NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: **U.S. Army Corps of Engineers, New England District**

Activity Considered: Proposed Permit for Installation of Net Pens at Black Island South, Frenchboro, Maine. Corps File No. NAE-2009-01698
F/NER/2011/01597
GARFO-2011-00009

Conducted by: National Marine Fisheries Service
Northeast Region

Date Issued: June 10, 2011

Approved by:

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1. INTRODUCTION AND BACKGROUND

This constitutes the National Marine Fisheries Service's (NMFS) biological opinion (Opinion), issued in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), on the impacts to threatened and endangered species concerning the proposed U.S. Army Corps of Engineers (ACOE) permit to Phoenix Salmon authorizing the installation and maintenance of aquaculture fish pens off Black Island South in Blue Hill Bay, Hancock County, Frenchboro, Maine. Phoenix Salmon is a subsidiary company of the parent company Cooke Aquaculture USA and herein after is referred to as Cooke Aquaculture in this Opinion.

This activity will be authorized by the ACOE permit to be issued under Section 10 of the Rivers and Harbors Act (RHA) of 1899 (33 U.S.C. '403). ACOE permits have previously authorized the installation and maintenance of fish pens to rear Atlantic salmon within the State of Maine; however, the proposed action represents a new Federal action and is outside the scope of any consultations previously completed between NMFS and the USACOE.

1.1. Consultation History

October 5, 2010 – ACOE publishes a Public Notice describing the proposed activity and requesting public comments.

January 18, 2011 – ACOE held a meeting to identify the information necessary to initiate a formal Section 7 consultation under the ESA regarding the proposed permit to authorize the installation of floating fish pens off Black Island South. The ACOE, Cooke Aquaculture, Maine Aquaculture Association, Maine Department of Environmental Protection (MDEP), United States Fish and Wildlife Service (USFWS) and NMFS were in attendance at this meeting. Additional correspondence from the ACOE and applicant is summarized below.

February 16, 2011 – NMFS received request for formal consultation from the ACOE

February 25, 2011 – Electronic correspondence received by NMFS from Cooke Aquaculture in regards to annual information provided for compliance with ACOE special conditions currently required for existing sites.

March 3, 2011 – Electronic correspondence received by NMFS from ACOE in regards to a summary of compliance with ACOE special conditions provided by Cooke Aquaculture.

March 16, 2011 – Additional information provided by Cooke Aquaculture completed the information request by NMFS and this serves as the initiation date for this consultation.

1.2 Relevant Documents

This Opinion is based on the following: (1) information provided in the ACOE February 16, 2011 initiation letter and attachments in support of formal consultation under the ESA; (2) additional correspondence on February 25, 2011, March 3, 2011 and March 16, 2011; (3) spring stocking plans for permitted sites in 2011, received from Cooke Aquaculture on January 28, 2011; (4) previous consultation conducted between NMFS, the USFWS (collectively, the Services) and the U.S. Environmental Protection Agency (EPA) on the National Pollution Discharge Elimination System (NPDES) program , including all documents and discussions that served as the basis of those consultations; (5) A final endangered status for a Distinct Population Segment (DPS) of anadromous Atlantic salmon (Salmo salar) in the Gulf of Maine (Federal Register Vol. 74, (117): June 19, 2009); (6) Endangered and Threatened Species; Designation of Critical Habitat for Atlantic salmon (Salmo salar) Gulf of Maine Distinct Population Segment (Federal Register Vol. 74, (117): June 19, 2009); (7) A Review of the Status of anadromous Atlantic Salmon under the U.S. Endangered Species Act [Report to the National Marine Fisheries Service and U.S. Fish and Wildlife Service 2006]; (8) 2003 Biological Opinion on the ACOE proposed modification of permits authorizing the installation and maintenance of net pens to raise finfish off the coast of Maine; (9) U.S. Focus Area Report on Aquaculture, Introductions and Transfers to North Atlantic Salmon Conservation Organization (NASCO) 2009; (8) comments received on the May 5, 2011 draft of this Opinion; and (10) other sources of information. A complete administrative record of this consultation will be kept on file at the NMFS Maine Field Office in Orono, Maine.

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

This section reviews the approach used in this Opinion in order to apply the standards for determining jeopardy and destruction or adverse modification of critical habitat as set forth in Section 7(a)(2) of the ESA and as defined by 50 CFR §402.02 (the consultation regulations). Additional guidance for this analysis is provided by the Endangered Species Consultation Handbook, March 1998, issued jointly by NMFS and the USFWS (collectively referred to as the Services in this Opinion). In conducting analyses of actions under Section 7 of the ESA, NMFS takes the following steps, as directed by the consultation regulations:

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

In completing the last step, NMFS determines whether the action under consultation is likely to jeopardize the ESA-listed species or result in the destruction or adverse modification of designated critical habitat. If so, NMFS must identify a reasonable and prudent alternative(s)

(RPA) to the action as proposed that avoids jeopardy or adverse modification of critical habitat and meets the other regulatory requirements for an RPA (see 50 CFR §402.02). In making these determinations, NMFS must rely on the best available scientific and commercial data.

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

2. PROJECT DESCRIPTION AND PROPOSED ACTION

2.1 Project Overview

The ACOE proposes to issue a 10 year permit under the Section 10 of the RHA to Phoenix Salmon US Inc. (Cooke Aquaculture or applicant) authorizing the installation and maintenance of up to 20, 100 meter floating net pens (cages) within a 38.5 acre area off the western shore of Black Island (Black Island South) in Blue Hill Bay at Frenchboro, Maine (Figure 1). In addition, the applicant must possess a valid Section 10 Clean Water Act 404 permit from the State of Maine Pollution Discharge Elimination System (MEPDES) program which has delegated authority through the Environmental Protection Agency (EPA). The applicant proposes to rear Atlantic salmon (*Salmo salar*), halibut (*Hippoglossus hippoglossus*), Artic char (*Salvelinus alpines*), cod (*Gaddus morhua*) and blue mussels (*Mytillus edulis*) at the site. However, the ACOE permit conditions prohibit the placement of any fish other than Atlantic salmon on this site without prior written approval and permit amendment from the ACOE in consultation with the Services.

According to the applicant, the existing uses in the area are mainly commercial fishing activities including lobster and crab. There is no known shellfish or eel grass beds in the area. The applicant has also requested authorization to place a feed barge (10m x 7m) at the site to support the Atlantic salmon feeding operations. The sea floor under the proposed site is uniformly flat with sediments composed of predominantly fine sand and cobble. The site will be stocked with approximately 40,000 fish per cage for a total of 800,000 fish at thethe site. The fish will be stocked at a target density of 18 kg/m^3, with a maximum of 30 kg/m^3.

The installation of marine net pens for rearing Atlantic salmon for commercial aquaculture purposes involves placing a mooring system directly on the sea floor to securely anchor the floating net pens. The net pens to be used are 100 meters in size and are configured within a grid system, anchored to the substrate by manufactured Danforth style anchors and/or large concrete or granite blocks. The cages are secured to the moorings by 1 5/8" line that is fastened to a large compensator buoy to maintain tension in the line and terminates with a 1" diameter chain, shackle and connector plate. The floating structure for net pens are typically High Density Poly Ethylene (HDPE) circular tubes (rings) filled with foam for added buoyancy which support a primary containment net and predator nets. The primary containment net is secured to the inside floating ring which bears the weight of the net, a jump net or skirt is sewn into the net above the water line and is attached to a support structure and hand rail. An avian predator net is attached to the hand rail and is placed above the entire net pen and is supported in the middle by a floating structure to keep it above the water line. Another predator net is attached to the outer ring of the net pen and is deployed below the water line to deter seals from tearing the primary containment net. This net is usually spaced several feet from the primary containment net and is held in place with a HDPE ring or weighted collar filled with cement to keep it taught and to help maintain its shape when exposed to tidal current.

The net pens are stocked with juvenile Atlantic salmon for grow out to harvest; the fish are transported to the site with specially designed well boats or barges containing large tanks filled with sea water and salmon smolts. Fish are stocked into each cage through a large diameter hose attached to a fish pump or gravity feed from holding tanks. Feeding the fish is done by hand or automated by using a feed barge to control the amount of feed dispersed to each cage via a pneumatic pump operated by a computer system which records the specific amount fed to each cage on site. Typically, there is an underwater camera and/or radar system set up to monitor the feeding behavior of the fish to limit feed waste and reduce environmental impacts associated with deposition of uneaten food on the ocean floor. Fish are treated at sea for parasites and disease by administering medication through feed or externally through a bath treatment. Harvesting fish is achieved by seine netting the fish in each cage and pumping or brail netting the fish into holding tanks placed on a large barge or work boat. Fish are dispatched at sea and put into containers with super chilled saltwater for further processing on land at a processing facility in Canada. Whole gutted fish are then transported to another facility in Machiasport for additional processing into filets and other value added products.

The applicant proposes to rear other species at this site which includes halibut (*Hippoglossus hippoglossus*), Artic char (*Salvelinus alpines*), cod (*Gaddus morhua*) and blue mussel (*Mytillus edulis*). Most of these species have been reared in Maine on a limited experimental basis, but have been shown to be a commercially viable species in other countries. With the exception of blue mussels, these species would be reared in a similar fashion as described above. As such, juvenile fish would be stocked into circular net pens and reared to a harvestable size, after this period, the fish would be removed from the net pens by Braille nets and further processed on shore at their facilities in Canada or Maine. As a requirement of the MDMR lease permit, similar disease testing is conducted to certify the stocks as disease free prior to fish being stocked. Blue mussels are grown differently from most finfish and do not require a large net pen for containing the species. Blue mussels are grown on submerged lines which have seed stock attached. This is often referred to as suspended culture and keeps the mussels off the bottom and in the top 20 feet of the water column where they can obtain more natural prey items and grow faster. Typically the suspended lines contain flow through mesh bags with seed stock inside which are attached directly to the lines. After a period of time, the seed stock will attach itself to the line and the mesh bag eventually degrades. The mature mussels are harvested by removing the lines from the floats and removing all the mussels attached either by hand or machine. The lines are then reseeded and placed back in the water.

ACOE Special Conditions to be Included in the RHA Section 10 Permit.

The following section describes the ACOE special conditions that will be required and incorporated into the operating plans for this facility. These conditions are consistent with conditions resulting from a Biological Opinion conducted between the ACOE and NMFS in 2003 regarding other Atlantic salmon aquaculture operations in Maine.

1. Genetic Restrictions. All reproductively viable Atlantic salmon placed in net pens at this facility must be of North American origin. Non-North American stock is defined as any Atlantic salmon (*Salmo salar*) that possess genetic material derived partially (hybrids) or entirely (purebreds) from any Atlantic salmon stocks of non-North American heritage, regardless of the number of generations that have passed since the initial introduction of the non-North American genetic material.

   a. For the purposes of this permit, classification of brood fish as either North American or non-North American stock will be based on genetic evaluation of each fish's DNA in accordance with Appendix 1, *Atlantic Salmon Microsatellite Analysis Protocol*, of this permit. The Microsatellite Protocol shall be used to classify each brood fish.
   b. Only individual fish determined to be North American, according to Appendix 1, can be used to produce offspring to be placed in net pens. No fish classified as non-North American according to Appendix 1 can be utilized to create progeny for stocking in net pens.
   c. Prior to January 1 of each year, genetic evaluation information developed pursuant to Appendix 1 shall be submitted to the Services, with confirmation sent to the ACOE and MDEP.
   d. Prior to the transfer of any eggs from individual family lots, the permittee shall submit to the ACOE and MDEP confirmation from the Services demonstrating compliance with Special Condition I.1.a above. The permittee will include in this letter information demonstrating that the origin of the fish is North American, including identification of the hatchery, testing results, and a description of the chain of custody of the fish. In the event any fish or gametes are classified as non-North American pursuant to Appendix 1, the permittee shall also report to the Department and the Services the disposition of those fish or gametes. No eggs shall be transferred without prior written approval from the ACOE and MDEP.

2. Transgenic salmonids. Transgenic salmonids are prohibited at this facility. Transgenic salmonids are defined as species of the genera *Salmo*, *Oncorhynchus* and *Salvelinus* of the family Salmonidae and bearing, within their DNA, copies of novel genetic constructs introduced through recombinant DNA technology using genetic material derived from a species different from the recipient, and including descendants of individuals so transfected. This prohibition does not apply to vaccines.

3. Alternative salmonid species. Prior to stocking salmonid species other than Atlantic salmon at this facility, certification from the Maine Fish Health Technical Committee and MDMR of compliance with disease management standards permitting the culture of alternative salmonid species shall be provided to the ACOE. No alternative salmonid species shall be stocked without prior written approval from the ACOE.

4. Containment. This facility shall employ a fully functional marine containment management system ("CMS") designed, constructed, and operated so as to prevent the accidental or consequential escape of fish to open water. The CMS plan shall include a site plan or schematic with specifications of that particular system. This facility shall develop and utilize a CMS consisting of management and auditing methods to describe or address the following: inventory control procedures, predator control procedures, escape response procedures, unusual event management, severe weather procedures, and training. The CMS shall contain a facility-specific list of critical control points ("CCP") where escapes have been determined to potentially occur. Each CCP must include the following: the specific location, control mechanisms, critical limits, monitoring procedures, appropriate corrective actions, verification procedures that define adequate CCP monitoring, and a defined record keeping system.

a. The CMS will be audited at least once per year and within 30 days of a reportable escape (more than 50 fish two kg or larger and/or 25% reduction in cage biomass) by a party other than the facility operator or owner who is qualified to conduct such audits and is approved by the ACOE and the Services. The first annual audit shall be conducted within 1 year of stocking the facility. The ACOE, with the approval of the Services, may exempt a facility from an escape-triggered audit when circumstances preclude the possibility that it was the source of the escaped fish. A written report of these audits shall be provided to the facility, the ACOE, and the Services within 30 days of the audit being conducted. If deficiencies are identified during the audit, the report shall contain a corrective action plan, including a timetable for implementation and re-auditing to verify that deficiencies are addressed in accordance with the corrective action plan. Additional third party audits to verify correction of deficiencies shall be conducted in accordance with the corrective action plan or upon request of the ACOE. The facility shall notify the ACOE and the Services upon completion of corrective actions.

b. At this facility, personnel responsible for routine operation shall be properly trained and qualified to implement the CMS.

c. This facility shall maintain complete records, logs, reports of internal and third party audits, and documents related to the CMS. The CMS shall require the submission of standing inventory at the facility, including all transfers in and out and all losses associated with disease, predation, or escapes as reported to the Maine DMR at the pen level of detail on a monthly basis according to the requirements of 12 MRSA Section 6077.

d. If corrective actions required by the corrective action plan are not implemented, all pens and fish will be removed from the water within 30 days of notification from the ACOE.

5. Escape Reporting. The permittees shall report any known or suspected escape of more than 50 fish with an average weight of two kg each or more and/or a 25% reduction in biomass within 24 hours to the contacts given below. The caller should indicate they are providing notification of a reportable escape event at a marine cage. They should identify the location, DMR site ID for marine cages, contact person and number, time of event, estimated size of escape, and actions being taken. The escape reporting form must be faxed to the Services (USFWS: 207-827-6099 and NMFS: 207-866-7342) and the ACOE (207-623-8206). Other escape events must be logged according to the CMS and provided to the ACOE and the Services upon request.

6. Marking. Atlantic salmon introduced into net pens at this facility must be marked to designate their commercially-reared origin so that in the event they escape from this facility, these fish can be identified back to this facility. An approved QA/QC program needs to be in place to monitor compliance with aforementioned requirement (See attachment 2).

a. Prior to marking fish to be stocked, the facility shall submit to the ACOE and the Services for review and approval a description of the marking method(s) to be used for this purpose. In the event similar or conflicting marking systems are proposed by different facilities, the ACOE may require a facility to make changes to assure that each facility owner will be uniquely identifiable.

b. In the event that a commercially-reared Atlantic salmon from this facility is found in a river within the range of the GOM DPS, the facility shall conduct a third party audit of containment procedures as described in Special Condition number 4 above.

7. Inspections. Personnel from the ACOE and the Services shall be allowed to inspect the work authorized by these permits during normal operation hours. These personnel will provide credentials attesting to their position and will follow the site's biosecurity procedures. These personnel shall be allowed to take tissue samples from fish or, if necessary, take random samples of fish from these facilities (as well as fish at any life stage from the hatcheries that support these facilities) to monitor compliance with Special Conditions No. 1, 2, and 6. Operational records regarding compliance with this permit shall be made available by the permittee to these personnel for their inspection and reproduction upon request.

8. Boundary markers around the lease area and the structures themselves shall be placed and maintained in accordance with appropriate Coast Guard Regulations. The permittee shall contact the First Coast Guard District, Aids to Navigation Office at 617-223-8337.

9. Except in the surface areas physically occupied by the net pen structures, the permittee shall permit normal fishing and/or recreational and commercial boating activity to occur in the project area.

10. The permittee shall provide any annual environmental monitoring data to the NMFS point of contact Peter Colosi at 978-281-9332 at 55 Great Republic Drive, Gloucester, MA 01930.

11. Only antibiotic chemicals approved by the US Food and Drug Administration ("US FDA") shall be applied. All applications must comply with 21 CFR 529, 556 and 558. Prophylactic use of antibiotics is prohibited.

12. There shall be no discharge of pollutants from the facility other than fish excrement, ammonia excretions, unconsumed fish food and medications approved by the US FDA.

13. All mortalities (dead fish), feed bags, fish food fines and other waste materials excluding fish excrements and secretions and unconsumed food, shall be removed to the mainland shore and disposed of properly. Neither the permittee nor his employees shall land on or use Black Island in any way connected to their aquaculture activities unless it is for the purpose of debris or litter clean up.

14. The permittee must report any incidental take of marine mammals allowed under the 1988 amendment to the Marine Mammal Protection Act of 1972, as amended 16 USC Section 1372. For information, contact: Protected Species Division Marine Mammal Coordinator, NMFS, Northeast Regional Office, 55 Great Republic Drive, Gloucester, MA 01930–2298; telephone 978–281–9280.

15. This authorization only allows the raising of Atlantic salmon in the permitted structures. No other species of fish may be raised at this site without prior written approval from the Corps.

16. If, based on a review of environmental monitoring data, degradation of environmental resources, to include federal and state water quality standards, is indicated, this permit may be modified, suspended or revoked.

17. The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the Opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2.2. Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action". Accordingly, the effects of the action will extend beyond the footprint of the project to waters transited and occupied by any fish that escape from the facility. The proposed permit and effects from the related activity reviewed in this Opinion involves a substantial portion of the federally listed Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon, including the rivers with and without weirs and trapping facilities found within the Penobscot and Downeast Salmon

Habitat Recovery Units (SHRUs) (Figure 1). The best available historic data on aquaculture origin escapees detected in GOM DPS rivers is provided in table 2. However, this data is not complete as some of the GOM DPS rivers do not have an operating weir or trapping facility. Nevertheless, this information was used for identifying the anticipated area and GOM DPS rivers in which aquaculture origin salmon may migrate into because sufficient information is included for the larger rivers in the Penobscot, Downeast and Merrymeeting Bay SHRUs including the Sheepscot, Kennebec, Androscoggin, Penobscot, Union, Narraguagus, Pleasant, and Dennys Rivers (USASAC 2010). Based on this information, there is no evidence of aquaculture origin fish captured at the southern extent of the expanded GOM DPS to include Kennebec, Androscoggin and Sheepscot rivers, therefore the Merrymeeting Bay SHRU is not included within the action area for this proposed activity. Furthermore, as explained further in the "Effects of the Action" section, effects of the action on the GOM DPS of Atlantic salmon are largely due to aquaculture origin escaped Atlantic salmon entering GOM DPS rivers inhabited by wild Atlantic salmon. As such, only accessible freshwater reaches within the Penobscot and Downeast SHRUs and any oceanic migration corridors are being considered in this Opinion (Fig. 1). For example, fish would be captured at the first trapping facility (i.e., currently located at the Veazie dam) on the Penobscot river which is a permanent structure and effectively captures all returning salmon. A fish trapping facility enables biologists an opportunity to handle and screen all returning adult salmon for putative aquaculture origin; any Atlantic salmon captured and determined to be of aquaculture origin would be removed and prevented from migrating any further into the watershed.

Available information on the behavior of escaped farm fish is not site specific because of a lack of individual marks or tags applied for each site (see section below for more details). Generally, when fish escape from a net pen, they enter the marine environment and may head farther out to sea or head into a nearby coastal river. Typically, juvenile Atlantic salmon imprint on the freshwater chemical signatures of their natal rivers prior to entering the marine environment, this enables them to detect their natal rivers upon returning to freshwater to spawn. Since the commercial aquaculture origin fish are transferred directly to saltwater from the hatcheries, these fish have only imprinted to the hatchery water sources which are groundwater or lake water; this most likely will affect their homing ability and may lead to fish dispersing randomly into freshwater inputs from nearby coastal rivers. There are not sufficient data currently available to confidently estimate what distance an escaped fish will travel and what percentage of fish that escape from a cage will survive and enter nearby GOM DPS rivers. The distance and percentage is likely influenced by the season during which the loss occurs, the age of the fish that escape, the proximity of the cage to a river, as well as other factors (Whorisky et al., 2006). Available data on occurrences of putative aquaculture origin fish collected at fishways and weirs currently indicates escaped fish have been documented in GOM DPS rivers (Table 2) which are in close proximity to existing marine net pens. Historically, there have been no aquaculture origin fish detected in rivers outside of the Penobscot or Downeast SHRUs (USASAC 2010).

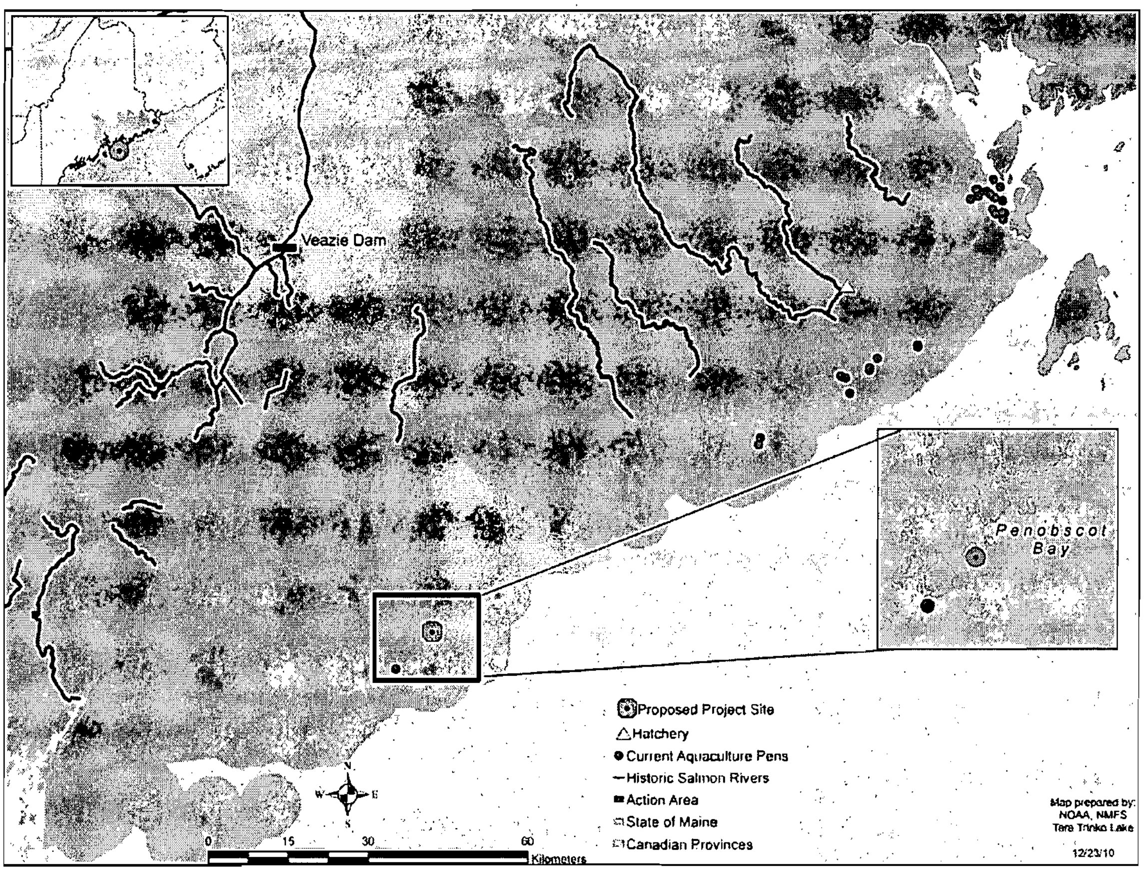

Figure 1. Map showing location of active Atlantic salmon aquaculture lease sites in Maine. Project and action area in shaded green and grey with some GOM DPS Atlantic salmon rivers in blue.

3. Listed Species In Action Area

This section will focus on the status of listed species within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action on listed species. In this Opinion, NMFS considers effects to listed species other than GOM DPS Atlantic salmon in the project area of Blue Hill Bay rather than the entire action area within the Downeast and Penobscot SHRUs because any potential effects from the action (i.e., loss of foraging habitat, decrease in forage items and interactions with gear) on other listed species would be localized to the vicinity of the net pens. As described further in the effects of the action section, any effects outside the project area footprint are specific to GOM DPS Atlantic salmon (i.e., redd superimposition, competition, disease transfer and genetic introgression) and would be limited to the areas where aquaculture escapes may migrate. There is currently no information describing potential disease transfer from Atlantic salmon aquaculture operations or escapes to other listed species under NMFS jurisdiction.

The GOM DPS of Atlantic salmon (*Salmo salar*) is known to occur in the project and action area. Shortnose sturgeon (*Acipenser brevirostrum*) are known to occur in the Gulf of Maine, however, they are not known to occur in the project area. As such, no impacts to shortnose sturgeon are anticipated and this species will not be considered further in this Opinion.

ESA listed marine mammal species under the jurisdiction of NMFS, including the North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), leatherback (*Dermochelys coriacea)* and loggerhead (*Caretta caretta*) sea turtles, are known to transit through the Gulf of Maine in pursuit of food. While Fin (*Balaenoptera physalus*), Sei (*Balaenoptera borealis*) and Sperm (*Physter macrocephalus*) whales are also seasonally present in New England waters, they are typically found in deeper offshore waters and are not likely to occur in the action area. Blue Hill Bay is not known to be frequently visited by any listed whales.

Despite the presence of marine cages off the coast of Maine for the past thirty years, there are no known entanglements of marine mammals or sea turtles in any marine cage. This is likely due to the fact that the gear is very visible to marine mammals and the fact that the mooring lines are very taut, posing a low risk of entanglement to marine mammals and sea turtles. Further, the marine cages are set nearshore or inshore, thereby reducing the potential for interaction with these predominantly pelagic species. Given the known low probability of interaction between marine cages and marine mammals or sea turtles, the proposed action is not likely to adversely affect the Atlantic right whale, humpback whale, fin whale, sei whale, leatherback sea turtle, and loggerhead sea turtle; therefore, no further consultation related to these species is needed pursuant to the ESA.

