of these fishways will still adversely affect the critical habitat by blocking passage to 5% of migrating salmon that are presumably motivated to pass each dam.

The proposed project will not improve passage into the Stillwater Branch of the Penobscot River. Although a new fish lift will be constructed at Orono, trapped Atlantic salmon will not be allowed to continue their migration in the Stillwater Branch; rather they will be released into the mainstem. Although the lack of passage adversely affects the migratory PCE in the Stillwater Branch, Atlantic salmon that are attracted to the Orono Project have been found to eventually continue their migration in the mainstem of the River (Shepard 1995). Thus, the presence of the Orono Project does not prevent migration to the high quality spawning and rearing habitat in the upper river, although it may lead to significant levels of migratory delay. As no performance standard has been proposed for the Orono Project, the SPP does not define the level of expected delay. Based on the results of a study conducted by Shepard (1995), 33% of Atlantic salmon that are attracted to the discharge of the Orono Project could be subject to significant delay (more than 48 hours).

Summary of Downstream Passage Effects

The proposed downstream performance standard will improve migratory conditions in the action area by allowing more Atlantic salmon smolts and kelts to survive downstream passage through the Stillwater, Orono, Milford and West Enfield Projects. A significant proportion of Atlantic salmon smolts and kelts are injured or killed while passing dams during their downstream migration. The proposed downstream performance standard will significantly reduce this effect by requiring that 96%, based on a 75% confidence interval, of outmigrating Atlantic salmon smolts and kelts survive passage. The performance standard will lead to a relative reduction in smolt mortality of between 43% and 74%, when compared to the maximum and minimum survival rates reported by Alden Lab (2012). Similarly, it is expected to be a relative reduction in kelt mortality of between 55% and 80%. It is also anticipated that the performance standard will lead to a reduction in delay as a smolt or kelt will only be considered to have met the standard if it safely passes the dam within 24 hours of approaching within 200 meters of the project trashracks.

We expect that the proposed project would continue to harm the PCEs in the action area. We expect the continued operations of these projects to cause 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, designated critical habitat in the Penobscot River watershed is anticipated to improve for Atlantic salmon with the implementation of the upstream and downstream performance standards outlined in the proposed SPP. Operation of the projects pursuant to the amended licenses is expected to achieve these performance standards by 2023. At this time, effects of hydroelectric operations to the migration PCE will be reduced by improving passage rates and reducing delay for both upstream and downstream migrating Atlantic salmon. Therefore, the proposed project is not likely to adversely modify or destroy Atlantic salmon critical habitat.

8.3. Shortnose sturgeon

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

Shortnose sturgeon will not be able to access the Milford, Orono, Stillwater, West Enfield and Medway Projects during construction as they cannot currently move upstream of the Veazie Dam, which will not be removed until 2013 at the earliest. Therefore, the species will not be exposed to any effects associated with the construction of the new powerhouses and fish lifts; and consequently, all construction related effects are likely to be insignificant and discountable.

Future operations of the Stillwater, West Enfield and Medway Projects are not likely to result in negative effects to shortnose sturgeon as they are located upstream of what is believed to be the historic range of shortnose sturgeon in the Penobscot River, and no shortnose sturgeon will be exposed to effects of project operations. The Milford and Orono Projects are located at what is believed to be the upstream extent of the historic range of shortnose sturgeon and, therefore, they are not considered barriers to upstream migration. It is anticipated that once the Great Works and Veazie Dams have been removed that shortnose sturgeon will utilize habitat downstream of these projects, potentially for spawning. Therefore, it is possible that the operation of the facilities could impact shortnose sturgeon and its habitat downriver of the project.

We have determined that the proposed action will affect shortnose sturgeon by resulting in the capture of four shortnose sturgeon in the fish lifts at the Orono and Milford Projects annually. It is expected that three of these fish will be captured at the Milford Project, while only one is expected to be captured at the Orono Project. Additionally, the stranding of one shortnose sturgeon at the Orono Project per year is expected in pools downstream of the dam during the replacement or maintenance of flashboards. Black Bear will adhere to a monitoring plan and handling plan to ensure that any shortnose sturgeon captured in the fish lifts, or in isolated pools, are removed promptly and returned safely downstream. It is possible that some captured shortnose sturgeon could experience minor injuries, such as abrasions, due to contact with the concrete surface of the fish lift. Shortnose sturgeon captured in the fish lifts will be temporarily delayed from carrying out spawning activities. However, given that monitoring will be continuous during the spawning season the amount of time that any shortnose sturgeon would spend in the fish traps, or in an isolated pool, is short and certainly less than 24 hours. As such, it is extremely unlikely that the fish would miss a spawning opportunity. Similarly, it is unlikely that the temporary capture in the traps, or in the pools, and subsequent removal and placement back downstream of the fish lift would cause an individual shortnose sturgeon to abandon their spawning attempt. Considering this analysis, the capture of four (three at the Milford Project and one at the Orono project) shortnose sturgeon in fish lifts, and an additional one stranded per project in pools during flashboard replacement, is not likely to result in any injury or mortality or affect the fitness of any individuals, or cause any reduction in the number of eggs spawned or in the successful development of those eggs and larvae.

The proposed action is not likely to reduce reproduction of shortnose sturgeon in the action area because: (1) there will be no reduction in the number of spawning adults; (2) there will be no reduction in fitness of spawning adults; (3) there is not anticipated to be any reduction in the number of eggs spawned or the fitness of any eggs or larvae; and (4) the project will continue to operate in run of river mode thus there is no potential for pulsed flows which could disrupt spawning or rearing.

The action is also not likely to reduce the numbers of shortnose sturgeon in the action area as there will be no mortality of any individuals and no reason shortnose sturgeon would abandon the action area during the spawning season. The distribution of shortnose sturgeon within the action area will not be affected by the action, as shortnose sturgeon will have access to the entirety of its historic range.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for shortnose sturgeon in the wild (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect shortnose sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent shortnose sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the action will not result in the mortality of any shortnose sturgeon (2) as the action will not result in the mortality of any individuals, the action is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the temporary adverse effects to individuals captured in the fish lifts will not affect the reproductive output of any individual or the species as a whole; (5) the action will not affect the distribution of shortnose sturgeon in the action area or beyond the action area (i.e., throughout its range); (6) the action will not affect the reproductive fitness of any individual spawning adult or result in any reductions in the number of eggs spawned or the successful development of any eggs or larvae; (7) the operations of the project will not affect the ability of shortnose sturgeon to successfully spawn or for eggs and larvae to successfully develop and, (9) the action will have no effect on the ability of shortnose sturgeon to shelter or forage.

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

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

The proposed action is not expected to modify, curtail or destroy the range of the species since it will not result in any reductions in the number of shortnose sturgeon in the action area and since it will not affect the overall distribution of shortnose sturgeon other than to cause temporary changes in movements throughout the action area. The proposed action will not utilize shortnose sturgeon for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect this species, or affect their continued existence. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the action will not prevent the species from growing in a way that leads to recovery and the action will not change the rate at which recovery can occur. 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.

