NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency:	U.S. Army Corps of Engineers New England District
Activity Considered:	Issuance of a Permit to Cooke Aquaculture for Installation of marine net pens for commercial rearing of Atlantic salmon at the Calf Island site in Maine NER-2016-13205 **GARFO-2016-00324**
Conducted by:	National Marine Fisheries Service Greater Atlantic Regional Fisheries Office
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1.0 INTRODUCTION AND BACKGROUND

This is the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) issued under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543). This Opinion analyzes the effects resulting from the installation and operation of eighteen marine net pens for commercial finfish aquaculture on species listed as threatened or endangered under our jurisdiction. The proposed lease site is held by Cooke Aquaculture and is located east of Calf Island in Eastern Bay, Jonesport, Maine (Figure 1). The U.S. Army Corps of Engineers (USACE) is proposing to authorize Cooke Aquaculture's activity under Section 10 of the Rivers and Harbors Act (RHA) of 1899 (33 U.S.C. 403). The proposed USACE permit is valid for 10 years; therefore, this Opinion will consider the effects of the action over the 10-year permit as well as any effects to listed species that remain after the permit expires.

This Opinion is based on information provided by the USACE and Cooke Aquaculture/Phoenix Salmon U.S. A complete administrative record of this consultation will be maintained at our Maine Field Office in Orono, Maine. Formal consultation was initiated on March 3, 2016.

1.1 Consultation History

- December 3, 2015 - USACE held a meeting with NMFS and U.S. Fish and Wildlife Service (USFWS) to discuss a March 3, 2015 permit application from Cooke Aquaculture for installation of net pens off Calf Island Jonesport, Maine and any additional information needed to complete consultation.

- January 15, 2016 - USACE sent email to Cooke Aquaculture requesting additional information as discussed on December 3, 2015.

- January 15, 2016 - Cooke Aquaculture provided some additional information to NMFS.

- January 25, 2016 - Cooke Aquaculture provided additional information to NMFS as discussed previously.

- February 22, 2016 - Maine DMR held public hearing to discuss Calf Island permit request.

- March 3, 2016 - USACE requested formal consultation for issuing Cooke Aquaculture a permit to raise Atlantic salmon off Calf Island Jonesport, Maine at the "Calf Island marine site."

- March 18, 2016 - Maine DMR issued lease permit to Cooke Aquaculture for net pen installation for rearing Atlantic salmon off Calf Island Jonesport, Maine (MDMR lease site EASTW CALF).

1.2 Relevant Documents

This Opinion is based on: (1) information provided by the USACE on December 3, 2016 and the March 3, 2016 initiation letter and attachments in support of formal consultation under the ESA; (2) additional correspondence from Cooke on January 15, 25, 2016; (3) spring stocking plans for permitted sites in 2016, received from Cooke Aquaculture on December 22, 2015; (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 (74 FR 29345; June 19, 2009); (6) Endangered and Threatened Species; Designation of Critical Habitat for Atlantic salmon (*Salmo salar*) Gulf of Maine Distinct Population Segment (74 FR 29300; 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 USACE proposed modification of permits authorizing the installation and maintenance of net pens to raise finfish off the coast of Maine; and 2011 Biological Opinion for Black Island site: (9) U.S. Implementation Plan on Aquaculture, Introductions and Transfers to North Atlantic Salmon Conservation Organization (NASCO) 2012-2016; (10) Final Recovery Plan for Shortnose Sturgeon (December, 1998); (11) Final listing determinations for the five distinct population segments of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) (77 FR 5880 and 77 FR 5914; Feb.6, 2012) and (12) other sources of information.

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

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

- Identify the action area based on the action agency's description of the proposed action (Section 2);
- Evaluate the current status of the species with respect to biological requirements indicative of survival and recovery and the essential features of any designated critical habitat (Section 4);
- Evaluate the relevance of the environmental baseline in the action area to biological requirements and the species' current status, as well as the status of any designated critical habitat (Section 5);
- Evaluate the relevance of climate change on environmental baseline and status of the species (Section 6);
- Determine whether the proposed action affects the abundance, reproduction, or distribution of the species, or alters any physical or biological features of designated critical habitat (Section 7);

- Determine and evaluate any cumulative effects within the action area (Section 8); and,
- Evaluate whether the effects of the proposed action, taken together with any cumulative effects and the environmental baseline, can be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the affected species, or is likely to destroy or adversely modify their designated critical habitat (Section 9).

