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FWS/Region5/ES/MEFO

August 27, 2010

LTC Steven M. Howell, Deputy District Engineer
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751

Re: Formal Consultation for replacement and/or rehabilitation of culverts and bridges throughout the State of Maine (Log No. 53411-2010-F-0254)

Dear Colonel Howell:

The enclosed document contains a biological opinion (Opinion) prepared by the U.S Fish and Wildlife Service (USFWS) pursuant to section 7(a)(2) of the Endangered Species Act (ESA) on the effects of the U.S. Army Corps of Engineers (ACOE) proposal to issue a permit under section 404 of the Clean Water Act in order to rehabilitate and/or reconstruct multiple culverts and bridges throughout the State of Maine. In this Opinion, USFWS concludes that the action, as proposed, is not likely to jeopardize the continued existence of Atlantic salmon or result in the destruction or adverse modification of designated critical habitat for Atlantic salmon.

As required by section 7 of the ESA, USFWS provided an incidental take statement with the Opinion. The incidental take statement describes reasonable and prudent measures USFWS considers necessary or appropriate to minimize incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal agency, and any person involved with these projects, must comply with to carry out the reasonable and prudent measures. Incidental take from activities that meet these terms and conditions will be exempt from the ESA take prohibition. To ensure that this consultation remains valid, USFWS requests that the action agency or applicant keep us informed of any proposed changes to the projects and gets clearance from us before implementing such changes.

Mr. Clayton Hawkes (207) 866-3344 ext. 152 is the USFWS contact for this consultation.

Sincerely,

Steve Mierzykowski, Acting Field Supervisor
Maine Field Office

cc: Jay Clement, ACOE - Manchester, ME
Mark Hasselmann, FHWA – Augusta, ME
Jeff Murphy, NOAA Fisheries – Orono, ME
Norm Dube, MEDMR – Bangor, ME
Steve Timpano, MEIFW- Augusta, ME
Dan Tierney, MEDOT – Augusta, ME

ENDANGERED SPECIES ACT SECTION 7 CONSULTATION

BATCHED BIOLOGICAL OPINION

Lead Action Agency:	Department of the Army, Corps of Engineers, New England District
Activity:	Proposed rehabilitation and/or reconstruction of multiple culverts, struts, and bridges throughout the State of Maine (Corps of Engineers file number: NAE-2010-00958)
Consultation Conducted By:	U.S. Fish and Wildlife Service, Maine Field Office [53411-2010-F-0254]
Date Issued:	August 27, 2010
Approved by:	Steve Mierzykowski, Acting Field Supervisor

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INTRODUCTION

This constitutes the biological opinion (Opinion) of the U.S. Fish and Wildlife Service (USFWS) for ten proposed road crossing projects proposed by the Maine Department of Transportation (MEDOT) within the Gulf of Maine (GOM) Distinct Population Segments (DPS) for Atlantic salmon (*Salmo salar*). This Opinion and incidental take statement were prepared by the USFWS in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, *et seq.*), and implementing regulations at 50 CFR 402. With respect to designated critical habitat, the following analysis relied only on the statutory provisions of the ESA, and not on the regulatory definition of "destruction or adverse modification" at 50 CFR 402.02.

Background and Consultation History

December 11, 2009 – Dan Tierney and John Perry (MEDOT) meet with Wende Mahaney (USFWS) and Norm Dube (Maine Department of Marine Resources; MEDMR, formerly the Atlantic Sea Run Salmon Commission) to begin screening projects.

January 14, 2010 – Maine Department of Transportation (MEDOT) provided a first draft of its biological assessment (BA).

January 19 & 20, 2010 – Dan Tierney briefed USFWS on the proposed projects.

February 8, 2010 – MEDOT uploaded a second draft of its BA, with additional projects added to the batch, on to the Federal Highway Administration (FHWA) "online file cabinet" for review.

February 11, 2010 – USFWS provided comments on the second draft.

March 5, 2010 – Clayton Hawkes (USFWS) visited several of the proposed projects in this batch with Dan Tierney, as well as several of MEDOT's 2009 projects.

March 22, 2010 – MEDOT uploaded a third draft of its BA, refining the project list and culvert proposals. USFWS provided no additional comments.

April 21, 2010 – MEDOT submitted a final BA to the Corps of Engineers (ACOE) and uploaded a copy on to the FHWA online file cabinet for review.

May 19, 2010 – The ACOE initiated formal consultation with the submission of the attached Biological Assessment to the USFWS.

May 24, 2010 – Letter from USFWS to ACOE acknowledging initiation of formal section 7 consultation. USFWS's biological opinion is due to the ACOE by October 3, 2010.

June 21, 2010 – The ACOE revised its request to initiate formal consultation after conditions were revised.

August 24, 2010 – USFWS shared the draft BO with MEDOT and the ACOE for review and comment.

The consultation history for this action also includes numerous other telephone conversations and electronic mail exchanges between staff of the USFWS, MEDOT, and ACOE to share additional information or make relatively minor changes to the scopes of individual projects. The ACOE is considering authorization for these projects under section 404 of the Clean Water Act (CWA).

This Opinion presents USFWS' review of the status of Atlantic salmon, the condition of designated critical habitat, the environmental baseline for the action area, all the effects of the action as proposed, and cumulative effects (50 CFR 402.14(g)). For the jeopardy analysis, USFWS analyzes those combined factors to conclude whether the proposed action is likely to appreciably reduce the likelihood of both the survival and recovery of the affected listed species.

This Opinion is based on the following: 1) information provided in the ACOE May 19, 2010, initiation letter and attachments in support of formal consultation under the ESA; 2) the May 26, 2010, MEDOT permit application to the ACOE under section 404 of the CWA; 3) Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*) in the Gulf of Maine (65 FR 69459; November 17, 2000); 4) Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States (Fay *et al.* 2006); 5) Determination of Endangered Status for the Gulf of Maine Distinct Population Segment of Atlantic salmon; Final Rule (74 FR 29345; June 19, 2009); 6) Designation of Critical Habitat for Atlantic salmon Gulf of Maine Distinct Population Segment (74 FR 29300; June 19, 2009 and 74 FR 39903; August 10, 2009); 7) field investigations; 8) numerous meetings; and 9) other sources of information. A complete administrative record of this consultation will be maintained by the USFWS Maine Field Office in Orono, Maine. The USFWS log number is 53411-2010-F-0254.

BIOLOGICAL OPINION

I. DESCRIPTION OF THE PROPOSED ACTION

For purposes of this consultation, the proposed action is the ACOE's issuance of a permit to discharge fill below the below the ordinary high water mark in habitat occupied by ESA-listed fish in order to rehabilitate and/or reconstruct multiple culverts, struts, and bridges throughout the State of Maine. Two of the projects (Chesterville-Farmington, PIN: 12774.10 and Kenduskeag, PIN: 17576) have been partially funded by the FHWA; but since all of them require federal permitting the Corps is the lead action agency in this consultation. These projects would all be carried out by the MEDOT, although the actual construction work will often be done by hired contractors under the oversight of MEDOT staff. The ten proposed projects are listed and briefly described below in Table 1. Appendix A of this Opinion contains a more detailed description for each of the ten project locations and the anticipated scopes of work, with an emphasis on construction activities that could affect federally-listed species and designated critical habitat.

1.1 General Project Scope Descriptions

In order to facilitate the review of the ten projects in this batch consultation the projects have been grouped into separate categories based on general scope of work. The three categories of project scopes are 1) Replacement Projects, 2) Bridge Pier Projects, and 3) Linear Projects with Multiple Crossings. A basic description of each category is given below, with more details to follow in section **1.2 More Detailed Project Scope Descriptions** (beginning on page 5).

1.1.1. Replacement Projects

Structures in this group are culverts (corrugated metal pipes) that would be replaced with new longer culverts that are generally needed to accommodate a safer, expanded road shoulder with

Table 1. Projects being considered under the 2010 MEDOT bridge and culvert batched section 7 consultation.

Project	PIN	DPS	CH	Stream/River	Watershed	Instream Work Window
Culvert Replacement Projects						
Enfield	15644.00	X		Cold Stream	Passadumkeag	July 15-Sept 30
Brownville		X	X	2 unnamed tributaries	Piscataquis River	July 15-Sept 30
Columbia Falls		X	X	unnamed tributary	Pleasant River	July 15-Sept 30
Meddybemps		X	X	unnamed tributary	Dennys River	July 15-Sept 30
Frankfort		X	X	unnamed tributary	Marsh Stream	July 15-Sept 30
Charleston		X	X	Crooked Brook	Kenduskeag Stream	July 15-Sept 30
Linear Project with Multiple Stream Crossings						
Chesterville-Farmington	12774.10	X	X	4 unnamed tributaries	Sandy River	July 15-Sept 30
Bridge Pier Work						
Strong		X	X	Sandy River	Sandy River	July 15-Sept 30
Atkinson		X	X	Piscataquis River	Penobscot River	July 15-Sept 30
Bridge Replacement						
Kenduskeag	17576.00	X	X	Kenduskeag Stream	Kenduskeag Stream	Dec 1-Mar 30 July 15-Sept 30

new guard rail. Additionally, a new bridge is proposed to be replaced across Kenduskeag Stream. This bridge project also requires the placement of riprap to protect abutments and along the streambanks.

1.1.2. Bridge Pier Repair Projects

Inwater work on bridge piers is proposed in order to rehabilitate and extend the useful lives of bridges across the Sandy and Piscataquis rivers.

Between July 19 and August 13, 2009, MEDOT personnel conducted inwater work on one of the Atkinson bridge piers in the Piscataquis River in 0.30-0.46 m (12-18 inches) of water.

Cofferdams were not installed and the work site was not dewatered. This work was also conducted without a permit from the ACOE and without section 7 consultation. Therefore, the effects of that work were not analyzed for a jeopardy or adverse modification determination, nor was any take authorized. Inwater work was suspended after the error was discovered. There is no mechanism for authorizing incidental take "after-the-fact" except in emergencies.

1.1.3. Linear Projects with Multiple Crossings

The Chesterville-Farmington road rehabilitation project includes four culvert replacements as well as approximately 45.72 m (150 feet) of stream channel realignment in order to minimize erosion of the road shoulder into the stream.

1.2 More Detailed Project Scope Descriptions

Details for all ten projects (14 associated stream crossing structures) included in this consultation are provided in Appendix A. General descriptions of the work scopes that will be used in association with the projects are described below. While individual details may vary, including timing, duration, materials, and extent of stream and riparian impacts, these descriptions generally apply to all MEDOT projects involving instream work. Any modifications will still meet the requirements of the MEDOT Best Management Practices for Erosion and Sediment Control (BMP manual; 2008a) and will minimize impacts to aquatic resources.

1.2.1. Cofferdam Descriptions

The purpose of cofferdams (*e.g.*, sheetpile, sandbag, industrial sandbag, inflatable dam) is to dewater the work area so that all work in the stream channel is conducted in the dry. While the projects in this batch consultation vary by scope, the same conceptual construction guidelines for the installation of cofferdams will be employed. With blocknets installed across the stream, MEDOT will: 1) set up cofferdams both upstream and downstream to prevent water from leaking into the work area, 2) dewater the work area, and 3) divert the existing stream flow out of the channel using suction hoses and/or a diversion culvert. Individual details will vary by project.

A staged (slow, controlled) dewatering procedure will be clearly understood and agreed to by the contractor in order to allow fish to be removed from the area per the Appendix B Fish Evacuation Plan. Dewatering should begin gradually and sufficient people should be in place to conduct capture and removal in order to avoid fish stranding in the dry streambed.

Cofferdam Placement and diversion:

For sandbag cofferdams:

1. The upstream cofferdam will be installed first. Heavy duty plastic sheeting is laid along the width of the stream when practicable. The sand bags are then placed on the plastic up to a height somewhat higher than the current level of the stream, working from the stream bank to the center.
2. The excess plastic will then be folded over the dam in the upstream direction and another layer of sand bags will be laid on the plastic to help seal the dam from infiltration. The plastic will be extended along the stream bottom as far upstream as practicable.

3. The downstream cofferdam will then be installed. This second dam is a safeguard against a failure of the upstream dam. Most cofferdams leak somewhat, so a pump may be placed within the work area to catch accumulating water, which would then be pumped into the "Dirty water" Treatment System.

For sheetpile cofferdams:

1. The upstream portion of the dam will be installed first, followed by the downstream dam if it is deemed necessary to keep the work area dry. If the substrate is conducive to driving sheets (*i.e.*, substrate without ledge and/or boulders), then the dam would be installed by vibrating the interlocking sheets into the substrate. If the substrate has ledge or boulders, then pre-excavation may be required to install the sheets. This would consist of a small amount of dredging with a clam-shell bucket.
2. If the cofferdam is being established around a culvert structure, the sheets will be driven deep enough into the stream substrate so that they are self supporting. If there is any concern about the bottom of the sheets "kicking out", then large sand bags or rip-rap will be placed along the bottom on the inside of the sheets.
3. If the cofferdam is being established around a new pier location, then a concrete seal will be placed on the floor of the dam. This seal provides a concrete pad on which to construct the new pier footing and ensures that the cofferdam is sealed tightly. If placing a seal, the substrate within the dam will be excavated with a clam-shell bucket prior to pouring the concrete seal. Once the seal is placed on the stream bottom and the cofferdam is braced, the work area can be dewatered.
4. If a concrete seal has been placed, dewatering will take place after the underwater concrete has cured, which generally takes seven days. Sediment is allowed to settle on top of the seal. Most of the water inside the cofferdam is discharged overboard (*i.e.*, directly into the stream) as the water in the upper elevations of the cofferdam has not been in contact with the concrete or accumulated sediments. At the first sign of sediment stirring in the cofferdam, the pump is stopped and an outlet hose is attached so that sediment laden (high pH) water can be captured and properly treated in the "Dirty Water" Treatment System. A representative of the MEDOT Surface Water Quality Unit will periodically monitor pH and determine what water is sufficiently clean to be pumped directly back into the river or what water needs to be treated first. Once dewatered, the seal can be cleaned of sediment to accommodate construction work. After the seal is cleaned, the cofferdam can be maintained in a "dry" condition by pumping to facilitate construction of the new structure.

For inflatable cofferdams:

1. Inflatable dams require a relatively even and stable substrate for successful installation. Relatively narrow spots in the stream are chosen both upstream and downstream. The coffers are laid across the channel, either by hand or by boat.
2. The inflatable coffers are pumped full of water and installed around the structure. The weight of the water creates a seal with the stream substrate.
3. Prior to dewatering, upstream diversion pumps are started and flow is pumped around the work area while the area between the cofferdams would remain flooded. During dewatering, a representative of the MEDOT Surface Water Quality Unit will determine what water is sufficiently clean to be pumped directly back into the river or

what water needs to be treated first. As the area between the coffers is dewatered, either overboard into the stream if clean or into a sediment basin if the installation has disturbed the sediment, the hydraulic pressure on the outside of the inflatable dam becomes greater than that inside the cofferdams. When this happens, the cofferdams have a tendency to roll toward the dewatered side. The contractor will generally support the cofferdam on the inside using sandbags, clean stone, or Jersey barriers. Once the cofferdam is stabilized, it can be maintained in a "dry" condition by pumping to facilitate construction of the new structure.

Stream Diversion after Cofferdam Installation

The stream will need to be continually diverted around the work area when cofferdams block the entire channel. If there is a large volume of water in the stream, a culvert may be placed adjacent to the existing structure to carry the stream flow during construction. Generally, however, stream flow is diverted around the work area using the following procedure, which applies to all types of cofferdams:

1. Prior to instream work, a diversion culvert may be placed under the road away from the stream to run a diversion hose. This protects the hose during the construction activities. Another approach is to run the hose over the road and block up around it with wood to protect it from vehicle traffic.
2. The intake hose will be placed at the upstream end of the culvert, just upstream of the cofferdam. In order to minimize impact on the streambed, the hose end will be placed in a bucket and/or the stream bottom will be lined with geotextile fabric. A fish screen that meets criteria specified by the National Marine Fisheries Service (2008) will be installed on the intake hose end(s) to prevent injury to fish and other aquatic organisms within the work area. Square screen face openings shall not exceed 2.38 mm (3/32 inch) on a diagonal. The intake screen(s) shall be sufficient in size for the approach velocity at the intakes to be not greater than 6.10 cm sec^{-1} (0.20 ft $sec^{-1)}$ in order to minimize juvenile fish/screen contact.[1]
3. The gasoline diversion pump(s) will then be placed as far away from the stream as possible. The number and size of pumps used varies depending on the stream flows present when the work is being conducted.
4. The downstream discharge point within the stream channel will be protected from scour caused by high-velocity water by discharging onto ledge, large boulders, or non-woven geotextile fabric laid along the streambed.

"Dirty Water" Treatment System

After the cofferdams and water diversion pumps have diverted the stream around the work area, it will be necessary to dewater the work area itself. This water will be pumped into a sediment basin for filtration.

1. The system will be installed according to MEDOT's BMP manual (2008a).
2. The "dirty water" treatment system will either be comprised of a hay bale basin or a "dirt bag." Erosion control fabric is draped over the hay bales and sometimes placed

[1] For screen design, the effective screen area is calculated by dividing the maximum screened flow by the allowable approach velocity.

underneath to assist in trapping sediments. These sediments will be disposed of away from the stream in a manner that they cannot erode back into the stream.

3. The sedimentation basin will be located close to the project location with adequate vegetation between it and the stream to act as a filter.
4. Pumping:
    a. Hoses will be laid between the treatment basin and the downstream scour pool within the work area.
    b. The "dirty water" pump(s) will then be started in the downstream scour pool.
    c. Before dewatering of the area inside the cofferdam is started, MEDOT staff will attempt to remove Atlantic salmon and other fishes from the work area. As the pool is dewatered, remaining fish (including Atlantic salmon) will be caught and transferred to the downstream channel by a MEDOT biologist (See Appendix B for the fish evacuation plan). Fish evacuation on "big river" projects, such as Strong and Atkinson bridge pier repair projects on the Sandy and Piscataquis rivers, may not be feasible due to the depth of the water.
5. The work area will then be pumped dry, with this water going to the "dirty water" treatment system.
6. If there is leakage around the cofferdam, or upwelling in the work area through the stream substrate, this water will be pumped into the "dirty water" system for treatment prior to its release back into the stream. In some situations, it is necessary to excavate a pocket within the cofferdam to allow such pumping. All pumps, hoses, dams, and the sediment basins are monitored closely and maintained throughout construction.

Closeout Procedures

After all construction work within the cofferdams has been completed, the cofferdams can be removed and stream flow restored through or around the crossing structure. The same basic closeout procedure is followed for all cofferdam types, with some slight variations in the removal techniques.

1. The upstream "dirty water" pump will be stopped and removed.
2. The diversion pump system will be stopped and the upstream cofferdam will slowly be breached. The site will be rewatered slowly enough to prevent the loss of surface water downstream as the streambed absorbs water and to minimize or avoid a sudden increase in stream turbidity. The first flush of dirty water from the restored stream flow will be captured by the downstream "dirty water" pump, which will then pump the water into the sediment treatment system.
3. When the water behind the remaining downstream cofferdam is clean, that dam will be breached as well.
4. The remainder of the upstream cofferdam and the diversion pump system will then be removed.
5. All disturbed areas will be stabilized and permanent erosion and/or sediment control BMPs will be installed as appropriate.

Sandbag cofferdams will either be removed by hand for small bags or by an excavator or crane working from the stream bank for large, industrial-sized sandbags. Sheetpile cofferdams will be removed by vibrating or pulling the sheets out with an excavator or other equipment. Sometimes sheetpiles are cut off at the bottom and left in place below the river bottom. Inflatable cofferdams

will be removed by slowly opening the dam so that the water can drain into the dam at a steady rate. Heavy inflatable "bags" are generally removed from the stream with an excavator or other equipment.

1.2.2. Culvert Replacement Projects

1. Once the pumps are running and the work area is dewatered, the culvert replacement can commence. At this point, the crews are working in the dry and there is no sediment release into the stream. All pumps, hoses, dams, and the sediment basin are monitored closely and maintained throughout construction.
2. The old culvert will be removed and the new one replaced in the dry.
3. When the culvert and rip-rap installation is complete, all headwalls, disturbed areas, and permanent drainage ditches are stabilized with final treatments (to include seeding), utilizing temporary erosion control BMPs as necessary (MEDOT 2008a).