Despite the threats faced by individual shortnose sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual shortnose sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will impact shortnose sturgeon in the action area or how the species will adapt to climate change-related environmental impacts, no additional effects related to climate change to shortnose sturgeon in the action area are anticipated over the life of the proposed action (i.e., through the license period of the individual projects). We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and has concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change.

8.4. Atlantic sturgeon

We have estimated that the proposed project may interact with New York Bight and GOM DPSs of Atlantic sturgeon. As explained in the "Effects of the Action" section, the operation of fish traps at the Milford and Orono Projects and the lowering of water levels in the Orono bypass reach during flashboard maintenance is expected to directly affect adult Atlantic sturgeon. Because these activities are not selective for which populations may be captured, we anticipate that the effects from the proposed action could impact both the NYB and GOM DPSs of Atlantic sturgeon (Table 18). As described previously, we expect Atlantic sturgeon to occur at the following frequencies in the action area: St. John River (Canada) 36%; Gulf of Maine DPS 63% and New York Bight DPS 1%. Therefore, impacts from the anticipated interaction and capture of several individual Atlantic sturgeon that could originate from either the GOM DPS or NYB DPS are described below. Note that if you add the values in the table below for the individuals allocated among the DPSs, the value exceeds the total expected. This is an artifact of the mixed stock analysis information being applied to calculate a whole value by population. As an example, to calculate the number of GOM DPS fish affected at the Milford Project using the MSA, one would multiply the total number of affected fish (25) by the proportion anticipated to be from the GOM DPS (63%). This equals 15.75, which, since portions of an individual fish cannot be affected, is equal to 16 fish. In this case, no more than 25 Atlantic sturgeon are anticipated to be trapped at Milford, of which, up to 16 could come from the GOM DPS.

Table 18. Number of Atlantic Sturgeon expected to be affected by the proposed project.

Project	**Source**	**Duration**	**Total**	DPS		
				GOM (63%)	**St. John (36%)**	**NYB (1%)**
Milford	Trapping	2013-2038	25	16	9	1
	Stranding		0	0	0	0
Orono	Trapping	2013-2048	35	23	13	1
	Stranding		35	23	13	1

8.4.1 Gulf of Maine DPS of Atlantic Sturgeon

While Atlantic sturgeon occur in several rivers in the Gulf of Maine, recent spawning has only been documented in the Kennebec River and possibly in the Androscoggin River. However, Atlantic sturgeon are known to occur in the Penobscot River, and it is possible that a spawning population may persist in the River below Veazie Dam. The removal of Veazie Dam provides Atlantic sturgeon with access to what is believed to be the full range of their historic habitat in the river.

During construction, Atlantic sturgeon will not be able to access the Milford, Orono, Stillwater, West Enfield and Medway Projects as they cannot currently move upstream of the Veazie Dam, which will not be removed until 2013 at the earliest. Therefore, the species will not be exposed to any effects associated with the construction of the new powerhouses and fish lifts; and consequently, all construction related effects are likely to be insignificant and discountable.

Future operations of the Stillwater, West Enfield and Medway Projects are not likely to result in negative effects to GOM DPS Atlantic sturgeon as they are located upstream of their historic range in the Penobscot River. The Milford and Orono Projects are located near the upstream extent of the historic range of Atlantic sturgeon and, therefore, they are not considered barriers to upstream migration. It is anticipated that once the Great Works and Veazie Dams have been removed that GOM DPS Atlantic sturgeon will utilize habitat downstream of these projects. Therefore, it is possible that the operation of the facilities could impact GOM DPS Atlantic sturgeon and its habitat downriver of the project.

We have determined that the proposed action will affect Atlantic sturgeon by resulting in the capture of one adult per project per year in the new fish lifts at the Orono and Milford Projects. These fish are from the GOM DPS (threatened) and NYB DPS (endangered), as well as from the St. John River (Canada). As outlined in Table 18, over the term of the FERC license this equates to the capture of no more than 35 Atlantic sturgeon at the Orono Project, with up to 23 coming from the GOM DPS. Likewise, no more than 25 Atlantic sturgeon are expected to be captured at the Milford Project over the term of its license, with up to16 coming from the GOM DPS. An additional Atlantic sturgeon per year is expected to be stranded in pools downstream of the Orono Project during the replacement or maintenance of flashboards. This equates to the stranding of no more than 35 Atlantic sturgeon over the term of the license, with up to 23 coming from the GOM DPS. As all in-water work will occur prior to the removal of the Veazie Dam, no GOM DPS Atlantic sturgeon will be exposed to the effects of construction. Black Bear will adhere to a monitoring plan and handling plan to ensure that any GOM DPS Atlantic sturgeon captured in the fish lifts, or in isolated pools, are removed promptly and returned safely downstream. It is possible that some captured GOM DPS Atlantic sturgeon could experience minor injuries, such as abrasions, due to contact with the concrete surface of the fish lift. GOM DPS Atlantic sturgeon captured in the fish lifts will be temporarily delayed from carrying out spawning activities. However, given that monitoring will be continuous during the spawning season the amount of time that any Atlantic sturgeon would spend in the fish traps, or in an isolated pool, is short and certainly less than 24 hours. As such, it is extremely unlikely that the fish would miss a spawning opportunity. Similarly, it is unlikely that the temporary capture in the traps, or in the pools, and subsequent removal and placement back downstream of the fish lift would cause an individual Atlantic sturgeon to abandon their spawning attempt. Considering this analysis, the capture of GOM DPS Atlantic sturgeon at the Milford (15 adults trapped) and Orono (21 adults trapped, 21 stranded in pools) Projects, is not likely to result in any injury or mortality or affect the fitness of any individuals, or cause any reduction in the number of eggs spawned or in the successful development of those eggs and larvae.

The proposed action is not likely to reduce reproduction of GOM DPS Atlantic sturgeon in the action area because: (1) there will be no reduction in the number of spawning adults; (2) there will be no reduction in fitness of spawning adults; (3) there is not anticipated to be any reduction in the number of eggs spawned or the fitness of any eggs or larvae; and (4) the project will continue to operate in run of river mode thus there is no potential for pulsed flows which could disrupt spawning or rearing.

The action is also not likely to reduce the numbers of GOM DPS Atlantic sturgeon in the action area as there will be no mortality of any individuals and no reason they would abandon the action area during the spawning season. The distribution of GOM DPS Atlantic sturgeon within the action area will not be affected by the action, as they will have access to the entirety of their historic range.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for GOM DPS Atlantic sturgeon in the wild (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect GOM DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the action will not result in the mortality of any GOM DPS Atlantic sturgeon (2) as the action will not result in the mortality of any individuals, the action is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the temporary adverse effects to individuals captured in the fish lifts will not affect the reproductive output of any individual or the species as a whole; (5) the action will not affect the distribution of Atlantic sturgeon in the action area or beyond the action area (i.e., throughout its range); (6) the action will not affect the reproductive fitness of any individual spawning adult or result in any reductions in the number of eggs spawned or the successful development of any eggs or larvae; (7) the operations of the project will not affect the ability of Atlantic sturgeon to successfully spawn or for eggs and larvae to successfully develop and, (9) the action will have no effect on the ability of Atlantic sturgeon to shelter or forage.