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

The critical habitat analysis determines whether the proposed action will destroy or adversely modify designated or proposed critical habitat for ESA-listed species by examining any change in the conservation value of the physical and biological features of that critical habitat. As defined by NMFS and USFWS, destruction or adverse modification "means a direct or indirect alteration that appreciably diminishes the conservation value of critical habitat for listed species. Such alterations may include, but are not limited to, effects that preclude or significantly delay the development of the physical and biological features that support the life-history needs of the species for recovery" (81 FR 7214; Feb.11, 2016).

2.0 PROJECT DESCRIPTION AND PROPOSED ACTION

The USACE proposes to issue a 10 year permit under the Section 10 of the RHA to Cooke Aquaculture USA (Cooke Aquaculture or applicant) authorizing the installation and maintenance of up to 18, 100-meter in diameter floating net pens (cages) within a 28 acre leased area off the eastern side of Calf Island. The site is located approximately halfway between Hardwood and Hall Islands in Eastern Bay at Jonesport, Maine. 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*) at the site.

According to the applicant, the existing uses in the area are mainly commercial fishing activities including lobster and crab. There are no known shellfish or eel grass beds in the area. The applicant has 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 predominately composed of soft silt sediments interspersed with large rocks and ledge outcroppings. The site will be stocked with approximately 30,000 fish per cage for a total of 540,000 fish at the 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 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 taut 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. Hatchery fish are transported from their inland hatcheries with specially designed distribution trucks. Fish are then transferred to well boats or barges containing large tanks filled with sea water. 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 adult fish is achieved by seine netting the fish in each cage and pumping the fish into holding tanks placed on a large barge or work boat. Market size adult fish are dispatched at sea and put into containers with super chilled seawater 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.

2.1 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". The action area includes the waters where the net pens will be placed and the areas transited by vessels used to stock and service the pens. The USACE permit requires containment be appropriate to prevent escapes and reporting any breaches of containment that have occurred and resulted in an escape of farmed fish. However, despite compliance with the permit conditions, extreme weather and predators are reasonably likely to result in escape events over the 10-year life of the permit. The effects of the action extend to waters transited and occupied by any fish that may escape from the marine facility, as effects of the action would be experienced in any area where escaped fish interact with listed species. As explained below, the action area is 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 Bay, Merrymeeting Bay and Downeast Coastal, Salmon Habitat Recovery Units (SHRUs)

(Figure 2).

We expect that future breaches of containment will result in escapes of farmed fish that will migrate into GOM DPS rivers and/or interact with co-mingle or occupy the same areas as listed Atlantic salmon consistent with escapees from other net pen facilities where breaches of containment have previously occurred. For many years, available information on the behavior of escaped farm fish was not site specific because of a lack of individual marks or tags applied for each site (see Effects of the Action section below for more details). However, since 2005, a site specific mark has been required for all commercially reared Atlantic salmon, thus providing site specific information of all commercially reared salmon in the US.

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. Normally, 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 GOM DPS 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 and many other salmon rivers in Canada which are in close proximity to existing marine net pens (Morris *et. al.*, 2008). Morris *et al*., (2008) found aquaculture origin farmed fish in 54 of 62 (87%) rivers investigated within a 300 km radius of the aquaculture industry in eastern North America. Accordingly, we have considered this information to estimate the likelihood of farmed origin salmon from the Calf Island site to enter any of the GOM DPS rivers and have concluded that all of the GOM DPS rivers may be affected by escapes of farmed origin Atlantic salmon (see Effects of the Action section below for more detail).

As explained further in the "Effects of the Action" section, effects of the action on the GOM DPS of Atlantic salmon are caused by aquaculture origin escaped Atlantic salmon entering GOM DPS rivers inhabited by wild Atlantic salmon. As such, the action area includes escapee accessible freshwater reaches within the GOM DPS rivers, including, the entire length of rivers with no barriers to migration and any ocean waters transited by escaped salmon as they move into those rivers (Fig. 1). The inland extent of the action area is, for rivers with barriers or traps, determined by the location of those barriers and traps. For example, escaped farmed fish are expected to be captured at the first trapping facility on the Penobscot river (currently located at the Milford dam) which is a permanent structure and effectively captures all returning salmon. At a fish trapping facility, biologists 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. As such, there would be no effects from escaped farmed fish upstream of the trap the fish was captured.