1.2.3. Culvert Rehabilitation Projects—Pipe End Reset

Resetting Culvert Ends

Resetting the ends of culvert can commence once cofferdams are installed, pumps are running and the work area is dewatered. At this point, the crews are working in the dry and there is no sediment release into the stream. All pumps, hoses, dams, and the sediment basins are monitored closely and maintained throughout construction.

The fill over the culvert end is excavated so that the existing ends can be temporarily removed to allow final grade work around the pipe to allow the end to be reset back in its original location or to allow placement of a new pipe end or pipe extension. This typically includes adding gravel bedding that the pipe end can sit on. To prevent scour at the outlet, a riprap apron is placed below the water line under the pipe invert. This apron may extend downstream beyond the end of the pipe. The installation of gravel bedding or rip-rap will not affect fish passage through the culvert. Once final grading is complete, the pipe end will be placed back onto the culvert. The site is then backfilled and slopes rip-rapped. Finally, the cofferdams are removed and normal stream flow is restored.

1.2.4. Bridge Pier Repair Projects

On the Strong project, on the Sandy River, which is nearly 61 m (200 feet) across and 3.05 m (10 feet) deep in the vicinity of the pier repair project, MEDOT proposes to work without a cofferdam using divers. On the Atkinson project, an undermined pier will be repaired behind cofferdams, as described below.

At bridge abutment and pier repair projects, some of the grout is contained within bags and the rest applied as free flowing grout. The grout will be mixed with an anti-washout admixture to improve visibility for the divers and reduce water quality impacts downstream of the project. The grout slurry is pumped through a 3.81-cm (1.5-inch) hose at a rate of 1.53 m^3 (2 $yards^3$) per hour into 1.83-m x 1.83-m (6-foot x 6-foot) or 1.52-m x 2.13-m (5-foot x 7-foot) bags that have been positioned underneath and around the undermined footing. In areas where the footing is exposed, bags are placed and filled to create a terraced foundation wall up to the base of the footing. This terracing increases the footprint of the footing by 1.52 m (5 feet) in the areas where it is necessary. After the bags are filled, free flow grout will be used to fill the seams between the

bags and to armor the area between the bags and the substrate. Once a seal has been created around the footing, grout will be pumped through a 2.54 cm (1-inch) PVC pipe into the undermined area under the pier that is behind the bags. The divers pump the grout slurry behind the bags until it starts to seep out underneath the footing. For a complete description of the use of grout in repairing undermined bridge structures refer to section 2.3 of the BA.

At the Union Bridge in Atkinson Work repairs to the remaining two piers will occur in the dry within the confines of industrial sandbag cofferdams, which will be left in place until the sand/cement bags have cured.

1.2.5. Bridge Replacement Project

The following section describes the step-by-step process that will be undertaken to construct a new bridge across Kenduskeag Stream. The following equipment, typical of most construction activities, may be utilized during the construction of the temporary (if necessary) and new bridges: crane, dump trucks, air compressors, welders and cutting torches. Other construction equipment may also be used as necessary.

Removal of an Existing Bridge

The Kenduskeag project is the replacement an existing 114-foot single span bridge. The existing deck will be removed by dragging it off of the abutments to shore where it can be dismantled and disposed of out of the water. To facilitate the removal of the bridge it will likely be necessary to place a temporary pile bent in the middle of the stream. The three to six H-piles required for the bent will most likely not be driven, given the lack of overburden at this location, but will instead be placed on the substrate. They will most likely be attached to H-piles that are connected horizontally between the upright piles. A small amount of substrate (approximately 0.2 m^2 per pile) would be disturbed by the placement of these piles. If there is enough overburden onsite to drive the piles, they will most likely be driven in just one to two meters with a vibratory hammer for additional stability. Once the pile bent is installed, the bridge deck will be removed by pulling the deck to shore for demolition.

New Bridge Structure, Construction, and Road Approaches

During construction flow will be diverted away from the abutments using a cofferdam while in-water work occurs and riprap is placed. The cofferdam used to divert flow around the work area will most likely be constructed of industrial sandbags, water dams, or jersey barriers. Although unlikely due to the lack of overburden, it is possible that sheetpile cofferdams could be used at the Kenduskeag project.

Within the cofferdam, ledge or other substrate is typically cleaned and prepared by an excavator or crane with a clam-shell bucket and with hand tools and high pressure water contained and filtered through a sediment detention basin before going back into the waterbody. The concrete will then be placed inside cofferdams and forms. Abutments and piers will be constructed up to grade. Reinforcing steel will be placed and forms will be built. Where the concrete trucks cannot get close enough to place the concrete directly from the road or stream bank, concrete will be placed using a concrete bucket attached to a crane.

While the abutments and piers are being built, any wing walls and retaining walls will also be constructed. These will be built using the cofferdams or by doing work in the dry at low water

when possible. Precast walls, if utilized, will be set by crane and backfilled with gravel that will be compacted by a walk-behind vibratory compactor and brought up to grade.

Up to 163 m^2 (1,755 $feet^2$) of riverine and palustrine wetlands would be impacted by the proposed project including riprap that may be needed to armor the abutments and along the stream banks at the base of the road slope. Riprap would be placed along approximately 11.3 m (37 feet) of stream (3.0 m-wide) at the abutment and along the road bank for roughly 30.5 m (100 feet). Riprap applied behind the cofferdams will be placed in the dry; but the riprap placed along the slopes, especially along the northwest slope, will likely be placed in the wet. In order to minimize potential direct effects to salmon juveniles while placing the riprap, MEDOT biologists will isolate the area with siltation fence or block nets and evacuate any salmon that are contained within the enclosed area as described in the evacuation plan (Appendix B).

1.2.6. Linear Project with Multiple Crossings

Most of the activities that occur as part of a "linear" road reconstruction or resurfacing project do not affect Atlantic salmon or their habitat, since they do not occur in or near streams or rivers. In general, linear reconstruction projects involve removing the road materials and then rebuilding. This is accomplished by removing the pavement to subgrade or below, as necessary. Gravel base material is then placed and compacted to the required density using dump trucks, backhoes, bulldozers and graders. New pavement is then installed along the roadway.

The Chesterville-Farmington project requires the replacement of four stream culverts. The scope for these activities can be found above in sections 1.2.1 and 1.2.3 above. Additionally, MEDOT proposes to realign approximately 45.72 m (150 feet) of the third unnamed tributary to Wilson Stream in three places when they reconstruct the road. The new channel will be approximately the same size (bank full width = 1.22 m) and slope as the natural channel but shifted enough to create a vegetated buffer from the road to provide water quality protection from runoff and snowplowing. It will be excavated in the dry using sandbag cofferdams until the old channel is filled in. Stone substrate will be placed before flow is diverted into it the new channel. MEDOT Environmental Office staff will be present during the construction to oversee shaping of the new stream channel and the placement of rock.

Some small trees and shrubs will be cleared from the slopes and banks to allow for access to the work site. In-stream work will occur at low flow during the standard summer work window and will take approximately one day per culvert to complete. The stream realignment will take approximately one week to complete.

1.3 Best Management Practices for Erosion and Sedimentation Control

All MEDOT construction project contracts, including those covered by this batch consultation, are required to be in accordance with the most recent version of the MEDOT BMP manual (MEDOT 2008a). These BMPs require that contractors prepare and submit a Soil Erosion and Water Pollution Control Plan (SEWPCP) that is approved by the MEDOT and fully enforced as a contractual agreement. This SEWPCP is prepared and performed in accordance with the BMP manual. Section IID, *Guidance for Sensitive Water Bodies*, of the BMP manual specifies under what conditions a project will be designated as a "sensitive" project. Criteria include state or federal designation of the water bodies, project scope of work, proximity of the project to the water body, etc. All projects considered under this consultation are considered sensitive due the presence of endangered Atlantic salmon or their critical habitat. A representative of the MEDOT

Surface Water Quality Unit is assigned to all construction projects and will evaluate each project and provide a contract Special Provision to specify what additional requirements need to be addressed in the SEWPCP to protect the waterbody and its aquatic life.

1.4 MEDOT Waterway and Wildlife Crossing Policy and Design Guide

All of the projects in this batch consultation have been reviewed in accordance with and will be constructed following the Waterway and Wildlife Crossing Policy and Design Guide (MEDOT 2008b). This document has been developed by MEDOT in cooperation with several state and federal resource and regulatory agencies. Through implementation of this policy and design guide, MEDOT continues to support the goal of developing effective ways to build, repair and maintain the transportation infrastructure, while protecting important aquatic and surface water resources.

A MEDOT hydrologist and biologist assessed culvert replacements projects in this consultation to determine whether small Atlantic salmon would be capable of moving upstream through the proposed structures. Additionally, the software FishXing 3.0[2] was used to calculate the percentage of passable flows, given species specific information as well as stream and culvert characteristics. FishXing models the complexities of culvert hydraulics and fish performance for a variety of species and crossing configurations. Literature swimming capability reported for small Atlantic salmon have not been well documented. Therefore, MEDOT modeled each culvert using 7 cm (2.76 inch) brook trout (*Salvelinus fontinalis)* as a surrogate for juvenile Atlantic salmon.

Monitoring of fish passage at road crossing structures will be done according to the MEDOT crossing policy, ACOE permit conditions, the terms and conditions of the Incidental Take Statement (ITS) in this Opinion, and the Fish Passage Monitoring Plan (Appendix C) attached to this BO.

1.5 Proposed Instream Work Windows

Instream work for all projects will be completed during the standard summer instream work window, with the exception of the placement of H-piles that will be temporarily installed to remove the existing Village Bridge over Kenduskeag Stream. Given the ice conditions and the objective of completing the project in a single construction season, the installation of the pile bent will need to occur prior to the standard work window. To avoid work during the spring smolt migration and fall spawning, installation of the pile bent would occur between December 1 and March 30.

Standard Instream Work Window

MEDOT is proposing a restricted low flow instream work window for most of the projects in this batch due to the possible year-round presence of Atlantic salmon within or near the action areas. Since all of these projects are in fresh water habitats, the work window will be the standard Atlantic salmon summer-time work window of July 15 to September 30 of any given year.

[2] FishXing. Version 3.0.15. June 8, 2009. Available at: http://www.stream.fs.fed.us/fishxing/software.html

1.6 Fish Passage Testing

In order to ensure compliance with state and federal permits and to minimize adverse effects on Atlantic salmon, MEDOT will monitor and evaluate the success of all of the completed structures during the first, third and fifth year post-construction when flows are low and later at near normal flow conditions (*e.g.*, about average annual minimum and average annual). Generally, effectiveness monitoring must be done at each of culvert replacements in this batch of projects to determine how well the engineering methods, models, and specifications satisfied the project design criteria for the passage of juvenile Atlantic salmon. Fish passage testing will be conducted at a subset of these projects. Design validation and fish passage testing will determine whether methods of design and analysis were appropriate and effective, whether the design criteria were satisfied, and evaluate how the design can be improved for future projects.

Design validation shall consist of measuring hydraulic characteristics including water depth, water velocity, and stream discharge with a calibrated gauge at 5.0-10.0-m intervals, and in sites where substantial variations in velocities are apparent. Measurements shall be taken about 5 cm from the bottom and in the water column at approximately 0.6 of the water depth. Near bottom velocity measurements would reflect the influence of the bottom materials present. Photos will be taken during the inspection to document characteristics of the culvert inlet, outlet, bed details and the stream upstream and downstream from the road surface. MEDOT shall note changes of scour and deposition in the stream. Annual monitoring reports shall provide tables stating when the proposed projects are constructed and inspected. Velocities and depths will be compared to the results of known swimming capabilities of fish that might inhabit these stream reaches. Additionally, characteristics of the substrate deposited in the structure (including type, size, depth, and relative amounts) and use by aquatic organisms will be documented.

Within a year of completing construction, MEDOT will test fish passage on a subset of the proposed batch of culvert projects, including: Enfield (PIN 15644.00), Brownville-1 (no-PIN), Charleston (no-PIN), Columbia Falls, and Meddybemps (no-PIN) to determine the efficacy of replacement culverts with brook trout or other species captured onsite (see Appendix C for the complete MEDOT monitoring plan). These structures were designed to pass juvenile salmonids, mainly federally-listed Atlantic salmon and brook trout. The structures that will be tested include those that the FishXing model indicates will not pass 7 cm brook trout at 100 percent of the design flow range. FishXing indicates that Brownville-2 (no-PIN), Frankfort (no-PIN) and the four Chesterville-Farmington (PIN 12774.00) culverts would pass 7 cm brook trout at 100 percent of the design flows.

The ability of fish to pass through the structures will be tested by installing block nets above and below the structure, capturing fish in the stream reach between the nets (including inside the structure if possible), and relocating a subset of the captured fish to the stream reach immediately upstream of the downstream-most block net. The site will be revisited the subsequent day and sampled again to confirm fish movement through the structure.

Monitoring reports will be submitted in a timely fashion that will allow for the planning and implementation of any necessary instream construction work to correct identified fish passage problems during the following July 15 to September 30 work window (unless another work window is approved by USFWS). After the fifth year monitoring report is evaluated, the USFWS will determine the need for any further monitoring or corrective measures.

1.7 Action Area

'Action area' means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The ten bridge and culvert projects included in this Opinion occur throughout a large portion of the State of Maine spread throughout the 45,980 km^2 of the Atlantic salmon GOM DPS, as well as specific areas within the geographic range of the GOM DPS that are designated as critical habitat (Figure 1). These projects occur in all three of the Salmon Habitat Recovery Units (SHRU) in Maine, which represent the geographic framework within which critical habitat has been designated. The projects occur within eight different 10-digit HUC[3] watersheds throughout the three SHRUs (Table 2). These ten projects are only located within the freshwater portion of the GOM DPS. One of the projects (Enfield, PIN: 15644.00) is exempt from critical habitat review, however, as it is in the Passadumkeag River watershed, which was designated as an economic exclusion zone.

The action area includes some or all of the following:

- An area of stream that is temporarily isolated and dewatered within a cofferdam so that construction work can proceed in the dry;
- An area downstream of the cofferdam that would experience a temporary increase in sediment from construction activities, particularly during removal of the cofferdam;
- An area of riparian land along the stream bank where vegetation is removed to facilitate construction, including access of equipment to the stream; and
- An area of stream bank and/or stream bottom that is rip-rapped to stabilize the inlet and outlet of the culvert.
- An area of stream channel upstream and/or downstream existing culverts affected by culverts being lengthened.
- An area upstream of some the culvert sites that may become somewhat more accessible to salmon as a result of improved fish passage conditions.

The action area contains designated critical habitat for Atlantic salmon except for the Enfield project, which was excluded for economic reasons. There is Atlantic salmon rearing and migratory habitat in the vicinity of all of the projects. Juvenile Atlantic salmon may be present during the work window. Spawning habitat could occur in the vicinity of the Enfield, Strong, Atkinson and Kenduskeag projects. However, due to the proposed work window (July 15 to September 30) spawning activity and redds are not expected to be present.

Based on a construction overview provided by MEDOT for each project, combined with previous experience from similar bridge and culvert replacement or rehabilitation projects, Table 3 provides a reasonable estimate of the likely action area for each project. The manner in which this action area table was developed is supported by several previous biological opinions written by the USFWS for MEDOT bridge and culvert replacement projects (USFWS 2005, 2008 and 2009). It is anticipated that the action area will extend 30.48 m (100 feet) downstream and 9.14 m (30 feet) upstream on streams that have very low flows (<0.03 m^3 sec^{-1} or <1 ft^3 sec^{-1}) during the summer work window when the projects will be constructed. Cofferdams are anticipated to be placed within 9.14 m and downstream of the inlet and outlet of the culvert. At projects on larger streams and rivers (Enfield, Strong, Atkinson and Kenduskeag) the action area may extend

[3] HUC = hydrologic unit code as defined by the U.S. Geological Survey.

91.44 m (300 feet) downstream and 15.24 m (50 feet) upstream of the structure. Also at Strong and Atkinson, it was assumed that effects would only be detected in half of the channel.

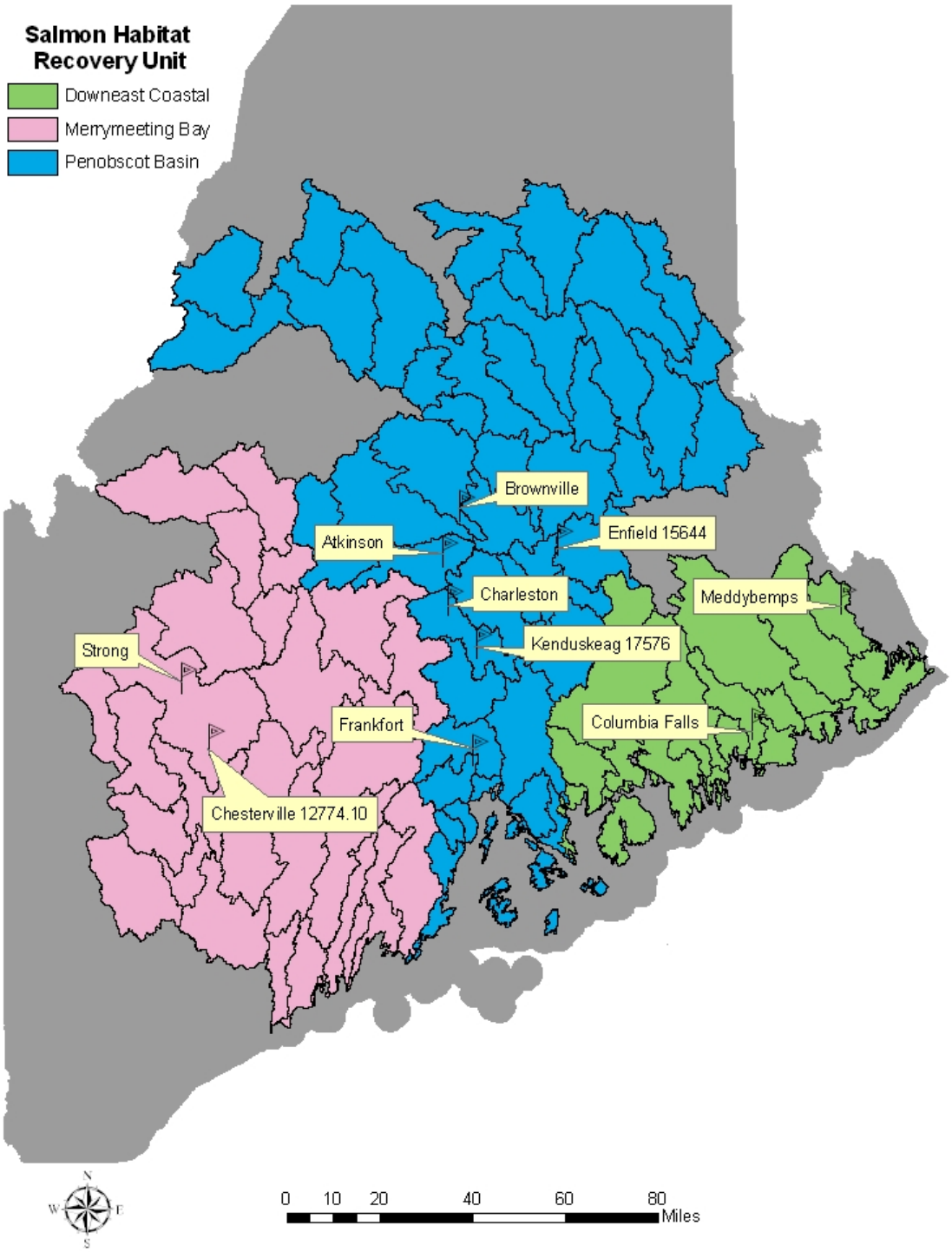

Figure 1. Location map of all projects considered under this batch consultation. All projects except Enfield (PIN: 15644.00) were considered for critical habitat effects.

Table 2. List of the SHRU and HUC-10 watersheds that contain the MEDOT projects being considered under this consultation.