3.1 RANGEWIDE STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT

The NMFS agree with the ACOE's determination that the proposed project is likely to adversely affect the GOM DPS of Atlantic salmon. As discussed earlier in this Opinion, other listed species in the action area are not likely to be adversely affected by this action, therefore, the endangered GOM DPS of Atlantic salmon is the only listed species further considered in this Opinion.

3.1.2 Gulf of Maine DPS of Atlantic Salmon

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

The Gulf of Maine (GOM) Distinct Population Segment (DPS) of anadromous Atlantic salmon was initially listed by the USFWS and NMFS (collectively, the Services) as an endangered species on November 17, 2000 (65 FR 69459). A subsequent listing as an endangered species by the Services (74 FR 29344; June 19, 2009) included an expanded range for the GOM DPS of

Atlantic salmon. The decision to expand the geographic range of the GOM DPS was largely based on the results of a Status Review (Fay *et al.* 2006) completed by a Biological Review Team (BRT) consisting of federal and state agencies and Tribal interests. Fay *et al.* (2006) concluded that the DPS delineation in the 2000 listing designation was largely appropriate, except in the case of large rivers that were excluded in the 2000 listing determination. Fay *et al.* (2006) concluded that the salmon currently inhabiting Maine's larger rivers (Androscoggin, Kennebec, and Penobscot) are genetically similar to the rivers included in the GOM DPS as listed in 2000, have similar life history characteristics, and/or occur in the same zoogeographic region. Further, the salmon populations inhabiting the large and small rivers from the Androscoggin River northward to the Dennys River differ genetically and in important life history characteristics from Atlantic salmon in adjacent portions of Canada (Spidle *et al.* 2003; Fay *et al.* 2006). Thus, Fay *et al.* (2006) concluded that this group of populations (a "distinct population segment") met both the discreteness and significance criteria of the Services' DPS Policy (61 FR 4722; Feb. 7, 1996) and, therefore, recommended the geographic range included in the new expanded GOM DPS. The final rule expanding the GOM DPS agreed with the conclusions of BRT regarding the DPS delineation of Maine Atlantic salmon.

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

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

3.1.3 Species Description

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

Adult Atlantic salmon return to rivers from the ocean and migrate to their natal stream to spawn.

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

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

A single female may create several redds before depositing all of her eggs. Female anadromous Atlantic salmon produce a total of 1,500 to 1,800 eggs per kilogram of body weight, yielding an average of 7,500 eggs per 2 sea-winter (SW) female (an adult female that has spent two winters at sea before returning to spawn) (Baum and Meister 1971). After spawning, Atlantic salmon may either return to sea immediately or remain in freshwater until the following spring before returning to the sea (Fay et al. 2006). From 1967 to 2003, approximately 3 percent of the wild and naturally reared adults that returned to rivers where adult returns are monitored; mainly the Penobscot River; were repeat spawners (USASAC 2004).

Embryos develop in the redd for a period of 175 to 195 days, hatching in late March or April (Danie et al. 1984). Newly hatched salmon referred to as larval fry, alevin, or sac fry, remain in the redd for approximately 6 weeks after hatching and are nourished by their yolk sac (Gustafson-Greenwood and Moring 1991). Survival from the egg to fry stage in Maine is estimated to range from 15 to 35 percent (Jordan and Beland 1981). Survival rates of eggs and larvae are a function of stream gradient, overwinter temperatures, interstitial flow, predation, disease, and competition (Bley and Moring 1988). Once larval fry emerge from the gravel and begin active feeding they are referred to as fry. The majority of fry (>95 percent) emerge from redds at night (Gustafson-Marjanen and Dowse 1983).

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

First year parr are often characterized as being small parr or 0+ parr (4 to 7 cm long), whereas second and third year parr are characterized as large parr (greater than 7 cm long) (Haines 1992). Parr growth is a function of water temperature (Elliott 1991); parr density (Randall 1982); photoperiod (Lundqvist 1980); interaction with other fish, birds, and mammals (Bjornn and Resier 1991); and food supply (Swansburg et al. 2002). Parr movement may be quite limited in the winter (Cunjak 1988; Heggenes 1990); however, movement in the winter does occur (Hiscock et al. 2002) and is often necessary, as ice formation reduces total habitat availability (Whalen et al.1999). Parr have been documented using riverine, lake, and estuarine habitats; incorporating opportunistic and active feeding strategies; defending territories from competitors including other parr; and working together in small schools to actively pursue prey (Gibson 1993; Marschall et al.1998; Pepper 1976; Pepper et al. 1984; Erkinaro et al. 1998; Halvorsen and Svenning 2000; Hutchings 1986; O'Connell and Ash 1993; Erkinaro et al. 1995; Dempson et al. 1996; Klemetsen et al. 2003).

In a parr's second or third spring (age 1 or age 2 respectively), when it has grown to 12.5 to 15 cm in length, a series of physiological, morphological, and behavioral changes occur (Schaffer and Elson 1975). This process, called "smoltification," prepares the parr for migration to the ocean and life in salt water. In Maine, the vast majority of naturally reared parr remain in freshwater for 2 years (90 percent or more) with the balance remaining for either 1 or 3 years (USASAC 2005). In order for parr to undergo smoltification, they must reach a critical size of 10 cm total length at the end of the previous growing season (Hoar 1988). During the smoltification process, parr markings fade and the body becomes streamlined and silvery with a pronounced fork in the tail. Naturally reared smolts in Maine range in size from 13 to 17 cm, and most smolts enter the sea during May to begin their first ocean migration (USASAC 2004). During this migration, smolts must contend with changes in salinity, water temperature, pH, dissolved oxygen, pollution levels, and predator assemblages. The physiological changes that occur during smoltification prepare the fish for the dramatic change in osmoregulatory needs that come with the transition from a fresh to a salt water habitat (Ruggles 1980; Bley 1987; McCormick and Saunders 1987; McCormick et al. 1998). The transition of smolts into seawater is usually gradual as they pass through a zone of fresh and saltwater mixing that typically occurs in a river's estuary. Given that smolts undergo smoltification while they are still in the river, they are pre-adapted to make a direct entry into seawater with minimal acclimation (McCormick et al. 1998). This pre-adaptation to seawater is necessary under some circumstances where there is very little transition zone between freshwater and the marine environment.

The spring migration of post-smolts out of the coastal environment is generally rapid, within several tidal cycles, and follows a direct route (Hyvarinen et al. 2006; Lacroix and McCurdy 1996; Lacroix et al. 2004, 2005). Kocik et al. (2009) documented smolt migrating with the tides primarily at night. Post-smolts generally travel out of coastal systems on the ebb tide and may be delayed by flood tides (Hyvarinen et al. 2006; Lacroix and McCurdy 1996; Lacroix et al. 2004, 2005). Lacroix and McCurdy (1996), however, found that post-smolts exhibit active, directed swimming in areas with strong tidal currents. Studies in the Bay of Fundy and Passamaquoddy Bay suggest that post-smolts aggregate together and move near the coast in "common corridors" and that post-smolt movement is closely related to surface currents in the Bay (Hyvarinen et al. 2006; Lacroix and McCurdy 1996; Lacroix et al. 2004). European post-smolts tend to use the open ocean for a nursery zone, while North American post-smolts appear to have a more near-shore distribution (Friedland et al. 2003). Post-smolt distribution may reflect water temperatures (Reddin and Shearer 1987) and/or the major surface-current vectors (Lacroix and Knox 2005). Post-smolts live mainly on the surface of the water column and form shoals, possibly of fish from the same river (Shelton et al. 1997).

During the late summer and autumn of the first year, North American post-smolts are concentrated in the Labrador Sea and off of the west coast of Greenland, with the highest concentrations between 56 °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 non-maturing adults located along the coasts of Newfoundland, Labrador, and Greenland, and in the Labrador and Irminger Sea in the later summer and autumn.

3.1.4 Status and Trends of Atlantic Salmon Rangewide

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

Contemporary abundance estimates are informative in considering the conservation status of the GOM DPS today. After a period of population growth in the 1970s, adult returns of salmon in the GOM DPS have been steadily declining since the early 1980s and appear to have stabilized at very low levels since 2000 (Figure 2). The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from GLNFH that was constructed in 1974. Marine survival remained relatively high throughout the

1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s marine survival rates decreased, leading to the declining trend in adult abundance observed throughout 1990s. Poor marine survival persists in the GOM DPS to date.

Adult returns to the GOM DPS have been very low for many years and remain extremely low in terms of adult abundance in the wild. Further, the majority of all adults in the GOM DPS return to a single river, the Penobscot, which accounts for most of all adult returns to the GOM DPS rivers (Figure 2). Most of these returns were also of hatchery origin (USASAC 2010). The term naturally-reared includes fish originating from natural spawning and from stocked hatchery fry. Hatchery fry are included as naturally-reared because hatchery fry are not marked; therefore, they cannot be distinguished from fish produced through natural spawning. Because of the extensive amount of fry stocking that takes place in an effort to recover the GOM DPS, it is possible that a substantial number of fish counted as naturally-reared were actually stocked as fry.

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

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

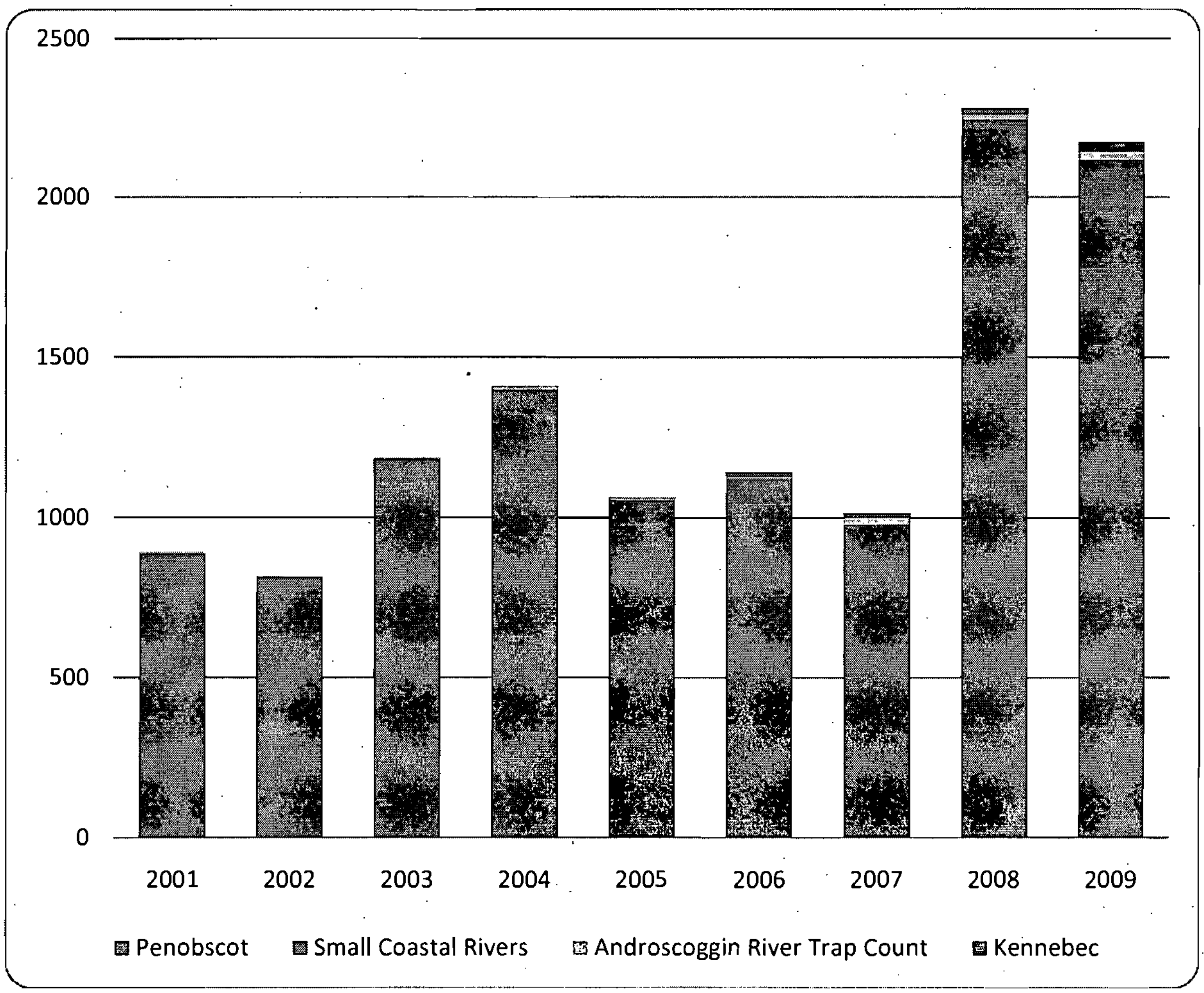

Figure 2. Adult returns to the GOM DPS 2001-2009.

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

3.1.5 Critical Habitat

Coincident with the June 19, 2009 endangered listing, NMFS designated critical habitat for the GOM DPS of Atlantic salmon (74 FR 29300; June 19, 2009). Designation of critical habitat is focused on the known primary constituent elements (PCEs) within the occupied areas of a listed species that are deemed essential to the conservation of the species. Within the GOM DPS, the PCEs for Atlantic salmon are 1) sites for spawning and rearing and 2) sites for migration (excluding marine migration[1]). NMFS chose not to separate spawning and rearing habitat into distinct PCEs, although each habitat does have distinct features, because of the GIS-based habitat prediction model approach that was used to designate critical habitat (74 FR 29300; June 19, 2009). This model cannot consistently distinguish between spawning and rearing habitat across the entire range of the GOM DPS.

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

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

B1. Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations.
B2. Freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon.
B3. Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.
B4. Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.
B5. Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration

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

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

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

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

Salmon Habitat Recovery Units within Critical Habitat for the GOM DPS

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

<u>Downeast Coastal SHRU</u>

The Downeast Coastal SHRU encompasses fourteen HUC 10 watersheds covering approximately 747,737 hectares (1,847,698 acres) within Washington and Hancock Counties. In this SHRU there are approximately 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 includes 45 specific areas occupied by Atlantic salmon that comprise approximately 19,571 km of perennial river, stream, and estuary habitat and 799 square km of lake habitat within the range of the GOM DPS and on which are found those physical and biological features essential to the conservation of the species which may require special management consideration. Within the occupied range of the GOM DPS, approximately 1,256 km of river, stream, and estuary habitat and 100 square km of lake habitat have been excluded from critical habitat pursuant to section 4(b)(2) of the ESA.

3.1.6 Summary of Factors Affecting Recovery of Atlantic Salmon

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

Efforts to Protect the GOM DPS and its Critical Habitat

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

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

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

In light of the 2009 GOM DPS listing and designation of critical habitat, the Services will produce a new recovery plan for the expanded GOM DPS of Atlantic salmon and are currently working on a draft revised recovery plan, which will identify key tasks needed for recovery of the GOM DPS. A number of conservation and recovery activities have been underway for some time prior to the new listing to address the declining numbers of Atlantic salmon in some Maine rivers. The USFWS, NMFS, Maine DMR and the Penobscot Indian Nation have drafted an Atlantic Salmon Recovery Framework which identifies objectives, strategies and actions to be undertaken using agency resources to facilitate recovery. The Services are also actively engaged in discussions with various state agencies, stakeholders, Non-Governmental Organizations (NGOs) and industry representatives to identify and insure implementation of measures to protect the GOM DPS of Atlantic salmon.

Threats to Atlantic Salmon Recovery

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 section provides more information 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 commercial and recreational harvest of Atlantic salmon historically played a role in the decline of the GOM DPS of Atlantic salmon. From the 1960s through the early 1980s, the average exploitation rate in Maine rivers was approximately 20% of the run (Beland 1984; Baum 1997). In 1995, the State of Maine passed regulations to allow only catch and release fishing for Atlantic salmon. Because the catch and release salmon fishery posed a threat of mortality or injury to the GOM DPS of Atlantic salmon, it was discontinued by the State of Maine in December 1999. However, recreational fishing targeting other species still has the potential to result in incidental catch of various life stages of Atlantic salmon that could result in their injury or death. Atlantic salmon parr remain vulnerable to harvest by trout anglers, and mortality associated with this activity has been documented (Maine Atlantic Salmon Conservation Plan 1997). Both poaching and by-catch in recreational and commercial fisheries for other species remain of concern, given critically low numbers of salmon.

In 1987, the New England Fishery Management Council, pursuant to its authority under the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. 1801 *et seq.*, prepared and implemented a federal Fishery Management Plan (FMP) for Atlantic salmon. The FMP prohibits fishing for and possession of Atlantic salmon in the U.S. exclusive economic zone, eliminating additional impacts to the GOM DPS. The potential exists, however, for juvenile and adult GOM DPS Atlantic salmon to be taken incidentally as bycatch in commercial fisheries targeting other species. While a review of existing commercial fishery records does not indicate that bycatch of Atlantic salmon is a significant threat, additional investigation is warranted.

The Canadian Department of Fisheries and Oceans has regulated a closure of the commercial Atlantic salmon fishery for Newfoundland and Labrador since 1992. A small commercial fishery also exists off St. Pierre et Miquelon, a French territory off the coast of Newfoundland. Recent efforts to establish a sampling program to determine the composition of the St. Pierre catch have so far been limited. However, some data has become available for genetic analysis to estimate the level of take and the potential threat this fishery may pose to the GOM DPS.

In August of 2002, the Organization of Hunters and Fishermen in Greenland and the North Atlantic Salmon Fund signed an agreement to suspend all fishing for Atlantic salmon within Greenland territorial waters, except for annual harvest for internal use. The initial agreement covering the 2002 fishing season has been extended through 2011. The terms and conditions of this agreement may be extended yearly to cover the successive fishing seasons through 2013. The West Greenland Commission of the North Atlantic Salmon Conservation Organization (NASCO) agreed on a multi-year approach for conservation of salmon stocks in Greenland which sets a zero quota for the commercial fishery thereby limiting the fishery to an internal use only fishery for 2009, 2010 and 2011. The reported West Greenland catch in 2008 was estimated at 9,500 fish the majority of which, 9,300 were 1 SW fish (ICES NASWG 2009) a portion of this catch was estimated to be of North American origin. Although the commercial harvest of North American origin Atlantic salmon has contributed negatively to the status of the GOM DPS, the continuation of the 2002 agreement will reduce the ongoing threat to the GOM DPS. Given the current low level of abundance for the GOM DPS, even a small amount of ongoing internal use harvest could substantially affect the status of wild salmon.

Regulations developed under Section 10 of the ESA allow for "take" of listed species for the purposes of scientific research and recovery actions. Since the ESA listing, permits cover the river-specific hatchery and stocking program of the USFWS, research and monitoring activities of the MDMR BSRFH, research activities of the NMFS, and research conducted by the U.S. Geological Survey's Biological Resources Division and University of Maine. All of these activities can result in some level of take of Atlantic salmon. A certain amount of mortality is expected as a result of many of these activities, particularly with respect to fish culture. Harassment and stress may also occur as a result of capture and release activities conducted annually to assess population growth and estimate survival during critical life history stages. These permitted activities, while resulting in some take, will result in additional scientific information, improved fish culture and assessment techniques, a greater understanding of the species and its habitat, and will also collectively promote recovery of the species. Most of the "take" associated with these salmon recovery actions will be an integral consequence of these actions, rather than incidental to them. There are, however, occasions wherein take will be considered incidental (e.g., habitat improvements, dam removal or installation of fish passage, and construction or placement of in-river weirs). Currently, the USFWS has authorized incidental take of salmon, related to various recovery actions, within the GOM DPS for any given year not to exceed 2% of the life stage being impacted, except that for adults, it would be less than 1%.

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. Known predators of Atlantic salmon include marine mammals (e.g., seals, porpoises, and dolphins), terrestrial mammals (e.g., otters, minks), birds, fish and sharks. Atlantic salmon post-smolts are preyed upon by cod, whiting, cormorants, ducks, terns, gulls, and many other opportunistic predators (Hvidsten and Møkkelgjerd 1987; Gunnerød *et al.* 1988; Hvidsten and Lund 1988; Montevecchi et al. 1988; Hislop and Shelton 1993). Cormorants and striped bass are transitory predators that impact migrant juveniles in the lower river and estuarine areas (Hawkes in review). Seals have reached high population levels not reported before, and salmon remain vulnerable to seal predation throughout much of their range. Predation has always been a factor influencing salmon numbers; but under conditions of a healthy population, this would not be expected to threaten the continued existence of that population. However, low numbers of adult salmon returning to spawn in the GOM DPS, combined with the dramatic increases in population levels of some predators, such as cormorants and seals, elevate the threat to wild salmon from predation. Although the magnitude of the effect of predation on the current status of wild salmon is unknown, the loss of even a small number of adult fish to predation could adversely affect the GOM DPS population.

   Atlantic salmon are susceptible to a number of diseases and parasites, but mortality is primarily documented at conservation hatcheries and aquaculture facilities. Fish diseases represent a natural source of mortality to Atlantic salmon in the wild, though major losses due to disease are generally associated with salmon raised in captivity or used in commercial aquaculture. Recent events have increased the Services' awareness of the threat from disease pathogens and have provided evidence as to the susceptibility of the hatchery conservation program for the recovery of the GOM DPS and other Atlantic salmon populations in New England. Relevant disease occurrences include: (1) the appearance of infectious salmon anemia virus (ISAV) in 1996 in Canada; (2) the detection of ISAV on a Maine salmon farm in Cobscook Bay in January 2001, and subsequent outbreaks at other farms in Cobscook Bay (15 sites confirmed by MDMR) which led to a total eradication of all commercial Atlantic salmon production facilities in Cobscook Bay; (3) the discovery of retrovirus salmon swimbladder sarcoma virus (SSSV) in 1998 within the GOM DPS population; (4) Infectious Pancreatic Necrosis Virus (IPNV) found in the Connecticut River Atlantic salmon population and; (5) new information on other emerging threats from diseases that may affect salmon such as cold water disease, sea lice, Didymo and Viral Hemorrhagic Septicemia Virus (VHSV). As more methods for disease detection become available and we gain more knowledge about the triggers for disease expression, this information can inform alternative management practices that could be put in place to reduce these risks.

The section below briefly describes these findings in greater detail and provides some background on the measures employed in hatchery conservation programs designed to minimize the threats from infectious diseases entering the State and Federal hatchery systems supporting recovery of Atlantic salmon.

Infectious Salmon Anemia Virus

ISAV represents a critical threat to wild Atlantic salmon in the US and is a serious concern to captive Atlantic salmon sea-run brood populations used in the recovery of this species. To address this concern, measures have been indentified and in most cases implemented to decrease this risk. As a result of the need for better risk management practices, a new quarantine building was constructed in 2009 at the Craig Brook National Fish Hatchery (CBNFH) that will allow for enhanced ISAV screening practices to be implemented on the Penobscot River sea-run brood population. All sea-run hatchery brood fish are screened for ISAV in the Penobscot, Merrimack, and Connecticut River populations each year prior to spawning. Although positive ISAV infections have not been confirmed in hatchery brood populations, in 2009 the Penobscot River hatchery brood population had six fish identified as ISAV suspects. Follow up cell culture did not confirm any ISAV pathogen.

Starting in 2010, each sea run adult returning to the Penobscot river and transported to the CBNFH was be held in a quarantine facility until fish health screening could be completed. After the fish is found to be free of the virus, which currently takes an estimated 3-4 days to complete, it can be placed in with other brood that have been previously screened and found to be ISAV free. There are only five bays in the screening building, and it is assumed the holding capacity of each bay will be between 50-75 fish each. Logistics for implementing the enhanced ISAV screening program are very complex, and will be a notable challenge to both the USFWS and the MDMR. Standard operating procedures for handling brood fish and disease screening practices, as well as a decision tree to provide guidance with fish movement and positive ISAV identifications has been implemented.

IPN Virus at Cronin National Fish Hatchery

In 2007, the viral pathogen Infectious Pancreatic Necrosis Virus (IPNV) was isolated from Connecticut River Atlantic salmon during routine fish health screening of brood stock by the USFWS. No clinical signs of disease were noted in the fish. Two ovarian fluid samples were confirmed positive for IPNV using cell culture and polymerase chain reaction (PCR) assays. Each sample represented a pool of brood stock spawned at the Richard Cronin National Salmon Station. Thus, a minimum of two sea-run salmon females were infected. All the eggs and brood stock at the facility and eggs transferred to another facility were destroyed. This resulted in the loss of the entire year class of sea-run Connecticut River Atlantic salmon brood stock. Follow-up cell culture assays, PCR assays and histology were conducted on kidney, spleen, blood and pancreatic tissues from the killed brood stock. Infection and prevalence levels were low (3 of 121 positive) in the population indicating large scale horizontal transmission had not occurred while the fish were held in captivity at the station for eight months. The US Geologic Survey (USGS) Western Fisheries Research Center identified the isolate to be most similar in base pair structure to the Canada 3 genotype, which is significantly different from most other North American IPNV genotypes studied (Cutrin *et al.* 2004). Because this is not a typical North American isolate, pathologists speculate that the salmon were exposed during ocean migration.

IPNV represents a critical threat to Atlantic salmon recovery in the US. The discovery of IPNV at any US Atlantic salmon conservation hatchery will result in loss of genetic diversity for one or more stocks and from one to three spawning cohorts for a stock. Current procedures for screening and isolating fish at all the hatcheries are inadequate to protect against an IPNV outbreak. Enhancing bio-security protocols at each of the hatcheries seem to be the only way to reduce the risk of losses. A new bio-security plan for the sea run brood stock population at Richard Cronin includes isolating and increasing the number of holding tanks. Isolation involves separate equipment, footbaths, barriers to prevent direct transfer of water from tank to tank, and using separate spawning and egg rinsing equipment for in each holding tank. Discrete egg incubation isolation units (fitted with enclosures for isolation) will be maintained for each brood stock pool and separate egg equipment (rinsing counting shocking picking) will be used for each incubation unit. Should IPNV be isolated in a particular tank, brood stock and all resulting spawn from that tank will be destroyed. Eggs from brood stock tanks where spawners all tested negative will be carried through to hatch. Fry from these units will also be tested for all listed viruses prior to transfer/release.

Sea lice

The common sea louse, *Lepeophtheirus salmonis*, is prevalent on Atlantic salmon at sea. Commercial salmon farms are often associated with increased levels of sea lice in the wild because of the number of hosts available for the parasite. During specific life stages, sea lice require a host (typically salmon) to provide a food source and are parasitic during the adult phases. Sea lice feed on the outer layer or epidermis of the fish and remove the protective layer of mucous that exposes the host fish to external pathogens which could lead to further disease issues. The motile stages referred to as chalimus are the most damaging to the fish and are the stages that are monitored regularly in programs designed to prevent larger epizootic outbreaks. Sea lice infestations are known to increase stress levels in individual fish, which in turn could lead to a decrease in appetite and loss of condition factor that compromises the fish's ability to cope with changing environmental conditions (i.e., water temperature and salinity) and ultimately could affect survival. Fish are treated at sea for parasites and disease by administering medication through feed or externally through a bath treatment. More recently on salmon farming sites located in Cobscook Bay, administering therapeutic treatments for the prevention of sea lice involves pumping fish into a large well boat filled with a specific concentration of Hydrogen Peroxide and then held for a specified amount of time and pumped back into the cage. More recently, evidence from other salmon farming countries has raised concern over sea lice transfer to wild stocks and disease resistance to therapeutic treatments. These data are of particular interest to regulators overseeing the US salmon farming industry, because of the location of the fish pens in relation to outmigrating salmon smolts which may acquire sea lice infestations if they migrate close to infected salmon aquaculture facilities (Krkocek 2005). To better understand and characterize the effects from interactions around salmon farms, further investigations are ongoing in Cobscook Bay to evaluate the level of sea lice present on outmigrating salmon smolts.