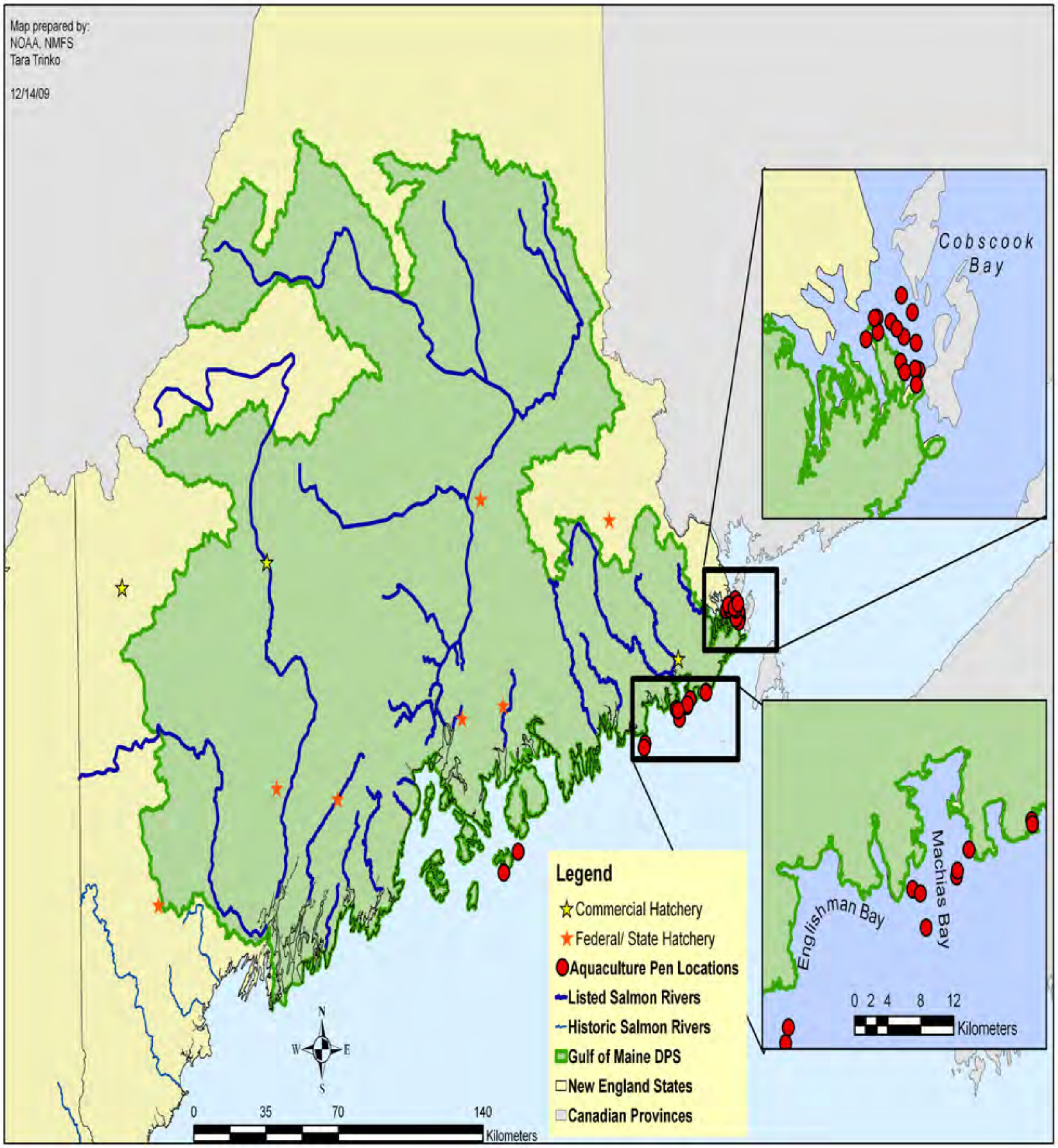

Figure 1. Locations of existing commercial salmon farms and supporting hatcheries