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

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

The proposed action is not expected to modify, curtail or destroy the range of the species since it will not result in any reductions in the number of GOM DPS Atlantic sturgeon in the action area and since it will not affect the overall distribution of Atlantic sturgeon other than to cause temporary changes in movements throughout the action area. The proposed action will not utilize Atlantic sturgeon for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect this species, or affect their continued existence. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the action will not prevent the species from growing in a way that leads to recovery and the action will not change the rate at which recovery can occur. Therefore, the proposed action will not appreciably reduce the likelihood that GOM DPS Atlantic sturgeon can be brought to the point at which they are no longer listed as endangered or threatened.

Despite the threats faced by individual Atlantic sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual GOM DPS Atlantic sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will impact GOM DPS Atlantic sturgeon in the action area or how the species will adapt to climate change-related environmental impacts, no additional effects related to climate change to GOM DPS Atlantic sturgeon in the action area are anticipated over the life of the proposed action (i.e., through the license period of the individual projects). We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change.

8.4.2 New Your Bight DPS of Atlantic Sturgeon

NYB DPS Atlantic sturgeon will not be able to access the Milford, Orono, Stillwater, West Enfield and Medway Projects during construction as they cannot currently move upstream of the Veazie Dam, which will not be removed until 2013 at the earliest. Therefore, the species will not be exposed to any effects associated with the construction of the new powerhouses and fish lifts; and consequently, all construction related effects are likely to be insignificant and discountable.

Future operations of the Stillwater, West Enfield and Medway Projects are not likely to result in negative effects to NYB DPS Atlantic sturgeon as they are located upstream of their historic range in the Penobscot River. The Milford and Orono Projects are located near the upstream extent of the historic range of Atlantic sturgeon and, therefore, they are not considered barriers to upstream migration. It is anticipated that once the Great Works and Veazie Dams have been removed that Atlantic sturgeon will utilize habitat downstream of these projects. Therefore, it is possible that the operation of the facilities could impact NYB DPS Atlantic sturgeon and its habitat downriver of the project.

We have determined that the proposed action will affect Atlantic sturgeon by resulting in the capture of one Atlantic sturgeon per project per year in the new fish lifts at the Orono and Milford Projects. These fish are from the GOM and NYB DPSs, as well as from the St. John River (Canada). As outlined in Table 18, over the term of the FERC license this equates to the capture of no more than 35 Atlantic sturgeon at the Orono Project, with up to one coming from the NYB DPS. Likewise, no more than 25 Atlantic sturgeon are expected to be captured at the Milford Project over the term of its license, with up to one coming from the NYB DPS. An additional Atlantic sturgeon per year is expected to be stranded in pools downstream of the Orono Project during the replacement or maintenance of flashboards. This equates to the stranding of no more than 35 Atlantic sturgeon over the term of the license, with up to one coming from the NYB DPS. As all in-water work will occur prior to the removal of the Veazie

Dam, no Atlantic sturgeon will be exposed to the effects of construction. Black Bear will adhere to a monitoring plan and handling plan to ensure that any Atlantic sturgeon captured in the fish lifts, or in isolated pools, are removed promptly and returned safely downstream. It is possible that some captured Atlantic sturgeon could experience minor injuries, such as abrasions, due to contact with the concrete surface of the fish lift. Atlantic sturgeon captured in the fish lifts will be temporarily delayed from carrying out spawning activities. However, given that monitoring will be continuous during the spawning season the amount of time that any Atlantic sturgeon would spend in the fish traps, or in an isolated pool, is short and certainly less than 24 hours. As such, it is extremely unlikely that the fish would miss a spawning opportunity. Similarly, it is unlikely that the temporary capture in the traps, or in the pools, and subsequent removal and placement back downstream of the fish lift would cause an individual Atlantic sturgeon to abandon their spawning attempt. Considering this analysis, the capture of one NYB DPS Atlantic sturgeon in the fish lifts at the Milford and Orono Projects, and the additional stranding of one NYB DPS Atlantic sturgeon at the Orono Project due to flashboard replacement, is not likely to result in any injury or mortality or affect the fitness of any individuals, or cause any reduction in the number of eggs spawned or in the successful development of those eggs and larvae.

The proposed action is not likely to reduce reproduction of NYB DPS Atlantic sturgeon in the action area because: (1) there will be no reduction in the number of spawning adults; (2) there will be no reduction in fitness of spawning adults; (3) there is not anticipated to be any reduction in the number of eggs spawned or the fitness of any eggs or larvae; and (4) the project will continue to operate in run of river mode thus there is no potential for pulsed flows which could disrupt spawning or rearing.

The action is also not likely to reduce the numbers of NYB DPS Atlantic sturgeon in the action area as there will be no mortality of any individuals and no reason they would abandon the action area during the spawning season. The distribution of NYB DPS Atlantic sturgeon within the action area will not be affected by the action, as they will have access to the entirety of their historic range.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for NYB DPS Atlantic sturgeon in the wild (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect NYB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the action will not result in the mortality of any NYB DPS Atlantic sturgeon (2) as the action will not result in the mortality of any individuals, the action is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the temporary adverse effects to individuals captured in the fish lifts will not affect the reproductive output of any individual or the species as a whole; (5) the action will not affect the distribution of NYB DPS Atlantic sturgeon in the action area or beyond the action area (i.e., throughout its range); (6) the action will not affect the reproductive fitness of any individual spawning adult or result in any reductions in the number of eggs spawned or the successful development of any eggs or larvae; (7) the operations of the project will not affect the ability of NYB DPS Atlantic sturgeon to successfully spawn or for eggs and larvae to successfully develop and, (9) the action will have no effect on the ability of Atlantic sturgeon to shelter or forage.

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

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

The proposed action is not expected to modify, curtail or destroy the range of the species since it will not result in any reductions in the number of NYB DPS Atlantic sturgeon in the action area and since it will not affect their overall distribution other than to cause temporary changes in movements throughout the action area. The proposed action will not utilize NYB DPS Atlantic sturgeon for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect this species, or affect their continued existence. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the action will not prevent the species from growing in a way that leads to recovery and the action will not change the rate at which recovery can occur. Therefore, the proposed action will not appreciably reduce the likelihood that NYB DPS Atlantic sturgeon can be brought to the point at which they are no longer listed as endangered or threatened.

Despite the threats faced by individual NYB DPS Atlantic sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will impact NYB DPS Atlantic sturgeon in the action area or how the species will adapt to climate change-related environmental impacts, no additional effects related to climate change to shortnose sturgeon in the action area are anticipated over the life of the proposed action (i.e., through the license period of the individual projects). We have considered the effects of the proposed action in light of the cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change.