Ichthyopthiriasis

The etiological agent of Ichthyophthiriasis, *Ichthyophthirus multifilliis*, is a protozoan with worldwide distribution leading to one of the most prevalent diseases of fishes (Post 1987). This disease is also known as white spot or "ich" because of the visible small white patches of cysts which form on the epidermis of the host. Sea run adult salmon held at CBNFH during the summer months until ready for spawning and juvenile salmon captured in Maine Rivers are most susceptible to disease outbreaks from this pathogen. Treatment for the control of the disease in large fish culture facilities is often difficult and has been limited by the use of specific chemical treatments such as Formalin due to changes in discharge permit limits from the State of Maine. Other parasites can also affect juvenile salmon in Maine rivers, the common brook trout ecto-parasite has been occasionally observed.

Coldwater Disease

The causative agent for Coldwater disease, the bacterium *Flavobacterium psychrophilum,* has previously been thought to be a serious problem for Atlantic salmon in New England waters. The pathogen causes significant mortality in infected juvenile salmon. The pathogen is transmitted vertically from carrier sea-run adults to offspring via eggs (Atlantic Salmon Assessment Committee, 2000; 65 FR 69476, Nov. 17, 2000). Recent information from hatchery production has shown an improved eye-up rate and fry survival for cohorts spawned at CBNFH possibly indicating fewer impacts from Coldwater disease.

Didymo

Didymosphenia geminate (aka., didymo or rock snot) has recently been detected in many water bodies throughout New England indicating this new and emerging alga may be spreading rapidly. Recent detections include the White River in Vermont just upstream of the White River National Fish Hatchery in 2007 and the Farmington River in Connecticut in 2010. This has not been shown to infect fish, but has a direct effect on fish habitat. The algae prefer rocky substrate and prefer sunny reaches found in open areas of the river. It is thought this requirement will prohibit colonization of upper reaches of the drainage that may have a less open canopy.

Vibriosis

In salt water, Vibriosis is a common bacterial disease caused by *Vibrio anguillarum*, affecting most species of marine and freshwater fish, including farmed and wild Atlantic salmon. This pathogen has caused major problems with aquaculturists throughout the years. The salmon farming industry in Maine routinely uses a vaccine to reduce the likelihood of infection from this disease. It is currently believed Vibriosis could also affect wild salmon populations (Baum 1997).

Disease Summary

Although direct loss of listed salmon in the wild from the above-mentioned diseases is difficult to assess, there is also an indirect effect of these diseases through their impact on the river-specific fish culture programs in place to enhance maintenance and recovery of the GOM DPS. The impacts of ISAV, IPNV, SSSV and coldwater disease in the fish hatchery environment are of particular concern because hatchery managers are required to destroy diseased salmon to prevent the spread of disease and this loss of hatchery populations will hinder salmon recovery. Such diseases could pose a significant threat to the USFWS's hatchery program and its' ability to function effectively, thereby significantly degrading an important salmon recovery strategy.

4. **Inadequacy of existing regulatory mechanisms** – The ineffectiveness of current federal and state regulations at requiring fish passage and minimizing or mitigating the aquatic habitat impacts of dams is a significant threat to the GOM DPS today. Furthermore, most dams in the GOM DPS do not require state or federal permits. Although the State of Maine has made substantial progress in regulating water withdrawals for agricultural use, threats still remain within the GOM DPS, including those from the effects of irrigation wells on salmon streams. While current state and federal regulations pertaining to finfish aquaculture have reduced the risks to the GOM DPS (including eliminating the use of non-North American Atlantic salmon and improving containment protocols), risks from the spread of diseases or parasites and from farmed salmon escapees interbreeding with wild salmon still exist.

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. Scientific studies are ongoing to partition Atlantic salmon mortality into critical life stages. For a number of years, marine survival rates have been known to be low for U.S. stocks of Atlantic salmon (Beland and Friedland 1997). Scientists attribute natural mortality in the marine environment to sources including stress, predation, starvation, disease, and parasites. Because the year-to-year variation in return rates for U.S. salmon stocks is generally synchronous with other North American stocks, low marine survival appears, in part, to be due to some unknown factors in the North Atlantic, particularly the Labrador Sea. Low marine survival rates are currently adversely affecting the GOM DPS population. In recent years, outmigrating smolts have been trapped on some rivers within the GOM DPS. These studies have revealed that parr to smolt survival is significantly lower than was previously estimated (Kocik *et al.* 1999). A portion of the smolts leaving some of the GOM DPS rivers have been tagged and tracked in order to gain information on the outmigration route and success. Recent telemetry data has shown smolt migrations through the inner and outer estuary involves complex behavior and select routes possibly indicating interactions with environmental conditions as being a large influence in post smolt ecology (Kocik *et al.* 2009). These studies have revealed that a large portion of the smolts do not make it out of the bay and into the open ocean. Investigations of post smolt behavior in the Penobscot River Bay have shown the dispersal of smolts occurring after salt water entry is significantly influenced by tidal movement and environmental conditions (Renkawitz & Sheehan in review). Further, recent studies on smolt conditions indicate that the smolts are not adequately prepared for the transition to salt water. Smolts entering the estuary and marine environment unprepared for this transition are likely to experience high mortality. These results indicate that there may be factors within the nearshore marine environment that are negatively impacting survival. Additional studies on smolt physiology and migratory behavior are currently being conducted, and data are being collected on various water quality parameters in GOM DPS watersheds and estuaries.

Competitive interactions between wild Atlantic salmon and other salmonid fishes, especially introduced species, are not well understood and in Maine. State managed programs supporting recreational fisheries often include stocking non-indigenous salmonid fish into rivers containing anadromous Atlantic salmon. Interactions between wild Atlantic salmon (*Salmo salar*) and other salmonids include; indigenous brook trout (*Salvelinus fontinalis*) and landlocked Atlantic salmon (*Salmo salar sebago*) and hatchery reared non-indigenous brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*). Competition plays an important role in habitat use by defining niches that are desirable for optimal feeding, sheltering and spawning. Limited resources may also increase competitive interactions which may act to limit the time and energy fish can spend obtaining nutrients essential to survival. This is most noticeable shortly after fry emerge from redds, when fry densities are at their highest (Hearn 1987) and food availability is limited. Prior residence of wild salmonids may infer a competitive advantage during this time over domesticated hatchery juveniles (Letcher 2002; Metcalfe 2003), even though the hatchery reared individuals may be larger (Metcalfe 2003). This may limit the success of hatchery cohorts stocked annually to support the recovery of

Atlantic salmon. This could also influence the ability of juvenile Atlantic salmon to establish residency after escaping from commercial hatcheries located on GOM DPS rivers. Annual population assessments and smolt trapping estimates conducted on GOM DPS rivers indicates stocking of hatchery reared Atlantic salmon fry and parr in areas where wild salmon exist could limit natural production and may not increase the overall population level in freshwater habitats. The amount of quality habitat available to wild Atlantic salmon may also increase inter and intra-specific interactions between species due to significant overlap of habitat use during periods of poor environmental conditions such as during drought or high water temperatures. These interactions may impact survival and cause Atlantic salmon, brook and brown trout populations to fluctuate from year to year. However, since brook trout and Atlantic salmon co-evolved, wild populations should be able to co-exist with minimal long-term effects (Hearn 1987; Fausch 1988). Domesticated Atlantic salmon and rainbow trout produced by the commercial aquaculture industry that escape from hatcheries or net pens also compete with wild Atlantic salmon for food, space and mates. This topic is discussed further later in this section of the Opinion, as well as in the Effects of the Action section.

Brown trout (*Salmo trutta*) have been stocked by the MIFW into a number of headwater lakes and rivers within the watersheds of the GOM DPS, including the Machias and East Machias Rivers (MASCP 1997) and mainstem Kennebec River. Brown trout stocked by the MIFW in the Kennebec and Sheepscot Rivers have established a self-sustaining population. Although the potential exists for brown trout to prey upon juvenile Atlantic salmon in these systems, most brown trout reside in portions of the Sheepscot river headwater above Sheepscot Lake where few Atlantic salmon spawn (MASCP 1997) and lower in the Kennebec below the Shawmut dam where there is little Atlantic salmon spawning and rearing habitat. Because brown trout females are known to prefer to spawn on existing redd sites, there is some potential for redd superimposition in Atlantic salmon spawning areas (MASC/ MIFW MOA 2002). Interspecific competition between brown trout and Atlantic salmon also has the potential to negatively affect Atlantic salmon growth and survival. Habitat use by Atlantic salmon has been found to be restricted through interspecific competition with brown trout that are more aggressive (Heggenes *et al.* 1999; Kennedy *et al.* 1986; Hearn 1987; Fausch 1998). Furthermore, Harwood *et al.* (2001) determined that competition is not limited to the summer months; instead, competition for food and resources observed during overwintering indicates potential effects on both the long-term and short-term growth of wild Atlantic salmon. Also, at lower water temperatures, Atlantic salmon fry may compete less effectively than brown trout. In Europe, however, brown trout and Atlantic salmon are sympatric and habitat segregation allows them to remain genetically isolated (Hesthagen 1988; Hearn 1987).

While there is compelling evidence that brown trout may have a negative impact on wild Atlantic salmon, within the GOM DPS the extent of predation and competition between brown trout and Atlantic salmon has not been well documented. Although brown trout are capable of hybridizing with Atlantic salmon, this also has not been documented in the GOM DPS rivers. Therefore, it is likely that the impact of brown trout on wild Atlantic salmon in the Sheepscot and Kennebec Rivers is relatively low. However, given that studies in other regions have documented negative interactions between brown trout and

Atlantic salmon, brown trout stocking poses a potential threat to Atlantic salmon.

Starting in 1995, the MIFW stocked splake [lake trout (*Salvelinus namaycush*) x brook trout (*Salvelinus fontinalis*)] in seven lakes within the Sheepscot, Narraguagus, Pleasant, and Machias River watersheds. In 2001, stocking of splake in Beddington Lake (a lake on the mainstem of the Narraguagus River) was terminated. The splake stocking program in Beddington Lake was the only downeast program on a mid-drainage lake that Atlantic salmon smolts migrate through. In other downeast lakes, splake are only stocked upstream of currently occupied Atlantic salmon rearing habitats. Little information is currently available to assess the level and significance that predation by splake on Atlantic salmon has had on the GOM DPS, but cessation of the Beddington Lake stocking program has reduced this threat substantially.

Landlocked salmon (*Salmo salar sebago*) are present in lakes within the Sheepscot, Narraguagus, Pleasant, Machias, East Machias, and Dennys River watersheds. Except for Pleasant River Lake, where the residual population of landlocked salmon is sustained by natural reproduction, fishery biologists sustain these landlocked salmon populations through regular stocking programs, some of which began in 1937 or earlier (MASCP 1997). Predation on juvenile salmon by adult landlocked salmon may occur either during periods of cool water temperatures before landlocked salmon move to nearby lakes or during periods of high flows when larger landlocked salmon might temporarily reside near nursery habitat (MASCP 1997). It is believed that the extent of predation of wild Atlantic salmon by landlocked salmon is relatively minor (MASCP 1997).

Threats to Critical Habitat within the GOM DPS

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

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

Penobscot sub-basins by altering predator/prey relationships. Similar to smallmouth bass, recent Northern pike introductions threaten habitat in the lower Penobscot River below the Great Works Dam.

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

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

Water withdrawals have the potential to reduce or expose salmon habitat in rivers. Sufficient water flow, both in quality and quantity, is critical for all life stages of Atlantic salmon, from spawning through smolt emigration and adult migration. Both water quality and quantity can be affected by extraction of water for irrigation or other purposes. Changes in stream flow from withdrawals can also affect basic sediment transport functions and result in stream channel modifications that could be detrimental to salmon.

The MDEP has identified sediment pollution as one of the more serious threats to stream health in Maine (AASBRT 1999). Non-point source (NPS) pollution problems occur on all GOM DPS rivers and include various sources such as agriculture, forestry, airborne pollutants (e.g., acid rain), livestock grazing, septic systems, stream channel alteration, and urban runoff. The most common NPS pollutants are sediment and nutrients but others include agricultural pesticides and herbicides, heavy metals, pathogens, and toxic chemicals. Rivers and streams within the GOM DPS are at risk to other types of pollutants that could be transferred to the watercourse via a road way or bridge crossing. For example, a recent diesel fuel spill from a delivery truck tank in March of 2011, that contaminated the lower Pleasant River in Columbia Falls directly impacted the annual migration of rainbow smelt and may have long lasting impacts to stream habitat and overall water quality. Additional concerns from the fuel spill include long term impacts to GOM DPS salmon being reared by the Down East Salmon Federation who operate a small scale fish culture facility on the Pleasant River which holds a small portion of endangered Atlantic salmon.

Hexazinone (velpar), a herbicide used by blueberry growers, has been detected at sites in the Narraguagus River. Concentrations detected have been relatively low and studies demonstrate that the river was capable of producing Atlantic salmon at a level considered normal given the adult abundance at the time. Since these studies, however, increased fry abundance has not resulted in a commensurate increase in parr and smolt abundance (AASBRT 1999). Hexazinone plays a currently unknown but potential role in the status of salmon in the GOM DPS, particularly for the population in the Narraguagus River.

Water sampling by the MDEP in cooperation with the watershed councils and the University of Maine (UM) has identified low pH (i.e., acidic) values coinciding with low calcium and high exchangeable aluminum levels on downeast GOM DPS rivers. Measurements demonstrated healthy water quality conditions in the summer but the occurrence of acidic episodes in the fall. The combination of low pH, high exchangeable aluminum, and low calcium levels is toxic to fish and can injure or kill individuals. Currently, studies are being conducted by the Services and their many resource partners in salmon conservation to further investigate the role of pH and labile aluminum on the physiology of Atlantic salmon in the GOM DPS and potential measures to improve the current situation. There are a number of conservation organizations and watershed councils which are assisting in recovery efforts by providing additional resources for projects involving increasing connectivity to quality habitat, securing conservation easements on property adjacent to GOM DPS rivers with the intention of protecting riparian habitat and identifying non-point source pollution.

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

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

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

the level of observer coverage has increased in recent years for both USA gillnet and trawl fisheries and that no reports have been made of Atlantic salmon catch in recent years, these fisheries are not thought to be causing a large amount of Atlantic salmon bycatch.

4. ENVIRONMENTAL BASELINE OF THE ACTION AREA

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

4.1 Factors Affecting GOM DPS Atlantic salmon in the Action Area

A summary of the status of the species rangewide and designated critical habitat in its entirety was provided above. This section will focus on the status of Atlantic salmon and designated critical habitat in the action area. Atlantic salmon in the GOM DPS currently exhibit critically low spawner abundance, poor marine survival, and are confronted with a variety of threats, including artificially-reduced water levels, diseases and parasites, predation, sedimentation of habitat, and genetic intrusion by commercially-raised Atlantic salmon that escape from freshwater hatcheries or marine cages. The Services listed the GOM DPS as endangered because of the danger of extinction created by inadequate regulation of existing dams and land use practices, including forestry and agriculture, which 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 (74 FR 29344; June 19, 2009. Water withdrawals, elevated sediment levels, and acid rain have also degraded Atlantic salmon habitat. These and other factors, including exotic diseases, aquaculture, predation and low marine survival affecting the current status of the Atlantic salmon GOM DPS are discussed below. Additionally, some significant proactive conservation actions the U.S. aquaculture industry has been involved with in the past are highlighted.

Formal or Early Section 7 Consultations

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

One formal consultation was completed with the ACOE concerning their proposed continuation and modification of existing Rivers and Harbor Act Section 10 permits authorizing the installation and maintenance of 42 marine aquaculture sites off the coast of Maine. Atlantic salmon were the primary species for finfish cultivation at the 42 sites. The Services concluded in the biological Opinion issued on November 19, 2003 that the proposed ACOE action including the incorporation of seven special conditions to protect the GOM DPS of Atlantic salmon would adversely affect but would not likely jeopardize the continued existence of the endangered Atlantic salmon within the DPS. Because the proposed permit modifications and special conditions could not eliminate the potential for permitted activities at the 42 aquaculture sites to result in "take" of Atlantic salmon, the Services issued an Incidental Take Statement (ITS) with the final Opinion. The anticipated incidental take was the detection at weirs or traps in DPS rivers of up to 21 and then further reduced to 16 escaped aquaculture Atlantic salmon from the 42 aquaculture sites per year, based on a three year rolling average. To date, there has been no take associated with this ITS, if this level is exceeded, the ACOE must reinitiate Section 7 consultation for these aquaculture sites.

Since the initial listing of Atlantic salmon on November 17, 2000, there have been two formal Section 7 consultations completed that focused on impacts to the GOM DPS as a result of issuing federal permits under Section 402 of the Clean Water Act. Each of these consultations were related to the EPA's National Pollution Discharge Elimination System (NPDES) permit program. The first consultation concerned the EPA's proposed approval of the State of Maine's application to administer the NPDES permit program. The second consultation with the EPA related to the issuance of a NPDES permit authorizing the discharge of pollutants from Cooke Aquaculture's site at Dunham's Cove in Blue Hill Bay. Based on the proposed permitting procedures and commitments made by the EPA, the Services were able to conclude that the EPA's proposed action could result in take but was not likely to jeopardize the GOM DPS. The State of Maine's administration of the NPDES program was subsequently approved by the EPA on January 12, 2001. No take was associated with the NPDES program delegation to the State of Maine.

On February 21, 2002, the EPA issued a final NPDES permit for Cooke Aquaculture for their site off Dunham's Cove in Blue Hill Bay. The permit conditions proposed by the EPA to protect Atlantic salmon are similar to the ACOE special conditions included in this proposed action. Although the Dunham Cove site has both an ACOE permit and a NPDES permit, it does not hold a valid state lease. The site was never developed and no aquaculture gear was deployed or farmed fish stocked and has subsequently been discontinued.

On March 17, 2008, NMFS issued an Opinion to USGS on the effects of sea run brook trout research in Cove Brook, a tributary to the lower Penobscot River. In the Opinion, NMFS concluded that the proposed action may adversely affect but was not likely to jeopardize the continued existence of listed Atlantic salmon. The ITS accompanying the Opinion exempted the incidental take of up to 22 juvenile Atlantic salmon which are reported annually.

On December 10, 2009 NMFS issued an Opinion concerning the effects of the Federal Energy Regulatory Commission's (FERC or Commission) approval of applications to surrender licenses and decommission via dam removals at the Veazie (FERC No. 2403) and Great Works (FERC No. 2312) Projects and surrender license and construct a fish bypass at the Howland Project (FERC No. 2721) located on the Penobscot and Piscataquis Rivers in Penobscot County, Maine.

Cumulative Threats from Other Activities

Cumulative impacts from federal and private actions occurring in the geographic range of the GOM DPS of Atlantic salmon have the potential to impact Atlantic salmon and critical habitat designated for this species. These include direct and indirect modification of habitat due to hydroelectric facilities and the introduction of pollutants from paper mills, sewers, and other industrial sources. Hydroelectric facilities can alter the river's natural flow pattern and temperatures and release of silt and other fine river sediments during dam maintenance can be deposited in sensitive spawning habitat nearby. These facilities also often represent barriers to normal upstream and downstream movements. Passage through these facilities may result in the mortality of downstream migrants. Pollution has been a major problem for GOM DPS rivers, which continue to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons). Additionally, commercial fisheries occurring within the Gulf of Maine and Atlantic Canada as described in more detail below may have the potential to impact Atlantic salmon.

Atlantic salmon as bycatch in commercial fisheries for herring

Commercial scale fishing is conducted in the waters of the Gulf of Maine and Canadian Maritimes for the purpose of catching herring for lobster bait or other uses such as for processed agriculture products like feed for poultry, swine and aquaculture. Although most of the fish meal and fish oil for processed salmon feed comes from capture fisheries targeting Anchovies and other small pelagic baitfish off the coast of South America (WWF 2005). Herring stocks on Georges Bank and the coastal waters of Canada are harvested by both large and small purse seines and by boats using gillnets. Both types of gear target herring and Atlantic mackerel, but do have occasional records of bottom fish. There is an overlap in the timing and location of the fishing operations and the spatial and temporal distribution of Atlantic salmon that has the potential to cause bycatch. Historical data may provide some evidence of potential for bycatch, and salmon have been reported in commercial landings and reported in the annual report to NASCO.

Observer databases maintained by both the Northeast Fisheries Science Center (NEFSC) of the National Marine Fisheries Service (USA) and the Department of Fisheries and Oceans (DFO, Canada) were examined for records of Atlantic salmon catch (2004 WGNAS report to NASCO). Direct observations of Atlantic salmon catch in the observer database are rare. With the NEFSC observer database, there were a total of five trips which occurred in the early 1990's that recorded a total of 12 kg of Atlantic salmon catch. In 1990 one gillnet trip discarded one pound of Atlantic salmon. In 1992, one otter trawl trip discarded 1 kg of Atlantic salmon. In 1992, three separate (but close in time) gillnet trips discarded 7 kg and kept 3 kg of Atlantic salmon. Observer coverage for gillnet fisheries in Maine during the summer of 1996 was approximately 9%. There are no salmon bycatch records associated with these observer trips. Technologies available to quantify bycatch amount include observer programs, experimental fishing and tagging studies with automated detection systems that allow large catches to be scanned automatically. Salmon abundance in waters off the USA, southern Nova Scotia and southern New Brunswick is presently low enough that quantifying bycatch rates may be difficult in these areas. Given that

Aquaculture operations

a. Background

Atlantic salmon farming operations are concentrated in large bays and interspersed among the many islands characteristic of the Maine coast (Figure 1). Some Maine rivers supporting the GOM DPS of Atlantic salmon have active commercial aquaculture net pen facilities located within the near shore embayment areas, in addition to commercial hatcheries on several of the rivers within the range of the GOM DPS (Figure 1). The finfish aquaculture industry in Maine is currently composed of 26 finfish leases (620 acres total) located in marine and estuarine waters along the Maine coast (MDMR 2010). Most production sites (16) are located in the Cobscook Bay area, near the Maine-New Brunswick border (Figure 1). Each of these sites is permitted by the ACOE, MDMR and MDEP. The Atlantic salmon is the primary species of finfish under cultivation, with other species being reared in recent years including cod, halibut, flounder, rainbow trout and charr. The most common net pens used today are 100 meters in size and are configured within a grid system, anchored to the substrate by manufactured Danforth style anchors and/or concrete or granite blocks.

In Maine, growing Atlantic salmon to harvestable size requires approximately 18 months, yielding an average standing crop of about 5 million salmon in two-year classes. Typically salmon are harvested from October through March, although some salmon are harvested throughout the year. Most of the salmon are stocked into cages each spring; however some fish are stocked in the fall to extend the annual production throughout the year. The annual total production of farmed Atlantic salmon in Maine has increased from a low of 8,562,277 lbs in 2007 to more than 24,530,940 lbs in 2010 (Table 1). Contemporary production of farmed salmon has increased slightly since 2008 mostly through operational changes which Cooke Aquaculture and its' subsidiary companies have made to fully utilize existing lease sites and support a farmed salmon processing plant in Machiasport. The salmon farming industry in Maine has adjusted for the changes in regulatory requirements, fish health protocols and anticipates increasing production slightly too fully utilize existing lease sites with some potential for expansion of new sites into other areas along the coast of Maine.

Since 2002, the Maine salmon farming industry has significantly changed due to both state and federal regulatory requirements, bay management areas, fish health protocols and change of lease ownerships. These changes have led to a decrease in active farm sites (Table 1) and a decrease in the number of leases and have directly affected production in Cobscook Bay the greatest. Since implementation of a bay wide management plan for Cobscook Bay, the number of active farm sites has been reduced as a result of alternate year class stocking in pre-designated bay area's to provide for fallowing periods between production cycles (this is discussed further in section on disease transfer). The number of aquaculture finfish sites stocked with Atlantic salmon has fluctuated significantly over the last two decades with a peak of 31 sites in 2001 (Table 1). The number of available lease sites has significantly decreased since the last Opinion was initiated in 2002. The decrease in the number of active lease sites has also resulted in significantly less gear deployed, which has declined from roughly 570 net pens and steel cages to less than half that, currently around 225 100 meter net pens in the water. However, the number of aquaculture fish currently being reared is approaching the number prior to implementing the state and federal regulations following the changes described above (Table 1). Although there is not significant data to analyze gear related escape events, past escape reports in the US that have led to significant losses have mostly been from sites deploying steel cages (i.e., approximately 100,000 fish from Stone Island in 2000). The circular net pens currently deployed throughout the Maine salmon farming industry are much improved since the early cage designs and can compensate for larger forces from high winds and waves. However, larger net pens have a much larger volume to hold more fish and therefore could have the potential to have a larger escape if there is a gear malfunction. However, this risk is balanced somewhat by reducing the number of individual net pens deployed which could be affected by extreme environmental conditions or human related incidences leading to an escape event. More information is becoming available through a MDMR database maintained on escape related causes. The changes in the number of cages deployed and gear type (steel cages to circular net pens) in combination with CMS plans for each site could have contributed to a decrease in the reported number of escaped farmed fish documented in GOM DPS rivers, which went from a high of 65 in 2001 to zero during the last four years (Table 2.)

Table 1.

Annual production for Maine Atlantic salmon farming industry (1991-2010) from active lease sites.

Year	# of Sites stocked	Salmon (Whole Pounds)
1991	19	10,032,655
1992	21	12,869,732
1993	19	14,740,106
1994	23	13,511,472
1995	25	22,000,651
1996	29	22,020,910
1997	23	26,706,548
1998	28	28,965,124
1999	29	26,826,457
2000	28	36,049,476
2001	31	29,105,536
2002	12	14,987,837
2003	14	13,243,419
2004	15	18,773,038
2005	12	11,602,436
2006	6	10,303,944

2007		**5**		**8,562,277**
2008		**7**		**19,873,323**
2009		**6**		**13,559,471**
2010		**9**		**24,530,940**

Below is a brief history of the Services' involvement with the aquaculture industry which led to improved practices that have presumably reduced escapes as shown in Table 3.

In May of 2001, Maine's three largest aquaculture companies signed an agreement with several conservation groups and the Services pledging to strengthen fish containment and husbandry practices. The agreement is voluntary but is intended to allow for continuous improvement in the containment of farmed salmon and led to the development of a mandatory, enforceable Containment Management System (CMS) for Maine salmon farmers. Representatives from the Maine Aquaculture Association (MAA), state and federal agencies, and conservation groups formed a steering committee to provide advice and direction on a National Fish and Wildlife Foundation grant to the MAA that addresses containment issues and fish marking techniques. The steering committee reviewed the work of two groups, the containment audit working group and the marking working group. These groups have developed a containment audit policy and reporting form based on a Hazard Analysis Critical Control Point model.