SHRU	*HUC-10 Watershed*	*Habitat Units*	*Biological Score*	*# of Projects*
Merrymeeting Bay		**372,639**		**2**
	Sandy River	43,137	Highly Suitable	2
Penobscot		**323,740**		**6**
	Piscataquis River (4)	9,669	Highly Suitable	1
	Piscataquis River (3)	8,165	Highly Suitable	1
	Passadumkeag River	7,950	Marginally Suitable	1
	Kenduskeag Stream	6,869	Suitable	2
	Marsh River	6,018	Suitable	1
Downeast Coastal		**61,395**		**2**
	Pleasant River	3,025	Suitable	1
	Dennys River	1,717	Suitable	1

Table 3. Estimates of Project-Specific Action Areas (square meters).

Project	Stream	Bankfull width (m)	Upstream	Dewatered Within Cofferdam	Downstream	Total Stream Impact	Riprap	Riparian
Culvert Replacements								
Enfield	Cold Stream	12.19	185.81	222.97	1,114.84	1,523.61	0.00	18.58
Brownville	2 unnamed tributaries	1.52, 1.52	27.87	102.19	92.90	222.97	0.00	18.58
Columbia Falls	unnamed tributary	1.22	11.15	40.88	37.16	89.19	3.34	9.29
Meddybemps	unnamed tributary	1.68	15.33	69.49	51.10	135.92	3.34	9.29
Frankfort	unnamed tributary	1.52	13.94	49.24	46.45	109.63	5.57	9.29
Charleston	Crooked Brook	1.83	16.72	55.74	55.74	128.21	0.00	9.29
Linear Projects with Multiple Culverts								
Chesterville-Farmington	4 unnamed tributaries	0.61, 0.61, 1.22, 1.22	33.45	167.41	445.93	646.79	14.86	176.52
Pier Rehabilitation								
Strong	Sandy River	60.96	0.00	0.00	2,787.09	2,787.09	23.23[4]	0.00
Atkinson	Piscataquis River	48.77	371.61	278.71	2,229.67	2,879.99	240.88[5]	0.00
Bridge Replacement								
Kenduskeag	Kenduskeag Stream	30.48	464.52	92.90	2,787.09	3,344.51	27.87[6]	74.32

[4] Grout bag impact
[5] Pier expansion impact
[6] Riprap placed without cofferdams

MEDOT calculated dewatered areas at culvert by multiplying culvert length, plus 9.14 m (30 feet) at both ends, times the bankfull stream widths. However, at Enfield a culvert will be placed next to the existing pipe and flow will be diverted into it. Sandbag cofferdams will be set upstream and down of the existing culvert; but even though the bankfull width of the stream is 12.19 m (40 feet) wide, only the area immediately around the culvert ends will be blocked. For the estimate it was assumed that the width of the dewatered area was 6.10 m (20 feet) and that the dams would be set within 6.10 meters of the culvert ends. Therefore, the area was calculated by adding the length of the pipe (24.38 m, 80 feet) to the combined cofferdammed length at the inlet and outlet (12.19 m) and multiplying the result by the width of the cofferdammed area (roughly 6.1 m); (80+40 X 30 = 2,400 feet^2 =229.97 m^2). The realignment portion of the Chesterville-Farmington project along the third stream will impact approximately 153.29 m^2 of stream habitat with a net loss of 40.41 m^2.

II. STATUS OF THE SPECIES AND CRITICAL HABITAT

The ESA establishes a national program to conserve threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the USFWS, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitats. Section 7(b)(4) requires the provision of an incidental take statement that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) to minimize such impacts.

This Opinion presents USFWS' review of the status of each listed species considered in this consultation, the condition of designated critical habitat, and the environmental baseline for the action area.

Other federally-listed species under the jurisdiction of USFWS occur in areas of Maine, where the 10 projects are proposed, including the threatened Canada lynx (*Lynx canadensis),* the threatened small whorled pagonia (*Isotrea medeoloides*), and the threatened Eastern prairie fringed orchid (*Plantanthera leucophaea*). Neither of the two listed plant species is known to occur at any of the project location, and therefore, will not be considered further in this consultation. Although the Canada lynx could occur in the general vicinity of some of the proposed projects (Chesterville-Farmington, PIN: 12774.10; Strong, no-PIN; Enfield, PIN: 15664.00; Kenduskeag, PIN: 17576.00; Brownville, no-PIN; and Atkinson, no-PIN) in portions of Aroostook, Franklin, Penobscot, Piscataquis, and Somerset Counties, the proposed culvert and bridge rehabilitation activities in and near a stream channel would not be expected to affect lynx or its critical habitat according to the section 7 Programmatic Agreement between MEDOT, USFWS, and FHWA (signed December 16, 2008). Therefore, the Canada lynx and its critical habitat will not be considered further in this consultation.

This section defines the biological requirements of each listed species affected by the proposed action, and the status of each designated critical habitat relative to those requirements. Listed species facing a high risk of extinction and critical habitats with degraded conservation value are more vulnerable to the aggregation of effects considered under the environmental baseline, the effects of the proposed action, and cumulative effects.

2.1 Gulf of Maine Distinct Population Segment of Atlantic Salmon

2.1.1. Species Description and Listing History of the GOM DPS

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

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

The newly listed GOM DPS includes all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment. The following impassable falls delimit the upstream extent of the freshwater range: Rumford Falls in the town of Rumford on the Androscoggin River; Snow Falls in the town of West Paris on the 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 and Craig Brook National Fish Hatcheries, 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).

2.1.2. Life History of Atlantic Salmon in the GOM DPS

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. Adults ascend the rivers within the GOM DPS beginning in the spring. The ascent of adult salmon continues into the fall. Although spawning does not occur until late fall, the majority of Atlantic salmon in Maine enter freshwater between May and mid-July (Meister 1958; Baum 1997). Early migration is an adaptive trait that ensures adults have sufficient time to effectively reach spawning areas despite the occurrence of temporarily unfavorable conditions that naturally occur within rivers (Bjornn and Reiser 1991). Salmon that return in early spring spend nearly 5 months in the river before spawning, often seeking cool water refuge (*e.g.*, deep pools, springs, and mouths of smaller tributaries) during the summer months.

In the fall, female Atlantic salmon select sites for spawning. Spawning sites are positioned within flowing water, particularly where upwelling of groundwater occurs, allowing for percolation of water through the gravel (Danie *et al.* 1984). These sites are most often positioned at the head of a riffle (Beland *et al.* 1982); the tail of a pool; or the upstream edge of a gravel bar where water depth is decreasing, water velocity is increasing (McLaughlin and Knight 1987; White 1942), and hydraulic head allows for permeation of water through the redd (a gravel depression where eggs are deposited). Female salmon use their caudal fin to scour or dig redds. The digging behavior also serves to clean the substrate of fine sediments that can embed the cobble/gravel substrate needed for spawning and consequently reduce egg survival (Gibson 1993). 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 2 sea-winter (SW) female (an adult female that has spent two winters at sea before returning to spawn) (Baum and Meister 1971). After spawning, Atlantic salmon may either return to sea immediately or remain in freshwater until the following spring before returning to the sea (Fay *et al.* 2006). From 1967 to 2003, approximately 3 percent of the wild and naturally reared adults that returned to rivers where adult returns are monitored--mainly the Penobscot River--were repeat spawners (USASAC 2004).

Embryos develop in 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 6 weeks after hatching and are nourished by their yolk sac (Gustafson-Greenwood and Moring 1991). Survival from the egg to fry stage in Maine is estimated to range from 15 to 35 percent (Jordan and Beland 1981). Survival rates of eggs and larvae are a function of stream gradient, overwinter temperatures, interstitial flow, predation, disease, and competition (Bley and Moring 1988). Once larval fry emerge from the gravel and

begin active feeding they are referred to as fry. The majority of fry (>95 percent) emerge from redds at night (Gustafson-Marjanen and Dowse 1983).

When fry reach approximately 4 cm in length, the young salmon are termed parr (Danie *et al.* 1984). Parr have eight to eleven pigmented vertical bands on their sides that are believed to serve as camouflage (Baum 1997). A territorial behavior, first apparent during the fry stage, grows more pronounced during the parr stage, as the parr actively defend territories (Allen 1940; Kalleberg 1958; Danie *et al.* 1984). Most parr remain in the river for 2 to 3 years before undergoing smoltification, the process in which parr go through physiological changes in order to transition from a freshwater environment to a saltwater marine environment. Some male parr may not go through smoltification and will become sexually mature and participate in spawning with sea-run adult females. These males are referred to as "precocious parr."

First year parr are often characterized as being small parr or 0+ parr (4 to 7 cm long), whereas second and third year parr are characterized as large parr (greater than 7 cm long) (Haines 1992). Parr growth is a function of water temperature (Elliott 1991); parr density (Randall 1982); photoperiod (Lundqvist 1980); interaction with other fish, birds, and mammals (Bjornn and 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.* 1998; Halvorsen and Svenning 2000; Hutchings 1986; 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 freshwater for 2 years (90 percent or more) with the balance remaining for either 1 or 3 years (USASAC 2005). In order for parr to undergo smoltification, they must reach a critical size of 10 cm total length at the end of the previous growing season (Hoar 1988). During the smoltification process, parr markings fade and the body becomes streamlined and silvery with a pronounced fork in the tail. Naturally reared smolts in Maine range in size from 13 to 17 cm, and most smolts enter the sea during May to begin their first ocean migration (USASAC 2004). During this migration, smolts must contend with changes in salinity, water temperature, pH, dissolved oxygen, pollution levels, and predator assemblages. The physiological changes that occur during smoltification prepare the fish for the dramatic change in osmoregulatory needs that come with the transition from a fresh to a salt water habitat (Ruggles 1980; Bley 1987; McCormick and Saunders 1987; McCormick *et al.* 1998). The transition of smolts into seawater is usually gradual as they pass through a zone of fresh and saltwater mixing that typically occurs in a river's estuary. Given that smolts undergo smoltification while they are still in the river, they are pre-adapted to make a direct entry into seawater with minimal acclimation (McCormick *et al.* 1998). This pre-adaptation to seawater is necessary under some circumstances where there is very little transition zone between freshwater and the marine environment.

The spring migration of post-smolts out of the coastal environment is generally rapid, within several tidal cycles, and follows a direct route (Hyvarinen *et al.* 2006; Lacroix and McCurdy 1996; Lacroix *et al.* 2004, 2005). 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) and/or the major surface-current vectors (Lacroix and Knox 2005). Post-smolts live mainly on the surface of the water column and form shoals, possibly of fish from the same river (Shelton *et al.* 1997).

During the late summer and autumn of the first year, North American post-smolts are concentrated in the Labrador Sea and off of the west coast of Greenland, with the highest concentrations between 56°N. and 58°N. (Reddin 1985; Reddin and Short 1991; Reddin and Friedland 1993). The salmon located off Greenland are composed of both 1SW fish and fish that have spent multiple years at sea (multi-sea winter fish, or MSW) and includes immature salmon from both North American and European stocks (Reddin 1988; Reddin *et al.* 1988). The first winter at sea regulates annual recruitment, and the distribution of winter habitat in the Labrador Sea and Denmark Strait may be critical for North American populations (Friedland *et al.* 1993). In the spring, North American post-smolts are generally located in the Gulf of St. Lawrence, off the coast of Newfoundland, and on the east coast of the Grand Banks (Reddin 1985; Dutil and Coutu 1988; Ritter 1989; Reddin and Friedland 1993; and Friedland *et al.* 1999).

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.

2.1.3. Status and Trends of Atlantic Salmon in the GOM DPS

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

Contemporary abundance estimates are informative in considering the conservation status of the GOM DPS today. After a period of population growth in the 1970s, adult returns of salmon in the GOM DPS have been steadily declining since the early 1980s and appear to have stabilized at very low levels since 2000. However, total adult returns to the GOM DPS improved somewhat in

2008 and 2009 (Figure 2). The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from Green Lake National Fish Hatchery that was constructed in 1974. Marine survival remained relatively high throughout the 1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s marine survival rates decreased, leading to the declining trend in adult abundance observed throughout 1990s. Poor marine survival persists in the GOM DPS to date.

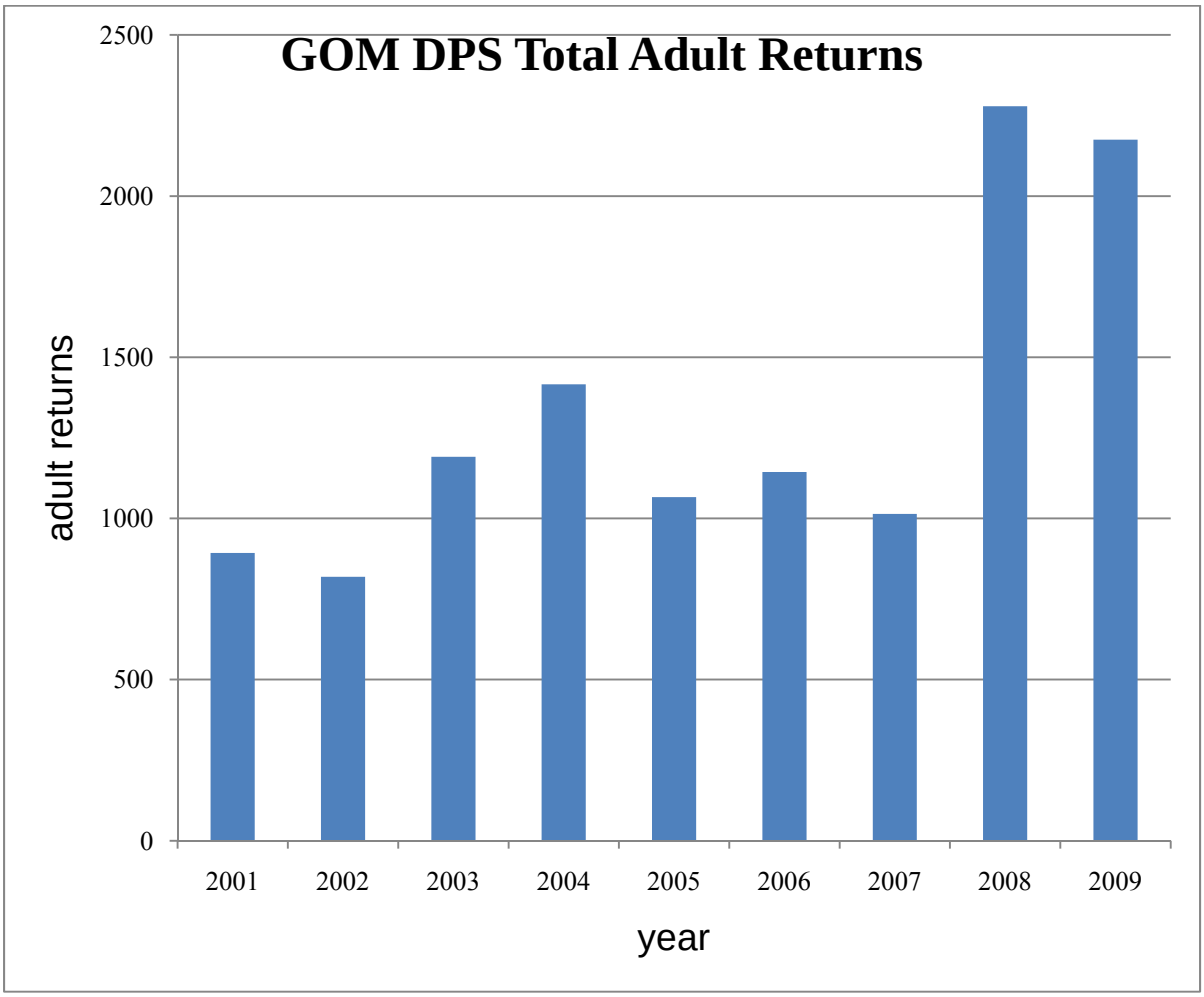

Figure 2. Total adult returns for the GOM DPS. Figure reproduced using data from US Atlantic Salmon Assessment Committee reports, including 2010 USASC report (USASC 2010).

Adult returns to the GOM DPS have been very low for many years and remain extremely low in terms of adult abundance in the wild. Further, the majority of all adults in the GOM DPS return to a single river, the Penobscot, which accounted for 91 percent of all adult returns to the GOM DPS in 2007. Of the 1044 adult returns to the Penobscot in 2006, 996 of these were the result of smolt stocking and only the remaining 48 were naturally-reared. The term naturally-reared includes fish originating from natural spawning and from hatchery fry (USASAC 2008). Hatchery fry are included as naturally-reared because hatchery fry are not marked; therefore, they cannot be distinguished from fish produced through natural spawning. Because of the

extensive amount of fry stocking that takes place in an effort to recover the GOM DPS, it is possible that a substantial number of fish counted as naturally-reared were actually 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 hatcheries. In short, hatchery production over this time period has been relatively constant, generally fluctuating around 550,000 smolts per year (USASAC 2008). In contrast, the number of naturally reared smolts emigrating each year is likely to decline following poor returns of adults (three years prior). Although it is impossible to distinguish truly wild salmon from those stocked as fry, it is likely that some portion of naturally reared adults are in fact wild. Thus, wild smolt production would suffer three years after a year with low adult returns, because the progeny of adult returns typically emigrate three years after their parents return. The relatively constant inputs from smolt stocking, coupled with the declining trend of naturally reared adults, result in the apparent stabilization of hatchery-origin salmon and the continuing decline of naturally reared components of the GOM DPS observed over the last two decades.

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

In conclusion, the abundance of Atlantic salmon in the GOM DPS has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is very small (approximately 10%) and is continuing to decline. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to halt the decline of the naturally reared component of the GOM DPS.

2.2. 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 3). The final rule was revised on August 10, 2010 to revise the designated critical habitat for the expanded GOM DPS of Atlantic salmon to exclude all trust and fee holdings of the Penobscot Indian Nation and to correct a table (74 FR 39003; August 10, 2009).

2.2.1. Primary Constituent Elements of Atlantic Salmon Critical Habitat

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

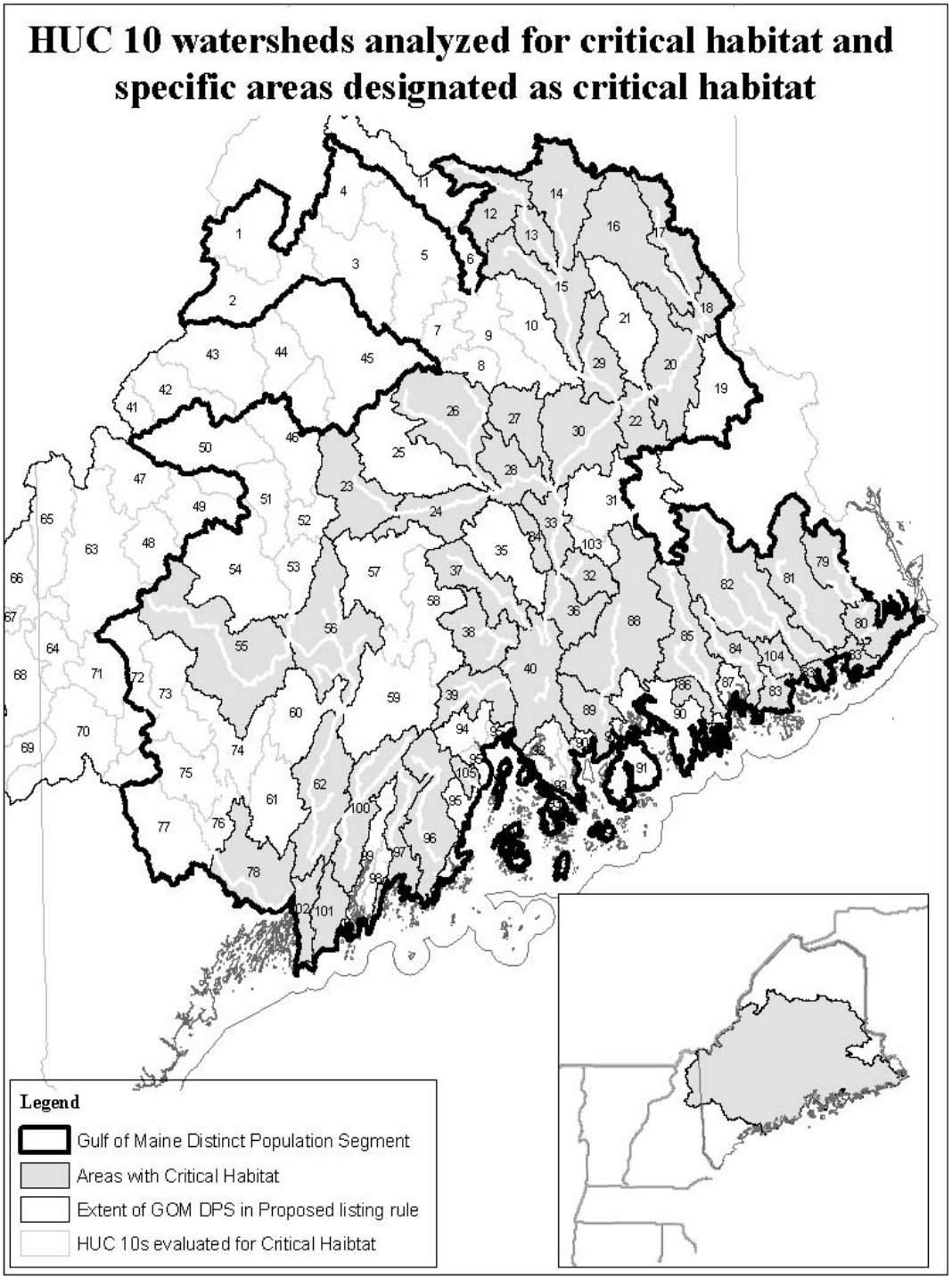

Figure 3. HUC-10 watersheds designated as Atlantic salmon critical habitat within the GOM DPS.

rearing, and 2) sites for migration (excluding marine migration[7]). NMFS chose not to separate spawning and rearing habitat into distinct PCEs, although each habitat does have distinct features, because of the GIS-based habitat prediction model approach that was used to designate critical habitat (74 FR 29300; June 19, 2009). This model cannot consistently distinguish between spawning and rearing habitat across the entire range of the GOM DPS.