9. 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 our biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon, the GOM DPS of Atlantic sturgeon, the New York Bight DPS of Atlantic sturgeon or the GOM DPS of Atlantic salmon. Furthermore, the proposed action is not expected to result in the destruction or adverse modification of critical habitat designated for the GOM DPS.

10. 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. We interpret the term ''harm'' as an act which actually kills or injures fish or wildlife. It 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). We have not defined the term "harass"; however, it is commonly understood to mean to annoy or bother. In addition, legislative history helps elucidate Congress' intent that harassment would occur where annoyance adversely affects the ability of individuals of the species to carry out biological functions or behaviors: "[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.

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

An incidental take statement specifies the amount or extent of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary and appropriate to minimize and/or monitor incidental take and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures. The measures described in this section are nondiscretionary. If the FERC fails to include these conditions in the license articles or Black Bear 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 Black Bear to report the progress of the action and its effect on each listed species to NMFS, as specified in this incidental take statement (50 CFR §402.14(i)(3)).

10.1. Amount or Extent of Take

In Section 6, we described the mechanisms by which ESA-listed anadromous fish and designated critical habitat would likely be affected by the construction of new powerhouses at the Orono and Stillwater Projects, the construction of fishway enhancements at the Orono, Milford and Stillwater Projects, and the incorporation of protective measures and performance standards proposed in Black Bear's SPP at the Milford, West Enfield, Medway, Orono and Stillwater Projects. The following sections describe the amount or extent of take that we expect would result based on the anticipated effects of the proposed action.

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

10.1.1. Amount or Extent of Incidental Take of Atlantic salmon

10.1.1.1. Construction Activities

Construction is anticipated to commence in late summer of 2012, and will be completed by the end of 2013. The majority of in-water construction is anticipated to occur in 2012 after the trapping and upriver trucking of salmon associated with the Great Works Dam removal has ceased. At that point all upstream migrants will be released into the Veazie headpond. Based on Atlantic salmon returns between 2007 and 2010, 7% of the run passes the Veazie Project between August and October. Therefore, it is expected that at least 7% of the Atlantic salmon run in the Penobscot could be migrating through the project area during construction activities in the late summer and fall of 2012. Due to the use of erosion and sedimentation BMPs, the rock and ledge composition of the substrate and the fact that all blasting and drilling will occur within dewatered cofferdams, it is not anticipated that there will be any take of Atlantic salmon due to turbidity and noise effects associated with construction. However, it is possible that a small number of salmon could become entrapped within the cofferdams constructed at the Stillwater and Orono Projects. It is anticipated that one Atlantic salmon could be temporarily trapped at each of these two projects (Table 19). As qualified fisheries biologists will conduct stranding surveys and remove trapped salmon prior to dewatering, the fish are not expected to be killed. However, capturing and handling fish causes physiological stress and can cause physical injury although these effects can be kept to a minimum through proper handling procedures. Therefore, the construction of cofferdams at the Stillwater and Orono Projects may potentially harm one adult Atlantic salmon per project.

In addition to the entrapment of migrating Atlantic salmon, it is likely that some salmon will be significantly delayed in their migration due to the construction at the Orono Project during 2013. As described previously, adult migrating salmon are attracted to the discharge of the existing powerhouse at the Orono project, where they can be significantly delayed. The installation of an intake cofferdam, and the rerouting of 100% of the flow over the spillway, will cause fish to be attracted to the spillway rather than to the powerhouse discharge. As the spillway is more than 800 feet from the confluence with the mainstem, it is possible that the decrease in attraction to the river will lead to increased delay at the Orono Project during construction. Although the increase in delay cannot be quantified, it is expected that at least 33% of the Atlantic salmon attracted to the spillage will be harassed due to significant delay caused by the installation of the intake cofferdam at the Orono Project between July and October 2013.

Table 19. Summary of Atlantic salmon incidental take associated with FERC's authorization of Black Bear's proposed project.

Project	Source of Effect	Lifestage	Type of Effect	Mechanism of Effect	Baseline Conditions		SPP Conditions	
					Timeframe	Extent	Timeframe	Extent
Milford	Upstream Passage	Adult	Harassment	Forced straying	2013-2014	9.90%	2015-2038	4.90%
			Mortality	Direct and Indirect		0.10%		0.10%
	Downstream Passage	Smolt	Mortality	Direct and Indirect	2013-2022	24.40%	2023-2038	4.00%
		Kelt		Direct and Indirect		31.40%		4.00%
		Adult		Due to fall back		31.40%		4.00%
	Trapping	Adult	Collect	Fishway	2013-2038	100%		
			Mortality	Handling		100 fish		
	Monitoring Studies	Smolt	Harm	Handling and Surgery	2013-2022 and 2032	1899 fish		
			Mortality			38 fish		
		Adult	Harm	Handling and Surgery	2013-2014, 2024 and 2034	160 fish		
			Mortality			3 fish		
		Kelt	Harm	Handling and Surgery	3 year study	120 fish		
			Mortality			3 fish		
Orono	Construction	Adult	Harm	Cofferdam	2012	1 fish		
			Harassment	Significant Delay	2013	33%		
	Upstream Passage	Adult	Harassment	Forced straying	2013-2014	100.00%	2015-2048	4.90%
			Mortality	Direct and Indirect		0.00%		0.05%
			Harassment	Significant Delay	2013-2048	33.00%		
	Downstream Passage	Smolt	Mortality	Direct and Indirect	2013-2022	18.40%	2023-2048	4.00%
		Kelt		Direct and Indirect		28.00%		4.00%
		Adult		Due to Fall back		28.00%		4.00%
	Trapping/Trucking	Adult	Mortality	Handling and Transport	2014-2048	34 fish		
			Collect	Fishway	2013-2048	100%		
	Monitoring Studies	Smolt	Harm	Handling and Surgery	2013-2022 and 2032 and 2042	720 fish		
			Mortality			15 fish		
		Kelt	Harm	Handling and Surgery	3 year study	120 fish		
			Mortality			3 fish		