To minimize escapes of farmed salmon, the Atlantic salmon farming industry in Maine is required to employ a fully functional CMS at all production facilities supporting commercial salmon aquaculture; this includes both freshwater hatcheries and marine sites. The generic CMS template and framework was developed through the collaboration between private industry, public interest groups, environmental NGOs and state and federal agencies and was led by the MAA. These generic plans were used by the hatchery and marine site managers to develop site specific actions and response plans based on the specific needs of each site. A hazard analysis was conducted to identify critical control points and appropriate equipment modifications needed to eliminate losses from each facility. The site specific plans were refined during a one year trial period in 2004, during which time state and federal agencies provided oversight to site managers to implement CMS plans at each site. The MAA in cooperation with the salmon farming industry developed equipment standards (Belle, Code of Containment) which formed the basis of each plan and were established using industry expertise and data collected through analyses of load exerted on cages during extreme weather and tide conditions. The major components of the CMS plans include standard operating procedures specific to fish husbandry, stocking, harvesting, predator control, vessel operation, fish transfers, net changes and managing unique events such as storms and winter icing. Reporting of escapes, record keeping (e.g., cage and net numbers), corrective actions and annual training of employees and managers explaining how to implement CMS plans are mandatory components of each plan.

As specified in the ACOE permit condition number 4; for each marine grow-out site, CMS protocols are in place to prevent losses during all activities including stocking and harvesting. Seals and avian predators are controlled using predator nets. Farmed salmon are contained within their rearing areas (e.g., floating net pens) by jump barriers and containment nets meeting gear requirements specific to moorings, nets and cage design found in the Code of Containment. The CMS plan requires that all terminal gear and mooring lines be visually inspected regularly by divers to monitor for unusual wear or chafing and all mooring components will be hauled out of the water every six years for closer inspection. Maintenance of net pens includes regular cleaning and visual inspections by divers for extreme wear. All nets deployed must be individually tagged and regular maintenance records must be kept on site. For each individual net placed in active service a written maintenance log will track the net by date of deployment and time in water and any service to the net such as in-water inspections and dates of shore-side cleaning. Maintenance and stress testing shall be recorded and kept until a net has been condemned or retired. The gear maintenance log and any corrective actions will be maintained on site by the permittee until an annual performance audit is completed. Each aquaculture company maintains records of all gear deployed, these records are audited annually by a third party and the results of these audits are reviewed by the Services and permitting agency for compliance to permit conditions. Mandatory audits and escape notification are required for losses greater than 25% of cage biomass or 50 fish greater than 2 kg in size. Facilities found not in compliance will be required to initiate corrective measures to bring the facility into compliance before smolts can be transferred. Any deficiencies found during the routine annual audits are corrected through a corrective action plan and if major deficiencies are found, a follow up audit to monitor the progress of implementing corrective actions is conducted. Commercial freshwater hatchery facilities located on rivers with endangered salmon populations are required through a MEPDES permit to eliminate losses of juvenile salmon by screening discharges from the hatchery. For example, a three barrier system is required to be installed on the outflow from each facility to prevent salmon from escaping into streams and rivers. As is illustrated in Table 3, documented farmed origin salmon entering US GOM DPS Atlantic salmon rivers have decreased significantly since the full implementation of these measures in 2005.

In the past, the Maine aquaculture industry has participated in the supplementation program by rearing eggs derived from GOM DPS rivers pecific broodstock and holding mature adults to be released into the river. Preliminary analyses indicated that the adults stocked in 2001 were responsible for an increase in the number of redds documented within each recipient river (Finaly *et al.* 2002). In an effort to directly estimate the reproductive success of these fish, Mackey and Atkinson (2003) trapped redds in the Dennys River and Cathance Stream in the spring of 2001 and 2002 to estimate the number of fry emerging per redd and to document the quality of the fry (size). Small numbers of fry were detected, verifying that some reproduction did occur. Although interpretation of the results was problematic, the authors still believed they had detected both failed and extremely low rates of reproduction by the net pen-reared adults (Mackey and Atkinson 2003).

A follow up study by Mackey and Brown (2003) investigated the possibility that the poor reproductive success displayed by stocked pen-reared adult Atlantic salmon was due to fertilization problems caused by poor or defective gametes. The study indicated that there was not a problem with the gametes of these fish. However, the low rates and late timing of sexual maturity among both males and females in the study indicate that spawning in the wild may have been at a lower rate than expected due to a paucity of sexually mature fish. Furthermore, spawning well past the window of natural spawning may have reduced the reproductive success of those fish that did sexually mature and spawn. The study concludes that future enhancement efforts that use adult salmon as natural spawners should not be attempted before issues of maturation rates and timing are resolved (Mackey and Brown 2003). Although these assessment studies were somewhat problematic, all efforts undertaken to date (ultrasonic telemetry, redd counts, fry trapping, electrofishing) to evaluate the success of the adult pen-reared stocked salmon indicate that they achieved low reproductive success. As a result, the adult stocking program has probably not contributed significantly to the current status of the GOM DPS. However, this approach may show promise, particularly in rivers with very low or no adult returns, if some factors (such as low maturation rates and timing) can be addressed (Mackey and Atkinson 2003).

More recently, Cooke aquaculture and MDMR BSRFH embarked on a cooperative venture to hold and re-condition up to 250 Atlantic salmon kelts at the Bingham hatchery located on the Kennebec river. The four year old adults were transferred from the United States Department of Agriculture (USDA) National Cold Water Marine Aquaculture Research Center in Franklin, Maine shortly after spawning was completed. The fish originated from eyed eggs of Penobscot F_1 origin transferred from CBNFH to the USDA facility in 2004 (e.g., 2003 spawn). Preliminary analyses indicated there was significant movement of adults prior to spawning with some fish moving out of the river. Limited reproductive success was observed in these individuals which has lead to investigations into the methodology around releasing hatchery stocks into the wild. More recently attempts have been made to hold adult Atlantic salmon returning from the ocean at the CBNFH facility during the summer and releasing the fish into different drainages later in the fall prior to spawning. Similar results from the previous studies found a high tendency of fish to move with some fish exiting the drainage completely. Attempts are being made to refine the stocking practices and understand the factors behind the limited spawning success of these programs.

NOAA aquaculture Program

The NOAA aquaculture program (established in 2004) is focused on providing support for developing environmentally sustainable aquaculture. Funding opportunities are made available through federally managed programs such as the Saltonstall-Kennedy (S/K) grant program (established in 1990) and the National Marine Aquaculture Initiative program initiated in 1998 – which serve as competitive grants programs supporting research and demonstration projects advancing sustainable marine aquaculture. Through the S/K grant program, the NMFS set aside federal money in 2003 to promote the continued development of the Atlantic salmon aquaculture industry by minimizing the potential for negative impacts on wild Atlantic salmon. Some of the projects funded included many fish health projects investigating ISAV (i.e., monitoring and detection techniques, developing effective vaccines), an engineered lift-up system to reduce environmental impacts and investigations into understanding the behavior of escaped farmed fish (Whorisky et al. 2006) and the feasibility of their recapture.

b. Documentation of Escapes from Marine Aquaculture Facilities

Based on the information presented below, and on the previously cited evidence regarding impacts of escapees, it is the NMFS' opinion that the escape of aquaculture salmon into the

GOM DPS has had a negative effect on wild salmon and that this effect will likely continue into the future. As demonstrated below, there is substantial evidence that, where these aquaculture facilities exist, there are substantial escape events and that a portion of the escaped fish make their way into river systems.

The finfish aquaculture industry has been operating in Maine since about the 1980s. Permanent and temporary weirs and trapping facilities on nearby GOM DPS rivers have provided information on the number of aquaculture fish entering these rivers. Atlantic salmon from marine aquaculture facilities have been found in the Union, St. Croix, Penobscot, Dennys, East Machias, and Narraguagus Rivers (USASAC 1995-2010). Escaped aquaculture salmon have also been documented in the recreational fishery and observed in the Boyden, Hobart, and Pennamaquan Rivers (all streams that flow into Cobscook Bay, where 16 of the 26 farm sites in the Maine industry are currently located). Aquaculture fish have also been reported by anglers in the Dennys and East Machias Rivers since 1995. In 1999, 23 (64%) of the fish captured in a trap in the St. Croix River were of aquaculture origin; 63 (91%) of the fish captured in the Union River were aquaculture fish; and three of the fish trapped in the Narraguagus River were commercially cultured. In 2001, 65 of 83 (78%) of the fish captured in the Dennys River and 58 of 77 (75%) in the St. Croix were aquaculture escapees (USASAC Annual Report 2002/14). Also in 2001, three or four superimposed redds were documented in the Dennys River, which had been constructed either by aquaculture escapees or released captive-reared broodstock, in the short stretch of suitable spawning habitat between the weir and tidewater (USASAC 2002). In 2002, four of the six returns to the Dennys River (67%) were of suspected aquaculture origin (USASAC Annual Report 2003/15).

Beginning in 1996, sexually-mature escapees have been documented annually in Maine rivers. In the St. Croix River, 17 escapees were examined in September 1998 and five (30%) exhibited evidence of sexual maturation. In 1999, all three escapees in the Narraguagus River were sexually mature males (USASAC Annual Report 2000/12). In 2001 in the Dennys River, four of the 16 female escapees examined were sexually mature and one of the seven male escapees examined was sexually mature (USASAC Annual Report 2002/14). In 2005, escaped aquaculture origin farmed fish from vandalized sites in Canada entered the Dennys River and possibly other DPS waters (Greg Mackey Pers. Comm.). Since 2005, no aquaculture origin fish have been documented in GOM DPS rivers (Table 2).

Table 2. Aquaculture Atlantic Salmon Caught in Traps and Weirs in Maine Rivers, in Numbers of Fish, 1994-2010

	St.Croix	Union	Narraguagus	Dennys	Pleasant	DPS rivers Total
1994	97	n/a	1	48	n/a	49
1995	14	n/a	0	4	n/a	4
1996	20	n/a	8	21	n/a	29
1997	27	n/a	0	2	n/a	2

1998	24	n/a	0	1	n/a	1
1999	23	63	3	n/a	n/a	3
2000	30	6	0	29	0	29
2001	58	2	0	65	0	65
2002	5	6	0	4	0	4
2003	9	0	0	2	0	2
2004	4	0	0	0	0	0
2005	35	4	0	8	n/a	8
2006	7	0	1	4	n/a	5
2007	1*	0	0	0	n/a	0
2008	0	0	0	0	n/a	0
2009	0	0	0	0	n/a	0
2010	0	0	0	0	0	0

Data source: U.S. Atlantic Salmon Assessment Committee Report 2011
n/a- No trapping facility in place and/or operational, * found dead on fishway screening

More complete data in regards to aquaculture escape events occurring at the existing permitted sites within the GOM DPS are being reported, documented and collected as information becomes available from any new events. These data reflect the best available information to estimate the historic and future impact of escaped aquaculture salmon on the GOM DPS of Atlantic salmon. However, these data do not represent complete information on the total number of marine aquaculture escapees historically intruding into the GOM DPS rivers because: (1) there is a lack of counting or interception facilities on several GOM DPS rivers; (2) escapees are not externally marked (previously aquaculture escapees have been identified by physical characteristics such as fin deformities, scale patterns, and body shape and size); (3) these interception facilities do not operate year-round, and; (4) commercial salmon culture in Maine started several years before existing weirs and trapping/counting facilities were placed on salmon rivers. An accurate count of Maine industry origin escapees is further confounded by the fact that some of the escapees detected in the GOM DPS rivers may have come from nearby Canadian marine cages. While these data do not show the total number of marine aquaculture escapees that have entered GOM DPS rivers, they can be used as an index for the number of escapees expected to enter the GOM DPS rivers. In view of the fact that the NMFS are not able to count every escapee entering each GOM DPS river, the actual detection of escapees in a GOM DPS river at which there are weirs or traps, while an underestimate of opportunities for interaction, appears to be a reasonable surrogate method by which to measure incidental take (see ITS section for more detail).

In summary, data from 1994 through 2010, showed the median number of aquaculture fish detected in GOM DPS rivers with weirs (Narraguagus, Dennys, and Pleasant River) was 3 per year (see Table 3 below). However, data from 2002 through 2010, (i.e., the aquaculture industry in Maine after implementing ACOE special conditions and Cobscook Bay management plan), showed the median number of aquaculture fish detected in GOM DPS rivers with weirs and traps was 0. The median value was used to represent the number of fish detected in GOM DPS rivers during the period of 1994-2010 because the data has skewed distributions due to the nature of the escape events which occur randomly in time and have values of escaped farmed salmon which have a wide range. Therefore, the median value better represents the data than the arithmetic mean to determine the middle value or central tendency and describes the likelihood of escape events better. The NMFS also specifically looked at the time period, 2002-2010, because the industry has implemented measures to reduce escapes and minimize disease outbreaks (e.g., CMS plans and Cobscook Bay Management plan), which also significantly reduced the number of active farms and amount of gear deployed. For comparison, analyzing the data from 2002 through 2010 by using the arithmetic mean, indicates the number of escapes detected in GOM DPS rivers, on average, was about 2 fish per year, a significant decrease since the previous Biological Opinion was concluded in 2003. More importantly, this information indicates that the number of aquaculture origin escapes detected in GOM DPS rivers have declined from a high of 65 in 2001 to zero over the last four years. The previous Opinion concluded that, beginning in 2006, the Services expected that the number of escapes from the 42 existing sites would fall to 16 as a result of implementing the ACOE special conditions. However, the data collected from 2006 through 2010 has indicated a larger decline in escape events and detections in GOM DPS weirs than previously estimated. Further, the number of active finfish leases has significantly declined since the original Opinion in 2003 from 42 to 26, whereas many of the previous lease site permits were surrendered.

In Atlantic Canada, most aquaculture occurs in the lower Bay of Fundy and Passamoquoddy Bay. Since the aquaculture industry began in the Canadian Maritimes in 1979, escapees have been documented in 14 rivers in New Brunswick and Nova Scotia (DFO 1999). The Magaguadavic River in Canada is monitored for interactions between wild and commercially-culture fish and has found aquaculture origin adults entering this river in most years. In the past, farmed females have been shown to successfully spawn in the river and in 1993 up to 55% of the redds were at least partially of farmed origin (Carr *et al.*, 1997). Escapees from Canadian fish farms, particularly those from Passamaquoddy Bay and the Bay of Fundy, are likely to enter Maine rivers along the Downeast coast and thus may have contributed to the current endangered status of Atlantic salmon in the Downeast SHRU.

There have been few reports of large scale escapes from Canadian fish farms in the past. However, in 1994 a large scale escape event led to many aquaculture origin fish showing up in some of the rivers in the Bay of Fundy Region up to two years after the event occurred (Carr *et al.*, 1997). Additionally, in 2004 between 20,000 and 40,000 fish escaped from an aquaculture facility in New Brunswick. Further, four marine salmon aquaculture sites in New Brunswick, Canada, were vandalized from early May through November 2005, resulting in approximately 136,000 escaped farmed salmon (Bean *et al.*, 2005). Most escapees were unmarked one sea winter salmon of similar size (5-10 lbs). Escaped aquaculture origin farmed fish from these vandalism events entered the Dennys River and possibly other DPS waters in 2005 (Greg Mackey Pers. Comm.).

There were four known cases of vandalism to sea cages in Passamaquoddy Bay during 2005.

- A site on the west side of Deer Island had an escape in May of approximately 13,000 fish with an average weight of around 1500 grams.
- The same site had an escape on or about August 22 for another loss of approximately 13,000 fish, which at that point weighed around 2,400 grams.
- A site near St. Andrews lost approximately 20,000 fish in mid-August that were about 400-500 grams.
- Two sites near Deer Island lost about 100,000 market size (i.e., 5-10 lbs) farmed salmon from 11 different cages on November 9 or 10.

More recently, during December 2010, approximately 138,000 aquaculture salmon escaped into the Bay of Fundy when a storm caused gear failure to a site off Deer Island, in New Brunswick, Canada. Also, during this time another escape occurred from a cage site off Grand Manan Island, Canada resulting in the loss of approximately 33,000 farmed salmon.

c. Hatchery Escapement

There are currently three active commercial hatcheries in Maine that continue to supply juvenile salmon for grow-out in cage sites in Maine, as well as Canada. Two of the three of the active commercial hatcheries supporting salmon farms in Maine are located within the Atlantic salmon GOM DPS (Gardner Lake hatchery in East Machias, Bingham hatchery in Bingham, Maine). Cases of chronic and large escapements from freshwater hatcheries in Maine and Canada have been documented and are discussed further below. Carr and Whorisky (2006) investigated rivers and streams in New Brunswick, Canada which had a commercial hatchery operation sited within the watershed and found over 75% of the streams surveyed had juvenile salmon of aquaculture origin. A relationship has been demonstrated between the reproductive success of cultured fish and the amount of time that the fish has lived in nature before reaching sexual maturity (i.e., better reproductive success if the escaped fish have lived longer in a stream) (Jonsson 1997). In a controlled experiment, Garent *et al.* (2003) found mature male parr of farmed origin were extremely successful in fertilizing eggs when competing with their wild counterparts. In support of this work, Weir *et al.* (2005) designed an experiment to quantify the spawning behavior and fertilization success of mature male parr of different genetic origin (e.g., farmed, hybrid and wild). Their study found the differences in behavior among mature male parr of farmed, hybrid and wild origin can result in differences in reproductive success. Overall, the data showed there was poor embryo survival. However, even in the presence of large adult males, precocious parr participated in 68-73% of the observed spawning events conducted during the study. From these data they concluded that there was a high variance in fertilization success among mature male parr and that parr of farmed origin can successfully fertilize eggs in competition with wild parr or adult males. Consequently, the NMFS believe that escapees from freshwater hatcheries may pose a larger threat to wild populations than escapees from marine cage sites. The earliest life stages of fish (such as sac fry) that might escape from hatcheries, however, are not likely to survive the temperature differences between elevated incubation water and colder river temperatures.

In the past, annual population assessments conducted by MDMR BSRFH on Chase Mill Stream, a tributary to the East Machias River, have documented suspected aquaculture salmon in the vicinity of a commercial aquaculture hatchery discharge (Gardner Lake hatchery). In October 1999, Chase Mill Stream was specifically electrofished in the vicinity of the hatchery outlet and 28 suspected aquaculture-origin salmon were collected (USASAC 2000/12). These fish are frequently characterized by deformed fins and occasionally by their large size, compared to wild parr. Subsequent improvements were made at the Gardner Lake hatchery in accordance with CMS requirements as part of the Maine Pollution Discharge Elimination System (MPDES) permit conditions to address escapement, including the addition of drum filters and multiple barrier screens.

In 1999, the NMFS Northeast Fisheries Science Center (NEFSC) monitored the outmigration of smolts on the Pleasant River using a rotary screw smolt trap deployed near the head of tide in Columbia Falls, Maine. A total of 676 smolts were captured between April 22 and May 29; 31 smolts (approximately 5%) were observed with fin deformities, coloration and body form suggesting that they were from freshwater hatcheries (aquaculture fish generally display these characteristics due to the conditions of rearing in the freshwater hatchery). Scale samples and tissue samples for DNA analysis were also collected. Based on additional information provided by scale pattern analysis and genetic assignment test, it was subsequently determined that approximately 20-25% of the 1999 smolt run in the Pleasant River was of commercial hatchery origin. Following the capture of these fish, electrofishing surveys were conducted within Beaver Meadow Brook at the outflow of the Deblois hatchery. Cursory electrofishing surveys documented 87 salmon parr near the vicinity of the hatchery outflow. The effects from the hatchery escapement were minimized due to the location of the hatchery on a small tributary (Beaver Meadow Brook) and a stretch of dead water habitat before reaching the Pleasant River. This information led the Maine Atlantic Salmon Technical Advisory Committee (TAC) to conclude that hatchery-origin Atlantic salmon are escaping into the Pleasant River drainage from the Deblois hatchery, and that the escaped fish represent a threat to the remnant Atlantic salmon populations in the Pleasant River drainage (TAC 2000). Subsequent improvements were made at the Deblois hatchery to address escapement, including the addition of filters and screens.

In recent years the annual production of smolts for the Gardner Lake hatchery has been approximately one million. There have not been any smolts produced at the Deblois hatchery since 2001. Furthermore, the lease on the Deblois facility has not been renewed by any private firm beyond its expiration in 2004. The Bingham hatchery located on the Kennebec River also supports the marine salmon farms and will be providing salmon smolts to stock into net pens in the US. Recent improvements (e.g., installation of drum filter and containment screens) have been made at all of these hatcheries to help minimize escapement and comply with MEPDES permit conditions. Moreover, the industry has developed a hatchery CMS plan for each facility that includes a Hazard Analysis Critical Control Point (HAACP) analyses done for each hatchery that follows the hatchery production cycle from arrival of eggs to smolt transport. The effectiveness of CMS plans, filters, and screens in eliminating escapes from the three active hatcheries has been documented through annual audits and records which are required as part of the MEPDES permits in place at this time. Escapes of juvenile salmon from hatcheries could still occur from catastrophic events (e.g., floods, icing of the water intake, and power outages). Escapement of juvenile aquaculture salmon from hatcheries into GOM DPS river watersheds could negatively contribute to the status of the GOM DPS, although with recent hatchery improvements, escape events are much less likely to occur.

Interactions (i.e., competition for food and habitat) between escaped hatchery juveniles and wild salmon, particularly in the East Machias and Pleasant Rivers, are reasonably certain to have occurred and to have negatively contributed to the current status of the GOM DPS. Furthermore, prior genetic testing of juvenile Atlantic salmon collected in the East Machias River has identified fish with genotypes indicative of European origin. These fish would have been either escapees from the industry hatchery in the watershed, the offspring of an aquaculture escapee that entered the rivers and spawned, or the offspring of a juvenile hatchery escapee that later matured and spawned as either a precocious male parr or a returning adult. Genetic introgression would have resulted from fish that are a product of interbreeding between GOM DPS salmon and aquaculture escapees.

d. Interactions between Aquaculture Escapees and Wild Salmon in GOM DPS rivers

Detailed discussion of the impacts of escaped aquaculture salmon on wild populations is included below to support the conclusion that escapees have negatively affected the status of the GOM DPS. This subject is presented in more detail in this Opinion because of the relationship of this subject to the proposed action (i.e., many of the aquaculture-related factors contributing to the current status of the GOM DPS will continue to have an adverse effect on wild salmon in the future, even after adding the special ACOE conditions to the proposed permit for Black Island South aquaculture site).

In this section, NMFS' describe the genetic risks associated with interactions between domesticated Atlantic salmon of aquaculture origin and wild origin. The long term genetic effects from these interactions are associated with loss of genetic diversity among and between populations and the subsequent loss of fitness to the individual offspring and entire population. These effects are well documented; however it is difficult to predict the severity and direct impact from each interaction. Genetic studies demonstrate that there are significant differences between Maine, Canadian, and European Atlantic salmon populations (NRC 2002, and the references therein; Spidle *et al.* 2003). There is much scientific evidence that interbreeding among genetically divergent populations negatively impacts natural populations and may influence the ability of a population to evolve to changing environmental conditions (e.g., Utter *et al.* 1993; Verspoor 1997; Youngson and Verspoor 1998; McGinnity *et al.* 1997, 2003). When genetically divergent populations (e.g., GOM DPS salmon and aquaculture escapees) interbreed, the resulting progeny may be less fit than their parents because of the loss of local adaptations (Fiske *et al.*, 2006; Bourret 2011). The loss of fitness incurred by the affected individuals is termed outbreeding depression. Outbreeding depression is more likely to occur when interbreeding is between genetically differentiated populations, such as when a cultured fish from non-local sources interbreeds with a locally adapted wild population [Independent Scientific Advisory Board (ISAB) 2002].

Mork (1991) characterized the potential permanent effect of one generation burst of immigrations (i.e., effect when large numbers of fish escape from farms near spawning rivers) on the genetic differentiation among wild stocks. He reported that small Atlantic salmon populations may be most vulnerable to burst immigrations, and that these events could be the most significant way in which farmed salmon affect the genetic structure of wild populations. Natural selection may be able to purge wild populations of maladaptive traits, but may be less able to do so if the intrusions occur regularly year after year. Under this scenario, wild population fitness is likely to decrease as the selection from the artificial culture operation overrides wild selection (Fleming and Einum 1997; Hindar *et al.* 1991).

The following paragraphs describe studies from Europe and Canada demonstrating genetic interactions and competition between wild and escaped aquaculture Atlantic salmon. Similar studies on genetic and behavioral interactions have not yet been conducted in Maine. However, given the knowledge that aquaculture fish do escape from Maine marine pens and subsequently enter Maine GOM DPS rivers, conclusions from these European and Canadian studies can be used to analyze how aquaculture escapees are likely to have affected the current status of the GOM DPS.

Analysis of carotenoid pigments in eggs taken from the Magaguadavic River in New Brunswick in 1993 revealed that at least 20% of the redds were constructed by females that were commercially cultured and another 35% were of possible commercially-cultured origin (Carr *et al.* 1997). A study in the River Vosso, western Norway, examined synthetic astaxanthin (an additive to commercial fish feed) in offspring of fish. The study found that nine (45%) of the 20 female spawners in the sample were of confirmed farmed origin. Eggs from two of the farmed females showed that they had escaped recently and had entered the river and spawned before ingesting much natural food. Seven of the farmed females spawned eggs that indicated the females had ingested natural food for a prolonged period, indicating that they lived in the ocean for some time before entering the river to spawn. The study concluded that it is likely that all of the three-year classes of Atlantic salmon, which dominated the parr stock in this river in 1996, had more than 50% farmed female contribution. This study concluded that the effect of farmed escapees was dramatic and that the original stock was being gradually replaced by farmed salmon (Saegrov *et al.* 1997).

A multi-year study (1992-1995) was conducted in a natural tributary of the Burrishoole River system in western Ireland to compare the performance of wild, farmed, and hybrid Atlantic salmon progeny. Survival of progeny of farmed fish to the smolt stage was significantly lower than that of wild salmon. The progeny of farmed fish, however, grew faster and displaced native fish downstream (McGinnity *et al.* 1997). This study demonstrated that both farmed fish and hybrids can survive in the wild. It also indicates that escaped farmed salmon can produce long-term genetic changes in natural populations (McGinnity *et al.* 1997). The authors caution that repeated intrusions of escaped farmed salmon will depress smolt productivity in a cumulative fashion, potentially creating an extinction vortex (i.e., an inescapable downward spiral in population numbers; McGinnity *et al.* 2003). Following up on this study, McGinnity *et al.*, (2003), looked at returning adults from the next generation produced from these crosses and found these fish can survive and return as adults, however, at lower than predicted return rates as compared to their wild counterparts. Backcrosses of farmed origin with wild cohorts demonstrated higher survival to adult (89%) as compared to farmed X farmed offspring (2%) and resulted in more 2 SW adults than would typically be found in this catchment or river basin.