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

Physical and Biological Features of the Spawning and Rearing PCE[8]

A1. Deep, oxygenated pools and cover (*e.g.*, boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during the summer while they await spawning in the fall.

A2. Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development.

A3. Freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development and feeding activities of Atlantic salmon fry.

A4. Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.

A5. Freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production.

A6. Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.

A7. Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.

Physical and Biological Features of the Migration PCE[9]

B1. Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations.

B2. Freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (*e.g.*, boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon.

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

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

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

[8] Appendix A designates the seven physical and biological features of the spawning and rearing PCE as A1 – A7. That convention will be used throughout this Opinion.

[9] Appendix A designates the six physical and biological features of the migration PCE as B1-B6. That convention will be used throughout this Opinion.

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

B6. Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts.

Habitat areas designated as critical habitat must contain one or more PCEs within the acceptable range of values required to support the biological processes for which the species uses that habitat. Critical habitat 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 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 OHWM line or the bankfull elevation in the absence of a defined high-water line. In estuaries, critical habitat is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater.

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

2.2.2. Salmon Habitat Recovery Units within Critical Habitat for the GOM DPS

In describing critical habitat for the Gulf of Maine DPS, NMFS divided the GOM DPS into three Salmon Habitat Recovery Units or SHRUs. The three SHRUs include the Downeast Coastal, Penobscot Bay, and Merrymeeting Bay. The SHRU delineations were designed by NMFS to ensure that a recovered Atlantic salmon population has widespread geographic distribution to help maintain genetic variability and, therefore, a greater probability of population sustainability in the future. Areas designated as critical habitat within each SHRU are described in terms of habitat units. One habitat unit represents 100 m^2 of suitable salmon habitat (which could be spawning and rearing habitat or migration habitat). Habitat units within the GOM DPS were estimated through the use of a GIS-based salmon habitat model (Wright *et al.* 2008). Additionally, NMFS discounted the functional capacity of modeled habitat units in areas where habitat degradation has affected the PCEs. For each SHRU, NMFS determined that 30,000 fully functional units of habitat are needed in order to achieve recovery objectives for Atlantic salmon. A brief historical description for this SHRU, as well as contemporary critical habitat designations and special management considerations, are provided below. Brief historical descriptions 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 61,400 units of historical spawning and rearing habitat for Atlantic salmon among approximately 6,039 km of rivers, lakes and streams. Of the 61,400 units

of historical spawning and rearing habitat, approximately 53,400 units of habitat in eleven HUC-10 watersheds are considered to be currently occupied. Of the 53,400 occupied units within the Downeast Coastal SHRU, NMFS calculated these units to be the equivalent of roughly 29,111 functional units of habitat or approximately 47 percent of the estimated historical functional potential. This estimate is based on the configuration of dams within the SHRU that limit migration and the degradation of physical and biological features from land use activities which reduce the productivity of habitat within each HUC-10. Though the Downeast SHRU does not currently meet the objective of 30,000 fully functional units of habitat available to Atlantic salmon, there is enough habitat 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 323,700 units of historically accessible spawning and rearing habitat for Atlantic salmon among approximately 17,440 km of rivers, lakes and streams. Of the 323,700 units of spawning and rearing habitat (within 46 HUC-10 watersheds), approximately 211,000 units of habitat are considered to be currently occupied (within 28 HUC-10 watersheds). Of the 211,000 occupied units within the Penobscot SHRU, NMFS calculated these units to be the equivalent of nearly 66,300 functional units or approximately 20 percent of the historical functional potential. This estimate is based on the configuration of dams within the SHRU that limit migration and the degradation of physical and biological features from land use activities which reduce the productivity of habitat within each HUC-10. The combined qualities and quantities of habitats available to Atlantic salmon within the currently occupied areas in the Penobscot Bay SHRU currently meet the objective of 30,000 fully functional units of habitat available to Atlantic salmon. Three HUC-10 watersheds - Molunkus Stream, Passadumkeag River, and Belfast Bay - are excluded from critical habitat designation due to economic impact. Certain tribal lands within the Penobscot Bay SHRU are also excluded from critical habitat designation, although the Penobscot Nation specifically requested that their lands be included as critical habitat.

Merrymeeting Bay SHRU

The Merrymeeting Bay SHRU drains approximately 2,691,814 hectares of land (6,651,620 acres) and contains approximately 372,600 units of historically accessible spawning and rearing habitat for Atlantic salmon located among approximately 5,950 km of historically accessible rivers, lakes and streams. Of the 372,600 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. Of the 136,000 occupied units within the Merrymeeting Bay SHRU, NMFS calculated these units to be the equivalent of nearly 40,000 functional units or approximately 11 percent of the historical functional potential. This estimate is based on the configuration of dams within the Merrymeeting Bay SHRU that limit migration and other land use activities that cause degradation of physical and biological features and which reduce the productivity of habitat within each HUC-10. The combined qualities and quantities of habitat available to Atlantic salmon within the currently occupied areas within the Merrymeeting Bay SHRU meet the

objective of 30,000 fully functional units of habitat available to Atlantic salmon. 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.

2.3 Summary of Factors Affecting Recovery within the GOM DPS

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

2.3.1. Threats to the Species

The recovery plan for the previously designated GOM DPS (NMFS and USFWS 2005), status review (Fay *et al.* 2006), and the 2009 listing rule, provide a comprehensive assessment of the many factors, including both threats and conservation actions, for currently listed Atlantic salmon. USFWS is currently writing a new draft recovery plan that will include the current DPS, which was expanded in 2009 to include the Androscoggin and large portion of the Kennebec and Penobscot River basins. The draft recovery plan would likely include the following list of high priority threats requiring action to reverse the decline of GOM DPS salmon populations.

- Acidified water and associated aluminum toxicity, which decrease juvenile survival
- Aquaculture practices, which pose ecological and genetic risks
- Avian predation
- Changing land use patterns (*e.g.*, development, agriculture, forestry)
- Climate change
- Depleted diadromous fish communities
- Hydropower system physical and biological impacts, including altered flow regimes, prevention or poor upstream migration, downstream turbine mortality, migration delay, water quality impacts that result from impoundments, etc.
- Incidental capture of adults and parr by recreational anglers
- Introduced fish species that compete or prey on Atlantic salmon
- Low marine survival
- Poaching of adults in DPS rivers
- Recovery hatchery program (potential for artificial selection/domestication)
- 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 one of the significant threats 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 form the spread of diseases or parasites and from farmed salmon escapees interbreeding with wild salmon still exist.

2.3.2. 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.

Downeast Coastal SHRU

The Downeast Coastal SHRU once contained high quality Atlantic salmon habitat in quantities sufficient to support robust Atlantic salmon populations. 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.

Penobscot Bay SHRU

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

Merrymeeting Bay SHRU

Habitat throughout the Merrymeeting Bay SHRU was once of high enough quality to support a robust Atlantic salmon population. The mainstem Kennebec River has the highest biological value to the Merrymeeting Bay SHRU because it provides the central migration conduit crucial for much of the currently occupied habitat found in the Sandy River basin. The Sandy River has the greatest biological value for spawning and rearing habitat within the occupied range of the Merrymeeting Bay SHRU but is currently only accessible to adult salmon through a trap and truck program around the four lowermost dams. The construction of dams, and to a lesser extent pollution, has degraded habitat quality and accessibility and is likely responsible for the decline of Atlantic salmon populations within the Merrymeeting Bay SHRU. Today, dams are the greatest impediment, outside of marine survival, to the recovery of salmon in the 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.

2.3.3. Efforts to Protect the GOM DPS and its Critical Habitat

Efforts aimed at protecting Atlantic salmon and their habitats in Maine have been underway for well over one hundred years. These efforts are supported by a number of federal, state, and local government agencies, as well as many private conservation organizations. The 2005 recovery plan for the originally-listed GOM DPS (NMFS and USFWS 2005) presented a strategy for recovering Atlantic salmon that focused on reducing the severest 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 expanded listing and designation of critical habitat, the Services will produce a new recovery

plan for Atlantic salmon. The new plan, which will also cover the Kennebec, Androscoggin and Upper Penobscot watersheds, must address impacts that result from the hydropower systems on these rivers.

III. ENVIRONMENTAL BASELINE

The Environmental Baseline provides a snapshot of the health or status at a given time of the species and its habitat, within the action area, and is used as a biological basis upon which to analyze the effects of the proposed action. Assessment of the environmental baseline includes an analysis of the past and present impacts of all state, federal, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). An environmental baseline that does not meet the biological requirements of a listed species may increase the likelihood that adverse effects of the proposed action will result in jeopardy to a listed species or in destruction or adverse modification of a designated critical habitat.

The Environmental Baseline is typically a narrowly focused subset of the Status of the Species and Critical Habitat evaluation. For example, an opinion discussing a bridge replacement project on the East Machias River would have an environmental baseline that discusses the status of the salmon population and critical habitat in the East Machias River basin and the project-specific action area on the East Machias River. However, in this Opinion, the action area of the proposed agency action encompasses a considerable portion of the freshwater range of the entire Atlantic salmon GOM DPS and its critical habitat. MEDOT proposes 10 projects in 14 different rivers and streams scattered throughout the range of the GOM DPS and all three of the SHRUs with designated critical habitat. Projects occur in eight different HUC-10 watersheds, with five of these in the Penobscot Bay SHRU, two in the Downeast Coastal SHRU, and one in the Merrymeeting Bay SHRU. As such, the environmental baseline for the species and its critical habitat in the action area is basically the same as the current status of the species and its critical habitat as a whole, as discussed above in Section II. Status of the Species and Critical Habitat (pages 18-32). Based on the best available scientific information, there is nothing noticeably different about the 14 proposed project locations (*i.e.*, streams or rivers) when compared to the entire GOM DPS and its critical habitat.

USFWS describes the environmental baseline in terms of the biological requirements for habitat features and processes necessary to support all life stages of the listed species within the action area. The listed species considered in this Opinion resides in or migrates through the action area. Thus, for this action area, the biological requirements for Atlantic salmon are the habitat characteristics that support successful completion of rearing, freshwater migration, and spawning.

IV. EFFECTS OF THE ACTION

This section of the Opinion analyzes the direct and indirect effects of the proposed action on the GOM DPS of Atlantic salmon and its critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02, June 30, 1986). Effects of the action that reduce the ability of a listed species to meet its biological requirements may increase the

likelihood that the proposed action will result in jeopardy to that listed species or in destruction or adverse modification of a designated critical habitat. Indirect effects are those that are caused by the proposed action, are 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.

Because the projects included in this Opinion will, by and large, have similar effects on the GOM DPS and its critical habitat, this section will generally not include a project-specific analysis of effects. Instead, this section will focus on a general discussion of effects as they apply to most, if not all, of the projects under consideration. For example, many of these projects will involve the temporary isolation of an instream work area by cofferdams and the potential need to capture and relocate Atlantic salmon downstream to a safe location during construction within the cofferdam. A generic discussion of the effects to Atlantic salmon from capture and relocation, following a proposed standard protocol, would then apply to all of the proposed projects. The discussion of effects to critical habitat will pertain to all of the projects except the Enfield (PIN: 15644.00) culvert replacement on Cold Stream.

4.1 Effects to Atlantic Salmon from Specific Construction and Monitoring Activities

During construction the proposed action is likely to adversely affect Atlantic salmon through the effects of sediment, riparian vegetation removal, alterations in fish passage conditions, and through disturbing or handling fish during instream work activities.

4.1.1. Cofferdams, Dewatering, and Fish Relocation

Atlantic salmon may be killed or more likely temporarily disturbed, displaced, or injured by instream work activities. Isolation of a stream work area with a cofferdam is a conservation measure intended to minimize the overall adverse effects of construction activities on Atlantic salmon and their habitat. Dewatering of a stream inside a cofferdam would have a lethal effect on any fish left inside the cofferdam, but most fish in the work area would be successfully transported to a safe location. Fish release upstream of the project site is preferred as sediment impacts would not likely affect individuals upstream of the crossing. Adverse effects could result from the capture, handling, transport and stranding of these fish. We have not factored this unquantifiable amount of harassment and increased stress levels into the Incidental Take Statement. Nevertheless, there is the possibility that some mortality may occur if fish are missed or stranded in substrate interstices during salvage operations.

A block net will be installed upstream and downstream of the project site, secured to the stream channel, bed, and banks, until fish capture and transport activities are complete. Following installation of the upstream block net, fish will be hazed out of the proposed dewatered sections by walking seines downstream from the upstream block net location to the end of the work site in an attempt to ‘herd’ fish out of the worksite. A downstream block net would then be installed and efforts to capture remaining fish would follow. Before or while the cofferdam is being dewatered, Atlantic salmon that don’t move away and are subsequently captured inside the cofferdam will be relocated outside of the action area to suitable habitat (downstream or upstream), according to the fish evacuation plan (Appendix B). Gear such as dip nets, minnow traps and seines should be used first; electrofishing gear should be used last in an attempt to clear

the work area. Electrofishing should be used only where other means of fish capture are not feasible or effective following NOAA Fisheries guidelines found at: http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/upload/electro2000.pdf (NMFS 2000). To minimize temperature-related handling stress to Atlantic salmon the MEDMR recommends that electroshocking should not be conducted in water temperatures above 23°C. Reasonable effort should be made to avoid handling fish in warm water temperatures, such as conducting fish evacuation first thing in the morning, when the water temperature would likely be coolest. However, work areas isolated by cofferdams may be electrofished before dewatering if temperatures are greater than 23°C, although it must be acknowledged that this could lead to higher mortality that expected (<2%).

Atlantic salmon parr are highly territorial and actively defend their feeding territory to maximize their opportunity to capture prey items. Territory size increases with fish age and size. Atlantic salmon parr temporarily displaced from their territory by construction activities, particularly the de-watering of a section of stream, may be more vulnerable to predators, may be less able to capture prey, and may experience more stress while looking for another suitable, unoccupied area of stream in which to establish a new territory.

To avoid the death of fish caught inside a cofferdam as a result of dewatering, MEDOT will capture and remove all Atlantic salmon and other fish species. Netting and handling of fish is likely to result in harassment and increased stress levels. There is potential that some fish would be missed or stranded in substrate interstices. Capturing and handling salmon also causes physiological stress and can cause physical injury or death, including cardiac or respiratory failure from electrofishing (Snyder 2003). Studies have shown that all aspects of fish handling, such as dipnetting, time out of water, and data collection like measuring the length, are stressful and can lead to immediate or delayed mortality (Murphy and Willis 1996). Direct mortality may occur when fish are handled roughly, not properly restrained, sedated during handling, or kept out of the water for extended periods. It is common for fish to jump out of the worker's hand and fall onto a hard surface, resulting in internal injuries. Fish injured during handling, in association with a disease epizootic, typically die within 24 hours to 14 days. Examples of injuries which can lead to disease problems are loss of mucus, loss of scales, damage to the integument, and internal damage.

To minimize any injury or stress to Atlantic salmon captured during construction and dewatering of the cofferdam, only certain MEDOT Environmental Office staff will be allowed to handle fish and all personnel involved with electrofishing will have appropriate experience with salmonids in Maine (see Appendix B for a list of specific staff names). Handling stress and risk of injury will be minimized by 1) ensuring minimal handling time (no data will be collected from individual Atlantic salmon other than to record the number of salmon captured); 2) ensuring minimal time that fish are held out of water and the stream; and 3) using transfer containers with aerated stream water of ambient temperature. To minimize adverse effects to Atlantic salmon, other MEDOT staff, its consultants, or its contractors may not handle any Atlantic salmon during the course of these construction projects.

Despite precautions, some mortality is inevitable while electrofishing. The MEDMR annually reports to the USFWS juvenile salmon mortality associated with electrofishing activities in GOM

DPS waters.[10] While the MEDMR usually handles a few thousand juvenile salmon each year during electrofishing, mortalities are usually less than two percent of total fish captured.

Baum (1997) reported that Maine Atlantic salmon rivers support on average between five and ten parr per 100 m^2 of habitat (or one salmon habitat unit), based on data collected by the MEDMR. While electrofishing for juvenile Atlantic salmon population estimates (for both young-of-the-year [YOY] and parr) and collection of parr for use as broodstock at the USFWS's Craig Brook National Fish Hatchery, the MEDMR collected a GOM DPS average of 6.29 salmon/100 m^2 in 2005; 4.92 salmon/100 m^2 in 2006; 10.65 salmon/100 m^2 in 2007; 8.03/100 m^2 in 2008 and 10.31/100 m^2 in 2009. The five-year GOM DPS average for juvenile Atlantic salmon density is then 8.42 salmon/100 m^2. These data are from electrofishing efforts in many streams located in watersheds throughout the new GOM DPS (as defined in June 2009) and represent the best available scientific information to assist in determining the number of juvenile Atlantic salmon that are likely to be displaced or collected and relocated when a portion of a stream is dewatered within a cofferdam.

All projects that will use cofferdams to isolate instream work areas are expected to capture some juvenile Atlantic salmon within the cofferdam areas. The total dewatered area for all projects is 1079.53 m^2 or 10.8 units of salmon habitat. While some of the projects included in this total area do not contain juvenile habitat at the project site, there is juvenile rearing habitat upstream and/or downstream of the project; so it is possible that salmon could be moving through the project area during construction. Therefore, it is reasonable that as many as 91 juvenile Atlantic salmon (8.42 parr/100 m^2 x 10.8 habitat units = 90.90 salmon) could be displaced from or captured inside cofferdams. However, 8.42 parr/100 m^2 is likely high for the project areas covered by this BO. MEDMR's data is mainly based on sites where the numbers are affected by fish stocking. Additionally, some of the habitat within the cofferdams is currently inside of an existing culvert and may not be as suitable as habitat outside of the structure for Atlantic salmon. Therefore, we are reducing the number of salmon expected to be caught by electrofishing by 50%. As a result, it is reasonable that as many as 46 (90.9 x 0.50 = 45.47) juvenile Atlantic salmon could be displaced or captured inside cofferdams and subsequently relocated upstream or downstream of the isolated work area.