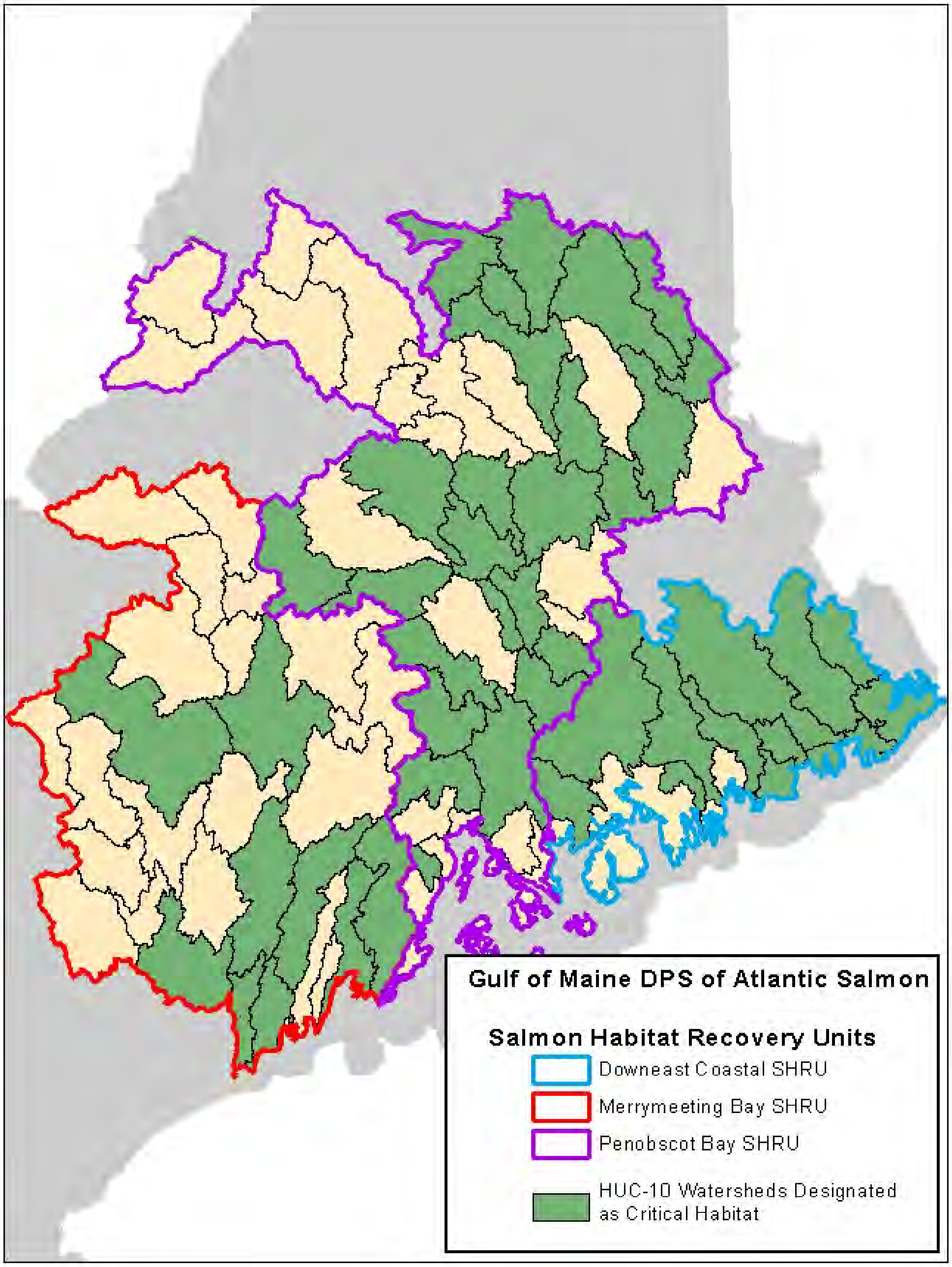

Figure 2. The Gulf of Maine DPS of Atlantic salmon and the three salmon habitat recovery units.