Table 19. continued…

Project	Source of Effect	Lifestage	Type of Effect	Mechanism of Effect	Baseline Conditions		SPP Conditions	
					Timeframe	Extent	Timeframe	Extent
Stillwater	Construction	Adult	Harm	Cofferdam	2012	1 fish		
	Upstream Passage	Adult	Harassment	Stray and Delay	2013-2048	100.00%		
	Downstream Passage	Smolt	Mortality	Direct and Indirect	2013-2022	9.50%	2023-2048	4.00%
		Kelt		Direct and Indirect		34.20%		4.00%
		Adult		Due to fall back		34.20%		4.00%
	Monitoring Studies	Smolt	Harm	Handling and Surgery	2013-2022 and 2032 and 2042	2448 fish		
			Mortality			49 fish		
		Kelt	Harm	Handling and Surgery	3 year study	120 fish		
			Mortality			3 fish		
West Enfield	Upstream Passage	Adult	Harassment	Forced Straying	2013-2022	10.78%	2023-2024	4.90%
			Mortality			0.22%		0.10%
			Collect	Fishway	2013-2024	100.00%		
	Downstream Passage	Smolt	Mortality	Direct and Indirect	2013-2022	7.70%	2023-2038	4.00%
		Kelt		Direct and Indirect		9.80%		4.00%
		Adult		Due to fall back		9.80%		4.00%
	Monitoring Studies	Smolt	Harm	Handling and Surgery	2013-2022	1620 fish		
			Mortality			33 fish		
		Adult	Harm	Handling and Surgery	2023	40 fish		
			Mortality			1 fish		
		Kelt	Harm	Handling and Surgery	3 year study	120 fish		
			Mortality			3 fish		
Medway	Upstream Passage	Adult	Harassment	Forced Straying	2013-2029	100.00%		
				Significant Delay		33.00%		

*The 480 smolts used in the tag retention/survival studies were allocated to each project based on the number of years each will be studied over the term of the consultation.

10.1.1.2. Hydroelectric Operations

We anticipate that the continued operation of the Milford, West Enfield, Medway, Orono and Stillwater Projects could potentially harm Atlantic salmon adults and smolts in the mainstem and Stillwater Branch of the Penobscot River. However, Black Bear's proposal to implement the provisions of the SPP will reduce the number of takes associated with these Projects.

Upstream Passage

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

Based on pooled passage rates (1987-1992 at Milford and 1989-1992 at West Enfield) calculated in a study conducted by Shepard (1995), it is anticipated that no more than 10% of the Atlantic salmon attempting to pass upstream of the Milford Project, or 11% attempting to pass West Enfield, are currently delayed[5], injured, or killed. Under the provisions of the SPP, passage efficiency is expected to be increased so that no more than 5% of pre-spawn adults will be delayed, injured or killed by either the Milford or the West Enfield Project. The upstream performance standard is anticipated to be achieved at the Milford Project no later than the migration season following the two year initial efficiency study. As no initial study is proposed at West Enfield, it will not be known if the performance standard is being met until the ten year verification study has been conducted in 2023. Therefore, it is assumed that no fewer than 89% of Atlantic salmon will achieve passage past the Project over the next ten years. Although no performance standard has been proposed for Orono, it is anticipated that the new fish lift and trap will perform similarly to the one proposed for the Milford Project for fish that enter the bypass reach.

We convened an expert panel in December 2010 to provide the best available information on what happens to the Atlantic salmon that fail to pass a project with an upstream fishway. The group estimated a baseline mortality rate of 1% for Atlantic salmon that fail to pass a fishway at a given dam on the Penobscot River (NMFS 2010, Appendix B). Additional mortality was assumed based on project specific factors, such as predation, high fallback rates, fish handling, lack of thermal refugia, etc. The panel assumed an additional 1% mortality due to fall back at the Veazie Project caused by handling associated with the trapping and handling facilities. The proposed project includes the construction of a similar facility at the Milford Project. Therefore, the proposed project will increase the mortality rate of fish that fail to pass the Milford fishway

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

by 1%. Therefore, it is assumed that under SPP conditions (post fishway construction) 2% of the Atlantic salmon that fail to pass the Milford Project will die; 1% due to baseline mortality and 1% due to increased fall back. Likewise, it is assumed for both the environmental baseline and SPP conditions at West Enfield that 2% of the Atlantic salmon that fail to pass the Project will be killed; 1% due to baseline mortality and 1% due to high fallback rates at that dam. Under the environmental baseline, there is no mortality associated with attempted passage at the Orono Project as no upstream fish passage facilities currently exist. However, after the proposed fish trap has been constructed, it is assumed that 1% of the fish that enter the bypass reach and fail to enter the fish trap, or exit the reach of their own volition, may be killed. Fish that fail to pass the fishway, but do not die, are harassed, and potentially harmed, by being forced to change their natural reproductive behavior; either by spawning in potentially less suitable habitat downstream, or by dropping back into the ocean without spawning. We estimate that take will occur at all five of Black Bear's projects in the Penobscot River due to the effects associated with upstream passage (Table 20). As it is not possible to predict with any certainty the number of Atlantic salmon that will be motivated to pass each of the projects on the Penobscot River, the amount of take due to upstream dam passage is provided as a proportion of the upstream migrants that approach within 200 meters of each individual project.

Table 20. The proportion of pre-spawn Atlantic salmon adults that are anticipated to be killed or harassed due to present and future operations at the Milford, West Enfield, Orono, Stillwater and Medway Projects. These estimates are based on pooled passage rates under the baseline and SPP conditions, and input from the expert panel convened by NMFS in December 2010.

		Fate of Salmon Approaching Dam			**Effect Duration**
		Pass	*Mortality*	*Harass*	
Environmental Baseline	Milford	90.00%	0.10%	9.90%	2013-2014
	West Enfield	89.00%	0.22%	10.78%	2013-2022
	Orono	0.00%	0.00%	100.00%	2013-2014
	Stillwater	0.00%	0.00%	100.00%	2013-2048
	Medway	0.00%	0.00%	100.00%	2013-2029
SPP Performance Standards	Milford	95.00%	0.10%	4.90%	2015-2038
	West Enfield	95.00%	0.10%	4.90%	2023-2024
	Orono*	95.00%	0.05%	4.95%	2015-2048
	Stillwater	0.00%	0.00%	100.00%	2013-2048
	Medway	0.00%	0.00%	100.00%	2013-2029

*This applies only to the Atlantic salmon that enter the Orono bypass reach. It is expected that 95% of the Atlantic salmon that enter the bypass reach will either be trapped in the fish trap, or will migrate out of their own volition.

As stated previously, there is no upstream performance standard at the Orono Project that describes the amount of significant delay to be expected under future operations. However, based on information collected by Shepard (1995) it is assumed that no more than 33% of the migrating adult Atlantic salmon attracted to the discharge from either of the two powerhouses will be harassed due to significant delay (more than 48 hours). A similar level of delay is anticipated at the Medway Project, where it is estimated that 33% of the fish that stray from the East Branch (approximately 7%) and approach within 200 meters of the Project may be delayed significantly. The Stillwater Project is anticipated to directly affect very few adult Atlantic salmon as there is no upstream access to the Project due to the lack of upstream passage facilities at the Orono Project. However, it is likely that a small proportion of the salmon run will fall back into the Stillwater Branch and over the Stillwater Project. One hundred percent of the fish that fall back will be significantly delayed by the Project because of its lack of upstream passage facilities.