From 2001-2009, MEDMR's electrofishing mortality during YOY and parr population estimation and broodstock collection has ranged from 3.33% (2001) to 0.82% (2006) with a mean mortality of 1.70% for both life stages combined over that period (Trial 2010). The vast majority of the mortality is to YOY. Considering only the most recent 5-year period (2005-2009), MEDMR's mortality rate for all juvenile life stages during electrofishing activities was 1.43%.[11] To the best of our knowledge, MEDOT has only killed one out of seven Atlantic salmon juveniles captured by electroshocking to evacuate fish from culvert work sites over the last five years. This "high" mortality rate (14%) is likely a due to the initial small sample size. Given that MEDOT staff biologists, and possibly consultants, who will be electrofishing, are experienced with handling salmonids in Maine, over the long-term we expect a similar level of

[10] The MEDMR is authorized by the USFWS under section 10(a)(1)(A) of the ESA (Blanket Permit #697823) to conduct various research and recovery activities for GOM DPS Atlantic salmon, some of which may cause take of Atlantic salmon.

[11] This mortality figure does not include "catch per unit effort" sampling or random "poke" sampling because the size of the stream area sampled is not know in these instances. The data above, however, captures the majority of MEDMR's electrofishing effort for Atlantic salmon and is thought to be representative of overall mortality rates.

mortality during electrofishing efforts. Consequently, USFWS expects that no more than one (1) juvenile Atlantic salmon will be killed as a result of electrofishing activities to relocate fish outside of cofferdam work areas (46 salmon captured x 1.43% mortality rate = 0.66 salmon mortalities; rounded up to 1 salmon mortality).

Even though very few Atlantic salmon are expected to be injured or killed by capture and relocation activities, fish will be temporarily disrupted from their normal behaviors (*e.g.*, territorial behavior of parr, which includes foraging on aquatic invertebrates). Additionally some mortality may occur if fish be missed or stranded in substrate interstices during salvage operations.[12] We have not seen literature or data on juvenile Atlantic salmon to quantify this potential form of take. Nevertheless, USFWS acknowledges that fewer fish are likely to be affected by the salvage operations because the density calculated by MEDMR may be higher than that found in most of the action area for the culvert projects. As described above, MEDMR's fish density estimates included areas known to have been supplemented with hatchery-raised juvenile salmon.

Within the area designated as critical habitat, Atlantic salmon spawning occurs in the action area of the Strong, Atkinson, and Kenduskeag projects. Given recent adult returns to GOM DPS rivers, the likelihood of an adult being present at any given project site is very small. 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 areas would very likely be disturbed and move away from the work zone. Therefore, the USFWS does not believe that take of an adult salmon is reasonably likely to occur.

In order to keep the stream flows diverted around the cofferdam (in situations where the entire stream channel is blocked off) for the duration of instream work, a pump will be used just upstream of the upper cofferdam. The intake hose has the potential to adversely affect fish, including juvenile Atlantic salmon, through impingement and entrainment. Approach velocities across the screen that are faster than a fish's swimming capability can draw and hold fish against the screen surface (*i.e.*, impingement), resulting in suffocation or physical damage to the fish (NMFS 2008). Impingement and entrainment can be avoided by putting a properly designed fish screen on the end of the intake hose.

To prevent entrainment of Atlantic salmon juveniles, MEDOT proposes to use pump intake screen(s) that are designed and sized to meet NMFS (2008) criteria as described in section *1.2.1 Cofferdam Descriptions*. With the implementation of this protective measure, diversion pumps should have minimal, if any, effects on Atlantic salmon. In order for these protective measures to be effective, they must be carefully planned to suit the project site conditions and monitored throughout the period of pumping.

At most of the project sites the relatively low numbers of Atlantic salmon in the rivers reduces the likelihood that a salmon would be captured inside a cofferdam. However, in the Piscataquis River, which is the site for the Atkinson project, MEDMR found relatively high densities of large parr Atlantic salmon in 2009 (maximum = 20.39 parr/100 m^2). Newly emerged fry occupy areas with current but select microhabitat with slower water in shallower water nearer shore. Parr select microhabitat with a wider range of velocity but prefer deeper water than fry. Most yearling or older parr occupy habitats with depths less than 90 cm (35 inches)(Stanley and Trial 1995).

[12] For ESA-listed Pacific salmon and steelhead, NMFS calculates an expected stranding rate of 8% (of total exposed population) for both electrofished and non-electrofished sites.

MEDOT intends to remove all fish, including Atlantic salmon captured inside of cofferdams, at the Atkinson project before concrete seals are poured underwater, thus avoiding any effects to salmon from high pH. Based on experience, MEDOT believes it is relatively rare for fish to be trapped within a bridge pier cofferdam, given the general construction-related activity associated with installation. Also, based on monitoring of pH levels inside a cofferdam during dewatering, MEDOT has determined that higher pH water is limited to the area in proximity to the concrete seal. For the Strong bridge pier repair project on the Sandy River, a cofferdam has not been contemplated because of the depth.

Riprap applied behind the cofferdams will be placed in the dry and have no effects on salmon; but the riprap placed along the streambanks, especially along the northwest slope (up to 30.48 m) at the Kenduskeag bridge project, will likely be placed in the wet. In order to minimize potential direct effects to salmon juveniles while placing the riprap, MEDOT biologists will isolate the area with siltation fence or block nets and evacuate any salmon that are contained within the enclosed area as described in the evacuation plan (Appendix B).

4.1.2. Bridge Pier and Abutment Repair using Grout Bags

At the Atkinson project, proposed concrete work on two piers work will be conducted behind cofferdams. Including the work completed in 2009, 61.3 m^2 of habitat will be permanently affected at the three piers.

Projects with concrete seals placed on the stream bottom for the rehabilitation of bridge piers could possibly expose Atlantic salmon to very high pH water (sometimes as high as pH 12) while the concrete is curing. High pH can kill fish; cause damage to or burn outer surfaces including gills, eyes, and skin; and impair a fish's ability to dispose of metabolic wastes. Cement and grout has the potential to adversely affect water quality and fish. Grout is composed of Portland cement and water and is a consistency sufficient to flow. The ingredients in Portland cement (chiefly tri-calcium silicate [$Ca_3Al_2O_4$], di-calcium silicate [Ca_2SiO_5], tri-calcium aluminate [$Ca_3Al_2O_6$], tetra-calcium aluminoferrate [$Ca_4A_{l2}Fe_2O_{10}$], and gypsum [$CaSO_4{\cdot}2H_2O$]) have been shown to have toxic effects on some species of fish when exposed directly to cement clinker[13] (Adamu *et al.* 2008). Cement poses a risk because as it dissolves, cement produces calcium hydroxide, a highly alkaline substance that may injure or kill fish (Department of Fisheries and Oceans Canada 2004).

At the Strong project, the grout bags will be filled by divers without cofferdams to isolate the work area. Sandy River is greater than 3 m-deep (10 feet) at the pier and flow will be substantially greater during the work period, as discussed in the Project Impacts section of the BA (page 63-64) than those encountered by Fitch (2003). Fabric barrier turbidity curtains are not practical for use where water velocities exceed 0.46 m sec^{-1} (1.5 feet sec^{-1})(MEDOT 2008a). Therefore, MEDOT does not propose to use turbidity curtains because of the velocity and because of risk, although low, that salmon could be trapped and exposed to elevated pH levels.

In Virginia, the upper pH limit is 9.0 (Fitch 2003), although in Maine, normal background levels of pH are in the range of 6 to 7 and safe limits are between 6.5 and 8.5 (University of Maine 2004). 8.5 pH is the upper limit for class B and C fresh surface water in Maine (U.S.

[13] Clinker is the solid material produced by the cement kiln stage that has sintered into lumps or nodules, typically of diameter 3-25 mm. Clinker is ground (usually with the addition of a little gypsum, that is, calcium sulfate dihydrate) to become Portland cement. It may also be combined with other active ingredients or chemical admixtures.

Environmental Protection Agency 1988). Fitch (2003) reported that pH exceeded 9.0 at a stream in Virginia (at an unreported distance downstream), but the grout pumping rate, 9.94 m^3 (13 $yards^3$) per hour, was much greater than that proposed to be maintained by MEDOT, about 1.53 m^3 (2 $yards^3$) per hour. Stream flows were also substantially lower in Virginia than in the Sandy River. Therefore, the Virginia stream only had a small amount of water available for dilution compared to the Sandy River during the instream work window. Additionally, MEDOT proposes to add an anti-washout admixture that will increase the cohesiveness of the wet cement and limit the downstream transport of any released cement. When Fitch's projects added an anti-washout admixture, pH did not exceed 8.9 during pumping at a high rate, even when the work occurred in slack water.

With MEDOT's proposed protection measures, anti-washout ad mixture, the size of the streams, which would quickly dilute suspended sediment and the pH released, we believe there would be minimal, if any, effects on Atlantic salmon.

4.1.3. Effects from Fish Passage Testing

Following construction of replacement culverts, validation of the design (measuring water depths, velocities, etc.) is necessary at each of the culvert projects. MEDOT will also test the efficacy of upstream fish passage at the following road crossing structures: Enfield (PIN 15644.00), Brownville-1 (no-PIN), Charleston (no-PIN), Columbia Falls, and Meddybemps (no-PIN). At these projects, the FishXing program predicted that 7 cm brook trout would not be able to pass upstream during the upper project design flows used in the model. Fish passage testing will involve the use of block nets, seines, dip nets and electrofishing to determine the ability of fish to move through the above subset of structures. If any Atlantic salmon are captured in these project areas, they could be subjected to physiological stress, injury, or death, as discussed above, related to electrofishing, netting, and relocation. Atlantic salmon will be relocated out of the area blocked by nets and not used for fish passage tests. However, the effects of this monitoring activity are expected to be very similar to those related to fish salvage operations. Other monitoring activities, to include measuring water depths and velocities and assessing the occurrence of stream substrates inside the culvert, are not expected to have any effect on Atlantic salmon.

Fish passage testing at these five culvert replacement projects, requires capture of fish, marking by clipping one of the fish's fins to determine identification during recapture, release of marked fish downstream of the culvert, and potential recapture upstream of the culvert to confirm fish passage capability. The total number of juvenile Atlantic salmon expected to be captured is based on the same expected occurrence of fish within the habitat that will be isolated by a cofferdam during construction for each electrofishing event for the projects where fish passage testing will occur (Enfield, Brownville-1, Charleston, Columbia Falls, and Meddybemps).

Based on previous monitoring experience, MEDOT does not anticipate an increase in mortality rates from electrofishing on the second day (John Perry, MEDOT, pers. comm.). The number of fish, including Atlantic salmon, may vary at these sites and salmon captured on the first day would be relocated out of the enclosure. New fish are not expected to be caught on the second day due to the presence of block nets in the stream both upstream and downstream of the culvert. Therefore, we have assumed that no Atlantic salmon would be incidentally captured when marked test fish are subsequently recaptured.

These projects sites contain approximately 844.40 m^2 of area that would be electrofished. Consequently, it is reasonable that as many as 36 Atlantic salmon could be captured by electrofishing and then released back into the stream (8.4 habitat units x 8.42 parr/unit x 0.50 captures = 35.55; rounded to 36 fish). Fish passage monitoring is proposed to occur over three separate years, so as many as 108 salmon could be captured during electrofishing over the course of the post-construction monitoring period. Total electrofishing mortality for fish passage testing is expected to be about one (1) salmon (108 x 1.43% = 0.51; rounded to 1 fish).

4.1.4. Sedimentation Effects

Construction activities that involve work in a stream or near the banks of the stream are likely to result in some level of sediment being discharged into the stream as a result of disturbance to either land-based soils or stream substrates. The amount of sediment entering streams in association with these projects, however, is expected to be relatively minor given the measures proposed by MEDOT to minimize erosion and sedimentation and the duration of instream work (1 day) at most projects. All projects covered by this Opinion, except a portion of the Kenduskeag bridge replacement project, will have all instream work limited to the period July 15 to September 30 when stream flows are relatively low, consequently limiting the potential for stream flows to generate erosion and carry sediment downstream. Furthermore, stream flows usually lowest during the summer in Maine, limiting the potential for rain and subsequent construction-site runoff to cause erosion and carry sediment into a stream.

Spawning habitat is present in the vicinity of the Enfield, Strong, Atkinson and Kenduskeag projects. However, due to the proposed work window (July 15 to September 30) spawning activity and redds are not expected to be present. Salmon eggs and newly emerged fry, which are generally considered the most sensitive life stages to the effects of increased suspended sediments, will not be present in streams during the summer instream work window (Robertson *et al.* 2007). However, YOY and parr juveniles could be present in the stream, but they will relocated away from the work area. Fish release upstream of the project site is preferred as sediment impacts would not likely affect individuals upstream of the crossing.

All projects will be constructed in accordance with the MEDOT BMP manual for sediment and erosion control (MEDOT 2008a). Each project will have an individual Soil Erosion and Water Pollution Control Plan (SEWPCP) that is approved and fully enforced by MEDOT. Because the project is located in habitat for an endangered species, the BMP manual designates the project as "sensitive" and requires that a combination of BMPs will be used to protect the resource, including that one of the BMPs must be an erosion control BMP versus a sedimentation control BMP. A higher level of inspection and compliance assurance is required by MEDOT for all projects where endangered species are present (MEDOT 2008a). Generally, the longer the construction period, the greater the urgency for adequate erosion control measures.

Limiting most instream work to a dewatered section of stream within a cofferdam will minimize the amount of sediment mobilized and distributed downstream. Turbid water from within a cofferdam will be pumped into the "dirty water" treatment system to minimize sedimentation impacts to the stream when the diverted water is returned downstream. However, the installation and removal of these cofferdams and the diversion of streamflow around the construction site can result in some amount of sediment being dispersed in the stream. The BA states that substrate containing clay is only present at the Columbia Falls project site. Because the rest of these projects are located in sections of streams with coarser substrates (boulder, cobble, gravel,

sand) the opportunity for sediment to be mobilized and carried downstream by construction activities will be minimal. Construction-related disturbances in riparian areas near the stream will also have the potential to result in erosion and sediment entering the stream, particularly if there are rainstorms during periods when there are disturbed soils on the construction site. Strict adherence to the SEWPCP plan and vigilant monitoring by MEDOT staff should minimize this source of erosion and subsequent sediment reaching the stream, as well.

Atlantic salmon are adapted to natural fluctuations in water turbidity, such as during high water events from spring runoff; a variety of anthropogenic activities, however, can result in short-term increases in suspended sediments and unnatural increases in stream turbidity (Robertson *et al*. 2007). Potential adverse effects of these increases in stream turbidity on Atlantic salmon could include the following (Robertson *et al.* 2006; Newcombe 1994): 1) reduction in feeding rates; 2) increased mortality; 3) physiological stress, including changes in cardiac output, ventilation rate, and blood sugar level; 4) behavioral avoidance of the work area; 5) physical injury (*e.g.*, gill abrasion); 6) reduction in macroinvertebrates as a prey source, and 7) a reduction in territorial behavior.

In a review of the effects of sediment loads and turbidity on fish, Newcombe and Jensen (1996) concluded that more than 6 days exposure to total suspended solids (TSS) greater than 10 mg/l is a moderate stress for juvenile and adult salmonids. A single day exposure to TSS in excess of 50 mg/l is also a moderate stress to salmonids. Robertson *et al.* (2007) found adverse effects to juvenile Atlantic salmon from short-term increases in suspended sediment at sediment levels as low as 15 nephelometric turbidity units (NTU) in a laboratory setting. These effects, however, were observed during the fall and winter seasons, a time period when most of the MEDOT projects will not be engaged in work activities that could release suspended sediment. Effects on fish from short-term turbidity increases (hours or days) are generally temporary and are reversed when turbidity levels return to background levels (Robertson *et al.* 2006).

The USFWS does not have sufficient information to compare the conclusions of Newcombe and Jensen (1996) with TSS levels that might be expected from the projects and various construction activities covered by this Opinion. However, based on our knowledge of instream construction activities in Maine of a similar nature to the projects discussed here, we would not expect construction-related TSS levels to reach those described by Newcombe and Jensen. The sediment and erosion control measures that will be employed for each project, including construction in the dry in most situations, should keep sediment effects on Atlantic salmon to a minimal level on a temporary basis. Based on professional judgment and MEDOT's observations at past projects, suspended sediment plumes should not exceed 30.48 m (100 feet) in small streams and 91.44 m (300 feet) in the larger streams (Cold Stream, Sandy River, Piscataquis River, and Kenduskeag River) in this consultation. Considering the expected small volume of suspended sediment likely to be introduced into the affected streams, any discharge is likely to dissipate quickly and return to background levels.

The effects of sediment on Atlantic salmon and their habitat will be most pronounced during culvert removal/installation, when the stream is rerouted, bypass culvert installation/removal, backfill of road surfaces, and when the stream flow is returned through the dewatered work site. Suspended sediment pulses are likely to last from a few minutes to several hours. Because of the minor amount of construction-related sediment expected to reach these streams and because of the relatively small number of salmon expected to be in the action areas, turbidity-related effects are expected to be minor and short-term. USFWS expects any exposed fish to volitionally seek

adjacent, less turbid habitats, thus avoiding direct sediment exposure. Once suspended sediment levels return to background levels, Atlantic salmon displaced from the action area would be expected to return and normal behaviors resumed (*e.g.*, foraging, defending territory). Such effects would not be expected to "harm" salmon. Under the ESA, harm is defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Any take associated with sediment generated by the project is expected to be sublethal in nature and take the form of harassment.

4.1.5. Temporary Pile Bent Installation and Bridge Removal Effects

The Kenduskeag Stream bridge replacement project involves dragging the existing 34.75-m (114-foot) single span bridge deck off of its abutments to shore where it can be dismantled and disposed of on land. To facilitate this maneuver MEDOT proposes to place a temporary pile bent in the middle of the stream. The H-piles required for the bent will most likely not be driven, given the lack of overburden at this location, but the end of the piles will instead be placed on the substrate. If there is enough overburden onsite to drive the piles, they will most likely be driven in just one to two meters with a vibratory hammer for additional stability. Some excavation with a clamshell bucket may be necessary prior to driving the piles, in order to create an even surface. A small amount of substrate (approximately 0.2 m^2 per pile) would be disturbed by the placement of these vertical H-piles. All piles would be removed when removal of the existing bridge deck is complete.

Work instream associated with creating an even surface, placing the piles, and their removal could release a small amount of sediment. The effects of sediment were addressed above.

4.1.6. Construction-Related Sound Effects

The Village Bridge across Kenduskeag Stream is the only project covered by this Opinion that may produce sound impacts for the installation of sheetpile cofferdams and temporary pile-bents with a vibratory hammer. Hydroacoustic effects from construction activities can kill, injure, or affect the behavior of fish, including Atlantic salmon which could be present during pile driving at the Kenduskeag project. Extreme changes in pressure can be especially damaging to species that have swim bladders, such as salmonids, and can cause severe injury or mortality, either instantaneously or over the course of a few days, in individuals exposed for any length of time (NMFS 2003). If there is enough overburden onsite in Kenduskeag Stream, the contractor will most likely use a vibratory hammer to drive the piles into the streambed (one to two meters) in order to provide additional stability.

An interagency work group (including USFWS and NMFS), primarily addressing effects to west coast ESA-listed fish, has provided interim criteria for what level of noise caused by pile driving will cause direct physical injury to fish (*i.e.*, "harm" in terms of the ESA) (Fisheries Hydroacoustic Working Group 2008). When evaluating potential injury impacts to fish, peak sound pressure (dB_{peak})[14] is often used (WSDOT 2010). The workgroup established dual sound

[14] dB_{Peak} - instantaneous peak sound pressure level

criteria for injury, measured 10 meters away from the pile, of 206 dB_{Peak} and 187 dB SEL[15] (the second criteria applies only to fish weighing 2 grams or more).

The driving of sheet piles was not specifically addressed by the hydroacoustic working group. Data exist from California, however, that allow for the comparison between the noise produced by driving sheet piles and a dual threshold criteria. The amount of noise produced by pile driving is affected by the type and size of the pile **(**Table 4**)**. The noise produced by driving wood, concrete, and steel piles under 61 cm (24-inches) in diameter is below the assumed threshold of direct physical injury for Atlantic salmon (based on Table 4 and the FHWG 2008 interim criteria).

Table 4. Sound levels produced by the driving piles of different types and sizes (from WSDOT, 2008).