3.0 SPECIES NOT LIKELY TO BE ADVERSELY AFFECTED BY THE PROPOSED ACTION

According to the Joint NMFS-FWS Section 7 Consultation Handbook, a conclusion that an action "is not likely to adversely affect" a listed species is appropriate when effects are expected to be discountable, insignificant, or completely beneficial: "Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur" (p. xiv). We have determined that all effects of the proposed action on shortnose sturgeon and Atlantic sturgeon will be insignificant and discountable. We do not anticipate any incidental take of shortnose or Atlantic sturgeon from any of the activities considered in this Opinion. Our supporting analysis is presented below.

3.1 Shortnose Sturgeon

Shortnose sturgeon (*Acipenser brevirostrum*) are listed as endangered as a single species throughout their range. To date, critical habitat has not been designated for shortnose sturgeon. Below, we present information on the use of the action area by shortnose sturgeon.

This project is located within the range of listed shortnose sturgeon (i.e., St. John River, Canada to St. Johns River, Florida, USA). There have been no shortnose sturgeon documented at the proposed net pen site in Jonesport; however, there have also not been any sampling effort targeting sturgeon in this area. We have considered the possibility that transient coastal migrant shortnose sturgeon (as described in Dionne *et al.* 2013 and Zydlewski *et al.* 2011) could be present at the net pen site.

Tagging and telemetry studies indicate that shortnose sturgeon are present in the Penobscot, Kennebec, Androscoggin, Sheepscot and Saco Rivers in Maine. Shortnose sturgeon are known to move between the Kennebec and Penobscot Rivers as well as between the Kennebec, Saco and Merrimack Rivers. Tagged individuals have also been detected at telemetry receivers in smaller coastal rivers (Damariscotta, Medomak, St. George) located between the Kennebec and Penobscot Rivers (Zydlewski *et al.* 2011; Dionne *et al.* 2013). Movement east of the Penobscot is thought to be rare, with only one tagged sturgeon detected in the Narraguagus River; however, the limited number of tagged fish and telemetry receivers make determinations regarding presence of shortnose sturgeon in waters east of the Penobscot difficult to predict (Dionne *et al.* 2013). Nearly all visits to these smaller coastal rivers were short in duration (1-48 hours and typically less than 24 hours, with the exception of one shortnose that spent three months in the Damariscotta River) (Zydlewski *et al.* 2011). Once in the rivers, shortnose sturgeon were most often detected at least 10 km from the coast.

The lack of telemetry receivers in other coastal rivers east of the Penobscot makes determining the likely presence of shortnose sturgeon outside of the rivers noted above difficult. However, no shortnose sturgeon have been documented at any existing telemetry receivers in Passamaquoddy Bay. It is possible that shortnose sturgeon occur in other estuaries in

Passamaquoddy Bay and they have gone undetected because of limited sampling or because of misidentifications of shortnose sturgeon as Atlantic sturgeon (Dadswell 1984). In 2013, the first verified shortnose sturgeon was captured in the Minas Basin of the Bay of Fundy (Stokesbury and Dadswell 2013). Given the wide range of locations along the coast where shortnose sturgeon have been documented, it is reasonable to expect that at least occasional shortnose sturgeon will be present at the Jonesport net pen site during the duration of the permit. Additionally, these animals are found in the larger rivers and estuaries within the action area of the GOM DPS, therefore, we anticipate some individuals could occupy the same areas where farm fish escapes could be found.

3.2 Atlantic Sturgeon

Four DPSs of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* are listed as endangered (New York Bight, Chesapeake Bay, Carolina, and South Atlantic) and one DPS is listed as threatened (Gulf of Maine) under the ESA (77 FR 5880 and 77 FR 5914; Feb.6, 2012). The range for all five DPSs includes all marine waters, coastal bays and estuaries, from Labrador Inlet, Labrador, Canada to Cape Canaveral, FL and includes the action area.

We have considered the best available information on the distribution of Atlantic sturgeon and have determined that most Atlantic sturgeon in the action area will be of Gulf of Maine (GOM) and New York Bight (NYB) DPS origin (Wirgin *et al.* 2015). However, it is also likely that a small portion of Atlantic sturgeon in the action area may be of Canadian origin and therefore not listed under the ESA (Wirgin *et al.* 2015). Therefore, for this consultation, we consider effects of the proposed action on the GOM and NYB DPSs of Atlantic sturgeon.