Fleming *et al.* (2000) undertook a large-scale experiment in order to quantify the lifetime success and interactions of farm salmon invading a Norwegian river. Sexually mature farm and native salmon were genetically screened, radio-tagged and released into the River Imsa where no other salmon had been allowed to ascend. The farm fish were competitively and reproductively inferior, with this inferiority more pronounced in farm males than in females. There were also indications of selection against farm genotypes during early survival of offspring of released adults, but not thereafter. Evidence of resource competition and competitive displacement existed, as the productivity of the native population was depressed by more than 30%. There was also considerable overlap in the diets of native, farmed, and hybrid offspring. Results indicated that such annual invasions have the potential for impacting population productivity, disrupting local adaptations, and reducing the genetic diversity of wild salmon populations. The native population will eventually be composed of individuals that have all descended from the migrants. Thus, farm salmon compete well against wild fish in the short term. Furthermore, even though farm fish may be competitively and reproductively inferior in the long term, repeated intrusions from different year classes of escapes of farm fish will result in genetic introgression.

Hindar *et al.* (1991) stated that the effects of gene flow can be reduced by assuring that the genetic differences between escaped fish and recipient wild populations are as small as possible. The authors further indicated that one way to achieve this objective of minimal differences is to strive for aquaculture programs that are based on local salmon populations. This approach will not prevent the cultured stocks from becoming increasingly different from their wild ancestors, because of selective breeding within the aquaculture industry and the inevitable process of domestication. It will, however, prevent the introduction of highly exotic genes into local wild populations.

Crozier (1993) analyzed the genetic changes that occurred to the wild population of Atlantic salmon in the Glenarm River in Northern Ireland following a significant escape in 1990 from a nearby salmon farm which led to interactions with farmed and wild salmon in the river. Looking at the variation across eight polymorphic allozyme loci to determine if any genetic change resulted from the spawning of farmed salmon in the river indicated two variant alleles were present in the farmed salmon which were not found in the wild population. A follow up investigation one year later showed a shift in allele frequency towards those in the farmed population indicating successful spawning had occurred between the farmed and wild populations. Further investigations seven years later showed significant changes to the genetic composition of the wild stocks after the first escape event, possibly indicating genetic introgression through hybridization of farmed and wild stocks (Crozier 2000).

e. Diseases and Parasites

Transmission from farms to local wild stocks

Disease transfer from farmed fish to wild fish was identified as a threat to the persistence of the GOM DPS in a previous Opinion to the ACOE on the issuance of permits for the maintenance and installation of marine net pens in coastal Maine waters (USFWS 2003). Migrating GOM DPS Atlantic salmon can be exposed to and infected by close proximity to diseased aquaculture sites or infected by escaped farmed salmon (DFO 1999). The greatest disease risk to both farmed and wild stocks is through the introduction of exotic pathogens into areas where local stock have no innate resistance, or through amplification of endemic pathogens. Serious epizootics[2] of furunculosis and *Gyrodactylus salaris* in stocks of salmon in Scotland indicate the severe consequences of new disease outbreaks linked to movements of live fish for farming or restocking purposes (McVicar 1997). This epizootic of furunculosis in Scotland became a severe problem in farmed Atlantic salmon during the latter part of the 1980s. In view of the fact that the furunculosis bacterium can spread up to a radius of 10 km from cage sites, it is highly probable that local stocks of wild fish were being regularly exposed to the infection during that period (McVicar 1997). Transfer of furunculosis from farmed salmon to wild salmon in Norwegian rivers has been documented (DFO 1999). Yet another example of a disease transmitted from a farm to a local wild stock is the spread of IPNV from a heavily infected freshwater rainbow trout farm into neighboring stocks of wild fish, including salmon, up to 7 km away (McVicar 1997). Although transmission of disease from Maine salmon farms to the GOM DPS has not been detected, these examples of disease transfer from farmed to wild salmon in other countries clearly demonstrate the risk to the GOM DPS.

Sea Lice

Control of disease outbreaks within farms has markedly improved in recent years, reducing the risk of farms being a focus or multiplier of locally occurring diseases, but problems still remain with some diseases and parasites, particularly sea lice. Lice from salmon farms contribute to lice populations in wild salmonids, but the extent and consequences of this have not been quantified (McVicar 1997). Outmigrating salmon smolts may acquire sea lice infestations if they migrate close to infected salmon aquaculture facilities (Krkocek 2005). For adult salmon returning to their natal streams to spawn, the threat is likely lower. Since most strains of lice commonly found to infect Atlantic salmon are not tolerant of low salinity, as soon as the fish enters freshwater, sea lice die and fall off. In Norway, the level of sea lice infestation on wild fish in some areas where Atlantic salmon farming is concentrated has been found to be ten times greater than in areas where there are no farms (NASCO 1993; Fiske *et al.*, 2006). A study by Jacobsen and Gaard (1997) also observed sea lice on wild and escaped farmed salmon in open ocean feeding grounds in the Norwegian Sea. It is also possible that escaped farm salmon transfer increasing numbers of sea lice to wild salmon in the open ocean. Sea lice affect fish by degrading their protective mucous layer and making them more susceptible to secondary infection or infestation by other parasites, thereby reducing fitness of the host. High densities of sea lice on an individual can cause direct mortality to the host. While sea lice are commonly present in low numbers in wild stocks, their presence rarely causes mortality or severe pathological effects (such as experienced on commercial aquaculture farms).

Post smolt trawling efforts conducted in Penobscot Bay have provided some insight to the levels of sea lice on salmon smolts as they enter salt water and migrate through the nearshore waters of the Gulf of Maine. Data from smolt captures in Penobscot Bay indicate very low levels of sea lice infestation, with very few fish having any lice at all (Sheehan Pers. Comm.). However, the closest salmon farm site was over 60 miles from the area covered by the research survey.

[2]An epizootic is a disease affecting a greater number of individuals than normal; typically epizootics involve many individuals in the same region at the same time.

Additional information from anticipated research investigating fish community structure in Cobscook Bay should provide valuable information for outmigrating smolts that pass through nearshore waters populated with salmon farms.

ISAV

On December 18, 2001, the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) implemented an ISAV indemnity, surveillance, biosecurity, and epidemiological research program for farm-raised fish in the United States. Participation in this program is mandatory for all salmon growers and covers all salmon finfish farms in the state. USDA's goal is to control and contain the disease through rapid detection and depopulation of salmon that have been infected with or exposed to ISAV. The APHIS program is being interfaced with the State of Maine's husbandry and bay management program that is being implemented via the Maine DMR's authority described in the previous sections above.

On January 7, 2002, the Maine DMR and the APHIS ordered the eradication of up to 1.5 million salmon located in seven aquaculture facilities in Cobscook Bay that were infected with or exposed to the ISAV. The January 2002 order followed the earlier removal of over one million ISAV-exposed fish by the aquaculture industry, as directed by the MDMR. The fish were removed from Cobscook Bay and the entire bay was fallowed for ninety-two days. The fallowing involved the removal of all the fish and the cleaning and disinfection of all the associated net pens, barges, and equipment at all the farms. The equipment was cleaned and disinfected by high pressure steam, either at the facility or off site. All cleaning and disinfection were authorized and supervised by the Animal Plant Health Inspection Service (APHIS) program. Additional surveillance by the APHIS and the MDMR includes tracking of the following: the dispersion of the virus in the water column; the attenuation of the virus on surfaces over time; and the environmental distribution of the virus in the water column, sediments, alternative species, and sea lice.

The MDMR BSRFH, working directly with the aquaculture industry, developed a comprehensive program of husbandry and management practices to restock Cobscook Bay in the spring of 2002 and 2003. MDMR's husbandry program requires that bay management areas be created for all finfish facilities; i.e., all farms within a bay management area must abide by standards that; (1) require farms to be stocked with only one year class of fish; (2) limit the capacity of bays and individual farms impacted by ISAV; (3) mandate fallowing between production cycles, and; (4) govern the density and stocking procedures for individual farms. Cobscook Bay was divided into two management areas: only the southern portion of the bay was stocked in 2002 (and will be stocked in even years thereafter); the northern portion was empty until spring 2003. In 2002 and 2003, fish farms in the bay were stocked with approximately 25% less fish than was previously authorized. The MDMR's bay management program is being developed following an evaluation of other ISAV control programs in New Brunswick, Canada; Scotland; and Norway. These jurisdictions have developed control programs that have been successful in minimizing further outbreaks of the disease.

A Finfish Bay Management Agreement has been developed for all US companies operating sites in Cobscook Bay and select Canadian companies operating sites immediately adjacent to

Cobscook Bay. The foundation for this agreement is coordinated management of common bay areas with Maine and New Brunswick agreeing to manage the Cobscook, Campobello, and Deer Island marine sites as one management area. There are several benefits to this approach: (1) better coordination of site fallows; (2) fewer overlapping year classes in production; and (3) reduced disease transmission between year classes. This approach is critical to effective disease management and addresses several key factors in minimizing outbreaks of ISA and sea lice. The Bay Management Area Fish Health and Biosecurity Plan guidelines are intended to minimize the spread of infectious diseases such as Infectious Salmon Anemia (ISA), through rigorous fish husbandry protocols and third party biosecurity audits. This agreement also seeks to control movements of fish and vessels within the bay in order to minimize disease transfer between US and Canadian marine sites. In addition to the bay area agreement, a compilation of best management practices and gear standards have been incorporated into a Code of Containment, CMS and Integrated Pest Management Program. These industry wide programs follow current state, federal and New England fish health protocols and are permit conditions for commercial Atlantic salmon aquaculture in Maine.

These programs developed by the USDA APHIS and the MDMR to address outbreaks of ISAV in the aquaculture industry should reduce the threat of this disease to wild salmon. Amplification of endemic diseases, such as ISAV, poses a threat to wild populations of salmon, but continued surveillance and monitoring programs should reduce the risk of future outbreaks within the aquaculture industry and therefore reduce the risk of transmission of ISAV to wild salmon. Furthermore, the U.S. is working with Canada on joint strategies for managing ISAV, recognizing the importance of working together on issues affecting a common water body.

Additionally, in response to the recent outbreaks of ISAV at finfish aquaculture facilities, the Maine DMR has implemented new fish health regulations. The MDMR's rules include mandatory surveillance and reporting of all testing results for ISAV in Cobscook Bay; sites with a confirmed case of ISAV are automatically subject to a remedial action plan developed by the MDMR. Vessel and equipment movement is also restricted. Prior to the rule changes, surveillance was not mandatory and reporting for the disease was only required when either active or passive surveillance identified a confirmed case of the disease. Sampling is now conducted monthly for all active finfish facilities in the state. The new rules expand the MDMR's authority to take action not only at infected facilities, but at those exposed to ISAV as well. These rules require the MDMR to consult with all relevant state and federal entities with expertise in ISAV control.

Although ISAV has not been observed to be a problem for wild stocks, the NMFS are concerned that ISAV will directly affect pre-spawning adults. More studies and tests need to be conducted on wild and aquaculture fish to look at existence of and trends in disease prevalence. Intensifying ISAV surveillance, avoiding future outbreaks, improving containment of aquaculture fish, and maintaining healthy, disease-free fish farms should reduce the disease risk that aquaculture salmon pose to wild stocks. ISAV and other diseases and parasites probably have not had much of an impact on the current status of the GOM DPS but remain a threat. In general, risks associated with the transfer of endemic diseases from farmed escapees appear to be low; however, the consequence of transmission of exotic diseases could be severe.

f. Salmonids Other than Atlantic Salmon

Some of the ACOE permits for existing aquaculture sites in Maine authorize the permittees to culture salmonid species other than Atlantic salmon. Salmonid species other than Atlantic salmon that escape from private aquaculture operations also pose a threat to wild Atlantic salmon populations. Because other salmonid species would be grown using the same equipment and husbandry practices as are used for Atlantic salmon, escapement of these other species would be expected.

Crossman (1991) reported the escape of rainbow trout from Canadian aquaculture facilities in New Brunswick and Newfoundland. Escaped salmonids can adversely impact wild Atlantic salmon through competition for food and habitat, transfer of disease, and redd superimposition. During the juvenile life stage of various salmonids, similar life histories and habitat preferences can overlap, creating interspecific competition that could adversely affect growth and survival of juvenile Atlantic salmon. Interspecific competition between Atlantic salmon and other salmonid species is dependent on a number of factors, including the availability of food and habitat. Ecological interactions between salmonids can lead to increased mortality and decreased growth (Fausch and White 1986).

Early life stages of the Atlantic salmon and rainbow trout are remarkably similar in habitat preferences, behavior and feeding (Bley and Moring 1988). The rainbow trout is native to the western United States and is an introduced species in Maine. In areas where Atlantic salmon and rainbow trout co-occur, significant niche overlap is expected to occur and under limiting circumstances, vigorous competition for resources is expected (Volpe *et al.* 2001). At juvenile stages, rainbow trout are likely to significantly interact with Atlantic salmon (Gibson 1981). Interspecific competition during juvenile stages may be an important factor affecting growth and survival of Atlantic salmon (Fausch 1988). In a study by Volpe *et al.* (2001), rainbow trout performance was superior to that of Atlantic salmon. Colonization of freshwater habitats within GOM DPS rivers by rainbow trout, either through intentional stocking or escapement from aquaculture facilities, could have adverse effects on wild salmon populations. Escapees could have a competitive advantage through domestication; selection for higher growth rates and aggressive feeding behaviors would enhance an escapee's ability to out-compete and displace resident Atlantic salmon.

Some salmonid strains, including sea trout (*Salmon trutta L.*) and rainbow trout are known to be asymptomatic carriers of ISAV (Nylund *et al.* 1997). Escaped or caged rainbow trout may pose a threat to endangered Atlantic salmon by functioning as a reservoir for ISAV. The virus does not seem to cause significant mortality of infected rainbow trout (Nylund *et al.* 1997).

The NMFS recognize that there has been only limited use of other salmonid species by the aquaculture industry in Maine. In previous years rainbow trout (*Oncorhynchus mykiss*) have been reared in marine net pens. These rainbow trout have been all female triploid (i.e., sterile) fish. Sterility in fishes includes the induction of a chromosomal abnormality, triploidisation, which can be accomplished in two ways: 1) chemical (anesthetic) and 2) physical (pressure and heat shocking ova), the latter of which is preferred in salmonids (Johnstone 1998). Both techniques are highly variable, and neither is 100% effective (Sutterlin and Collier 1991).

Therefore, a single sex population (all female) is used to eliminate the ability to effectively mate and produce offspring (Cotter *et al.* 2000). In a competition experiment, triploids were less aggressive than diploid rainbow trout (O'Flynn *et al.* 1997), which could reduce impacts to wild salmon through competition for food and space. Furthermore, the NMFS have no information on past escape events that may have resulted in other farmed salmonid species entering GOM DPS rivers. Although there is no indication that other aquaculture salmonids have impacted the status of the listed salmon to date, use of these fish poses risks similar to those posed by farmed Atlantic salmon, such as competition for food and space, disease transfer, and redd superimposition.

4.2 Summary and Synthesis of the Status of the GOM DPS

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

Actions occurring in the action area have the potential to impact Atlantic salmon. Despite improvements in water quality and the elimination of directed fishing for this species, Atlantic salmon still face numerous threats within the geographic range of the GOM DPS.

Summary of Current Status of GOM DPS of Atlantic salmon

Naturally-reproducing Atlantic salmon populations in the GOM DPS are at extremely low levels of abundance. This conclusion is based principally on the fact that spawner abundance is below 10% of the number required to maximize juvenile production, juvenile abundance indices are lower than historical counts, and smolt production is less than a third of estimated capacity (AASBRT 1999, USASAC 2009-2010, ICES NASWG). Conclusions about the status of the GOM DPS, however, must take into consideration the multiple-year classes of fish within the river and at sea at any given time, as well as the river-specific fish being reared in the USFWS's hatchery program. Furthermore, in order to acquire a full picture of the future of the species, consideration of the numbers of fish in the USFWS's hatchery program, the numbers of fry annually stocked, parr abundance, smolt outmigration, and marine survival.

Recovery efforts for GOM DPS of Atlantic salmon heavily rely upon stocking of hatchery reared juveniles into suitable juvenile rearing habitat to enhance wild populations. The river-specific conservation hatchery program is designed to supplement natural production in many of the GOM DPS watersheds. The USFWS conservation hatchery program for GOM DPS of Atlantic salmon raises several life stages in captivity and subsequent stocking of these hatchery fish supports most of the adult salmon returns to Maine rivers (USASAC 2010). In some GOM DPS river systems, hatchery reared smolts are stocked each spring along with sufficient numbers of stocked fry to fully saturate available habitat. Parr abundance has significantly increased as a result of the fry stocking program and the smolts have contributed significantly to adult returns.

There is much debate on the use of captive reared salmonids for use in recovery programs for threatened and endangered species. There is little empirical evidence showing successful recovery of listed salmon species in programs which primarily rely on re-introductions of hatchery reared fish to become self sustaining. This is because domestication causes changes to the genotypes of the individuals raised in captivity resulting from reduced selection pressures and changes due to adaptations to artificial rearing environments. For the GOM DPS hatchery program, the numbers of parr have increased, but parr abundance has not increased at the same rate as would be expected based on the level of fry stocking and previous estimates of in-river survival. The overwinter survival for parr during the winter just prior to their preparation for leaving the river and migrating to the ocean is of particular concern. Nevertheless, the higher numbers of parr in the rivers have resulted in more naturally reared smolts leaving the GOM DPS watersheds. Although the numbers of smolts have increased, they have not increased at the rate that would have been predicted based on levels of fry stocking and previous estimates of fry to smolt survival. Additionally, hatchery smolts stocked into the Dennys river in previous years has not contributed significantly to increased adult returns. These observations have increased concerns over hatchery practices, water quality and habitat conditions (NRC 2003). In an attempt to identify factors within the river that may be causing low parr abundance and overwinter mortality, the University of Maine in collaboration with the MDMR BSRFH are investigating habitat productivity, annual growth of hatchery stocked fry, parr and smolts and migration of smolts from different GOM DPS rivers. Recent smolt tracking studies and in river smolt trapping conducted by NOAA have also identified high mortality associated with outmigration through the estuary.

Atlantic salmon stocking in rivers of the GOM DPS has historically used stocks from the GOM DPS and neighboring river systems. The river specific stocking program for Atlantic salmon in the GOM DPS was initiated in 1991 by the State of Maine and the USFWS. Currently, captive broodstock populations are held in isolation bays at the Craig Brook National Fish Hatchery (CBNFH) in Orland, Maine for the following rivers: Penobscot, Dennys, East Machias, Machias, Narraguagus, Sheepscot, and Pleasant. These hatchery populations have increased the effective population size (wild and captive) and provide a buffer against extinction in the wild. The focus of the program has been to maintain genetic diversity of stocks and produce fry, parr and smolts that are then stocked back into the river of parental origin. Genetic monitoring indicates that genetic diversity and allelic richness remains high across multiple generations, although there is annual fluctuation in allele diversity most alleles are being maintained in the population. The stocking program seeks to saturate the available habitat in each river with hatchery juveniles. The hatchery program has contributed to increases in adult returns, but not to the levels needed for self-sustaining populations in the GOM DPS.

The North Atlantic Salmon Working Group of the International Council for the Exploration of the Sea (NASWG ICES) prepares an annual estimate of pre-fishery abundance of Atlantic salmon in the North Atlantic based on spawner abundance and habitat conditions. This relationship contains two phases, a high productivity phase and a low productivity phase based on observations of spawners and pre-fishery abundance since 1977. The relationship has been in the low productivity phase for the last twenty years. The stocking efforts described above have resulted in an increase in the number of salmon leaving the GOM DPS. However, low productivity in the marine environment in recent years has prevented this level of stocking from increasing returns. As shown from previous decadal data sets, a change in the marine environment to the high productivity phase would result in more returns to the GOM DPS. In an attempt to identify factors that are causing high smolt mortality, studies are currently being conducted to examine smolt condition and migration behavior post stocking as well as the role of estuaries in supporting a healthy ecosystem and recovery of Atlantic salmon.

Studies focused on partitioning out specific freshwater life stages of Atlantic salmon have identified periods of low survival during the last winter that parr are in the river (overwinter survival) and during smolt outmigration from rivers, in combination with salt water entry and during the long ocean migration. When considering the cumulative impacts from these low survival rates at various salmon lifestages, clearly these are critical factors which negatively impact the ability to recover Atlantic salmon. Research to identify factors affecting survival, and implementation of measures to address these factors, are ongoing and are of critical importance for the future of the GOM DPS of Atlantic salmon. Since the initial listing became effective (November 2000), a number of conservation activities have been accomplished, while others are still in progress. These include increasing accessibility to quality spawning and juvenile rearing habitat, river specific stocking, culvert replacement and dam removal, habitat restoration, and habitat protection through easements and education and outreach activities. Many of these actions are being implemented according to the 2005 Atlantic salmon recovery plan prior to the completion of a new recovery plan for the species.

As described earlier, the Maine Department of Inland Fisheries and Wildlife (MIFW) annually stocks a variety of native and non-native salmonids into rivers within the GOM DPS for recreational angling. Moreover, many non-native species of fish have been introduced illegally into GOM DPS watersheds by individuals that wish to fish for these species. Introduced fish may prey upon GOM DPS juvenile salmon and compete with wild salmon for food and habitat. Several other fish species occur in the GOM DPS rivers, including smallmouth and largemouth bass, pickerel, and landlocked salmon. Other species of freshwater fish introduced in GOM DPS rivers such as smallmouth bass (*Micropterus dolomieu)*, have also played an important role in defining distribution of juvenile Atlantic salmon in larger mainstem habitat. In general, conclusions cannot be drawn regarding the competitive effects of these species on salmon, as no quantitative data are currently available to accurately characterize the outcome from these interactions.

Although direct loss of listed salmon in the wild from the diseases described in this Opinion are difficult to assess, there is also an indirect effect of these diseases through their impact on the river specific fish culture programs in place to enhance maintenance and recovery of the GOM DPS. The impacts of ISAV, IPNV, SSSV and coldwater disease in the fish hatchery environment are of particular concern because hatchery managers are required to destroy diseased salmon to prevent the spread of disease and this loss of hatchery populations will hinder salmon recovery. Such diseases could pose a significant threat to the USFWS's hatchery program and its' ability to function effectively, thereby significantly degrading an important salmon recovery strategy.

There are currently 26 existing aquaculture lease sites permitted to rear Atlantic salmon in the Gulf of Maine from Penobscot Bay to Cobscook Bay. Most pen sites (16) are located in the Cobscook Bay area, several net pen sites also occur in Machias Bay and Blue Hill Bay. Atlantic salmon that escape from marine aquaculture facilities and freshwater hatcheries supplying these marine facilities pose a threat to GOM DPS of Atlantic salmon inhabiting coastal Maine rivers. The threat posed by commercially cultured salmon is increased by the fact that the industry currently has fish in net pens that are in close proximity to GOM DPS rivers containing GOM DPS Atlantic salmon. Escapement and resultant interactions with native stocks continue under current aquaculture practices. There is substantial documentation that escaped farmed salmon disrupt redds of wild salmon, compete with wild fish for food and habitat, interbreed with wild salmon (disrupting local adaptations), degrade benthic habitat, and transfer disease or parasites (Fleming *et al.* 2000; Clifford *et al.* 1998; Youngson *et al.* 1993; Webb *et al.* 1993; Windsor and Hutchinson 1990; Saunders 1991). There is also a concern with potential interactions when wild adult salmon migrate near closely spaced aquaculture cages, creating the potential for behavioral interactions, disease transfer or interactions with predators [Department of Fisheries and Oceans (DFO) 1999; Lura and Saegrov 1991; Crozier 1993; Saegrov *et al.* 1997; Carr *et al.* 1997]. While current state and federal regulations pertaining to finfish aquaculture have reduced the risks to the GOM DPS (including eliminating the use of non-North American Atlantic salmon and improving containment protocols), risks from the spread of diseases or parasites and from farmed salmon escapees interbreeding with wild salmon still exist.

5. 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, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02, June 30, 1986). 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. This Opinion also examines the likely effects (direct and indirect) of the proposed action on critical habitat designated for the GOM DPS of Atlantic salmon. The likely effects of the proposed action on the GOM DPS of Atlantic salmon and designated critical habitat are examined, within the context of the species' current status and the environmental baseline (which considers past and present impacts in the action area).

5.1 Effects to the GOM DPS of Atlantic salmon

Gear Installation and Construction Effects

According to the ACOE, suspended sediments and noise as a result of anchor and pen placement at the site may displace fish in the action area. However, these effects are anticipated to be short-term. The ACOE does not anticipate any long-term effects to endangered salmon resulting from the installation and construction of net pens at the proposed Black Island site. NMFS agrees that the footprint of the proposed activity is extremely small when compared to the area available in Blue Hill Bay for migrating Atlantic salmon. Therefore, based upon information presented in the ACOE permit for Black Island, the NMFS concurs that activities associated with the installation of net pens is likely to have temporary sedimentation effects and cause some minor effects to benthic resources as a result of anchor placements and would be insignificant and discountable.

Operation and maintenance effects

The effects associated with routine operations and maintenance occurs from rearing farmed Atlantic salmon and includes effects to the environment and benthic resources as a result of daily feeding, administering medications to control disease and parasites, routine cleaning of equipment and harvesting. Many of these potential effects are minimized by applying good fish husbandry practices and implementation of strict fish health protocols as required through state and federal permits. The applicant proposes to use a feed barge and computer controlled feeding regime to minimize feed waste and prevent uneaten food from reaching the bottom; which subsequently limits impacts to the benthic resources. This newer technology uses computer software to monitor the amount of food being dispersed to each cage and interfaces with remote sensors placed in the cage to detect when feeding activity drops. Since this technology has been implemented, the MDMR has observed a decrease in the amount of benthic impacts associated with excess food buildup and resulting changes to the benthic communities inhabiting the bottom directly under the cages. Implementation of strict fish health protocols requires regular monitoring of sea lice levels and disease prevalence, as a result, all medication is administered only when needed and is prescribed by a licensed veterinarian (see section on disease below for more information). Further, these fish health protocols in place require annual cleaning of equipment to occur on land to prevent effects to the water column and reduce the likelihood any pathogens and sediment will be transferred to the environment.

Competition from escapes of farmed fish

A proposed aquaculture site in Blue Hill Bay raises concerns over interactions with escaped farmed fish due to the close proximity of GOM DPS rivers as described herein this Opinion. There have been several aquaculture sites developed in the Blue Hill Bay area in the past and some Atlantic salmon escapees of aquaculture origin have been documented in the closest GOM DPS river (e.g., Union River). Since historic information on escapes lacked a site specific mark and there was limited reporting of escape episodes, it is difficult to assess where the fish might have originated. More recently, several of these sites in Blue Hill Bay have been decommissioned and a few sites have been rearing shellfish species such as blue mussels and oysters. The closest Cooke managed finfish site (e.g., Black Island) is also located in Blue Hill Bay and will have common fish husbandry, management practices and personnel shared between sites. Similar gear, moorings and operational protocols are proposed to be implemented at the Black Island South site which should minimize the difficulties in establishing a new facility and lease site. The net pens proposed (100 meter circular cages) will be new or transferred from the existing inventory within Cooke. The placement of new moorings and gear should significantly reduce the likelihood of experiencing gear failure due to fatigue or worn out components. Also, having experienced staff familiar with the environmental characteristics of the site should assist with preparation for storm events and serve to reduce the likelihood of gear failure due to severe weather. Nevertheless, gear failure associated with extreme storm events and consequently escapes of farmed fish could happen as observed in the past and described in more detail below.