Pile Type	Sound Level (Single Strike)		
Wood piles:	180 dBpeak	170 dBRMS	160 dB SEL
Concrete piles:	192 dBpeak	176 dBRMS	174 dB SEL
Steel H-piles:	190 dBpeak	175 dBRMS	155 dB SEL
12-inch steel piles:	208 dBpeak	191 dBRMS	175 dB SEL
14-inch steel piles:	195 dBpeak @ 30m	180 dBRMS @ 30m	
16-inch steel piles:	200 dBpeak@ 9 m	187 dBRMS @ 9m	
24-inch steel piles:	212 dBpeak	189 dBRMS	181 dB SEL
30-inch steel piles:	212 dBpeak	195 dBRMS	186 dB SEL
36-inch steel piles:	214 dBpeak	201 dBRMS	186 dB SEL
60-inch dia. steel piles:	210 dBpeak	195 dBRMS	185 dB SEL

Overall, data collected on in-water noise produced by vibratory versus impact hammers demonstrate that vibratory hammers produce lower sound levels. Vibratory hammers produce sounds of lower intensity, with a rapid repetition rate. The California Department of Transportation (CADOT) determined that the noise produced by driving a sheet pile with an impact hammer was more intense (205 dB_{Peak}, 190 dB_{RMS}, and 180 dB_{SEL} 10 m away from the source) than a sheet driven with a vibratory hammer (175 dB_{Peak}, 160 dB_{RMS}, and 160 dB_{SEL})(CADOT 2007). In general, MEDOT uses vibratory hammers to install and extract sheetpiles. In either case, the noise produced from driving sheetpiles or piles less than 61 cm (24 inches) is unlikely to exceed the thresholds described by the hydroacoustic working group in 2008 and is therefore not likely to cause physical injury or mortality to any salmon in the project area. Thus, utilizing a vibratory hammer will minimize the adverse effects to fish associated with underwater noise.

Noise in the water column may, however, still affect the behavior of salmon. As long as the piles being used for the MEDOT projects are below the upper threshold described in the Fisheries Hydroacoustic Working Group guidance, it does not appear that there will be a direct physical

[15] Sound exposure level (SEL) – The constant sound level acting for one second, which has the same amount of acoustic energy, as indicated by the square of the sound pressure, as the original sound. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels, and temporal characteristics (Hastings and Popper 2005).

effect to salmon in the action area, either by injury or mortality. If a project requires a larger pile, the noise level can be reduced below the effect threshold by using a bubble curtain or other noise attenuation technique. However, because of the large variability in the effectiveness of bubble curtains (and fabric barriers), there is no standard rate of attenuation assumed. Sound pressure levels in excess of 150 dB_{RMS} are expected to cause temporary behavioral changes, such as elicitation of a startle response, disruption of feeding, or avoidance of an area. (WSDOT 2010).

The statutory definition of "take" includes "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (ESA § 3(18)). Harass in the definition of take in the ESA means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 C.F.R. § 17.3). For example, driving sheet piles may cause a startle response in fish that causes an individual to move to another location in the river. Such short-term responses, however, are not expected to significantly disrupt normal behavior patterns (such as feeding or migration) such as to result in harassing salmon. It does not appear that there will be a direct physical effect to salmon in the action area, either by injury or mortality from this work. Based on the best available information presented above (including the FHWG 2008 interim criteria), it appears that driving piles and sheet piles should not cause mortality or injury (*i.e.*, harm) to Atlantic salmon. Therefore, this activity is not expected to result in a take of any Atlantic salmon.

4.1.7. Effects from Hazardous Materials Associated with Construction

As a component of the SEWPCP for each project, MEDOT or their contractor will develop and implement a Spill Prevention Control and Countermeasure Plan (SPCCP) designed to avoid any impacts to rivers and streams from hazardous chemicals associated with construction, such as diesel fuel, oil, lubricants, and other hazardous materials. All refueling or other construction equipment maintenance will be done at a location consistent with the SPCCP and in a manner which avoids chemicals or other hazardous materials getting into the stream. Petroleum-based materials, such as diesel fuel and oil, contain polycyclic aromatic hydrocarbons (PAHs). PAHs can be acutely toxic to salmonids and other aquatic organisms at high exposure levels or can cause sublethal effects at lower exposures (Albers 2003). Careful adherence to an approved SPCCP, as part of the overall SEWPCP, should make it highly unlikely that Atlantic salmon would be exposed to harmful chemicals during a construction project.

4.1.8. Effects on the Riparian Zone

At the project locations some vegetation, including trees, shrubs, or the herbaceous layer, will be removed from the stream banks to allow for construction access, placement of larger crossing structures, or other construction-related activities. Vegetation removal will be kept to minimum necessary to accomplish the project. Rip-rap will be used to stabilize stream slopes or protect structures from scour. On the Kenduskeag project riprap will be placed along 30.48 m (100 feet) of stream banks at the base of the road slope and the abutments (11.27 m), if necessary.

Although riprap along stream banks can increase stream water temperatures due to solar radiation, the generally small amounts of riprap proposed should not have a measurable effect on water temperature. Furthermore, minor vegetation removal should not result in any input of sediment into the streams, as long as appropriate erosion control BMPs, such as silt fence, are

employed. All disturbed areas will be mulched and stabilized following construction (MEDOT 2008a).

4.1.9. Effects on Stream Connectivity

Road crossing structures, particularly culverts, can have adverse effects on the passage of aquatic organisms, including Atlantic salmon. As stated in their BA, MEDOT intends to preclude passage of all life stages of Atlantic salmon during construction of culverts, which will last approximately one day per each culvert site. Long term, fish passage for adult and juvenile salmon will be provided and may be positively improved at all projects, except at the culvert on the first unnamed tributary to Wilson Stream at the Chesterville-Farmington project (PIN: 12774.10), which is currently not passable and will remain so. It is highly unlikely that habitat upstream of this culvert has the potential to provide habitat for Atlantic salmon. The majority of the proposed replacement culverts (Enfield, Chesterville-Farmington (#2, #3, and #4), Columbia Falls, and Frankfort) will be somewhat wider than the existing culverts. All 11 of the replacement culverts would be embedded, which will better facilitate natural bed load movement. However, except Enfield and Meddybemps, all of the culverts will be substantially lengthened. Increased length could be a critical factor at culverts where velocity is an issue affecting fish passage. The maximum water velocity that fish are able to swim against as they negotiate the full length of a culvert is dictated by the width, slope and length of a structure. The longer the culvert, the lower the maximum allowable velocity that fish are capable of sustaining as they swim upstream.

Additional discussion of fish passage through the culvert is provided below in section *4.2.2.*, which discusses effects of these projects on critical habitat and the migration PCE.

4.2 Effects to Atlantic Salmon Critical Habitat

This critical habitat analysis determines whether the proposed action will destroy or adversely modify designated critical habitat for listed species by examining any change in the conservation value of the essential features of that critical habitat. This analysis relies on statutory provisions of the ESA, including those in section 3 that define “critical habitat” and “conservation,” section 4 that describes the designation process, and section 7 that sets forth the substantive protections and procedural aspects of consultation.

The projects covered by this consultation were evaluated by an MEDOT biologist familiar with Atlantic salmon habitat requirements to determine which of the critical habitat PCEs (and their associated physical and biological features) are present within the project action area. All of the projects contain both spawning and rearing and migration PCEs (Table 5). One of these projects, Enfield (PIN: 15644.00), is excluded from critical habitat due to economic consideration. Appendix A provides a description of the salmon habitat at each project site and a list of the PCEs and specific habitat features present at each location. The discussion that follows lists each PCE and its associated biological and physical features and then discusses how the proposed bridge and culvert projects may affect the PCE and their associated features.

Table 5. PCEs in vicinity of projects that have critical habitat for GOM Atlantic salmon (A = Spawning and Rearing; B = Migration).

Project	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	B6
Brownville				X	X	X	X				X	X	X
Chesterville-Farmington				X	X	X	X				X	X	X
Columbia Falls				X	X	X	X				X	X	X
Meddybemps				X	X	X	X				X	X	X
Frankfort				X	X	X	X				X	X	X
Charleston				X	X	X	X				X	X	X
Strong	X	X	X	X	X	X	X	X	X		X	X	X
Atkinson	X	X	X	X	X	X	X	X	X		X	X	X
Kenduskeag	X	X	X	X	X	X	X	X	X		X	X	X

4.2.1. Effects to the Spawning and Rearing Primary Constituent Element and its Seven Physical and Biological Features

PCE A1) Deep, oxygenated pools and cover (e.g., boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during the summer while they await spawning in the fall.

Three of the ten projects in the area designated as critical habitat, the bridge repair projects in Strong and Atkinson and the bridge replacement project in Kenduskeag, have been identified as having PCE A1 present. Deep pools that could support adults during the summer are presumably present either upstream or downstream of all ten projects, somewhere in their respective watersheds. Based on the information available, these three projects will not result in the loss of any deep pools and cover that provide summer holding habitat for adults.[16]

These projects have the potential to generate some amount of suspended sediment. Given the various BMPs that will be employed to minimize the amount of sediment, particularly the use of cofferdams so that instream excavation work can be done in the dry, the amount of sediment that could affect deep pools is relatively minor and would not be expected to degrade or eliminate their use by adults as summer holding habitat.

PCE A2) Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development.

Three of the ten projects in the area designated as critical habitat, the bridge repair projects in Strong and Atkinson and the bridge replacement project in Kenduskeag, have been identified as having PCE A2 present. Additionally, spawning habitat for Atlantic salmon may be present either upstream or downstream of all nine projects with designated critical habitat. Instream work for Strong and Atkinson will be conducted from July 15 to September 30. At the Kenduskeag bridge project, most instream work is proposed during this work window. Three to six H-pile bents will be temporarily positioned in the river between December 1 and March 30 in order to

[16] In light of what USFWS and MEDOT learned at the Prentiss culvert replacement project in July, where a large number of salmonids (>100) and other fish resided in a deep pool, it is clear that habitat inside structures must be carefully evaluated (whenever safety procedures allow) so that important pool habitat is not overlooked again.

remove the old bridge deck. Spawning habitat will not be affected at a time when spawning, egg incubation, or larval development is occurring.

Repairs to the Strong bridge pier will be conducted by divers underwater without heavy equipment, which will affect approximately 18.58 m^2 of river bottom. However, this site, which is over 3 m deep would not result in the loss of any spawning habitat. In general, Atlantic salmon spawning sites are characterized by depth between 20 and 50 cm, flow velocity between 35 and 65 cm s^{-1}, and substrate size between 16 and 64 mm (Louhi *et al.* 2008). The effect of the project is a temporary increase in pH in the immediate area.

Work on the Atkinson bridge repair will occur in the dry within an industrial sandbag cofferdam, which will minimize water quality concerns in the Piscataquis River. There will be an insignificant loss of potential spawning habitat and a temporary increase in pH in the immediate area associated with the placement of cement. Jacketing of the piers would increase the pier footprint by approximately 40.8 m^2, (20.4 m^2 (220 $feet^2$) per each of the two piers). However, it is unlikely that spawning would occur next to bridge piers. Atlantic salmon adults select spawning sites at the tails of pools that have substrate composition reflecting sorting by the swift currents that move over this habitat (Stanley and Trial 1995). A small amount of sediment could be released when cofferdams are removed. It is expected that this impact would not extend more than 91.44 m (300 feet) downstream.

On the Kenduskeag bridge project, riprap will be placed along the northwest stream banks of the Kenduskeag Stream at the base of the road slope and the abutments, if necessary. This will permanently affect 27.9 m^2 of critical habitat, some of which may be potentially suitable for spawning. The Penobscot Bay SHRU currently has more than enough functional habitat to support the 2000 adult spawners deemed necessary for the conservation of the species (74 FR 29300; June 19, 2009). Bridge scupper drains that directly discharge stormwater to streams may contain relatively high pollutant concentrations, including sediment that would adversely affect spawning habitat (CASQA 1993). Under condition #4 in **Section 7C Terms and Conditions**, runoff from bridge decks will be directed to land, in order to allow for soil infiltration and treatment of stormwater before entering the river.

Consequently, suspended sediment and the loss of 68.7 m^2 (40.8 m^2 + 27.9 m^2) of gravel-cobble substrate resulting from the bridge projects in the Piscataquis River and Kenduskeag Stream are not expected to affect the function and conservation role of critical habitat for Atlantic salmon spawning, egg incubation and larval development in the Penobscot SHRU.

PCE A3) Freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development and feeding activities of Atlantic salmon fry.

Three of the ten projects in the area designated as critical habitat, the bridge repair projects in Strong and Atkinson and the bridge replacement project in Kenduskeag, have been identified as having PCE A3 in the project vicinity. Following emergence from redds, fry tend to move to shallower, lower velocity riffle habitats, often near stream margins. Newly emerged fry occupy areas with current but select microhabitat with slower water in shallower water nearer shore (Stanley and Trial 1995).

Some of these projects would involve temporary dewatering of a portion of the stream within cofferdams to allow for inwater work to occur with a minimal amount of sediment entering the

stream. All of these projects that could dewater fry habitat would do so from July 15 to September 30, after the time when fry would have entered the parr stage. Consequently, temporary dewatering would not affect fry habitat at a time when it is being used by fry. Long term, the lengthening of 9 out of 11 proposed culverts will impact 76.18 m^2 of additional stream bottom (bankfull x added length). This loss of fry habitat is relatively minor and will not affect the capacity of the Downeast or Penobscot SHRUs to produce salmon fry.

The Strong bridge repair, in water deeper than 3 m, will not result in the loss of any fry habitat.

Work on the Atkinson bridge repair will occur in the dry within an industrial sandbag cofferdam, which will minimize water quality concerns. Jacketing of the piers would increase the pier footprint by approximately 40.8 m^2 (20.4 m^2 per each of the two piers). Newly emerged fry occupy areas with current but select microhabitat with slower water in shallower water nearer shore (Stanley and Trial 1995). Therefore, few, if any, fry would be occupying the thalweg where the pier repair work would be completed.

On the Kenduskeag bridge project, each of the temporary pile bents would disturb approximately 0.2 m^2 of habitat in the middle of the channel. Additionally, riprap will be placed along the northwest stream banks at the base of the road slope and the abutments, if necessary, permanently affecting 27.9 m^2 of critical habitat. Because of the relatively small amounts of vegetation removal and the fact that the entire tree canopy would generally not be removed from a given section of stream, we do not anticipate any increase in stream temperature that would affect fry habitat.

Consequently, the loss of potential fry habitat (40.8 m^2 + 27.9 m^2 + 0.2 m^2 = 68.9 $m^{2)}$ resulting from the two bridge projects in the Penobscot SHRU is relatively minor and will not affect the function and conservation role of critical habitat for Atlantic salmon fry.

PCE A4-A7 for parr rearing habitat

The four distinct physical and biological elements of freshwater habitats used by Atlantic salmon parr will be considered together because of the similarity of the habitats that support these various features of critical habitat for parr. MEDOT identified that all four physical and biological features of the spawning and rearing PCE important for parr are present at ten project sites. There are no project locations where fewer than four parr PCEs were noted.

PCE A4. Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.

PCE A5. Freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production.

PCE A6. Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.

PCE A7. Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.

Non-spawning tributaries represent an important part of the habitat complex for Atlantic salmon. Sites occurring furthest upstream, with small cumulative drainage areas, such as the 11 proposed culvert projects, have high survival of fry and age 1+ parr (juveniles after their first year of life in freshwater) compared to sites lower in a watershed. A likely mechanism for higher survival in

stream reaches of small drainage area is that these areas provide more favorable temperatures (Sweka *et al.* 2007). Juveniles salmon tend to seek this habitat. Loughlin (2008) noted upstream migration of fry to 100 meters at all locations and up to 500 meters above the stocking point at one location. Juvenile 1+ and 2+ parr (juveniles after their second year of life in freshwater) enter small tributaries from the main stem of the river and can produce notable numbers of smolt (Erkinaro *et al.* 1998).

For seven of the ten proposed projects (11 culvert replacements), sections of streams will be completely dewatered (*i.e.*, the entire channel from one bank to the opposite bank), albeit temporarily, within cofferdams to allow construction work to occur in the dry. Two of the ten projects, Strong, and Kenduskeag, would require no cofferdams, which would avoid temporary dewatering and allow parr movement. The Atkinson bridge repair would have cofferdams placed only around the bridge piers, temporarily dewatering about 279 m^2 of parr habitat, but not preventing parr movement in the Piscataquis River.

The area of stream channel that is critical habitat for parr that would be temporarily dewatered to complete work in this batch of projects varies from about 41 m^2 to about 279 m^2. During the period of dewatering, which could last from one day (for small culverts) to several weeks (for bridge pier repairs), parr habitat within the cofferdam area would be unavailable to Atlantic salmon. The maximum length of time that a section of stream reach could be dewatered and displaced by cofferdam materials is about four weeks during the standard summer low-flow work window (July 15 to September 30). Once the project is completed, the cofferdams removed, and normal stream flows are restored, the temporarily impacted parr habitat should return to its prior condition. These projects would result in the total, temporary loss of 1,080 m^2 of parr habitat or about 10.8 units of juvenile habitat.

For the Chesterville-Farmington project, the realignment of 45.72 m (150 feet) of stream, in three short segments, along an unnamed tributary to Wilson Stream in the Sandy River watershed will impact approximately 153 m^2 of stream habitat that could support juvenile salmon; which is a net loss of 40.4 m^2. The channel will be shifted sufficiently to create a buffer from the road that will provide water quality protection from runoff. The new habitat will receive less non-point source pollution from erosion of the road shoulder and winter road maintenance. Streamside plantings will be required, as well as pre- and post-construction monitoring of the stream reaches. The new channel, which will not be significantly different in length, has the potential to provide higher quality parr habitat due to reduced sedimentation and improved water quality.

De-watered parr habitat at the realignment and culvert sites would experience a loss of aquatic invertebrates, which provide food for Atlantic salmon juveniles. This loss of food resources would be temporary; however, as aquatic invertebrates should recolonize the stream once flows are re-established. Since the stream habitat would not be permanently altered in any way, its ability to support aquatic invertebrates after construction activities are completed should not change. There will likely be a period of time following restoration of stream flows where the parr habitat will immediately regain the habitat elements of space and cool, oxygenated water but will still lack in food resources until aquatic invertebrates are able to recolonize the stream substrate.

Some projects will require rip-rap to stabilize new or repaired bridge abutments or the inlets and outlets of culverts. Some of this rip-rap will be placed in critical habitat that is used by Atlantic salmon parr. Only some of this rip-rap will result in a permanent loss of habitat because the rock

fill will extend above the stream surface (*i.e.*, the rip-rap placed closest to the edge of the stream). As the rip-rap slopes down into the stream from the abutments, some of the placed rock will be under water and would offer rearing habitat for Atlantic salmon parr. Rip-rap impacts are estimated to range from 0.0 m^2 to 40.9 m^2, which is a relatively minor effect to critical habitat given the amount of salmon habitat available in these streams.

Culverts can result in the loss of natural stream bottom inside the culvert, depending on the type of culvert and the site-specific conditions. Most of the proposed culverts would be longer to accommodate road widening and slope requirements, resulting in an additional 66.14 m of culvert and the displacement of 76.18 m^2 of parr habitat by the longer culverts. Natural stream bed materials can settle out inside the structure while others completely lack any natural stream substrate. Some habitat can be provided if the culvert is sufficiently embedded with substrate that is similar to the natural streambed. Culverts that have a relatively natural stream bottom, particularly bottomless structures, may offer habitat for salmonids. For example, a large pool under the existing bottomless arch culvert (PIN 16742.00) on Drew Road/Rt. 171 across Mud Brook in Prentiss Township provided rearing habitat for at least one hundred brook trout and other species, until fish were evacuated on August 3, 2010 to allow replacement with a 4-sided box culvert that will destroy the pool habitat.