The best available information indicates Atlantic sturgeon occur throughout the Gulf of Maine. There have been no Atlantic sturgeon documented at the Jonesport net pen site, although, no sampling specifically targeting Atlantic sturgeon has occurred in the area. Given the distribution of Atlantic sturgeon within the Gulf of Maine, it is reasonable to expect that at least occasional transient Atlantic sturgeon will occur at the net pen site. Additionally, these animals are found in the larger rivers and estuaries within the action area of the GOM DPS; therefore, we anticipate some individuals could be occupying the same areas where farm fish escapes could be found.

There are several effects that could occur to shortnose or Atlantic sturgeon as a result of this action; we have determined that all effects to shortnose and Atlantic sturgeon will be insignificant or discountable, our rationale is presented below.

Presence of escaped salmon in areas where Atlantic sturgeon are present
Sturgeon and salmon have co-evolved within the same river systems they have been utilizing the same freshwater resources throughout their existence. There is no evidence of competition, predation, disease transfer or other interactions between salmon and sturgeon. Escaped farmed salmon migrating into the rivers of the GOM DPS are not natural occurrences, but are not known to have any effects to Atlantic or shortnosesturgeon. We do not anticipate any effects to sturgeon from exposure to escaped aquaculture salmon.

Loss of foraging habitat from installation of gear in Eastern Bay

According to the site survey, the sea floor under the proposed site is predominately composed of soft silt sediments interspersed with large rocks and ledge outcroppings. There are no known shellfish or eel grass beds in the area. The loss of benthic habitat and invertebrates is limited to the footprint where the mooring gear is in contact with the bottom. This impact will result in the loss of an extremely small area of substrate (< 10 m^2), and the associated benthic invertebrates, available as a potential foraging area, however, the remainder of the lease area would be available to foraging animals if suitable habitat and prey is present. The effects to Atlantic and shortnose sturgeon from the loss of benthic resources will be insignificant for three reasons: (1) there are very few sturgeon in the area where the net pens will be deployed, (2) net pens installation only results in a small loss of habitat, and (3) suitable similar habitat is available in adjacent areas that can be accessed with no increased energy expenditure.

Collisions with vessels supporting the farm

This activity will result in a slight increase in vessel traffic in Eastern Bay. The area surrounding the farm is an active commercial fishing area for lobster, sea urchin, crab and scallop. This area is typical of the Maine coast, with deep water immediately outside of the harbor and along the shoreline providing sufficient depth for larger fishing vessels and work boats. Factors thought to be relevant to increasing risk of vessel strike include high speeds, limited clearance with the bottom, and restrictions or narrow waterways; these factors all seem to contribute to the reduced ability of a sturgeon to avoid an oncoming vessel. Here, the risk of an interaction is reduced by the slow speed of the work vessels. The work vessels are well boats or feed barges which are non planing hulls designed to be operated at speeds less than 10 MPH. Slow operating speeds are expected to reduce the risk of vessel strike for sturgeon because they would allow for greater opportunity for individuals to avoid the vessel. Additionally, there will be at least several feet of clearance between even the deepest draft vessels at the shallowest conditions, a sturgeon should be able to swim under the vessel without getting hit. There are no narrow channels or restricted areas; therefore, there is ample room for a sturgeon to avoid a vessel. The small number of sturgeon in the area where the vessels will operate combined with the small number of vessels makes the likelihood of co-occurrence very low. The slow operating speeds of the vessels, the clearance between the vessels and the river bottom, the wide un-impeded geography of the action area, make it likely that any sturgeon present near a project vessel would be able to avoid it. We conclude that it is extremely unlikely that a sturgeon will be struck by a project vessel; therefore, effects are discountable.