The first documented incidence of adult aquaculture salmon in Maine rivers occurred in 1990 when 14 of 83 (17%) of the rod catch in the East Machias River were of marine aquaculture origin. In 1993, there were an estimated 20 aquaculture origin escapees and 13 wild salmon in the Dennys River (61% of the run was aquaculture origin escapees). In 1994 and 1997, escaped aquaculture origin salmon represented 89% (48 of 54) and 100% (2 of 2), respectively, of the documented run for the Dennys River. The detection of escapees in a weir or trap on the Dennys, Narraguagus or Pleasant Rivers annually since 1994 provides evidence that there have been losses at marine cages and that some percentage of the escaped fish have entered rivers within the GOM DPS. As described in the section on "Status of the Species and Factors Affecting its Environment", in the past, tens of thousands of aquaculture fish have escaped from farms in Maine and Canada. Some of these escapees from commercial aquaculture facilities have been intercepted in the GOM DPS rivers and many have been sexually mature.

There has been little information available to evaluate the disposition or distances that escaped farmed salmon have moved in Maine because: (1) aquaculture fish have not been marked, either in Maine or Canada and; (2) reporting of escape events has not been required. Despite these prior inadequacies, NMFS has sufficient information to document aquaculture origin fish in several GOM DPS rivers. More recently, a study funded by NMFS in 2004 to address the current information gaps on escaped farmed Atlantic salmon in the Northeast, Whorisky *et al.*, intentionally released farmed Atlantic salmon in Cobscook Bay, Maine to better understand the movement of escaped farmed fish. For this study, releases of sonically tagged farmed Atlantic salmon occurred seasonally (spring/winter) to determine if time of year influenced migration behavior. The data showed the fish dispersed from the site (> 1 Km) in less than a day and most likely followed the strong tidal currents and major discharge routes. No fish were detected in the 43 rivers being acoustically monitored for the presence of these fish. One fish was detected as far south as the Narraguagus estuary over 180 days post release. They also found the survival rates of these fish were low, with the spring releases having greater mortality (84%) than the fall releases (56%) (Whorisky *et al*, 2006). A study in Norway (Heggberget *et al.* 1993) documented farmed Atlantic salmon migrating distances of 15-90 km from the point of intentional release. Bergan *et al.* (1991) reported that the proportion of escapees in rivers near fish farms (less than 20 km) was higher than in other rivers. Recent evidence suggests that escaped Atlantic salmon are capable of swimming significant distances from their marine pen sites in the Pacific Ocean (Volpe *et al.* 2000). For example, the northern limit of Atlantic salmon aquaculture in the Pacific Northwest is the northern tip of Vancouver Island, British Columbia (approximately lat 51°N); both marine and freshwater recoveries of Atlantic salmon are now well documented in Alaska, at least 300 miles away.

Despite the lack of specific information on the fate and movements of Maine aquaculture salmon escapees, based on the studies of Whorisky *et al.*, Heggberget *et al.*, Bergan *et al.*, and Volpe *et al.*, in combination with the distances of Maine salmon farms from GOM DPS rivers, NMFS is confident that escapees from Maine sites have entered GOM DPS rivers, including those without weirs or traps. Cooke's proposed site off Black Island is located within the geographic range of the GOM DPS (Figure 1). The closest river within the action area with known populations of endangered salmon (e.g., Union River), is located approximately 15 km from Black Island. The furthest river within the action area with known populations of the GOM DPS of Atlantic salmon is the Dennys River at 150 km from Black Island. Further, based on the studies described herein, NMFS is confident that escapees from the proposed Black Island South site could enter many of the rivers within the Penobscot and Downeast SHRUs with known populations of GOM DPS endangered Atlantic salmon.

Many of the interactions with escaped farmed fish occur during spawning events in the wild; these often results in a change to the overall reproductive success of the individuals involved. The presence of farmed fish on the spawning grounds during breeding can cause a disruption of mating or courting behavior. Interbreeding between farmed and wild salmon cohorts could reduce the spawning success of an individual breeding pair due to the infertility of the individuals involved. Studies on adult farmed salmon have shown that reproductive success is greatly reduced, where gene flow is greater from wild male to farmed female than farmed male to wild female (Weir 2004). Only sexually mature fish that spawn successfully in the wild can effectively change or influence the genotypes of surviving individuals in the next generation. There is evidence that genetic interactions between wild and farmed fish can disrupt local adaptations, threaten stock viability and composition, and lower recruitment (DFO 1999; Einum and Fleming 1997; Fleming and Einum 1997; Grant 1997; Saegrov *et al.* 1997; Roberge 2008., Bourret *et al.*, 2011). Experimental tests of genetic divergence between farmed and wild salmon indicate that farming generates rapid genetic changes as a result of both intentional and unintentional selection in culture and that those changes alter important fitness-related traits (McGinnity *et al.* 1997, 2003; Gross 1998; Roberge 2008). These changes have been identified as a threat to wild populations when cultured fish escape and subsequently compete and breed with wild salmon (Hindar et al. 1991; Fleming and Einum 1997; Roberge 2008; NMFS and USFWS 2005; 74 FR 29344; June 19, 2009).

Redd superimposition

Farmed fish may also have a direct effect on the viability of the eggs deposited within the redds; where there is redd superimposition from late spawning farmed individuals. The available scientific evidence on interactions with farmed origin fish suggests that aquaculture escapees sometimes spawn later in the year than wild fish (Lura and Saegrov 1991). Farmed salmon in Scandanavian countries have been documented to spawn successfully, but later in the season than wild salmon (Lura and Saegrov 1991; Jonsson *et al.* 1991), a factor that increases the potential for limiting the success of wild spawners through redd superimposition. Superimposition occurs when an existing redd is overlaid with eggs from a later spawning fish. Redds can suffer egg mortality (e.g., the eggs can be dislodged from the gravel) when new redds are superimposed on top of the existing redd. Lura and Saegrov (1991) observed farmed females destroying the redds of wild salmon (i.e., superimposition in an effort to create new redds over existing redds). It is reasonably certain that at least some aquaculture escapees from Maine salmon farms have exhibited the same behavior, disrupting redds and therefore reducing the reproductive success of GOM DPS salmon. For example, escapees entering the Dennys river have superimposed redds on top of the redds previously created by released hatchery brood fish or wild fish (Ernie Atkinson Pers. Comm.). In doing so, the escapees can dislodge the eggs of the wild fish or lay their eggs on top of the wild salmon eggs, resulting in a direct take of eggs, as well as other forms of take (i.e., harm or harass) through the disturbance of individuals engaged in spawning behavior which could result in a reduction in the reproductive success of the wild fish.

The potential also exists for Atlantic salmon redds to be superimposed by spring-spawning rainbow trout (Volpe *et al.* 2001). This risk, however, is reduced considering the biology of the species. Rainbow trout are typically late winter-early spring spawners, while Atlantic salmon in Maine typically spawn in the fall (mid-October through mid-November). This difference in spawning timing reduces the risk of reproductive interference. However, rainbow trout can still superimpose already established redds of Atlantic salmon. If the eggs in the Atlantic salmon redds have achieved sufficient development (such as reaching the eyed-egg stage) at the time of redd superimposition by rainbow trout, the Atlantic salmon eggs would be less susceptible to damage from this disruption, reducing the impact from redd superimposition.

Aquaculture escapees are also anticipated to negatively impact the reproductive success of wild fish by competing with wild stocks for preferred spawning habitat and mates. If aquaculture escapees are present in the rivers at the same time as wild fish, they may spawn with the wild fish, resulting in hybridization or unsuccessful gamete production and fertilization (Mackey and Brown). As explained in more detail previously in Section 3 (Status of the Species and Factors Affecting its Environment), this genetic introgression is likely to result in reduced genetic fitness of the wild stock, reducing its ability to cope with stress, disease pathogens and lowering reproductive success and therefore reducing numbers of wild fish in the future. Aquaculture escapees may also breed with each other, creating juveniles that will compete with wild juveniles for food and habitat and pose a future risk (i.e., if they become sexually mature) for genetic interactions with wild salmon. The impact of this anticipated genetic introgression is magnified by the extremely low number of fish surviving in the wild. However, the likelihood of this occurring is reduced by the biological differences inherent in domesticated or cultured fish used for commercial aquaculture. As previously described in Section 4, differences in the behavior and physiology of farmed fish significantly affect the ability of these fish to spawn in the wild and in order for these genetic impacts to occur, spawning between farmed and wild Atlantic salmon needs to be successful.

Disease

Because of the proposed site location being in close proximity to some GOM DPS rivers, disease and parasites may be transferred from aquaculture fish to wild fish in a variety of ways, including: (1) when wild fish migrate past net pens on their migration into or out of the rivers; (2) when aquaculture escapees and wild fish interact in the marine environment; or (3) when aquaculture escapees and wild fish interact in rivers, including when these fish are held at weirs or traps. Disease and parasite impacts were described in greater detail in Section 3 and 4. Many parasites and diseases are known to infect Atlantic salmon, but historically, Maine wild salmon populations are infrequently affected by them (Baum 1997). More recently, outbreaks of ISAV have raised concerns over disease transfers from aquaculture operations (see below). While it is possible escapees may affect wild stocks within the GOM DPS through the transfer of disease pathogens, there is currently not sufficient information to assume that disease transfer is reasonably certain to occur and result in take. However, while there is little evidence that impacts have manifested themselves in the wild salmon population to date, the threat remains as long as the aquaculture industry continues to operate in the geographic range of the GOM DPS.

ISAV appeared on the North American continent in 1996 in Canadian aquaculture pens, within the known infective range of U.S. sea pens. ISAV was first detected at a Maine salmon farm in Cobscook Bay in January 2001, with subsequent outbreaks at several other salmon farms in Cobscook Bay. The ISAV virus is extremely destructive to maturing salmon, and there is no known cure (USASAC 2000; 65 FR 69476, Nov. 17, 2000). Recent fish health surveys (2008-2010) have identified a new isolate (a variant or non-pathogenic strain) of ISAV from Maine salmon farms which presumably doesn't result in an epizootic event, but rather lays dormant in the population. The potential fish health risks from disease transfer are difficult to assess with great accuracy and confidence. Recent outbreaks of ISAV (2005 and 2006) on farm sites located in both Maine and Canada raise concern over escapees potentially transmitting the ISA virus. ISAV poses a major threat to both wild and hatchery populations. The potential exists for infected escaped farmed salmon to spread disease to endangered salmon populations. According to McVicar (1997) "the greatest disease risk to both farmed and wild stocks is through the introduction of exotic pathogens into areas where local stocks have no resistance". Strict fish health surveillance measures in place for both Maine and Canadian fish culture facilities allows monitoring diseases of concern for hatcheries and net pen sites before transfers and during fresh water and marine grow-out phases, but even the strictest monitoring cannot eliminate all occurrences of disease. In Maine, the outbreak of ISAV in Cobscook Bay and the close proximity of several fish farms to GOM DPS rivers raises concerns about wild salmon declines in the marine environment. The ISA virus has been found in wild salmon in Scotland (Raynard *et al.* 2001), as well as in confined rainbow trout, wild sea trout, and eels (65 FR 69469, Nov. 17, 2000). There has been one documented case of wild salmon exhibiting ISAV in Canada, but these wild fish were confined for a period in a trapping facility with infected aquaculture salmon (Whoriskey 1999).

The risks to the GOM DPS from transfer of sea lice from aquaculture salmon raised in net pens in Maine are reduced by bay wide management practices of fallowing sites, alternate year class stocking and sea lice treatments at fish pens to control outbreaks. Integrated pest management protocols in place for the Maine salmon farming industry include monitoring of sea lice levels and evaluating treatment efficacy. These guidelines include BMPs that seek to reduce the need for use of chemicals or medications. Routine monitoring of sea lice populations occur at least bi-weekly when water temperatures are greater than 8°C, and monthly when water temperatures are between 6°C and 8°C. A maximum treatment threshold for sea lice counts on individual fish are presently 1 gravid female and 5 pre-adult, on average, with a minimum of two samples. At the discretion of the licensed veterinarian, treatment may be initiated before such a count is reached. If therapeutic treatment is necessary, Emamectin Benzoate (SLICE®) has been prescribed to treat sea lice infestations since 2001 under an Investigational New Animal Drug (INAD) permit. In some cases smolts may receive a pre-treatment of SLICE® in the hatchery prior to placement at US marine sites. All treatments are authorized and monitored by the accredited Veterinary person in Charge (VC). If appropriate, coordinated bay-wide therapeutic treatments are used to reduce initial infection. All medications administered for the control of disease or parasites are in accordance with state and federal regulations and are prescribed by a licensed VC.

Recent scientific data has provided evidence that direct transfer of sea lice from salmon aquaculture facilities is a significant concern for recovery of depleted wild salmon populations. Further, resistance of *Lepeophtheirus salmonis* to therapeutic treatments used to control outbreaks of the parasite has been documented in other countries and is a growing concern for the US industry. The efficacy of using Emamectin Benzoate (Slice®) for treating sea lice infestations on thirteen farms in Cobscook Bay was evaluated from 2002-2005 (Gustafson et al, 2006). The treatment regime prescribed during this study followed guidelines provided within the USDA ISA Program Standards and Integrated Pest Management plan. The study showed a strong response to treatment as compared to pre-treatment baseline levels. Using untreated controls was not possible due to increased risk of exposure to ISAV. Additional investigational new animal drug studies for alternative treatments are ongoing with results and anticipated publications to follow. Starting in 2009, bath treatments of Hydrogen Peroxide have been administered under a new INAD to control the adult life stages found on salmon at sea.

Genetic introgression

Aquaculture escapees have been documented in Maine rivers (see Table 2) and previous genetic analysis of continent-of-origin of the current and past broodstocks maintained at CBNFH identified individuals of non-North American origin, putatively from reproduction of aquaculture adults, in five of six broodstock populations (Bartron Pers. Comm.). For at least three of these rivers without aquaculture hatcheries, the European-origin fish must have been the offspring of aquaculture escapees that spawned in the river with either wild fish or other escapees. Given the prevalence of farmed Atlantic salmon introgression observed in rivers outside the US (Carr 2009; Roberge 2008; Bourret *et al.*, 2011), indications of spawning by escapees in the GOM DPS rivers are not unexpected. Currently, analysis and screening of parr collected for broodstock occurs prior to spawning, thereby reducing the potential of spawning non-Maine Atlantic salmon. Screening methods have also been refined to include both continent-of-origin and likelihood of assignment to Maine populations. More recently, computer software has also been used to analyze the likelihood of matches to genetically marked Maine aquaculture individuals and should provide additional accuracy to determine the origin of the fish. To ensure no non-North American or aquaculture origin fish are used in the conservation hatchery program, all parr identified as such are culled out of the hatchery population prior to spawning.

The potential for genetic introgression to occur throughout all life stages is clear, and pose a risk to the GOM DPS. The biggest risk is amplification of deleterious genes and disruption of gene complexes that affect local adaptation and support immunological responses from exposure to disease pathogens. This could occur several ways; (1) if aquaculture/wild reproduction is successful, it is likely that opportunities for introgression will occur or (2) if aquaculture progeny enter the captive broodstock population. While it is possible to screen for farmed origin parr in the hatchery prior to spawning, interbreeding in the wild is impossible to prevent because not all parr are removed from the river, and therefore individuals of aquaculture or mixed origin will potentially exist in the wild. For example, looking at the potential genetic effects from the escape of farmed fish from Canada in the fall of 2005, introgression would first occur through wild precocious male parr mating with escaped farmed females. Subsequently, introgression in the wild would most likely occur through precocious parr of farmed or hybrid origin salmon spawning with wild or restoration adults or; in the hatchery from farmed or hybrid parr removed from the river for the captive broodstock program. Furthermore, returning adults of mixed origin (i.e., resulting from farmed or hybrid offspring) also have the potential to contribute to introgression. Based on the available scientific literature, along with the presence of escapees and putative offspring in the GOM DPS rivers, the NMFS have concluded that escapes from the Maine aquaculture industry constitute an existing and imminent threat to the GOM DPS through genetic interactions.

5.2 Effects from Interrelated or Independent actions

Transgenics

Research and development efforts on transgenic forms of Atlantic salmon and rainbow trout are currently being directed toward their potential use for sea pen aquaculture. Emphasis has been placed on enhancement of growth and low water temperature tolerance through the transfer of genetic material from other cold-tolerant species, such as flounder. In a study by Cook *et al.* (2000), growth-enhanced transgenic Atlantic salmon exhibited a 2.62- to 2.85-fold greater rate of growth relative to non-transgenic salmon, over the body weight interval examined. This study found that the transgenic experimental subjects possessed the physiological plasticity necessary to accommodate acceleration in growth well beyond the normal range for this species, with few effects other than a greater appetite and a leaner body (Cook *et al.* 2000).

The outcome of interactions with escaped farmed fish that have been genetically modified is not well documented. Because aquatic ecosystems function through complex interactions involving transfers of energy, organisms, nutrients, and information, it is difficult to predict the community-level impacts of releasing transgenic fishes that exhibit one or more types of phenotypic change (Kapuscinski and Hallerman 1990).

The Food and Drug Administration (FDA) received an application for approval to sell transgenic salmon in the United States. A private biotechnology company called Aqua Bounty, is pursuing legal authorization from the FDA to distribute Genetically Engineered (GE) Atlantic salmon for commercial sale and human consumption in the U.S. The fish are being marketed as AquaAdvantage® salmon and will be sold in select retail stores as cleaned and gutted whole fish or further processed into filets. The application is being reviewed under the authority of the Federal Food, Drug and Cosmetic Act as a new animal drug because the genetic construct used to make genetically engineered animals is an "article" that meets the definition of a new animal drug. The FDA is reviewing this application in regards to food safety issues focusing on consumption hazards and associated risks posed to the public and will comply with all statutory requirements of the National Environmental Policy Act; which includes an Environmental Assessment (EA) and summary Finding of No Significant Impact (FONSI). The assessment of environmental impacts includes an evaluation for the following specific conditions of production and use; 1) production of eyed eggs in Prince Edward Island (PEI), Canada; 2) shipment of eyed eggs to Panama; 3) grow-out of fish in the highlands of Panama; 4) processing of fish in Panama; and 5) shipment of table-ready processed fish to the U.S. Therefore, because the fish is being grown outside of the U.S., only the importation and distribution of the processed whole fish and filets are fully considered in the application. Any deviation from the above process will trigger a new action and will have to be reviewed under a separate application. Furthermore, the FDA is required to consult with NMFS on environmental risks associated with GE seafood products, including the impact on wild fish stocks. Staff from NMFS Northeast Regional Office in coordination with the Protected Resources and Aquaculture Program in Silver Springs, Maryland is currently consulting with the FDA on this matter.

Use of fish weirs to capture aquaculture escapes

Currently, there are temporary fish weirs located on two GOM DPS rivers (Pleasant and Dennys) that have remnant salmon populations. A weir is essentially a fence that is designed to lead the fish into a net or pound where they are captured (Baum 1997). These weirs and traps are used by state and federal fishery agencies to collect biological information about Atlantic salmon populations and, since the development of a salmon aquaculture industry in Maine, to prevent aquaculture escapees from entering Maine salmon streams and adversely affecting wild salmon. Aquaculture escapees are currently identified at the weirs by fisheries biologists using scale reading and physical characteristics such as fin deformities and body shape and size. Further analysis using specific genetic markers are compared to a database of commercial aquaculture broodstock and mating matrix to identify the potential parental pair used to create this offspring.

Typically, a seasonal weir is placed each year on the Dennys River at the head of tide in Dennysville, Maine and on some years the Pleasant River in Columbia Falls, Maine just upstream of the Route 1 Bridge. These two A-frame weirs both started operation in the spring of 2000. These weirs are designed to capture adult salmon migrating upstream, while allowing downstream migrating fish to pass freely. Prior to 2000, other types of temporary weirs (e.g., picket, floating, and resistance board) were sometimes placed on the Dennys, Pleasant and Sheepscot Rivers. These types of weirs are generally less effective in capturing fish than the current A-frame weirs. During periods when these older weirs were compromised, salmon may have gained upstream access (including aquaculture escapees). A fishway trap is located at the ice dam on the Narraguagus River in Cherryfield; this trap has been operated since 1991. Salmon have been observed jumping over the ice dam, so the fish trap is not considered 100% effective at intercepting upstream migrating salmon (USASAC 1996). The weirs and traps are generally in place and operating from mid-spring until the late fall of each year, although the dates can vary from year to year.

Escaped farmed Atlantic salmon that enter rivers with weirs may be intercepted and removed from the river, thereby preventing further in-river interactions between those escaped fish and wild salmon. However, weirs are not a complete barrier effectively preventing interactions because: (1) in some rivers there is spawning habitat below the weirs (e.g., the Dennys River); (2) the weirs are not present year-round, and; (3) the efficacy of the screening depends on the ability to be able to positively identify the fish as of aquaculture origin. The accuracy of identification of farmed fish at a weir or trap can be affected by the presence, persistence and readability of an external mark; scale preparation and readability; and experience of the individual tending the weir or trap. When water temperatures are high, the opportunity to handle fish in order to conduct an external examination can be severely limited (i.e., to avoid stress or injury to wild salmon that would be subsequently released upstream of the weir to spawn). Individual Atlantic salmon captured in a weir/trap and positively identified as aquaculture origin are removed from the system, and therefore are prevented from having additional impacts on wild salmon through redd superimposition, genetic introgression, competition or disease transfer. Their presence in a weir/trap, however, indicates that escapees are present in the marine environment, and some percentage of these escapees will continue to enter other rivers within the GOM DPS without weirs/traps and are likely to then adversely affect the wild stock through redd superimposition, genetic introgression, competition or transfer of disease pathogens. To date, the Machias, East Machias, Sheepscot, and Ducktrap Rivers and Cove Brook do not contain weirs or traps. Therefore, any aquaculture escapees at the Black Island site would have free access to these river systems where subsequent take is anticipated.

Although weirs are a useful tool for tracking GOM DPS salmon and reducing the number of aquaculture escapees that interact with GOM DPS salmon, there are some drawbacks to their placement in the rivers. The design and location of the weirs is intended to minimize any threats that may occur from excess handling, predators, and the possibility of excluding a fish from upstream passage to spawning habitat. Nevertheless, these threats will continue to exist, at some minimal level, as long as the weirs are in place. Interference with upstream fish passage and handling are the most significant known threats to adult migrating salmon associated with weirs. Adult salmon have been documented entering and then leaving a weir on their own, perhaps never to return to the weir (i.e., those adult fish were potentially prohibited from reaching upstream spawning habitat and reproducing). Although uncommon, biologists in Maine have mistakenly identified a wild fish as an aquaculture fish and have either removed the fish or returned the fish downstream of the weir rather than allowing the fish upstream passage. Handling adds additional stress to adult salmon, which can result in mortality or increased susceptibility to disease or predation, especially when water temperatures are high. A fish may be handled several times in the attempt to capture the fish and positively identify its origin. Lastly, wild and aquaculture salmon can be present in weirs at the same time, increasing the risk of disease transfer from farmed salmon to the GOM DPS. For the time being, fisheries biologists have determined that the benefits of learning more about the status of the GOM DPS and reducing interactions with aquaculture escapees outweigh the risks inherent in the use of weirs.

5.3 Effects to GOM DPS Critical Habitat

The environmental baseline of this Opinion describes the status of salmonid habitat, which is important for two reasons: (1) because it affects the viability of the listed species within the action area at the time of the consultation; and (2) because those designated critical habitat areas provide the biological and physical features and primary constituent elements (PCEs) essential for the conservation (i.e., recovery) of the species. The environmental baseline also describes the status of critical habitat over the duration of the proposed action because it includes the persistent effects of past actions and the future effects of Federal actions that have not taken place but have already undergone Section 7 consultation. There is no critical habitat designated for any federally-listed species in the project area, however, the action area as described in section 2.2, encompasses critical habitat designated for listed GOM DPS Atlantic salmon and therefore effects to critical habitat will also be analyzed in this Opinion.

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

Blue Hill Bay is a potential migration corridor for the GOM DPS of Atlantic salmon. The GOM DPS of Atlantic salmon potentially utilize Blue Hill Bay when emigrating through Penobscot Bay from the Union River, Ducktrap River and Cove Brook in the spring as smolts, and in the summer/ fall when returning as adults to spawn. As a result, there is the potential for GOM DPS Atlantic salmon to be present in the project area. Generally, salmon smolts begin moving out of Maine rivers in mid-April to June. Returning adult salmon can enter freshwater from May through early November. Out-migrating Atlantic salmon smolts are particularly susceptible to stress-induced mortality during their transition to the marine environment, and returning spawners rely on an olfactory sense to identify and navigate to their natal river.

Therefore, based on the above information NMFS has determined the location of marine net pen facilities in the marine environment does not affect the migratory corridor needed by adult or juvenile Atlantic salmon because of the small footprint of the project area as compared to the large geographic area found along the Maine coast. In addition, any effects to the designated critical habitat within the GOM DPS rivers and streams inhabited by wild Atlantic salmon will be temporary in nature and are insignificant and would not adversely modify critical habitat.

5.4 Summary of Effects to GOM DPS of Atlantic salmon

In summary, the proposed action is most likely to adversely affect individual Atlantic salmon within the Penobscot and Downeast SHRUs through fish escaping from this facility and entering the GOM DPS rivers and streams without weirs or traps and causing take through redd superimposition, competition for food, habitat and mates and genetic introgression. Some take may also occur in rivers with weirs or trapping facilities, for example where there is spawning habitat located downstream of the fishway or weir or if a fish enters when the weir is not in place. Information from relevant scientific studies, escape reports from the aquaculture industry and the detection of aquaculture fish in Maine GOM DPS rivers all discussed in this Opinion clearly establish that the anticipated impacts are reasonably certain to occur.

In view of this, NMFS has evaluated these impacts on the GOM DPS at a very detailed level of analysis. This analysis helps to distinguish the important difference between the impacts to individual GOM DPS salmon and effects to the population of salmon defined by the GOM DPS. The demonstrated influx of aquaculture fish into at least one GOM DPS river, repeatedly, over the last decade makes these impacts to wild salmon reasonably certain to occur. The greater the number of escapees that enter the GOM DPS rivers and the greater the period of time over which these events occur, the greater is the likelihood that the entire GOM DPS salmon population would be impacted versus occasional impacts to individual salmon within the GOM DPS. Therefore, to minimize the impacts of farmed fish interactions from the proposed Black Island South site facility to the any GOM DPS river or the entire GOM DPS population, NMFS has identified a limited number of farmed fish which are anticipated to enter GOM DPS rivers and may cause take that is incidental to the activities being permitted (see ITS section).

6. 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.