None of the existing culverts in this batch of projects have natural stream substrate on the bottom of the culvert. They are not embedded and hydraulic conditions do not allow the culverts to maintain substrate. Such culverts cause a loss or degradation in habitat conditions from changes in hydrology, sediment transport, and movement of woody debris. All of the proposed culverts will be embedded by 0.15- or 0.30-m (0.5- or 1-foot) depending on the diameter. Because of the increased width and placement of the new culverts, it is anticipated that some stream substrate will stay in the proposed new culverts, which could offer some habitat value for salmon parr. However, we would not expect the stream substrate habitat in round culverts to match or be as high in quality as a bottomless culvert. Stream substrate under Project SHARE's wide bottomless arch culverts in the Machias River watershed provide a natural stream with habitat for a diverse community of aquatic insects and juvenile salmonids.[17] MEDOT will monitor each of the culverts to evaluate whether hydraulic conditions are favorable for fish passage and whether or not stream substrate stays in the new culverts.

4.2.2. Effects to the Migration Primary Constituent Element and its Six Physical and Biological Features

The migration PCE is present at of the bridge and culvert projects within designated critical habitat. MEDOT noted that feature B3[18] was absent at all sites due to the overall depleted diadromous fish communities throughout rivers in Maine. However, native diadromous fish are still present in rivers where salmon occur, albeit in reduced numbers, and still provide an alternative prey species for predators of Atlantic salmon, as well as pulses of marine-derived nutrients. Nutrients deposited by fish carcasses that are retained in freshwater and riparian ecosystems are critical for maintaining their stream productivity, and thus, the freshwater phase of salmon populations as well. Each of the sites have an open migration corridor (B4),

[17] A University of Maine graduate student is documenting use by aquatic insects and juvenile salmon at Project SHARE culverts.

[18] Feature B3 of the migration PCE: Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.

sufficiently cool water temperatures and a natural flows regime (B5), and water chemistry needed to support sea water adaptation of smolts (B6). The larger streams at Strong, Atkinson, and Kenduskeag projects provide an adult migration corridor (B1) and adult holding and resting habitat (B2).

The 11 culvert replacement projects with the migration PCE present would result in a complete, temporary blockage of both upstream and downstream fish movements through the work site while cofferdams (which span from one stream bank to the other) are in place. This temporary blockage would occur between July 15 and September 30 and could last from as little as one day for simple culvert replacement projects. Since the summer instream work window occurs after the downstream migration of Atlantic salmon smolts, which is generally during the period from mid-April through mid-June (Baum 1997), these stream blockages will not affect smolt migration. Once the cofferdams are removed, the migration function of the critical habitat would be completely restored.

At the bridge projects an adequate zone of passage will be maintained at all times in the river channels. The Atkinson bridge project will use cofferdams that only isolate a portion of the approximately 45-meter-wide channel during construction (*e.g.*, a cofferdam around a mid-stream pier). Although a portion of the migration habitat will be temporarily obstructed, both juvenile and adult salmon are expected to be able to move through the work sites to access both upstream and downstream spawning and rearing habitat. Once the cofferdams are removed, the migration habitat will be restored to its original condition and there will be no permanent effect to the habitat. These partial stream blockages will generally occur during the July 15 to September 30 work window. Placing temporary pile bents in the approximately 30-m-wide Kenduskeag Stream, for bridge removal outside the summer work window (December 1 to March 31), is not expected to affect the ability of juvenile and adult salmon to pass around the construction site.

Culverts and bridges can have adverse effects on the passage of fish, including Atlantic salmon (Benton *et al.* 2008; Belford and Gould 1989). We do not believe that any of the bridges covered by this consultation are affecting movements of Atlantic salmon past the structures. Nor will the bridge projects affect pools that provide adult holding habitat. Road crossings with culverts, either round pipes or square boxes, can affect fish passage by acting as a physical barrier (*e.g.*, a hanging culvert) or by altering stream flows (*e.g.*, increasing water velocity, decreasing water depth), consequently limiting a fish's ability to navigate a stream crossing.

All of the projects covered by this consultation have been designed in accordance with the MEDOT Wildlife and Water Crossing Policy and Design Guide (MEDOT 2008b), which does not necessarily require the passage of native fish species through a given road crossing structure. While MEDOT recognizes the importance of providing aquatic habitat connectivity, they have to balance the design of transportation projects in light of many considerations including project costs and available funding, regulatory requirements, safety, and right-of-way issues. Consequently, fish passage for all species and all life stages will not be provided at every MEDOT stream crossing at all flows. Nevertheless, in their BA, the ACOE and MEDOT state that all projects covered by this consultation will be suitable for upstream passage of juvenile Atlantic salmon.

As discussed in section 1.6 and 4.1.9, fish passage may be positively improved at some of the culvert replacement projects, although a velocity barrier will still be present in several projects

during higher flows. Many of the proposed culverts are longer than the existing structures. Velocity adversely affects the capability of a fish to migrate upstream through a culvert to a greater extent when it is lengthened.

Given the design guide parameters in the MEDOT crossing policy (MEDOT 2008b), USFWS expects that the replacement culverts will pass the appropriate life stages of Atlantic salmon, at least to some degree. The MEDOT design guide utilizes the hydraulic design method, which bases culvert design on the known swimming abilities of the fish species that need to move through a structure and the recognition that crossings should mimic as much as possible the natural hydraulic conditions of the stream. Hydraulic designs optimize the hydraulic effects of culvert size, slope, material, and length to create water depths and velocities suited to the swimming ability of a target fish. However, MEDOT has not determined the actual passage efficacies of culverts that have been installed to date in accordance with the crossing policy (MEDOT 2008b).

The hydraulic design method is a focused approach methodology used to create water depths and velocities in culverts that meet the swimming abilities of target fish populations and life stages during specific periods of fish movement. The method requires the input of a number of uncertain criteria (hydrology and fish swim speeds, behavior and migration timing), but can be appropriate when designing for a small number of target species with similar requirements, if the hydraulic requirements of those species are known. This technique generates a smaller diameter culvert, usually narrower than bankfull width, which keeps cost of materials to a minimum. General considerations include the effect of culvert slope, size, material and length.

Significant errors associated with estimation of hydrology and fish swimming speeds must be resolved by making conservative assumptions in the hydraulic design process. On ungaged streams, hydrology models used for this method may produce design flows with high standard errors. Fish swimming capability is a function of water quality conditions and origin, size and condition of the fish. Swim speeds provided in the literature are typically determined in laboratory settings. Even within a given species, there can exist a large variation between individual capabilities. This can be the result of life stage, condition or individual prowess. It is important to recognize that fish do not always select the distance-maximizing swim speed, and the extent to which the optimum is approached appears to be under the influence of both individual variability and life history or phylogenetic constraints. Also, steady uniform velocity found in a laboratory apparatus is rare in the wild (Castro-Santos 2006).

Turbulence, as well as rapid fluctuations in water velocity and direction in a localized area, that may result from a hydraulic drop, are not considered in hydraulic designs. High levels of turbulence can disorient and exhaust a fish, creating a passage barrier. Also, most streams in Maine provide habitat for a number of different aquatic species. A culvert designed for salmonids would likely not be adequate for most other species. Many weak-swimming or crawling species use the slow water at bank edges and along the stream bottom itself. Little is known about movement timing and capabilities of many species of fish and organisms that migrate through Maine's stream corridors in the Atlantic salmon DPS. As discussed above, fish species other than Atlantic salmon provide an alternative prey species for predators of Atlantic salmon, as well as pulses of marine-derived nutrients when they die after spawning.

MEDOT believes that most of their existing fish passage structures do pass the target fish species, based on indirect evidence (*e.g.*, comparing known swimming speeds versus the water

velocity through the structure) or through direct observation of fish using the structure. Additional direct evidence of fish passage, such as mark-recapture studies, is needed to demonstrate that these structures can effectively pass both juvenile and adult Atlantic salmon at the various stream flows when salmon would be moving through a stream. At this time, USFWS believes that there is insufficient monitoring data from Maine road crossing structures to draw conclusions about overall effectiveness at providing passage for Atlantic salmon. MEDOT will test fish passage efficacy following the protocol found in Appendix C at the culverts that have fish (7 cm brook trout) passage only at certain flows, as indicated by FishXing.

The USFWS would prefer that MEDOT employ stream or geomorphic simulation designs that allows for a continuous streambed that simulates natural channel width, depth, and slope and connects the reaches upstream and downstream of the crossing (FHWA 2007; Forest Service Stream-Simulation Working Group 2008). Stream simulation was adopted by the U.S. Department of Agriculture, Forest Service as a pragmatic approach and sustainable long-term solution to maintain passage for all aquatic organisms at all life stages at road-stream crossings while meeting vehicle transportation needs and objectives. Rivers and streams are more than conduits for water and fish. They are linear ecosystems made up of the physical environment, communities of organisms, and a variety of ecological processes that shape and maintain these ecosystems over time. In Washington, monitoring results show that when road crossings are designed and constructed according to stream simulation design criteria (culvert bed width = 1.2 (channel width) + 2 feet, and slope of culvert < 1.25 (channel slope)), stream simulation culverts are reliable and create similar passage conditions compared to the adjoining channel (Barnard 2003). Also, the U.S. Forest Service has determined that its older (greater than approximately 5 years) stream-simulation type culverts, mainly open-bottom arches that have experienced a range of high flows and sufficient channel-forming flow durations have responded adequately to local hydrology (Inter-Fluve Inc. 2009).

4.3 Potential Effects not Considered in this Biological Opinion

Many of the projects in this batch do not yet have final designs. Consequently, there are many unknowns about site-specific conditions, project-specific construction techniques, and final amounts of habitat impacts from new or rehabilitated structures. In general, however, MEDOT and USFWS attempted to analyze projects in light of the greatest likely effects to salmon and their habitat. As project plans develop, it is possible that these plans will reveal an effect to Atlantic salmon or critical habitat that has not been assessed in this Opinion. If this situation develops, it will be necessary for the ACOE to reinitiate section 7 consultation for that particular project (or projects), as discussed below in section IX. The ACOE and MEDOT should allow for adequate time to reinitiate and complete consultation in light of project schedules.

V. CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section, because they require separate consultation pursuant to section 7 of the ESA.

Given that the action area encompasses a substantial amount of the freshwater portion of the GOM DPS and an extensive area of land (45,980 km^2) associated with many rivers, stream,

ponds, and lakes, there is potential for a vast array of future state, tribal, local, and private actions to occur. There is very little federal land within the GOM DPS watersheds. In a broad sense, future activities would include (but not be limited to) agriculture, forestry, residential and commercial/industrial development, and recreational fishing. Within each of these broad categories are a variety of actions that could affect Atlantic salmon and their habitat including water withdrawal to irrigate crops, logging roads and stream crossings, non-point source pollution from residential development, and loss of forest and other natural habitats within a stream or lake ecosystem from residential and commercial development. Irrigation of blueberry and cranberry fields from both surface water withdrawals and wells is an ongoing activity, generally with no federal nexus, that is expected to expand, particularly for blueberries, as crop acreages increase. Reduction in stream flows from irrigation practices during the summer is of concern for Atlantic salmon at a time when stream flows are naturally low in most years. The Services continue to work with state regulatory agencies to address impacts to Atlantic salmon from irrigation.

Because many activities that impact streams, ponds, and wetlands require federal permits from the ACOE under the Clean Water Act and the Rivers and Harbors Act, at least some future actions (whether state, tribal, local, or private in nature) that would affect Atlantic salmon and their critical habitat would be subject to ESA section 7 consultation. Indeed, even some of the activities mentioned above, such as residential development, could be subject to a federal action if impacts to wetlands or streams would occur.

Maine's total population in 2008 was 1,316,456 people, compared to 1,125,043 people in 1980 (14.6% growth over 28 years). The U.S. Census Bureau projected Maine's population growth from 2000 to 2030 and noted an overall aging of Maine's general population. Maine's population is expected to grow by 10.7% through 2030, indicating a reduced growth rate (USCB 2004). Subsequently, patterns and types of land use and development are not expected to dramatically change compared to trends seen over recent decades. Activities that have affected Atlantic salmon and their habitat in recent years are expected to continue relatively unchanged, although efforts at salmon conservation have and will continue to benefit Atlantic salmon (*e.g.*, dam removals and riparian conservation easements).

MEDOT has recently identified that some of their culvert and bridge maintenance projects (rehabilitation or replacement) will not require a permit from the ACOE or will not involve federal funding. Consequently, there is the possibility that some future projects, which would likely have effects on Atlantic salmon and critical habitat, will not undergo section 7 consultation. MEDOT and USFWS will be exploring the need to develop a Habitat Conservation Plan to authorize take of Atlantic salmon associated with this group of future road crossing maintenance projects. However, it appears that most future MEDOT projects that would affect Atlantic salmon or their critical habitat would involve either a federal permit or federal funding and, therefore, would be evaluated through the section 7 consultation process.

VI. CONCLUSION

This Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

After considering the current status of Atlantic salmon and its designated critical habitat, the environmental baseline, the effects of the proposed actions, and the potential for future cumulative effects in the action area, it is the USFWS's biological opinion that the proposed project is not likely to jeopardize the continued existence of the GOM DPS of Atlantic salmon throughout all or a significant portion of its range. Furthermore, the proposed actions are not expected to result in the destruction or adverse modification of critical habitat. In reaching these conclusions, the USFWS considered the best available scientific and commercial information regarding Atlantic salmon and the likely effects of the proposed bridge and culvert projects.

Effects to individual fish may, in turn, affect the attributes associated with a viable population (levels of abundance, productivity, spatial structure, and genetic diversity that support the species' ability to maintain itself naturally at a level to survive environmental stochasticity). USFWS has identified that the most significant direct effect to individuals from this proposed action will be injury and death that result from stream channel dewatering, fish salvage, and fish passage testing. The culvert replacement, in-water portion of the projects, would occur between July 15 and September 30 when juvenile Atlantic salmon could be present. Juveniles are likely to be killed as a result of stream dewatering and harmed from fish handling during the salvage operation. Because of the small project area, project timing, reduced stream flows associated with time of year, and the short time work would occur below ordinary high water; only a very small portion of the affected populations would be exposed to the project's adverse effects.

While some limited, short-term adverse effects and limited project-related injury and mortality of juvenile salmon will occur from implementation of these projects, the overall effects will not jeopardize the long-term survival and recovery of the species and or the function of designated critical habitat as needed for the conservation of Atlantic salmon. Degrading effects are expected to be short-term, and should be effectively minimized by the proposed work window, the small footprint of each project, project design criteria, and completing the bulk of the work in the dry. The overall impact of the proposed action on ESA-listed fish and designated critical habitats is expected to be outweighed by the long-term benefit of improving upstream fish passage. By replacing several of the stream crossings with larger structures, there should be an improvement in access to available habitat that is currently under-utilized.

As described in section 4.2.2 we have reservations about culverts designed with the hydraulic design method. Monitoring is needed to determine how well these culverts will function in regards to fish passage effectiveness, habitat connectivity, and the maintenance of ecological processes. However, the long-term effects of the proposed batch of projects on listed fish species and the conservation value of designated critical habitat may be beneficial if it increases the connectivity of watersheds, permitting greater access to areas critical for fulfilling life history requirements. the essential features of water quality, substrate, forage, upstream access (barriers), and floodplain connectivity should all experience some beneficial effects due to implementation. Replacement of the culverts should remove the risk of sediment inputs associated with road crossing failures.

Our conclusions regarding the GOM DPS of Atlantic salmon and its critical habitat are based on the following considerations.

- Impacts to Atlantic salmon habitat are largely temporary during various instream construction activities. Most habitat will be returned to its previous condition after

construction is completed and will continue to function to support Atlantic salmon, either as spawning and rearing habitat or migration habitat.

- Sediment and erosion control practices are enhanced for each project (in addition to standard MEDOT requirements) due to the presence of an endangered species and should result in very minor amounts of sediment being released into rivers and streams. Sedimentation is not expected to affect the long-term function of any spawning and rearing or migration habitat for salmon.
- Take of Atlantic salmon juveniles is expected to be largely non-lethal and is associated either with capture and removal from cofferdams or with fish passage monitoring. Capturing and relocating salmon during instream construction activities will avoid the more serious effects to salmon from temporarily dewatering habitat inside a cofferdam or not using a cofferdam at all during construction. Take of adult Atlantic salmon is not authorized and any effects to adults are expected to be relatively minor and short-term. Therefore, the current reproductive potential of the GOM DPS will not be affected.
- Overall, these projects will not adversely affect the ability of Atlantic salmon to access spawning and rearing compared to the existing projects, except on a short-term basis during certain in-water construction activities. MEDOT will monitor fish passage at culverts to verify that new structures are not fragmenting habitat by blocking fish movements.
- Most instream work is scheduled during the standard summer work window when stream flows and precipitation are typically low, minimizing the likelihood of erosion and sedimentation to effect salmon and their habitat. Furthermore, the summer work window avoids particularly sensitive times of the salmon's life cycle, such as spawning, egg incubation, and downstream smolt migration.
- Permanent losses to salmon habitat from piers, abutments, and rip-rap are relatively minor compared to the total amount of habitat available in each of the three SHRUs. The individual and cumulative losses of habitat will not affect the function of critical habitat as needed to support recovery of the species.

VII. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species without special exemption. The term "take" is defined to include harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Services to include an act that actually kills or injures wildlife. Such acts may include significant habitat modification or degradation that results in death or injury to a listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. The term "harass" is defined by the USFWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. 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 taking under the ESA, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

A. Amount or Extent of Take

The USFWS anticipates that there will be a lethal and non-lethal take of juvenile Atlantic salmon as a result of the proposed actions addressed in this Opinion. Incidental take, including injury and death, caused by the adverse effects of the proposed action will include the following: (1) capture and stranding of juvenile fish during work area isolation and dewatering; (2) post-construction capture of fish for fish passage testing of certain road crossing structures; and (3) an increase in turbidity and sediment due to construction that will harass juvenile fish.

The five-year GOM DPS average for juvenile Atlantic salmon density is 8.42 salmon/100 m^2. These data are from electrofishing efforts in many streams located in watersheds throughout the new GOM DPS (as defined in June 2009) and represent the best available scientific information to assist in determining the number of juvenile Atlantic salmon that are likely to be displaced or collected and relocated when a portion of a stream is dewatered within a cofferdam.

Given the known occurrence of Atlantic salmon somewhere in the affected watersheds, all 10 projects have the potential for salmon to be present in the action area. However, given the current low population size and the lack of hatchery supplementation in the vicinity of most projects, we would expect few project streams in the action area for this BO to contain Atlantic salmon. Therefore, few juvenile Atlantic salmon will be isolated within the cofferdam. Most Atlantic salmon captured during cofferdam installation will be properly handled and moved downstream outside of the work area by qualified MEDOT personnel according to the fish evacuation plan (Appendix B).

As discussed above in more detail in section *4.1.1 Cofferdams, Dewatering and Fish Relocation*, it is reasonable that as many as 46 juvenile Atlantic salmon could be captured within areas segregated from streams by cofferdams and subsequently relocated by MEDOT staff downstream of the action area. USFWS expects that no more than one (1) juvenile Atlantic salmon will be killed as a result of electrofishing activities to relocate fish outside of cofferdam work areas (46 salmon captured x 1.43% mortality rate = 0.66 salmon mortalities; round up to 1 salmon mortalities).

Discounted by 50%, electrofishing activities associated with fish passage testing, as many as 36 juvenile Atlantic salmon could be captured by electrofishing based on MEDMR density estimates during each pass through the site. Any Atlantic salmon that are captured will be documented and released immediately. Test fish would be marked with a fin clip, released back into the stream and recaptured to determine passage capability for a total of 36 potential fish captures (8.4 habitat units x 8.42 parr/unit x 0.50 = 35.36; rounded to 36 fish). With an estimated 1.43% mortality, capture of Atlantic salmon incidental to the capture of test fish may kill approximately one (1) salmon per year. Fish passage testing is proposed to occur over three separate years, so as many as 106.09 (3 x 35.36) salmon could be captured during electrofishing over the course of the monitoring program. Total electrofishing mortality is expected to be about two (2) salmon (106.09 x 1.43% = 1.52; rounded up to 2 fish). These totals represent all projects that require fish passage testing in accordance with the monitoring plan in Appendix C.

In total, incidental take is expected to be no more than 152 (45 + 107) juvenile Atlantic salmon. Furthermore, of these 152 salmon, lethal take of no more than three fish is expected due to capture, handling, relocation and fish passage testing. The loss of this small number of fish is too

small to influence the productivity, spatial structure, or genetic diversity of the affected ESA-listed Atlantic salmon population.