Downstream Passage

A significant proportion of Atlantic salmon smolts and kelts are injured or killed during dam passage every year. As it is not possible to predict with any certainty the number of Atlantic salmon smolts and kelts that will be outmigrating past each of the projects on the Penobscot River, the amount of take due to downstream dam passage is provided as a proportion of the smolts and kelts that attempt to pass each individual dam. Table 21 indicates the maximum proportion of smolts and kelts that are anticipated to be killed due to direct and indirect effects both before and after the full implementation of the SPP performance standards, based on estimates provided by Alden Lab (2012). It is anticipated that the performance standard of 96%, based on a 75% confidence interval, will be met at all four projects no later than 2023. At that point, the mortality rate is not expected to exceed 4% at any of the four projects in any year.

Table 21. The maximum proportion of Atlantic salmon smolts and kelts that are anticipated to be killed annually due to present and future operations at the Milford, West Enfield, Orono and Stillwater Projects based on survival estimates provided by Alden Lab (2012). Existing kelt survival numbers are based on Alden Labs data, but has been weighted to account for 80% of outmigration occurring in the spring and 20% in the fall (Lévesque *et al.* 1985, Baum 1997).

	Project	**Smolts**	**Kelts**	**Effect Duration**
Environmental Baseline	Milford	24.40%	31.40%	2013-2022
	West Enfield	7.70%	9.80%	2013-2022
	Orono	18.40%	28.00%	2013-2022
	Stillwater	9.50%	34.20%	2013-2022
SPP Performance Standards	Milford	4.00%	4.00%	2023-2038
	West Enfield	4.00%	4.00%	2023-2024
	Orono	4.00%	4.00%	2023-2048
	Stillwater	4.00%	4.00%	2023-2048

In addition to smolts and kelts, it is anticipated that a small number of pre-spawn adult Atlantic salmon that fall back into the Stillwater Branch and the mainstem Penobscot will be subject to mortality associated with downstream dam passage at the Milford, West Enfield, Orono and Stillwater Projects. It is anticipated that mortality for pre-spawn adults would be the same as for kelts under the Environmental Baseline and SPP performance standard conditions (Table 21).

Trapping and Trucking

The trapping and trucking of Atlantic salmon can lead to stress, injury and mortality of migrating

Atlantic salmon. Migrating Atlantic salmon are anticipated to be trapped at both the Milford and Orono Projects. All of the Atlantic salmon that are trapped, handled, or trucked at these facilities will be harassed, and potentially injured, but most of these fish are anticipated to continue their migrations once they have been returned to the River. MDMR maintains a database of adult Atlantic salmon mortalities attributable to trapping and trucking from the Veazie fish trap. Between 1978 and 2011, the median mortality rate for adult Atlantic salmon at the Veazie trap was 0.07%. In a typical year, between zero and four salmon are killed during trapping and transportation at the Veazie Project (O. Cox, MDMR, personal communication). Although the MDMR database does not account for incidences of injury, it is assumed that a larger proportion of trapped and trucked Atlantic salmon suffer from injuries than mortality and that some of these injuries may lead to delayed mortality.

It is anticipated that as many as four adult Atlantic salmon will be killed every year at the Milford Project due to trapping (100 fish over the term of the license). Although Black Bear is responsible for the operation of the fish trap, they are not responsible for the trucking of Atlantic salmon to GLNFH, which is conducted by MDMR. However, as the MDMR database does not indicate the source of salmon mortalities (trapping or trucking) it is assumed that four fish a year is a conservative estimate of the number of fish that could potentially be killed in the Milford fish trap.

We anticipate that a portion of the Atlantic salmon run will be attracted to the spillage in the bypass reach at the Orono Project. Black Bear is responsible for both trap operation and short-distance trucking at the Orono project. It is anticipated that no more than one Atlantic salmon a year will be killed due to trapping and trucking at that Project.

10.1.1.3. Fish Passage Monitoring

Black Bear will be conducting studies of upstream efficiency and downstream survival in order to test the efficacy of protective measures and to verify that the performance standards are being met. As described previously, to determine whether the downstream performance standard is being met, three year paired-release studies will be conducted after fish passage facilities have been improved per the SPP and, if performance measures are not being met, after the first two successive protective measures are implemented. The final measure (nighttime shutdowns of the turbines for two weeks during the smolt outmigration) will only require a single year of study. Therefore, it is possible that there could be up to ten years of downstream survival studies being conducted at the Milford, West Enfield, Orono and Stillwater Projects. Based on the proposed study plan and the potential for ten to twelve years of studies at each of the projects, a maximum of 7,050 Atlantic salmon smolts will be adversely affected by the proposed studies due to trapping, handling, and the implantation of radio tags (Table 13). All of these fish will be injured due to the surgery required for tag implantation, and up to 2% of the fish used at each project (or 141 fish total) may die as a result.

In addition to downstream smolt survival studies, Black Bear proposes to conduct upstream passage efficiency studies at the Milford and West Enfield Projects using adult Atlantic salmon. The Milford fish lift will be tested in two consecutive years; one study year prior to the removal of Veazie Dam, and one year after the dam has been removed. In addition, passage efficiency will be tested every ten years to ensure that the performance standard is still being met. Black Bear has proposed to tag 20 to 40 adult salmon for each year of the study. Therefore, given the length of the remaining license term at Milford (expires in 2038), there is potential for 160 adult Atlantic salmon to be affected ((2 year initial study + 2 one-year studies at ten year intervals) * a maximum of 40 fish per year = 160 total fish). Unlike the Milford project, Black Bear is not proposing to conduct an initial upstream passage efficiency study at the West Enfield Project. However, they have proposed to conduct a ten year verification study. It is assumed that up to 40 adult Atlantic salmon will be affected as part of this monitoring. Therefore, a total of 200 adult Atlantic salmon will be affected by upstream monitoring studies at the Milford and West Enfield Projects over the term of this consultation. All of these fish will be potentially harassed and harmed due to the handling and surgical procedures necessary to prepare them for the studies. As the procedures will be conducted by professional fisheries biologists using established protocols few mortalities are anticipated. Of the 200 adult Atlantic salmon being used for the upstream studies, no more than four are anticipated to be killed during monitoring of upstream fish passage (i.e. three during the monitoring of the Milford Project, and one during the monitoring of the West Enfield project).

In addition to the upstream studies, Black Bear proposes to conduct a downstream kelt study ten years after the implementation of the final enhancements for smolt outmigration. A three year study at the Milford, West Enfield, Orono and Stillwater Projects will require the take of no more than 480 male kelts (40 fish x 4 projects x 3 years = 480 fish). All of these fish will be potentially harassed and harmed due to the handling and surgical procedures necessary to prepare them for the studies. As the procedures will be conducted by professional fisheries biologists using established protocols few mortalities are anticipated. Of the 480 kelts being used in the three year kelt study, no more than 12 (three per project) are anticipated to be killed.

We believe this level of incidental take is a reasonable estimate of incidental take that will occur given the seasonal distribution and abundance of Atlantic salmon in the action area and the information provided by numerous empirical studies and models on the upstream and downstream survival rates of Atlantic salmon in the Penobscot River. In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy to the species. We consider this incidental take level to be exceeded if more than the specified amount of smolts and adults are harmed or harassed during the specified timeframe over the term of the individual projects license.