Future local activities that may impact the Atlantic salmon GOM DPS include agricultural and forestry practices, peat mining, and recreational fishing.

A. Agriculture

Agricultural production within the Penobscot and Downeast SHRUs of the GOM DPS includes the following: hay, silage, corn, livestock, Christmas trees, market vegetables, blueberries, cranberries, and horticultural plants (Maine Atlantic Salmon Task Force 1997). Water withdrawal for irrigation is the farming practice of greatest concern to the NMFS. Only the Narraguagus and Pleasant River watersheds are expected to continue to support significant agricultural water use, primarily for the blueberry industry, that may affect salmon in the future. However, as a result of a previous State Conservation Plan, a Water Use Management Plan (WUMP) were developed to better address the needs of Atlantic salmon, while allowing for continued use of irrigation water by the blueberry industry. The WUMP initiative identifies best management practices to conserve water on blueberry farms, and emphasizes use of alternatives sources, including wells and retention ponds, to avoid direct withdrawals from rivers and streams containing Atlantic salmon habitat. Although voluntary and non-regulatory in approach, the WUMP initiative should help reduce effects to salmon that would be caused by excessive agricultural water withdrawals.

No other agricultural practices are known to be major threats to salmon. However, due to the low numbers of returning adult salmon, minor impacts from erosion and sedimentation, livestock waste in salmon streams, or other agricultural practices take on added significance. Watershed councils are expected to continue to play an active role in successfully addressing a variety of non-point source pollution problems, including those related to agriculture and forestry, in the Penobscot and Downeast watersheds.

B. Forestry

NMFS does not believe that current and anticipated future forestry practices pose a significant threat to the well-being of the GOM DPS. Forestry is the dominant land use in the Downeast and Penobscot SHRUs especially in the Penobscot, Pleasant, Narraguagus, Machias, East Machias, and Dennys River watersheds. The Cove Brook, and Ducktrap River watersheds experience only limited forestry activity. Given the precarious status of the species, however, even minor impacts to wild salmon or their habitat should be recognized and addressed. Practices that cause erosion, reduced streamside shading, and debris dams are reasonably certain to occur and should be addressed. Forestry activities that cause erosion and stream sedimentation can degrade salmon spawning and juvenile rearing habitat. Removal of streamside vegetation can cause an increase in stream water temperatures that could lead to stressful conditions for salmon or make the habitat unsuitable. Debris dams caused by logging wastes can result in migration barriers that reduce the availability of salmon habitat. Consequently, watershed councils and Project Share are also expected to continue to play a role in addressing these forestry impacts through habitat connectivity and restoration activities.

C. Peat Mining

Continuation of activities at an existing peat mining facility in the Narraguagus River drainage may adversely affect Atlantic salmon within the Downeast SHRU. Peat mining can adversely affect Atlantic salmon and their habitat through the discharge of low pH water containing suspended peat silt and dissolved metals and pesticides. There is a concern that these factors may adversely influence juvenile salmon survival.

D. Recreational Fishing

Although the catch and release sport fishery for Atlantic salmon has been discontinued in Maine, recreational fishing that targets other species can potentially lead to incidental catch of various life stages of Atlantic salmon, resulting in injury or death. Atlantic salmon parr can be confused with brook trout and mistakenly harvested by anglers. The MIFW has stated that they are not able to estimate the number of Atlantic salmon caught as recreational bycatch or to estimate the resultant mortality [Land and Water Resources Council (LWRC) 1999]. Documented poaching events in 1998, 2000 and more recently in 2008 indicate that poaching occurs at fairly low levels in Maine rivers, and that poaching continues to pose a potential threat to Atlantic salmon.

Stocking of non-indigenous fish species and native enhancement fish for recreational fishing can increase the risks to wild salmon in the Penobscot and Downeast SHRUs through increased competition for food and through predation on juvenile salmon. Brook trout, brown trout, black bass, and landlocked salmon have all been stocked within the streams or headwaters of the Penobscot and Downeast SHRUs; impacts on salmon are still being monitored and evaluated. The State of Maine is assessing current stocking practices to identify possible adverse impacts to wild salmon.

Overall, the significance of the cumulative effects of the various activities discussed in this section on the Penobscot and Downeast SHRUs of Atlantic salmon is difficult to assess. The effects of these activities would also be expected to vary from one GOM DPS watershed to the next. It is important to realize that, although the cumulative effects mentioned are not threatening to the Atlantic salmon GOM DPS at the population level, the action area encompasses a large portion of the entire range of the GOM DPS. This results in a wide variety of perhaps individually minor impacts to the GOM DPS occurring over a vast geographic area encompassing many watersheds.

7. INTEGRATION AND SYNTHESIS OF EFFECTS

Although NMFS is reasonably certain that one or more of the impacts described in this Opinion (e.g., competition for food, habitat and mates, redd superimposition, genetic introgression) will occur as a result of the action, NMFS does not believe that every incident of an aquaculture fish entering a GOM DPS river will result in such take of GOM DPS salmon. NMFS does not anticipate that each aquaculture escapee that enters a GOM DPS river will cause redd superimposition or genetic introgression. For example, an escapee may not interact with any wild fish during the time of spawning or may have non-viable gametes which may lead to unsuccessful spawning.

While a certain level of impact is still anticipated, including some take, there are a number of factors mitigating these impacts at the GOM DPS population level. First, NMFS anticipates the permit conditions will both reduce the number of escapees entering GOM DPS rivers and eliminate the greatest long-term threat to wild salmon by eliminating the use of non-North American strains. Furthermore, there are multiple rivers within the GOM DPS and multiple-year classes present at any given time for each river (both within the river and at sea); consequently, each time an aquaculture escapee enters a GOM DPS river and causes an impact to wild salmon, the effect of that impact (e.g., redd superimposition or hybridization) is limited to only a subset of the entire river's population. The operation of a weir or trap on many of the GOM DPS rivers within the Penobscot and Downeast SHRUs also substantially reduces the opportunities for interactions between aquaculture escapees and wild salmon. Finally, the USFWS's river specific captive broodstock and stocking program effectively maintains population genetics and demographics for seven GOM DPS rivers, helping to offset the extremely low number of adult returns and minimizes genetic changes to the GOM DPS stocks in captivity.

Measures in place to minimize effects from commercial aquaculture operations

As explained in the "Description of the Action" section, the ACOE will require special conditions designed for the protection of the GOM DPS of Atlantic salmon from activities supporting commercial Atlantic salmon aquaculture in Maine. These proposed conditions, which NMFS expects to be incorporated into the issued permit, will significantly reduce, but will not eliminate, the potential for losses of farmed fish from net pens at the proposed Black Island South site. Losses of fish from net pens can occur in any one of three ways: (1) "trickle" losses of small numbers of fish during regular activities, such as rearing and feeding; (2) systemic losses during specific activities such as stocking smolts into cages, grading fish in net pens and harvesting; and (3) catastrophic losses due to predators, storms, structural damage, mooring failure, or accidents, such as vessels running into a cage. Losses from US cages have been attributed to all of these causes.

The special conditions required by the ACOE are also anticipated to provide much needed data to determine the efficacy of the containment measures implemented with a goal of eliminating losses of farmed fish. Annual third party audits validate the CMS plans and annual reviews from the appropriate state and federal agencies monitor these protective measures in place for compliance with the permit requirements (Fig. 3). Since 2005, third party audits of each marine and hatchery facility are conducted annually. The results from these audits have shown full compliance with CMS requirements and only minor infractions have been documented which did not decrease the effectiveness of the plans in reducing escapes. A diagrammatic representation is provided in Figure 3 to demonstrate the audit verification process in place to validate the ACOE special conditions implemented to reduce impact to wild Atlantic salmon from commercial aquaculture operations in Maine.

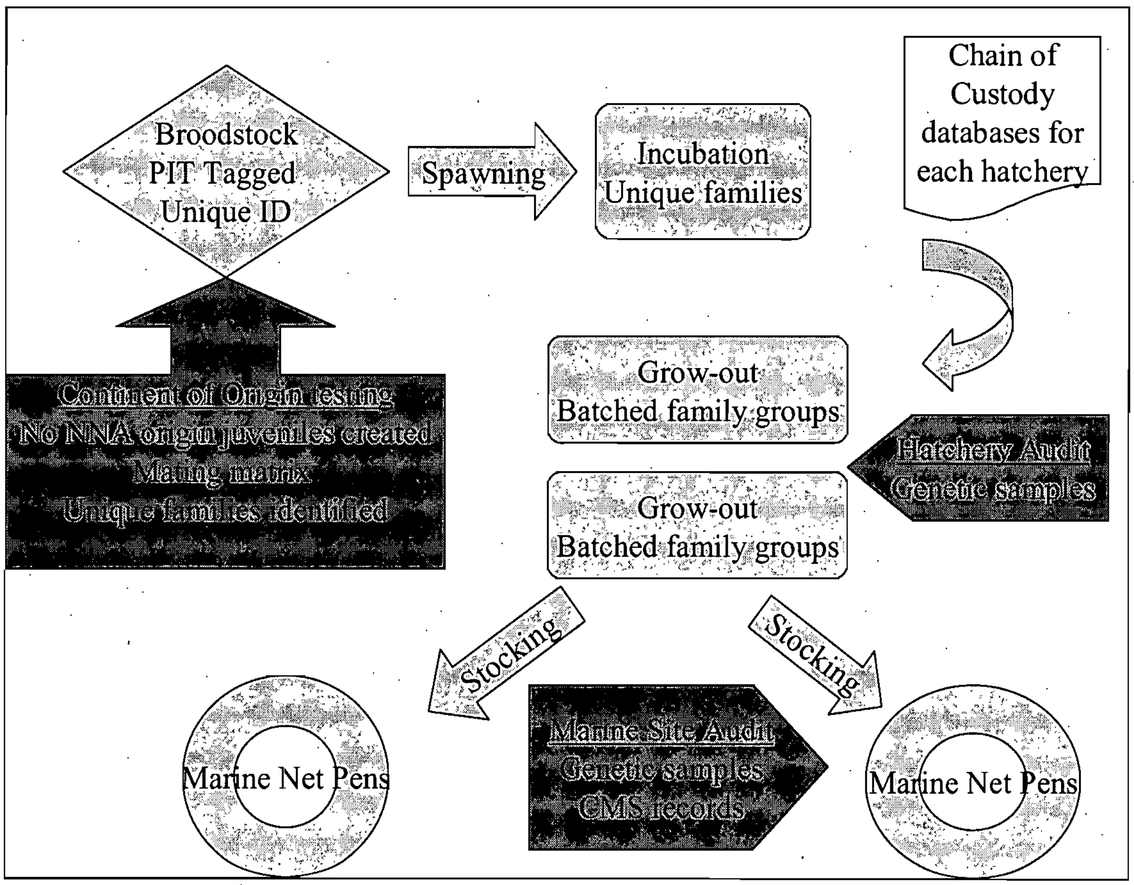

Fig. 3 QA/QC Program schematic of audit verification points

The ACOE special conditions proposed to be included in Cooke's proposed Black Island South site lease permit are specifically designed to address the effects of aquaculture on the endangered Atlantic salmon, as discussed above. However, even if the procedures described in the ACOE special conditions are implemented as envisioned at the site, there may still be accidents, storms or other events leading to failures of containment systems that result in an escape of aquaculture fish. Maine's fish farms are located in a highly dynamic ocean environment where net pens and their associated mooring gear are subject to damage from strong winds, high waves, ice, and boating accidents; these forces can damage gear and result in fish escapes, despite the best efforts of the aquaculture company's on-site staff. Furthermore, there will still be threats related to disease and parasites from aquaculture fish contained in net pens. Consequently, it is likely that some adverse effects to the Atlantic salmon GOM DPS will continue to occur with implementation of the proposed action. However, implementation of the proposed permit modifications significantly reduces the likelihood of interaction between farmed and wild fish and, consequently also significantly reduces the likelihood that any future interaction will appreciably reduce the potential for survival and recovery of the GOM DPS.

Efficacy of protective measures to minimize risk from aquaculture activities

The following section summarizes the ACOE protective measures and describes how these would address the risks from the proposed action and be implemented to reduce impacts to wild salmon.

1. Use of North American Stocks to Minimize Risk from Genetic Introgression

Special Condition No. 1 (Genetic Strain) removes the greatest potential for aquaculture-related effects (i.e., genetic introgression between the GOM DPS and non-North American strain stocks) to impact the survival and recovery of the GOM DPS of Atlantic salmon. By preventing the spawning of non-North American strain Atlantic salmon, Special Condition No. 1 immediately prevents the creation of any additional pure or hybrid non-North American strain Atlantic salmon in captivity or the wild. Condition No. 1 will ensure all fish stocked in net pens at the Black Island site will be of North American origin. This will reduce the severity of the adverse effects from the use of genetically divergent strains of aquaculture salmon on the GOM DPS. The best scientific data available concludes that large genetic difference between stocks of Atlantic salmon increases the likelihood that introgression between the two will result in significant, long-term, adverse impacts on the genetic composition of the wild stock. These genetic impacts would pose direct and indirect effects and significantly reduce the likelihood of survival and recovery of the GOM DPS of Atlantic salmon.

Adverse genetic interactions between North American aquaculture strain Atlantic salmon and wild salmon can still occur, although the absence of non-North American strain salmon will pose significantly less risk to the GOM DPS because the potential for highly exotic genes to be introduced into GOM DPS salmon will be eliminated (Hindar *et al.* 1991). Through the process of domestication, even North American strain aquaculture fish will genetically diverge from the wild strain. Therefore, it is still necessary to minimize escapees in order to minimize the adverse genetic impacts on the GOM DPS. If a North American strain aquaculture escapee successfully interbreeds with a wild salmon, this adverse genetic interaction can disrupt local adaptations, threaten stock viability, and lower recruitment. However, for introgression to reduce appreciably the likelihood of survival and recovery of the GOM DPS of Atlantic salmon as a whole, hybridization between escapees and wild fish would have to occur at a significant level within each river, occur in a number of rivers, and occur over a number of years. The likelihood of this occurring is reduced by the fact that: (1) not all of the GOM DPS rivers are in close proximity to marine cages; (2) some of the rivers are screened at least a portion of the year, and; (3) the CMS has significantly reduced the number of escapees entering rivers within the GOM DPS. Nevertheless, the potential for fish disease transmission and other undesirable ecological interactions exists, regardless of the genetic strain utilized by Cooke Aquaculture.

2. Improve Containment of Farmed Fish

Special Condition No. 4 (Containment) is intended to reduce the effects of escapement described above by requiring the facility to employ an approved Containment Management System (CMS), including a loss control plan that outlines critical control points (CCP) where escapement may occur. Developing a CMS plan will enable the facility operators to be aware ahead of time of specific areas, activities, and situations where the potential for escapement is elevated. This increased awareness and preplanning for escape response, severe weather procedures, and unusual event management is anticipated to reduce the frequency and magnitude of escapes. Auditing and the requirement for corrective actions should further the effectiveness of this system in reducing escapes over time, by providing a mechanism to continually update and improve upon the strategies and information outlined in the facility's CMS. Additionally, data collected on the causes of escapes will populate a database to provide a feedback loop to increase containment effectiveness and minimize the chances for these to occur in the future.

Reductions in the numbers of escapees entering rivers, as a result of the adoption of the CMS, have reduced the potential for genetic and ecological impacts from aquaculture activities. Fewer fish escaping from net pens has resulted in fewer fish entering rivers and therefore reduces the likelihood of interbreeding between escaped Atlantic salmon and the GOM DPS of Atlantic salmon. A reduction in number of escapees in rivers also reduces the impact of competition between farmed Atlantic salmon and wild Atlantic salmon. As explained previously, competition for mates, food and habitat is reasonably certain to impair essential behavioral patterns of wild Atlantic salmon including breeding, feeding, or sheltering (included in the concepts of harm and harass, which are included in the definition of take).

The CMS includes measures to reduce the potential for escapement to occur from all three of the types of losses identified above (i.e., trickle, systemic, and catastrophic losses). Inventory tracking, monitoring food consumption, and monitoring CCP will increase the potential for prompt identification of losses, which will result in quicker correction of the factors that lead to the loss, which in turn will reduce the potential for future losses. Monitoring the CCPs involved in management measures, such as smolt stocking, grading and harvesting, may result in the identification of improvements that need to be made in these management practices to reduce the potential for systemic losses during these activities. The CMS plan also includes provisions for maintaining records on equipment status, including dates of installation and maintenance, and requirements for net testing and mooring inspection. These provisions will reduce the potential for predator attacks or storms to cause damage that could result in catastrophic loss of fish from the net pens. This is significant, as equipment failures are more likely to result in large, one-time escape events, than are the other two types of losses identified above (i.e., trickle and systemic). The CMS also requires mandatory reporting of losses, which will populate a database that will facilitate our future ability to better understand the relationship between losses at cages and escapees entering rivers. While the two are known to be linked, and it is reasonable to assume that reductions in losses at cages will result in reductions in escapees entering rivers, there is no information, at this point in time, to be able to more specifically describe the relationship. Although it is not possible to precisely quantify the impact of these ACOE special conditions, it is reasonable to conclude that Special Condition No. 4 will result in a reduction in the frequency and magnitude of losses from net pens at the proposed Black Island site, which in turn will result in a reduction in the frequency and magnitude of escapees entering GOM DPS rivers (Table 3).

Unfortunately, evaluating the success of the CMS will be limited by the lack of a baseline, i.e., the lack of accurate information provided by the industry identifying the frequency, nature, genetic composition, and extent of past and ongoing escapes that is needed for comparison purposes (Table 1). As established in the November 19, 2003 biological Opinion prepared in response to the ACOE's proposed permitting of 42 existing aquaculture sites in the GOM DPS, it is reasonable to assume that the implementation of Special Condition No. 4 will result in at least a 25% reduction in the anticipated loss of fish from cages at the site that would otherwise occur under normal operation conditions (NMFS 2003).

This expected reduction is significant in reducing the frequency and number of escapees entering rivers. The potential for the most significant adverse genetic impacts to wild stocks is greatest if escapees persistently enter a river on an annual basis. Wild populations are better able to withstand and recover from a one-time genetic impact of escapees interbreeding with wild stocks than if interbreeding occurs on an annual basis. In focusing on areas where there is a greater potential for either "trickle" or systemic losses, through the monitoring of CCPs, the potential for the repeated annual intrusion of escapees is significantly reduced.

Starting in 2006, MDMR has been collecting data on the source and causes of losses from marine net pens and freshwater hatcheries. Information is provided from the salmon farming industry in response to losses caused by predation, severe weather, foreign objects, fish husbandry, human interactions and equipment failure. Detailed descriptions are identified for each of the major causes to allow the correct classification for each event to be documented. No reported losses of farmed salmon have occurred since initiating this specific reporting requirement.

3. Minimize Competition and Disease Transfer

Special Condition No. 5 will also minimize effects by requiring reporting of known or suspected escapes of more than 50 fish with an average weight of 2 kg each or more and/or a decrease in cage biomass of >25% within 24 hours. Fifty fish was identified by the aquaculture industry as a minimum number of escapees that they could reasonably detect; a 2 kg fish was identified by the Services and the MDMR BSRFH as a minimum weight at which an Atlantic salmon could be sexually mature. In addition, a reporting requirement which is based on the loss of greater than 25% of an individual cage biomass, regardless of the size of the fish will address "trickle losses of smaller fish". These reporting requirements will alert field scientists working in GOM DPS rivers to the fact that an escape has occurred. Further, several measures have been implemented to increase the efficacy of the CMS plans including a reporting form on escape events which seeks to identify the cause of the containment breach where possible. The reporting requirement will also contribute to a database that, in combination with information on detection of escapees in rivers, will allow for a clearer understanding of the chain of events that starts with salmon escaping from a net pen and ends with escapees entering rivers. This system will help determine, over time, what specific factors (e.g., season, age/size class, proximity to GOM DPS rivers, etc.) are more or less likely to result in escapees entering the GOM DPS rivers.

Atlantic salmon aquaculture companies operating in Maine have a mandatory requirement for participation in programs to reduce disease concerns in order to receive a fish transfer permit from the Maine DMR. The following programs in place are administered by the United States Department of Agriculture (USDA) through the ISA program established in 2001. The emphasis of the program is placed on the following: maintenance of the current state and federal fish health protocols; development of an emergency disease eradication program; and expansion of an ongoing epidemiological monitoring program to determine the type, incidence and geographic distribution of salmonid pathogens in Maine.

The major components of the program are:

- vaccination of farmed fish prior to stocking in sea cages;
- protocols for harvesting and stocking of farmed salmon;
- mandatory fallowing and single year class stocking and;
- vessel traffic protocols and gear and vessel disinfection protocols.

Further, an Integrated Pest Management (IPM) plan is a requirement for the ISA program. Integrated pest management protocols include monitoring of sea lice levels and evaluating treatment efficacy. The guidelines include BMPs that seek to reduce the need for use of chemicals or medications. Routine monitoring of sea lice populations occur at least bi-weekly when water temperatures are greater than 8°C, and monthly when water temperatures are between 6°C and 8°C. A maximum treatment threshold for sea lice counts is presently 1 gravid female and 5 pre-adult, on average, with a minimum of two samples. At the discretion of the licensed veterinarian, treatment may be initiated before such a count is reached. If therapeutic treatment is necessary, Emamectin Benzoate (SLICE®) has been prescribed to treat sea lice infestations since 2001 under an Investigational New Animal Drug permit. In some cases smolts being transferred from Canadian hatcheries may receive a pre-treatment of SLICE® in the hatchery prior to placement at US marine sites. All treatments are authorized and monitored by the accredited Veterinary person in Charge (VC). If appropriate, coordinated bay-wide therapeutic treatments are used to reduce initial infection. All medications administered for the control of disease or parasites are in accordance with state and federal regulations and are prescribed by a licensed VC.

4. Implement Site Specific Marking Plan for all farmed fish stocked in US waters

Special Condition No. 6 (Marking) will require Cooke Aquaculture to mark all fish stocked in pens at the proposed Black Island site so that these fish can be readily identified as aquaculture fish and as having been stocked at this site. As such, Special Condition No. 6 will reduce effects of genetic introgression and interactions between farm escapees and GOM DPS salmon because this identification will greatly enhance the ability to determine the origin of escapees entering GOM DPS rivers. Having a site specific mark (i.e., unique genetic groups of fish in production) will enable Cooke Aquaculture to work with the ACOE and the Services to quickly identify the cause of escapement and to correct problems leading to the escape. If an external mark is not applied (because a genetic marker has been identified), scale analysis and morphology will be used to identify escapees. The accuracy of field determinations made based on scale analysis and morphology would then be verified through extraction of the internal mark. Ongoing efforts to enhance the reference database of salmon scales and to provide sufficient training to field personnel have improved and will continue to improve the accuracy of the scale identification conducted streamside. NMFS firmly believes the ability to reduce, and ideally eliminate, the presence of escapees in rivers is dependent on the ability to identify and control the losses at the net pens.

Starting July 30, 2009, the Maine salmon farming industry was required to mark all salmon placed in marine net pens to enable the identification of the specific site the fish is being reared. The Services agreed to an incremental approach to marking specificity, from broad based US industry identification the first year, to more specific hatchery and hatchery sub-lots the following years. This allowed the different companies to work through production difficulties realized in trying to reach the goal of site-specific marking for all farmed Atlantic salmon placed into the waters of the state of Maine. Taking this approach allowed production techniques to be modified to provide more flexibility during freshwater rearing in commercial hatcheries. The Maine Atlantic salmon farming industry used different marking techniques to comply with these permit requirements and eventually chose genetic marking (e.g., parentage assignments) to achieve the benchmark for mark detection of greater than 95% set by the Services. Annual Quality Assurance and Quality Control (QA/QC) is guided by protocols developed in consultation with the Services (Attachment 2) and annual audits validate mark detection rates and Chain of Custody documentation in freshwater hatcheries and immediately following stocking into marine net pens (Fig. 3). This genetic based marking system will enable tracking fish through the complete production cycle and will provide sufficient information to identify the facility where the fish was reared.

Table. 3 Results from parentage assignment tests for marking compliance

Generation	% correct assignment*	Marker Panel	Software
2005	93%	US 5	Cervus
2006	84%	US 5	Cervus
2007	91%	US 5/ RPC 7	Cervus
2008	88%	CUSA7	Offspring A
2009	100%	CUSA	Offspring B

*Data from Cooke 2009 marking plan

5. Prohibit stocking of Transgenic salmon

The potential use of transgenic salmonids in the aquaculture industry has recently been identified as a possible threat to wild Atlantic salmon populations. Transgenic salmonids include fish species of the genera *Salmo, Oncorhynchus*, or *Salvelinus* in the family Salmonidae that bear, within their DNA, copies of novel genetic constructs introduced through recombinant DNA technology using genetic material derived from a species different from the recipient, and descendants of any individuals so transfected. Escaped, reproductively-viable transgenic salmon could interbreed with wild fish. Research to develop transgenic fish for aquaculture increased through the 1980s and had advanced to the extent that, by 1989, production of 14 species of transgenic fish, including Atlantic salmon, had been reported (Kapuscinski and Hallerman 1990). Transgenic fish produced for culture in marine net pens must be selected to survive under nearly natural physical and chemical environmental conditions. If they escape, therefore, it is likely that a portion of them will survive. In a study by Sheela *et al.* (1999), transgenes were inherited in many progeny from transformed fish, as determined through DNA analyses and through expression of the reporter gene. If an introduced construct can find its way onto or into a chromosome before the first cell division of a newly-fertilized egg, all the cells in the developing organism, including future germ cells, will contain copies (Lutz 2000). The transmission of novel genes to wild fish could lead to physiological and behavioral changes, and traits other than those targeted by the insert gene are likely to be affected. Ecological effects are expected to be greatest where transgenic fish exhibit substantial altered performance. Such fish could destabilize or change aquatic ecosystems (Kapuscinski and Hallerman 1990).

The prohibition on the use of transgenic salmonids at the proposed Black Island site (Special Condition No. 2) will eliminate the potentially adverse disease and ecological risks posed by the use of transgenic salmonids in aquaculture. The risk posed by a transgenic salmonid to wild salmon would be greatly affected by the specific gene manipulation conducted. Anyone proposing the use of transgenic salmonids in aquaculture would need to provide information on the methods used and the potential for genetic, fish health and ecological impacts on wild stocks. This information would have to be evaluated to determine the level of risk posed to wild Atlantic salmon stocks and a decision would have to be made as to whether that level of risk was acceptable or not. The use of transgenic salmonids will be prohibited under Condition No. 2 until such time as these risks can be evaluated.

6. Additional Protections provided to GOM DPS Atlantic salmon through State permits and cooperative agreements between salmon farming interests and Countries

The protections for Atlantic salmon provided through state and federal permitting authority are supplemented by many cooperative agreements between salmon farming interests. The private aquaculture industry in Maine has adopted many best management practices (BMPs) which have been implemented through several industry wide agreements. For example, an Industry Code of Practice (Belle 2001) was established to minimize adverse effects to the environment. Fish welfare is also considered in a Fish Culture Code of Practices for Atlantic salmon culture in freshwater and sea cage sites. These BMPs include optimal fish stocking densities, minimal handling and disturbance of fish during rearing, careful monitoring of diseases and parasites, and recommendations for using automated feeding systems to reduce waste of fish feed.