This ITS specifically does **not** authorize the take (lethal or non-lethal) of any adult Atlantic salmon associated with any of the 10 projects covered by this Opinion. If take of an adult salmon becomes a concern at any particular project, all activities that might be contributing to this concern should immediately cease and USFWS be contacted to discuss next steps. Reinitiation of section 7 consultation may be necessary depending on the particular circumstances at hand.

B. Reasonable and Prudent Measures

Conservation measures designed to avoid and minimize effects on listed species and critical habitat are integral components of the proposed action and it is expected that all proposed project activities will be completed consistent with those measures. We have completed our effects analysis accordingly. The measures described below are nondiscretionary and must be implemented by the ACOE (or the MEDOT and their contractors) in order for the exemption in section 7(o)(2) to apply. The ACOE has a continuing duty to regulate the activities covered by this incidental take statement. The protective coverage of section 7(o)(2) will lapse if the ACOE fails to require adherence (or the applicant fails to act in accordance with its permit) to terms and conditions of the incidental take statement, or to exercise that discretion as necessary to retain the oversight to ensure compliance with these terms and conditions. Further consultation may be required to determine what effect any modified action may have on listed species or designated critical habitats.

The USFWS considers full application of conservation measures included as part of the proposed action and the following reasonable and prudent measures to be necessary and appropriate to minimize the likelihood of incidental take of the Atlantic salmon associated with the 10 culvert and bridge projects. Any deviation from the following conservation measures will be beyond the scope of this consultation and will not be exempted from the prohibition against take as described in the attached incidental take statement:

- Minimize the adverse effects to and incidental take of Atlantic salmon in the rivers and streams where bridge or culvert projects will occur by employing construction techniques that avoid or minimize adverse effects to water quality, aquatic and riparian habitats, and other aquatic organisms.
- Minimize adverse effects to and incidental take of Atlantic salmon by ensuring that fish passage and habitat connectivity at culverts and bridges is either maintained in its current condition or is improved by the replacement or rehabilitated structure.
- Ensure completion of a monitoring, evaluation, and reporting program to confirm that the projects are effective in avoiding and minimizing incidental take from permitted activities.

C. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the ACOE, MEDOT, and their contractors, must comply with the following terms and conditions, which implement the reasonable and prudent measure described above, and outline the required reporting/monitoring requirements. These terms and conditions are nondiscretionary.

1. MEDOT shall hold a pre-construction meeting for each project with appropriate MEDOT Environmental Office staff, other MEDOT staff, and the MEDOT construction crew (as practicable) or 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 and their habitat. ACOE staff will attend these meetings as practicable.
2. MEDOT and their contractors will minimize the potential for impacts to Atlantic salmon and their habitat by conducting all instream work (which includes the installation and removal of cofferdams, as well as other activities) according to the work windows specified in Table 1 (page 4) of this Opinion.
3. MEDOT and their contractors will minimize the potential for impacts to Atlantic salmon and their habitat by conducting all construction activities for each project in accordance with the MEDOT-approved Soil Erosion and Water Pollution Control Plan. Instream turbidity will be visually monitored. All erosion controls will be inspected daily to ensure that the measures taken are adequate. If monitoring or inspection shows that the erosion controls are ineffective, immediately repair, replace, or reinforce controls as necessary.
4. To the extent practicable, untreated runoff from the proposed new Village Bridge across Kenduskeag Stream and roadway approaches shall be directed to upland and stream banks before entering the river in order to allow for soil infiltration and treatment of stormwater.
5. A fish evacuation plan must be implemented by appropriate MEDOT staff during construction and dewatering of all cofferdams to carefully remove juvenile Atlantic salmon from the work area (see Appendix B).
6. All Atlantic salmon mortalities from electrofishing or other related activities will be reported to the USFWS (Clayton Hawkes at 866-3344, Ext.152; FAX 866-3351; or clayton_hawkes@fws.gov) within 48 hours of occurrence. Salmon mortalities shall be immediately preserved (refrigerate or freeze) for delivery to: the USFWS office in Orono, Maine. If USFWS is not available contact NMFS in Orono (Jeff Murphy; 866-7379) to arrange for delivery.
7. To prevent entrainment of Atlantic salmon juveniles, MEDOT shall use a screen on each pump intake sufficiently large enough that the approach velocity does not exceed 6.10 m sec^{-1} (0.20 ft sec^{-1}).[19] Square or round screen face openings are not to exceed 2.38 mm (3/32 inch) on a diagonal. Criteria for slotted face openings must not exceed 1.75 mm (approximately 1/16 inch) in the narrow direction. Intake hoses shall be regularly monitored while pumping to minimize adverse effects to Atlantic salmon.
8. The MEDOT or their contractor will follow a Spill Prevention Control and Countermeasure Plan designed to avoid effects to rivers and streams from hazardous materials associated with construction activities. This plan will be approved by appropriate MEDOT Environmental Office staff prior to the start of construction and then carefully enforced throughout the duration of each construction project. It shall include:

[19] For screen design, the effective screen area is calculated by dividing the maximum screened flow by the allowable approach velocity.

- Vehicle refueling shall occur more than 30.48 m (100 feet) from any water course.
- All vehicles carrying fuel shall have specific equipment and materials needed to contain or clean up any incidental spills at the project site. Equipment and materials would include spill kits appropriately sized for specific quantities of fuel, shovels, absorbent pads, straw bales, containment structures and liners, and/or booms.
- During use, all pumps and generators shall have appropriate spill containment structures and/or absorbent pads in place.
- All equipment used for instream work shall be cleaned of external oil, grease, dirt, and mud. Any leaks or accumulations of grease would be corrected before entering streams or areas that drain directly to streams or wetlands.

9. To minimize adverse effects to Atlantic salmon and ensure that salmon and other fish species are able to pass through replacement culverts and that stream habitat is not fragmented, MEDOT will monitor and evaluate the replacement culverts as described in Appendix C of the BO. Two forms of monitoring will be conducted: Fish passage Testing and Design Validation. MEDOT will test fish passage through the following culvert replacement projects: Enfield (PIN: 15644.00), Brownville-1 (no-PIN), Charleston (no-PIN), Columbia Falls (no-PIN), and Meddybemps (no-PIN). Design validation will occur at each of the culvert replacement projects.

   During the first, third, and fifth years after construction, monitoring will follow the procedures outlined in Appendix C. Monitoring reports will be submitted in a timely fashion that will allow for the planning and implementation of any necessary instream construction work to correct identified fish passage problems during the following July 15 to September 30 work window (unless another work window is approved by USFWS). After the fifth year monitoring report is evaluated, the USFWS will determine the need for any further monitoring or corrective measures. Such monitoring will be used to test MEDOT's design assumptions and learn from feedback to guide the design of subsequent stream crossings.

   Annual monitoring reports that describe the procedures and results at each project, as well as numbers of fish captured and accidental fish mortalities, shall be submitted by March 31st each year to USFWS (Attn: Clayton Hawkes, 17 Godfrey Drive, Orono, ME 04473) with a copy to ACOE (Attn: Jay Clement, Maine Project Office, 675 Western Avenue #3, Manchester, ME 04351) and NMFS (Attn: Jeff Murphy, 17 Godfrey Drive, Orono, ME 04473).

10. All cofferdams shall be removed from the stream immediately following completion of construction, allowing for minor delays due to high stream flows following heavy precipitation, so that fish and other aquatic life passage is not unnecessarily restricted. If a project is not completed but there will be substantial delays in construction, cofferdams will need to be at least partially removed to allow unobstructed passage of Atlantic salmon until construction resumes.

11. ACOE staff shall carefully monitor the actions described in this Opinion and document the level of incidental take to ensure that these projects are minimizing the take of Atlantic salmon. ACOE will provide the USFWS Maine Field Office with an annual report summarizing the work done under this Opinion, accounting for all cumulative take of Atlantic salmon, until such time as all projects are completed. When all construction

projects are completed, the ACOE shall submit a final report to the USFWS summarizing the total amount of incidental take from all projects within four (4) weeks of completion.

VIII. 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.

- ACOE should fund or otherwise support research on the effects of culvert rehabilitation projects, including invert liners and slip liners, on fish passage, stream geomorphology, habitat connectivity, and other aspects of stream ecology.
- ACOE and MEDOT should collaborate to conduct monitoring of stream turbidity levels associated with various construction activities at several different project locations, preferably representing as much variation in site conditions as possible. Collecting this data will be useful for future section 7 consultations regarding MEDOT projects, when assessing the effects of construction projects on Atlantic salmon habitat and their habitat.
- MEDOT, FHWA, COE, NMFS, and USFWS should explore development of standard local operating procedures for ESA-listed fish species in Maine to administer road, culvert, and bridge actions that are authorized by the ACOE in Maine.
- Develop a strategy for conducting fish passage assessments of existing stream crossings across MEDOT administered roads within watersheds occupied by ESA-listed fish species. Work with USFWS and NMFS to establish a prioritization list and schedule for addressing problem stream crossings.

IX. REINITIATION NOTICE

This concludes formal consultation for the ACOE's proposed permitting of ten bridge rehabilitation and culvert replacement projects to be carried out by the MEDOT on rivers and streams throughout Maine. As provided in 50 CFR 402.16, reinitiation of formal consultation is required when 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 incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; or (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease, pending reinitiation.

Literature Cited

Adamu, K.M. and I.K. Iloba. 2008. Effects of sublethal concentrations of Portland cement powder in solution on the aminotransferases of African Catfish (*Clarias gariepinus* (Burchell, 1822). Acta Zoologica Lituanica. 18(1):50-54.

Albers, P.H. 2003. Petroleum and individual polycyclic aromatic hydrocarbons. Pages 341-371 in Hoffman, D.J., B.A. Rattner, G.A. Burton, Jr., and J. Cairns, Jr. (eds.). 2003. Handbook of Ecotoxicology. CRC Press. Boca Raton, FL.

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

Barnard, R. 2003. Evaluation of the stream simulation culvert design method in Western Washington, a preliminary study. Washington Dept. of Fish and Wildlife.

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

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

Beland, K.F., J.S. Fletcher, and A.L. Meister. 1982. The Dennys River: an Atlantic salmon river management report. Atlantic Sea Run Salmon Commission, Bangor, ME.

Belford, D.A. and W.R. Gould. 1989. An evaluation of trout passage through six highway culverts in Montana. N. Am. J. Fish. Mgmt. 9:437-445.

Benton, P.D., W.E. Ensign, and B.J. Freeman. 2008. The effect of road crossings on fish movements in small Etowah basin streams. Southeast. Nat. 7:301-310.

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

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

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

California Stormwater Quality Association (CASQA). 1993. California Stormwater Municipal Best Management Practice Handbook. Stormwater Quality Task Force, Sacramento, CA. http://www.cabmphandbooks.com/Documents/Municipal/SC-70.pdf

California Department of Transportation (CADOT). 2007. Compendium of pile driving sound data. Prepared by Illinworth and Rodkin, Inc. for CADOT. 129 pp.

Castro-Santos, T. 2006. Modeling the Effect of Varying Swim Speeds on Fish Passage through Velocity Barriers. Transactions of the American Fisheries Society 135:1230–1237.

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

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

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

Department of Fisheries and Oceans Canada. 2004. Concrete Wash Water: Characteristics. http://www-heb.pac.dfo-mpo.gc.ca/water_quality/fish_and_pollution/conc_char_e.htm.

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

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

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

Erkinaro, J., M. Julkunen, and E. Niemelä. 1998. Migration of juvenile Atlantic salmon *Salmo salar* in small tributaries of the subarctic River Teno, northern Finland. Aquaculture 168:105–119.

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

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

Federal Highway Administration. 2007. Design for fish passage at roadway-stream crossings: Synthesis report. Report Number: FHWA-HIF-07-033. 280 pages.

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

Fitch, G. 2003. Minimizing the impact on water quality of placing grout underwater to repair bridge scour damage. Virginia Transportation Research Council. VTRC 03-R16. 31 p.

Forest Service Stream-Simulation Working Group. 2008. Stream simulation: An ecological approach to providing passage for aquatic organisms at road crossings. National Technology and Development Program in partnership with U.S. Department of Transportation, Federal Highway Administration Coordinated Federal Lands Highway Technology Implementation Program.

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

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

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

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

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

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

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

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

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

Hastings, M.C. and A.N. Popper. 2005. Effects of sound on fish. Subconsultants for the California Department of Transportation.

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

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

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

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

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

Inter-Fluve Inc. 2009. Culvert Scour Assessment. 0877-1812-SDTDC. US Forest Service, San Dimas Technology and Development Center, San Dimas, CA, 54 p.

ICES (International Council for the Exploration of the Sea). 2005. Ecosystems effects of fishing: impacts, metrics, and management strategies. ICES Cooperative Research Report, No. 272, 177 pp.

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

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

Klemetson, A., P.A. Amundsen, J.B. Dempson, B. Jonsson, N. Jonsson, M.F. O'Connell, and E. Mortensen. 2003. Atlantic salmon *Salmo salar* (L.), brown trout *Salmo trutta* (L.) and Arctic char *Salvelinus alpinus* (L.): a review of aspects of their life histories. Ecology of Freshwater Fish 12(1):1-59.

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

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

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

Loughlin, M.; 2008. Upstream migration by *Salmo salar* hatchery fry in four Downeast streams. Annual report of the U.S. Atlantic salmon assessment committee. Report No. 20 - 2007 Activities. Portland, Maine. http://www.nefsc.noaa.gov/USASAC/2008%20USASAC%20Report/USASAC-Report2008-%2320.pdf

Louhi, P., A. Mäki-Petäys, J. Erkinaro. 2003. Spawning habitat of Atlantic salmon and brown trout: general criteria and intragravel factors. River Research and Applications 24:330–339.

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

Maine Atlantic Salmon Commission. 2005. Standard Operating procedure for Juvenile Atlantic Salmon Sampling by Electrofishing in Wadeable Streams.

Maine Department of Transportation (MEDOT). 2008a. Best management practices for erosion and sediment control. Maine Department of Transportation, Augusta, ME. http://www.maine.gov/mdot/environmental-office-homepage/pdf/bmpmanual2008/BMP2008-full.pdf

Maine Department of Transportation (MEDOT). 2008b. Waterway and wildlife crossing policy and design guide for aquatic organism, wildlife habitat, and hydrologic connectivity. 3rd edition. Maine Department of Transportation, Augusta, ME.

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

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

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

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

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

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

National Marine Fisheries Service (NMFS). 2000. Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act. http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/upload/electro2000.pdf

National Marine Fisheries Service (NMFS). 2003. Final biological opinion to the Federal Highway Administration for the Benicia-Martinez New Bridge Project. Southwest Region. Long Beach, CA.

National Marine Fisheries Service (NMFS). 2008. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon. http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish_Passage_Design.pdf.

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

National Marine Fisheries Service (NMFS). 2009. Endangered and threatened species; designation of critical habitat for Atlantic salmon (Salmo salar) Gulf of Maine distinct population segment; Final Rule. Federal Register 74 (117):39903- 39907.

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

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

Newcombe, C.P. 1994. Suspended sediment in aquatic ecosystems: ill effects as a function of concentration and duration of exposure. British Columbia Ministry of Environment, Lands and Parks, Habitat Protection Branch, Victoria, BC.

Newcombe, C.P. and J.O.T. Jensen.1996. Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact. N. Am. J. Fish. Mgmt. 16(4):693–727.

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

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

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

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

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

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

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

Reddin, D.G. and W.M. Shearer. 1987. Sea-surface temperature and distribution of Atlantic salmon in the Northwest Atlantic Ocean. American Fisheries Society Symposium.

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

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

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

Robertson, M.J., D.A. Scruton, R.S. Gregory, and K.D. Clark. 2006 Effects of suspended sediment on freshwater fish and fish habitat. Canadian Technical Report of Fisheries and Aquatic Sciences 2644. 37 pp.

Robertson, M.J., D.A. Scruton, and K.D. Clarke. 2007. Seasonal effects of suspended sediment on the behavior of juvenile Atlantic salmon. Transactions American Fisheries Society 136:822-828.

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

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

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

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

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

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

Stanley, J.G. and J. Trial. 1995. Habitat Suitability Index Models: Nonmigratory freshwater life stages of Atlantic salmon. U.S. Dept of Interior National Biological Service, Biological Science Report 3.

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

Sweka, J. M., L. Bartron, J. Trial, and P. Christman. 2007. Assessment of watershed scale habitat features on the survival of juvenile Atlantic salmon. Final Report NFWF Project Number 2003-0118-028.

Trial, J.G. 2010. January 22 letter to Lori Nordstrom (USFWS) documenting Maine Department of Marine Resources (MEDMR) activities authorized under Regional Endangered Species blanket permit #697823 for the take of Atlantic salmon under the Endangered Species Act during 2009.

U.S. Atlantic Salmon Assessment Committee (USASAC). 2004. Annual report of the U.S. Atlantic salmon Assessment committee: Report No. 16- 2003 Activities. 2003/16. Woods Hole, MA.

U.S. Atlantic Salmon Assessment Committee (USASAC). 2005. Annual report of the U.S. Atlantic salmon Assessment committee: Report No. 17- 2004 Activities. 2004/17. Woods Hole, MA.

U.S. Atlantic Salmon Assessment Committee (USASAC). 2008. Annual report of the U.S. Atlantic salmon assessment committee: Report No. 20 – 2007 Activities. 2007/20. Gloucester, MA.

U.S. Atlantic Salmon Assessment Committee (USASAC). 2010. Annual report of the U.S. Atlantic salmon assessment committee: Report No. 22 - 2009 Activities. 2009/22. Portland, ME.

U.S. Census Bureau (USCB). 2004. State interim population projections by age and sex: 2004-2030. www.census.gov/population/www/projections/projectionsagesex.html.

U.S. Environmental Protection Agency. 1988. Maine State Water Quality Standards Summary.

U.S. Fish and Wildlife Service (USFWS). 2005. Final biological opinion to the Federal Highway Administration on the proposed replacement of a bridge over Cathance Stream on Route 86 in Marion Township, Washington County, Maine. Old Town, ME.

U.S. Fish and Wildlife Service (USFWS). 2006. Endangered and threatened wildlife and plants; review of native species that are candidates or proposed for listing as endangered or threatened; annual notice of findings on resubmitted petitions; annual description of progress on listing actions. Federal Register 71 (176):53755-53835.

U.S. Fish and Wildlife Service (USFWS). 2008. Final biological opinion to the U.S. Army Corps of Engineers on the proposed replacement of an existing deteriorated culvert on an unnamed tributary of the Dennys River on Route 191 in Meddybemps, Washington County, Maine. Old Town, ME.

U.S. Fish and Wildlife Service (USFWS). 2009. Final biological opinion to the U.S. Army Corps of Engineers on the proposed maintenance, rehabilitation, removal, or replacement of multiple bridges and culverts on many streams throughout the State of Maine. Old Town, ME.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 1996. Policy regarding the recognition of distinct vertebrate population. Federal Register 61 (26):4722-4725.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2000. Endangered and threatened species; final endangered status for a distinct population segment of anadromous Atlantic salmon (*Salmo salar*) in the Gulf of Maine. Federal Register 65 (223):69459-69483.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2009. Endangered and threatened species; designation of critical habitat for Atlantic salmon (*Salmo salar*) Gulf of Maine Distinct Population Segment; Final Rule. Federal Register 74 (117):29300-29341.

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

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2009. Endangered and threatened species; designation of critical habitat for Atlantic salmon (*Salmo salar*) Gulf of Maine Distinct Population Segment; Final Rule. Federal Register 74 (152):39903-39907.

University of Maine. 2004. Safe Drinking Water Digest, Senator George J. Mitchell Center for Environmental and Watershed Research. 5710 Norman Smith Hall, Orono, ME 04469-5710. http://www.umaine.edu/waterresearch/outreach/safe_drinking_water_digest.htm

Washington State Department of Transportation (WSDOT). 2010. Biological Assessment Preparation for Transportation Projects - Advanced Training Manual - Version 02-2010, Part 2 - Guidance on Specific BA Topics.

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

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

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

Segment. NOAA National Marine Fisheries Service, Northeast Regional Office, Gloucester, MA.