10.1.2. Amount or Extent of Incidental Take of Shortnose sturgeon

The proposed action has the potential to directly affect shortnose sturgeon by capturing three shortnose sturgeon annually at the Milford Project, and one at the Orono Project, at the proposed upstream fish passage facilities. In addition, the project could result in the annual capture of one shortnose sturgeon at the Orono Project in isolated pools downriver of the dam during flashboard maintenance and replacement. All trapped individuals will be removed from the fish traps, or the isolated pools, and returned downstream. Any captured fish may be harmed by receiving minor injuries due to abrasions on the trap or the pool substrate. The capture of four shortnose sturgeon annually (three at Milford and one at Orono) in the upstream fish traps, as well as the stranding of one shortnose sturgeon in pools downstream of the Orono Project, is likely. Over the term of the amended license, this equates to 75 shortnose sturgeon being trapped at the Milford Project (license expires in 2038), and 70 being trapped or stranded at the Orono Project (license expires in 2048). Neither mortality nor major injuries of any shortnose sturgeon is anticipated or exempted.

We believe this level of incidental take is a reasonable estimate of incidental take that will occur given the seasonal distribution and abundance of shortnose sturgeon in the action area and the reports of shortnose sturgeon entering fish lifts, or being stranded, in other rivers. In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy to the species. We consider this incidental take level to be exceeded if more than three shortnose sturgeon are captured in the fish trap at the Milford Project, or more than one shortnose sturgeon is captured at the Orono Project on an annual basis over the term of their licenses. Additionally, take will be considered exceeded if more than one shortnose sturgeon per year is trapped in isolated pools downstream of the Orono Project during flashboard maintenance.

10.1.3. Amount or Extent of Incidental Take of Atlantic sturgeon

The proposed action has the potential to directly affect Atlantic sturgeon by resulting in the capture of one Atlantic sturgeon per project per year at Black Bear’s upstream fish passage facilities at the Orono and Milford Projects. In addition, the project could result in the capture of one Atlantic sturgeon per year in isolated pools downriver of the Orono Project during flashboard maintenance and replacement. All trapped individuals will be removed from the fish traps, or the isolated pools, and returned downstream. Any captured fish may be harmed by receiving minor injuries due to abrasions on the trap or the pool substrate. The capture of two Atlantic sturgeon annually (one each at the Milford and Orono Projects) in the upstream fish traps, as well as the stranding of one Atlantic sturgeon annually in pools downstream of the Orono Project, is likely. This equates to 70 Atlantic sturgeon affected by trapping and stranding at the Orono Project, and 25 affected by trapping at the Milford Project, over the terms of the amended licenses (Table 18). Based on a mixed stock analysis, we anticipate that no more than 62 of the Atlantic sturgeon (46 at Orono, 16 at Milford) will be GOM DPS origin and no more than three (two at Orono, one at Milford) will be NYB DPS origin. The remaining 35 Atlantic sturgeon (26 at Orono and 9 at Milford) will originate from St. John River Canada and are not protected under the US ESA. Neither mortality nor major injuries of any Atlantic sturgeon is anticipated or exempted.

We believe this level of incidental take is a reasonable estimate of incidental take that will occur given the seasonal distribution and abundance of Atlantic sturgeon in the action area and the reports of Atlantic sturgeon entering fish lifts, or being stranded, in other rivers. In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy to the species. We consider this incidental take level to be exceeded if more than one Atlantic sturgeon per year is captured in the traps at either the Orono or Milford Projects, or if more than one Atlantic sturgeon per year is stranded in pools downstream of the Orono Project.

10.2. Reasonable and Prudent Measures

We believe the following reasonable and prudent measures are necessary and appropriate to minimize and monitor incidental take of Atlantic salmon, shortnose sturgeon and Atlantic sturgeon. These must be included as enforceable terms of any amended operating licenses issued by FERC to Black Bear. Please note that these reasonable and prudent measures and terms and conditions are in addition to the measures contained in the June 7, 2012 SPP that Black Bear has committed to implement and FERC is proposing to incorporate into the project licenses. As these measures will become mandatory requirements of any new licenses issued, we do not repeat them here as they are considered to be part of the proposed action.

1. FERC must ensure, through enforceable conditions of the project licenses, that Black Bear conduct all 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.

2. FERC must ensure, through enforceable conditions of the project licenses, that Black Bear minimize incidental take from all in-water and near-water activities by applying best management practices to the proposed action that avoid or minimize adverse effects to water quality and aquatic resources.

3. To minimize incidental take from project operations, FERC must require that Black Bear measure and monitor the performance standards contained in the June 7, 2012 Species Protection Plan (SPP) in a way that is adequately protective of listed Atlantic salmon.

4. FERC must ensure, through enforceable conditions of the project licenses, that Black Bear complete an annual monitoring and reporting program to confirm that Black Bear is minimizing incidental take and reporting all project-related observations of dead or injured salmon or sturgeon to NMFS.

5. If the new Milford upstream fish lift is not operational prior to the Veazie Dam removal, or if it is proven ineffective during upstream monitoring studies, FERC must require Black Bear to install a broodstock collection device at the existing Denil fishway.

10.3. Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, FERC 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. Any taking that is in compliance with the terms and conditions specified in this Incidental Take Statement shall not be considered a prohibited taking of the species concerned (ESA section 7(o)(2)). In carrying out all of these terms and conditions, FERC as lead Federal agency in this consultation, is responsible for coordinating with the other Federal agencies that are party to the consultation, as well as with the licensee. FERC must implement these terms and conditions through enforceable conditions of the project licenses.

Where appropriate, the ACOE must require these terms and conditions as enforceable conditions of any permits or authorizations.

1. To implement reasonable and prudent measure #1, FERC and ACOE must require Black Bear to do the following:

    a. Hold a pre-construction meeting with the contractor(s) to review all procedures and requirements for avoiding and minimizing impacts to Atlantic salmon and to emphasize the importance of these measures for protecting salmon.

    b. Black Bear must notify NMFS one week before in-water work begins.

    c. Use Best Management Practices that will minimize concrete products (dust, chips, larger chunks) mobilized by construction 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.

    d. Employ erosion control and sediment containment devices at the Stillwater, Orono and Milford Dams construction sites. During construction, 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.

    e. 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.

    f. 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.

    g. 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.

    h. 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.

    i. 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.

    j. At the end of each work shift, vehicles will not be stored within, or over, the waterway.

k. 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.

l. Use temporary erosion and sediment controls on all exposed slopes during any hiatus in work exceeding seven days.

m. Place material removed during excavation only in locations where it cannot enter sensitive aquatic resources.

n. Minimize alteration or disturbance of the streambanks and existing riparian vegetation to the greatest extent possible.

o. Remove undesired vegetation and root nodes by mechanical means only. No herbicide application shall occur.

p. Mark and identify clearing limits. Construction activity or movement of equipment into existing vegetated areas shall not begin until clearing limits are marked.

q. Retain all existing vegetation within 150 feet (46 m) of the edge of the bank to the greatest extent practicable.