In addition to the regulatory requirements described in this section, state and federal resource agencies in Maine have implemented several measures to minimize deleterious effects from farmed fish interactions which include: (1) installation of permanent traps and seasonal weirs on several GOM DPS rivers to minimize potential adverse impacts from farmed fish introductions into rivers with wild salmon and to collect information on the native stocks; (2) screening wild parr used for captive broodstock for origin and disease; (3) farmed fish escape notification procedures between the US and Canadian commercial salmon farming industry, government agencies and state resource agencies to expedite the response time needed to minimize impacts from farmed fish interactions; and (4) USFWS initiated pedigree lines for GOM DPS rivers with high risk of genetic introgression from farmed fish interactions or poor demographic structure limiting recruitment success.

Therefore, while the probability of impacts to some individuals will remain, the magnitude of these impacts to the population is anticipated to remain low over time due to the ACOE special conditions and USFWS conservation hatchery program. The potential for impacts to individuals will be lower as a result of the decrease in escapees anticipated to result from implementation of the CMS. A decrease in the frequency of impacts to individuals will further reduce the potential for impacts to a year class and a river population. The severity of genetic effects that any individual aquaculture escapee poses to wild salmon will also be decreased by using solely North American strain Atlantic salmon in production.

8. CONCLUSION

The best available scientific data and commercial information indicates that the issuance of a RHA Section 10 permit to Cooke Aquaculture for the Black Island South site by the ACOE is likely to adversely affect individual wild salmon because escaped aquaculture salmon compete for food and habitat, disrupt redds and interbreed; thus disrupting breeding, feeding and sheltering of wild Atlantic salmon. Aquaculture facilities may also promote the transfer of disease and parasites to wild salmon, which may also adversely affect wild salmon..

The special conditions proposed by the ACOE are designed to reduce the impacts of the proposed aquaculture site on endangered Atlantic salmon. Special Condition No. 1 removes the greatest aquaculture-related threat to the survival and recovery of the GOM DPS by eliminating the use of reproductively viable non-North American Atlantic salmon. The other ACOE special conditions reduce the potential for future impacts by reducing the risk of escapement, monitoring the health of farmed fish, and providing a mechanism to refine containment practices and further evaluate the effectiveness of containment through marking.

Despite full implementation of the ACOE proposed special conditions, it is likely as explained in the Effects of the Action section, that a limited amount of take will still occur through interbreeding or genetic introgression, superimposition of redds, competition for food, habitat and mates, or the transfer of diseases and parasites. However, as also explained in the Effects of the Action section, the amount and extent of these impacts is mitigated by a number of factors. These factors include the following: (1) operation of weirs and traps; (2) a number of GOM DPS rivers not in close proximity to the proposed lease site (i.e., located in the Merrymeeting Bay SHRU); (3) multiple-year classes of salmon present at any given time for each GOM DPS river; (4) the USFWS's ongoing conservation hatchery program, and; (5) implementation of the ACOE's proposed permit conditions.

The ACOE permit conditions will eliminate the greatest long term threat and minimize the short-term adverse effects to listed Atlantic salmon by: (1) eliminating the use of non-North American strain Atlantic salmon; (2) implementing containment management systems with loss control plans and audits; (3) marking aquaculture fish; (4) prohibiting the use of transgenic salmonids;

and (5) requiring fish health certification before stocking any fish. As described in the Effects of the Action section, the anticipated level of impact remaining after the ACOE permit conditions are implemented is not anticipated to have a population level impact on the Atlantic salmon GOM DPS.

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of the GOM DPS of Atlantic salmon. NMFS has determined that the issuance of a RHA Section 10 permit to Cooke Aquaculture for the Black Island South site with the proposed ACOE special conditions is not reasonably likely to reduce the reproduction, number, and distribution of the GOM DPS of Atlantic salmon in a way that appreciably reduces its likelihood of survival and recovery in the wild. This determination is based on an assessment of the efficacy of the proposed permit conditions, including implementation of all of the ACOE special conditions in the project description. Furthermore, the proposed action is not expected to result in the destruction or adverse modification of Atlantic salmon critical habitat.

In summary, the NMFS have determined that the proposed action is not likely to jeopardize the continued existence of the GOM DPS of Atlantic salmon or adversely modify critical habitat.

9. 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 ITS.

The ACOE has a continuing oversight responsibility for the activities covered by this ITS. The measures described below are non-discretionary, and must be undertaken by the ACOE so that they become binding conditions of any permit modifications issued to the permittee in order for the exemption in Section 7(o)(2) to apply. If the ACOE either (1) fails to assume and implement the terms and conditions or (2) fails to require the permittee to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit, the protective coverage of Section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the ACOE or permittee must report the progress of the action and its impact on the species to the NMFS as specified in the ITS [50 CFR § 402.14(i)(3)]. If the terms and conditions of this ITS are complied with and the project is implemented as proposed, the ACOE and the permittee will be exempted from the prohibitions of Section 9 for take within the anticipated amount or extent.

A. Amount or Extent of Anticipated Take

Incidental take is anticipated to occur as a result of the proposed action of installing and maintaining up to 20 net pens off Black Island in Blue Hill Bay even with the addition of the ACOE special conditions. The reasonable and prudent measure in this Opinion, with the implementing terms and conditions, is designed to minimize the impact of incidental take that will result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, the ACOE must reinitiate consultation consistent with 50 CFR 402.16. The ACOE must immediately provide an explanation of the causes and circumstances surrounding the excess taking.

As described in the Effects of the Action section, fish that escape from a marine aquaculture facility (net pens) and supporting hatcheries enter a GOM DPS river will harm or harass wild Atlantic salmon through competition for food, mates and space, redd superimposition and/or genetic introgression. NMFS anticipates that the presence of aquaculture fish in a GOM DPS river will result in take, because it is reasonable to expect that the escapees will, at a minimum, impair essential behavioral patterns, most notably breeding and competition for food and space. Reproduction of wild stocks will be altered or disrupted through interbreeding between aquaculture and wild salmon or by redd superimposition. The intrusion of aquaculture fish into some GOM DPS rivers and their interbreeding with wild Atlantic salmon will result in genetic introgression and modifications to the wild population genotypes. These genetic modifications will decrease the wild fish's ability to adapt to local environmental conditions, compete for mates, food, nest sites, and other habitat needs, thus rendering the wild fish less fit for survival. Due to the difficulties associated with actually witnessing harmful interactions taking place in a GOM DPS river as described further in this Opinion, detections of escapees in GOM DPS rivers will serve as a surrogate measure of take for this Incidental Take Statement (ITS).

Based on the best scientific and commercial information available, the NMFS determined the following when developing a surrogate measure of take: (1) When salmon escape from an aquaculture facility, some portion of those escapees are likely to enter or attempt to enter a GOM DPS river within the Penobscot and Downeast SHRUs. Escaped salmon may enter or try to enter both GOM DPS rivers with weirs or traps and those without. (2) There is ample evidence to indicate that salmon will continue to escape aquaculture farms such as the proposed Black Island South site, and therefore will continue to enter some GOM DPS rivers both with and without weirs and trapping facilities. (3) Absent the ability to detect salmon entering the rivers without weirs, or even all fish entering rivers with traps and weirs (e.g., some escapees may remain below the fishway or weir and interact with wild fish there), it is reasonable to use detection levels of aquaculture salmon at rivers with weirs and traps as a relative index of the number of undetected, escaped salmon that are entering GOM DPS rivers. In other words, detection levels at the rivers with weirs and traps are indicative of proportional entries into GOM DPS rivers, and of anticipated take from escaped aquaculture salmon.

Accordingly, NMFS believes that aquaculture fish entering a GOM DPS river are reasonably certain to impair the essential behavior patterns of the wild salmon as described above. It will not be possible to identify the exact form of the take created by a single aquaculture fish unless the interaction is directly observed; however, the best available scientific information indicates that there is a reasonable certainty that escaped aquaculture fish will harm or harass (as defined above) native wild salmon and/or salmon eggs through one or more of the following means: competition for mates, food and space (e.g., foraging and breeding habitat), redd superimposition, impair spawning and reduce spawning success or genetic introgression. Furthermore, the impact of an escape event at the proposed Black Island South site would be affected by several factors including the age, sexual maturity and the number of fish lost; the proximity to a GOM DPS river; and the genetic strain. Devising an ITS for a single proposed marine site that incorporates all of these variables is impaired by continually changing cage inventory, unpredictable escape factors (e.g., number lost, time of year), and the lack of historic site specific monitoring information.

The ACOE special conditions proposed as part of this action requires a site specific mark for aquaculture salmon placed at the Black Island South site. As such, it will be possible to distinguish escapes at Black Island South from other aquaculture sites in Maine at GOM DPS rivers with weirs and traps. In order to monitor incidental take for this action, implementation of special condition number 6 (site specific marking) will provide the ability to detect the origin of the fish and assign any take directly to this ITS.

As described above, the NMFS have chosen to express incidental take at the proposed Black Island South site based upon the number of aquaculture fish detected at GOM DPS rivers within the Penobscot and Downeast SHRU's that have fish traps or weirs to include: Penobscot, Union, Narraguagus, Dennys, and Pleasant Rivers.[3] Therefore, incidental take occurring as a result of this action shall not exceed more than 1 fish per year from the Black Island South site as detected at these GOM DPS rivers with traps and weirs. If an aquaculture escape from the Black Island South site is detected in GOM DPS rivers outside of the Penobscot or Downeast SHRUs (e.g., Merrymeeting Bay SHRU; Kennebec and Androscoggin rivers), this would present new information not considered in this Opinion and may require reinitiation of consultation for the Black Island South site, consistent with 50 CFR 402.16. In addition, exceeding the incidental take level exempted herein will require reinitiation of consultation for the Black Island South site, consistent with 50 CFR 402.16.

B. Reasonable and Prudent Measures

Section 7(b)(4) of the ESA requires that when an agency action is found to comply with Section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of listed species, the NMFS will issue a statement specifying the impact of any incidental taking. Section 7(b)(4) also states that reasonable and prudent measures necessary to minimize impacts, and terms and conditions to implement those measures, must be provided. Only incidental taking by the federal agency or applicant that complies with the specified terms and conditions is exempted.

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[3] NMFS will continue to evaluate the appropriateness of this amount of take in light of any presently unknown advances in technology applied in the future (which could reduce escapement) or in light of the additional GOM DPS rivers with weirs and/or traps (which could increase the number of escapees intercepted at DPS rivers).

The reasonable and prudent measures and terms and conditions are required to document the incidental take and to minimize the impact of that take on the GOM DPS of Atlantic salmon. These measures and terms and conditions are non-discretionary and must be implemented in order for the protection of Section 7(o)(2) to apply.

NMFS believes that the following reasonable and prudent measure is necessary and appropriate to minimize incidental take of the GOM DPS of Atlantic salmon. The ACOE will ensure that this reasonable and prudent measure is implemented by working with the USFWS, NMFS, the EPA, the State of Maine, and the permittee, to collect the necessary information and develop procedures for the following:

1. Minimize the likelihood of incidental take from the escape of aquaculture salmon, minimize transfer of disease from salmon aquaculture and monitor and report on the implementation of the ACOE special conditions.

C. Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the ESA, the ACOE must assure compliance with the following terms and conditions, which implement the reasonable and prudent measure, described in the previous section, and outline the required reporting/monitoring requirements. These terms and conditions are non-discretionary.

a. To implement the above Reasonable and Prudent Measure (1), the ACOE will use its authority under Section 10 of the Rivers and Harbors Act to ensure that the special conditions proposed in the project description are adhered to by the permittee.
b. To implement the above Reasonable and Prudent Measure (1), the ACOE will follow guidelines and reporting procedures established in Atlantic Salmon Microsatellite Analysis Protocol (Attachment 1) and Quality Assurance/Quality Control procedures (Attachment 2) to ensure the appropriate implementation of special conditions.
c. To implement the above Reasonable and Prudent Measure (1), the ACOE will promptly notify NMFS if the permittee fails to adhere to any of the special conditions.
d. To implement the above Reasonable and Prudent Measure (1), the ACOE will complete an annual report and send it to NMFS. The report will cover the calendar year period and will be due by the following January 31. The purpose of the reporting is to validate the extent and amount of take. The report will include but not be limited to the following:

   a) a summary of the site's activities, including current information on species cultivated and stocking and harvesting figures;

   b) a summary of fish escapes at the site, including number of fish, description of incident, and corrective actions taken; and

c) a summary of known recoveries of aquaculture escapees and incidences of take as defined in this Opinion.

10. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat to help implement recovery plans, or to develop information.

1. The ACOE should evaluate the locations of proposed marine aquaculture sites to minimize the risk of catastrophic fish losses, disease transfer, and interference with migration patterns of wild Atlantic salmon.

2. The ACOE should continue to work with other state and federal agencies, the aquaculture industry, and other interested parties to coordinate, conduct, or support research to determine measures that could be implemented to reduce the potential for discharge of fish from freshwater and marine aquaculture facilities.

3. The ACOE should work with the aquaculture industry and regulatory agencies to develop and further refine Bay Management Plans encompassing the entire Maine industry. The plans should include, but not be limited to:

- a concise description of the bay/area in terms of physical characteristics, history, aquaculture operations, future/potential carrying capacity, water quality problems, flushing rates, etc;
- codes of practice for current aquaculture operations and translation of those codes to the specific circumstances of each bay or coastal region;
- consideration of species other than salmon if appropriate;
- a development plan for aquaculture in the bay;
- information on other activities in the bay; and
- coordination with Canada as appropriate.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

11. REINITIATION NOTICE

This concludes formal consultation concerning the ACOE's proposed issuance of RHA Section 10 permit to Cooke Aquaculture for the proposed Black Island South aquaculture site. In addition to the reinitiation procedures described in this Opinion, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and: (a) if the amount or extent of taking specified in the ITS is exceeded; (b) if new information reveals effects of the action that may affect the Atlantic salmon GOM DPS in a manner or to an extent not previously considered; (c) if the identified action is subsequently modified in a manner that causes an effect to the Atlantic salmon GOM DPS that was not considered in the Opinion; or (d) if a new species is listed or critical habitat designated that may be affected by the action (50 CFR 402.16).

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13. ATTACHMENTS

Attachment 1

Atlantic Salmon Microsatellite Analysis Protocol

This protocol will be used to determine which Atlantic salmon can be used for breeding and production stock under the State of Maine General Permit for Aquaculture Facilities and for Army Corps of Engineers permits prohibiting use of non-North American strain salmon. The protocol describes a standardized procedure to classify fish as either North American or non-North American stock and is largely based on the procedures used by King *et al.* (2001). The permittee will be responsible for providing genotype data to the Services for data analysis and fish classification as described herein.

DNA isolation

Genomic DNA will be isolated from tissue, fin clip or scale samples from each fish intended for use as broodstock employing either a commercially-available DNA extraction, such as PureGene (Gentra Systems) or DNeasy tissue kit (Qiagen Inc.) or a phenol/chloroform based extraction system such as used in Patton *et al.* (1997), or, particularly for scales, a Chelex-resin based protocol such as given in King *et al.* (2001). Quality and quantity of DNA will be visualized on 0.8% agarose gels, which will include a commercially-available DNA standard for quantification and size determination.

Microsatellite analysis

The loci used to classify brood fish as either North American or non-North American stock will be: Ssa85, Ssa171, Ssa197, and Ssa202 (O=Reilly *et al.* 1996); SSOSL311 and SSOSL438 (Slettan *et al.* 1995, 1996) and Ssa289 (McConnel *et al.* 1995).

PCR conditions for the selected loci will essentially follow that of King *et al.* (2001) and Patton et al. (1997), with possible minor modifications for optimization of products of individual loci. The loci will be labeled with the dyes, Ned, Hex, and 6-Fam by ABI or any other comparable commercial supplier of labeled oligonucleotides. The size standard to be used will be 400 HD Rox (ABI). Microsatellite analysis will be performed using the ABI 3100 autosequencer or any other commercial system providing equivalent results. Fragment analysis will be accomplished using a combination of GENESCAN and GENOTYPER software packages from ABI, or any other commercial system providing equivalent results. The permittee will present electronic data tables from the GENOTYPER program to the Services in spreadsheet format in Excel or any other commercially-available program providing equivalent results that allow the data to be easily reformatted for subsequent analyses. The output files (gel tracings) from GENESCAN and GENOTYPER will also be provided by the permittee at the same time to help the Services assure data quality. Data provided must be complete at all loci for all fish.

Size verification of allelic products

To ensure accurate sizing of allelic products from the aquaculture fish relative to the designations developed in the King laboratory (see King *et al.* 2001), Dr. King will provide samples for use as controls. The Services will provide an adequate supply of DNA samples from representative fish of known genotypes to enable calibration of equipment throughout the term of the controlling license conditions. Control samples will be used at the inception of the study to set the automated allele designation/binning parameters of the GENOTYPER software so that all subsequent calls made for aquaculture fish will be automatically sized relative to the standards originally provided by Dr. King.

Genetic screening

Identification of North American aquaculture stock will be based on assignment tests performed with the software GeneClass, which can be downloaded at http://www.montpellier.inra.fr/URLB/geneclass/geneclass.html. Aquaculture fish will be compared to two reference groups. The first group will be comprised of samples from North America, including samples from Maine (Dennys, Ducktrap, East Machias, Machias, Narraguagus, Penobscot mainstem, Pleasant, Sheepscot), Canada (Conne, Gold, Gander, Michaels, Miramichi, Saguenay, Sand Hill, St. Jean, St. John, Stewiacke) and aquaculture strains derived from St. John and Penobscot populations. The second group will be comprised of non-North American samples from Iceland (Ellidaar, Vesturdalsa), Norway (Lone, Vosso), Finland (Tornionjoki), Scotland (Shin, Nith), Ireland (Spaddagh, Blackwater), and Spain (Eo, Esva, Bidasoa, Sella); and the Landcatch aquaculture strain. Genetic data for the two reference groups are available upon request from the Northeast Fishery Center of the U.S. Fish and Wildlife Service, (570) 726-4247.

The likelihood for assigning any given fish to each reference population will be calculated using the program GeneClass. If the ratio of the likelihood scores indicates that North American origin is at least twice as likely as non-North American origin, that fish will be considered to be of North American origin. All other fish will be classified as non-North American stock. The Services will promptly report the results to the permittee.

Literature Cited

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Attachment 2

Guidelines for Quality Assurance and Quality Control Procedures for a Genetic Marking Program
October 2008 Version

Pursuant to permits issued by the Maine Department of Environmental Protection and/or the U.S. Army Corps of Engineers, Atlantic salmon aquaculture companies in Maine are required to develop plans for marking farmed fish to 1) designate the hatchery of origin; 2) designate a level that is more specific than the hatchery mark (e.g., hatchery sub lots, facility owners); and 3) designate the marine site (2007). Aquaculture companies have submitted plans that propose to use genetic marking to accomplish some of these permit requirements.

Purpose of genetic marking/parentage analysis:

- To identify specific parental pair origin of an unknown individual from a suite of potential parents.
- Parentage information will allow tracking of individual salmon to individual aquaculture company.
- Use of a unique mark is specified under the ACOE and DEP permits for farmed Atlantic salmon placed in aquaculture marine net-pens, and some companies are considering using genetic parentage analysis as the required mark.

The effective use of genetic analysis information to achieve these marking requirements can only be achieved through a comprehensive marking plan which includes a Quality Assurance/Quality Control (QA/QC) program. Quality Assurance (QA) is a system of planned review and audit procedures conducted by personnel not actively involved in marking or the collection of related data. Quality Control (QC) is a system for verifying and maintaining a desired level of quality in the collection of data through careful planning, use of proper equipment and technique, continued inspection and verification, and implementation of corrective actions as required. In addition to promoting the objectives of the QC system, a comprehensive QA review program provides the best available indication of the overall quality, accuracy, precision, comparability, and complete representation of the genetic data gathered throughout the marking process.

The individual aquaculture company marking plans require QA/QC procedures to maintain and verify proper tracking and to demonstrate effective genetic marking. This QA/QC system is required for each aquaculture company operating in Maine and is designed to reduce or eliminate any inherent bias in the data collection process. An important part of any marking strategy is the proper collection and analysis of data. QA/QC may be regarded as a chain of activities designed to deliver credible and accurate data. Complete genetic marking plans submitted to the Services for review must include instructions on the proper handling of genetic material (fin tissue), collection of data (when and how to take samples), recording of data (use of standardized data collection methods and data sheets), production of progress reports, and implementation of QA/QC procedures.

Goals of QA/QC for genetic marking/parentage analysis:

- To ensure markers used have sufficient diversity, variability, repeatability, and power to provide unique individual genotypes.
- To ensure parental genotypes are accurately determined and reported.
- To ensure spawning records are accurately kept.
- To ensure tracking information (from spawning to stocking) is complete, accurate and supports genetic marking for the intended purpose or requirement.

Specific QA/QC Requirements

Quality Control procedures or Standard Operating Procedures are required for all genetic sampling pertaining to permit requirements for marking.

Database information for tracking sub lots in a hatchery must include the following, at a minimum:

- Unique identification number for all individuals held to correlate with genetic, spawning, and tracking information.
- Information on parents spawned (e.g., spawning records);
- Genotypes for loci specified in marking requirements for each parent spawned;
- Numbers of fish in each group (e.g., egg numbers, fish numbers);
- Database for movement of fish and eggs through the hatchery (e.g., egg trays, rearing tanks, etc.).
- Incorporation of all specified and required data into a Service approved database.

Database information for tracking sub-lots through distribution must include the following, at a minimum:

- Information on disposition of sub-lots to marine sites.
- Numbers of fish in each group transferred to each site.
- Standardized and accurate information.

Quality Assurance procedures must include annual third party sampling of fish in each sub-lot (i.e., voucher samples taken at both the hatchery and marine sites). Sampling must be representative from all rearing tanks or marine pens, samples of fish should be taken from the targeted life stage from throughout the facility. Every effort should be made to process samples on site using existing laboratory facilities or designated work area. The key concept of this system is independent, objective review by a third party in order to assess the effectiveness of the internal Quality Control program and the quality of the data.

Required QA third party sampling procedures for genetic marking/individual identification:

1. Duplicate genetic samples (see instructions for sampling fin tissue) obtained from a sub-sample of the spawning parental lot (50 families-25 males, 25 females) will be provided to the USFWS Northeast Fishery Center Molecular Ecology lab annually to confirm parental genotypes. These individuals will have been previously genotyped by the aquaculture companies and included in the genotype database provided to the Services by the companies. These samples will be provided by the companies to check for consistency in allele determination and reporting.

2. Spawning records, genotypes of parents, stocking data, and other information specified by the Services will be provided annually using a standard database provided by the Services or an alternative database approved by the Services before implementation.

3. No later than March 31st of each year and prior to distribution to other fish cultural facilities, genetic samples (fin tissue) from 50 juveniles per hatchery will be provided to the Services and RPC annually to test for parentage assignment. These samples will be taken in quadruplicate for each fish. Samples will be divided into four groups with half of the samples sent directly to the USFWS Northeast Fishery Center Molecular Ecology lab and the other half sent to the Research and Productivity Council (RPC) genetics lab (see shipment information below). Each lab will receive 50 fin samples to be used for genetic analysis; this includes fin samples from 25 juveniles in duplicate (50 total). Half of the fin samples are to be used for genetic analysis and parentage assignment, the remaining fin samples are to be archived for future reference. The purpose of this testing is to check spawning records, parental genotypes, and to ensure that the "mark" can be determined by the Services prior to distribution into marine net pens.

4. As soon as possible after placement of fish into a marine site, genetic samples (fin tissue) from 50 juveniles per site will be provided to the Services and RPC annually to test for parentage assignment. These samples will be taken in quadruplicate for each fish. Samples will be divided into four groups with half of the samples sent directly to the USFWS Northeast Fishery Center Molecular Ecology lab and the other half sent to the Research and Productivity Council (RPC) genetics lab (see shipment information below). Each lab will receive 50 fin samples to be used for genetic analysis; this includes fin samples from 25 juveniles in duplicate (50 total). Half of the fin samples are to be used for genetic analysis and parentage assignment, the remaining fin samples are to be archived for future reference. The purpose of this testing is to check tracking information including, spawning records, parental genotypes, and to ensure that the "mark" can be determined by the Services after distribution into marine net pens.

5. Parental assignment will be conducted with a standard program (same program will be used by the Services and aquaculture companies) for final testing of parentage, with an assignment threshold of 95% accuracy to hatchery and sub-lot. Hatchery and sub-lot assignments lower than 95% accuracy will be considered not in compliance with the specific marking requirements in the permits.

6. Genotypes of parents will be provided in the database, but copies of electropherograms from **10%** of the parents will also need to be provided in Genescan and Genotyper (Applied Biosystems Inc) formats for allele confirmation and consistency in scoring practices.

7. All annual sub-sampling for the purpose of QA/QC must be performed by a third party or by state or federal agency staff. All efforts will be made to coordinate sampling in advance of submittal deadlines.

Genetic Sampling Protocol for QA/QC

Using hole-punch or scissors to extract genetic material, a total of 50 individuals are to be sampled; four samples are to be taken from each individual. Every effort should be made to process samples on site using existing laboratory facilities or designated work area.

Items needed for sampling:

1. Either Hole Punch or Scissors
2. Labeled tubes with 95-100% non-denatured ethanol
3. Pen for recording requested biological information (as needed)
4. Forceps
5. Bucket for fresh water to clean hole punch or scissors. If water is visibly fouled (pieces of tissue or is otherwise dirty), then empty, rinse, and refresh water.

To take fin clips:

1. Rinse hole punch or scissors in bucket of fresh water, and ensure no pieces of tissue are stuck to the punch (inside or out) or blades of scissors.
2. Using clean hole punch or scissors remove or punch a piece of tissue (approximately 2 cm X 2 cm) from the caudal or other fins of the fish.
3. Place fin clip into labeled sample tube already containing 95-100% non-denatured ethanol.
4. Ensure that the appropriate sample is going into appropriate tube.
5. Make sure lid/cap/top of vial is closed securely!
6. Shake the tube to make sure fin clip is immersed in the ethanol.
7. Clean (rinse) hole punch or scissors in water (swish around in the water and visually inspect) to ensure there is no residual tissue particles on the cutting utensil that could lead to cross-contamination.
8. Take next sample.
9. For this sampling, the companies have requested four samples per individual.
10. Label each box on orange tape with the Site Name, Location, and Date Sampled

When sampling is complete from a site, send half of samples (via Fed-Ex/UPS/DHL) sample #'s 1-25 and duplicates to:

<u>Please be sure to call and notify of shipment arrival</u>

Meredith Bartron
USFWS-NEFC
227 Washington Ave.
Lamar, PA 16848
Ph: 570-726-4995 x 5

Send other half (sample #'s 26-50 and duplicates) of samples to:

Dr. Benjamin Forward

Head, Food Fisheries & Aquaculture Department
Research & Productivity Council (RPC)
921 College Hill Rd.,
Fredericton, N.B. E3B 6Z9
Tel: 506.452.1365
Fax: 506.452.1395