2. To implement reasonable and prudent measure #2, FERC and ACOE must require Black Bear to do the following:

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

   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. Notify NMFS of any changes in project and fishway operations (including maintenance activities such as flashboard replacement and draft tube dewatering) at the Orono, Stillwater, Milford, West Enfield, and Medway Projects.

   d. Submit a fish evacuation protocol to NMFS at least two weeks prior to the commencement of in-water work. Daily visual surveys will be conducted by qualified personnel to verify that there are no Atlantic salmon within the project area during the installation and removal of any in-water cofferdam or bypass structure. If cofferdams overtop due a high flow event, the cofferdam will be resurveyed for adult Atlantic salmon prior to dewatering. If any Atlantic salmon are observed within the enclosed cofferdam they should be removed, either by herding or by capture. Handling should be minimized to the extent possible.

3. To implement reasonable and prudent measure #3, the FERC must require that Black Bear do the following:
   a. Require Black Bear to measure the survival performance standard for downstream migrating Atlantic salmon smolts and kelts at the Orono, Stillwater, Milford, and West Enfield Projects of 96% (within the lower and upper 75% confidence limit) using a scientifically acceptable methodology.
      i. That is, 96% of downstream migrating smolts and kelts approaching the dam structure survive passing the project, which would include from 200 meters upstream of the trashracks and continuing downstream to the point where delayed effects of passage can be quantified. Black Bear must coordinate with NMFS in selecting an adequate location for the downstream receivers.
      ii. Passage must occur within 24 hours of a smolt or kelt approaching within 200 meters of the trashracks for it to be considered a successful passage attempt that can be applied towards the performance standard.
      iii. The survival standard is considered achieved if each year of a three year study period achieves at least 96%, based on a 75% confidence interval, at each project. A Cormack-Jolly-Seber (CJS) model, or other acceptable approach, must be used to determine if the survival estimate and associated error bounds meet targets and efficiency/survival estimates are within scope of published telemetry work for salmon in the region.
      iv. Black Bear must consult with NMFS concerning the application of appropriate statistical methodology and must provide an electronic copy of model(s) and data to NMFS.

   b. All tags released in the system should have codes that are not duplicative of tags used by other researchers in the river, including university, state, federal and international tagging programs.

   c. Submit a study plan for a one year adult upstream study at the West Enfield Project to be conducted ten years post implementation of the SPP.

   d. Submit a study plan for a three year downstream kelt study at the Orono, Stillwater, Milford, and West Enfield Projects.

4. To implement reasonable and prudent measure #4, the FERC must require that Black Bear do the following:

   a. Require that Black Bear seek comments from NMFS on any fish passage design plans at the 30%, 60%, and 90% design phase. Also, allow NMFS to inspect fishways at the projects at least annually.

   b. Submit annual reports at the end of each calendar year summarizing the results of proposed action and any takes of listed sturgeon or Atlantic salmon to NMFS by mail (to the attention of the Section 7 Coordinator, NMFS Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930 and to incidental.take@noaa.gov.

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, immediate reinitiation of consultation and review of the reasonable and prudent measures are required. FERC 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.

Reasonable and prudent measures and their implementing terms and conditions may not alter the basic design, location, scope, duration, or timing of the action, and should involve only minor changes (50 CFR §402.14(i)(2)). The FERC and ACOE have reviewed the RPMs and Terms and Conditions outlined above and 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.

RPM #1, #2, as well as Terms and Conditions (#1-2) are necessary and appropriate as they will require Black Bear and their contractors to use best management practices and best available technology for construction. This will ensure that take of listed Atlantic salmon 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 #3 as well as Term and Condition #3 are necessary and appropriate as they describe how Black Bear will be required to measure and monitor the success of the proposed performance standards. 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 Term and Condition# 4 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.

RPM #5 is necessary and appropriate as it will require Black Bear to minimize the effect of the operation of the Milford Project if the Veazie Dam is removed prior to the completion of the proposed fish lift, or in the event that the new fish lift is proven to be ineffective. The lack of a collection device on the Penobscot River, even temporarily, would threaten the recovery and survival of the species as broodstock could not be obtained to sustain the hatchery program at the Green Lake National Fish Hatchery. This will ensure that take of listed Atlantic salmon is minimized to the extent practical. This requirement represents only a minor change to the proposed action as following these procedures should not increase the cost of the project significantly or result in any delays or reduction of efficiency of the project.

11. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS has determined that the proposed action is not likely to jeopardize the continued existence of shortnose sturgeon, the GOM DPS of Atlantic salmon and the GOM DPS and NYB DPS of Atlantic sturgeon. To further reduce the adverse effects of the proposed project on shortnose sturgeon, Atlantic sturgeon and Atlantic salmon, NMFS recommends that FERC implement the following conservation measures.

1. If any lethal take occurs, FERC should use its authorities to, and/or direct the licensee to, arrange for contaminant analysis of the specimen. If this recommendation is to be implemented, the fish should be frozen and NMFS should be contacted immediately to provide instructions on shipping and preparation.

2. FERC should use its authorities to implement license requirements for all FERC regulated projects in Maine to provide safe and effective upstream and downstream fish passage for listed Atlantic salmon and other diadromous fish species. For Atlantic salmon, this can be accomplished through station shutdowns during the smolt passage season (April to June) and kelt passage season (October to December and April to June) or the installation of highly effective fishways.

3. FERC should use its authorities to require all FERC regulated hydroelectric projects in Maine to document the effectiveness of station shutdowns or fishways in protecting listed Atlantic salmon.

4. FERC should use its authorities to require all FERC regulated hydroelectric projects in Maine to operate in a manner that is protective of NMFS listed species. This can be accomplished by requiring these facilities to operate in a run-of-river mode to simulate a natural stream hydrograph.

12. REINITIATION NOTICE

This concludes formal consultation concerning FERC’s proposal to amend licenses to allow for new powerhouses at the Stillwater and Orono Projects, as well as incorporate the provisions of the proposed SPP at the Stillwater, Orono, Milford, West Enfield and Medway Projects located on the Penobscot River 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 the SPP will be implemented upon issuance of this document and performance standard deficiencies addressed and progress documented annually. If standards are not achieved within ten years of issuance, FERC must reinitiate consultation with NMFS.

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APPENDIX A

Atlantic Salmon Survival Estimates At Mainstem Hydroelectric Projects on the Penobscot River

Draft Phase 3 Final Report

Alden Research Laboratory, Inc.

APPENDIX B

Atlantic Salmon Fate and Straying at Upstream Fish Passage Facilities on the Penobscot River

February 2011

APPENDIX C

NMFS Dam Impact Assessment Model

Northeast Fisheries Science Center
Woods Hole, MA

2012

APPENDIX D

Technical Memorandum

Assumptions Used and Verification Process for the Development of the Black Bear Hydro Species Projection Plan

USFWS 2012