Potential for interactions with escaped farmed salmon within the GOM DPS rivers and proposed critical habitat

On June 3, 2016, we issued a proposed rule designating critical habitat for the Gulf of Maine, New York Bight, and Chesapeake Bay Distinct Population Segments (DPSs) of Atlantic sturgeon. The proposed rule identified the physical and biological features that support successful spawning and recruitment of Atlantic sturgeon juveniles to the marine environment. Pursuant to 50 CFR 402.10, a conference on the impacts of an action on proposed critical habitat is required if an action is likely to result in the destruction or adverse modification of proposed critical habitat. Conference is optional if this threshold is not met. Conference is a process which involves informal discussions between a Federal agency and us under section 7(a)(4) of the Act regarding the impact of an action on proposed species or proposed critical habitat and recommendations to minimize or avoid the adverse effects. Here, we consider the effects of the proposed action on critical habitat proposed for designation for the Gulf of Maine DPS of Atlantic sturgeon.

The placement of net pens in the marine environment is not within the proposed critical habitat area for Atlantic sturgeon and therefore would not have any effects on critical habitat. The effects of this activity also include escapes of farmed fish found within the GOM DPS rivers in Maine where Atlantic sturgeon critical habitat is proposed (i.e., the Penobscot, Kennebec and Androscoggin rivers). The presence of aquaculture escapees would have no effect on any of the identified physical features and would not affect the essential features of spawning or recruitment of Atlantic sturgeon. Therefore, because no effects are anticipated, a conference is not required.

3.3 ESA listed Marine Mammals

Several species of ESA listed whales, including the North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), and four species of federally listed threatened or endangered sea turtles (threatened Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead (*Caretta caretta*), and the endangered Kemp's ridley (*Lepidochelys kempi*), green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) sea turtles) are seasonally present in the coastal waters of New England. Fin (*Balaenoptera physalus*), Sei (*Balaenoptera borealis*) and Sperm (*Physter macrocephalus*) whales are seasonally present in New England waters. In Maine, all of these species are typically found in deeper offshore waters.

While we would expect these species to occur in the Gulf of Maine within the extended action area identified, we do not expect any of these species to occur in the immediate area surrounding the marine net pen site in Eastern Bay; therefore, any effects from gear installation and increased vessel traffic to whales and sea turtles are not anticipated to occur. The listed whales and sea turtle species have a broad distribution throughout the Atlantic Ocean and for some species their northern migrations bring them into the Gulf of Maine. Because we can't predict where escapes of farmed Atlantic salmon will travel in the Atlantic Ocean and Gulf of Maine, we expect all these species could occur within the expanded action area, however, there is no evidence of competition, predation, disease transfer or other interactions between farmed salmon and whales or sea turtles. As such, we do not expect aquaculture salmon escapees to affect whales and sea turtles in any way.

4.0 STATUS OF SPECIES AND CRITICAL HABITAT

This section presents 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. We have determined that the Gulf of Maine DPS of Atlantic salmon and its designated critical habitat occur in the action area. This section will focus on the status of Atlantic salmon and critical habitat within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action.

4.1 Gulf of Maine DPS of Atlantic Salmon

Rangewide Status of Listed Atlantic Salmon (Salmo salar) and Designated Critical Habitat

The Gulf of Maine Distinct Population Segment (GOM DPS) of anadromous Atlantic salmon was initially listed by USFWS and NMFS (collectively, the Services) as an endangered species on November 17, 2000 (65 FR 69459). In 2009, a subsequent rule issued by the Services (74 FR 29344, June 19, 2009) expanded the geographic range for the GOM DPS of Atlantic salmon based upon the findings of the 2006 Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States (Fay *et al.* 2006). Based on the best scientific data available, the 2006 Status Review concluded that Atlantic salmon inhabiting larger river systems in Maine were genetically similar to those listed as endangered in 2000. Therefore, the GOM DPS of Atlantic salmon is defined as 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 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, as well as private watershed-based facilities (Downeast Salmon Federation's East Machias and Pleasant River facilities). 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).

Coincident with the June 19, 2009 rule, we designated critical habitat for the GOM DPS of Atlantic salmon (74 FR 29300; June 19, 2009). The final rule was revised on August 10, 2009. In this revision, designated critical habitat for the expanded GOM DPS of Atlantic salmon was reduced to exclude trust and fee holdings of the Penobscot Indian Nation and a table was corrected (74 FR 39903; August 10, 2009).

Species Description and Life History

The Atlantic salmon is an anadromous fish species that spends most of its adult life in the ocean but returns to freshwater to reproduce. Atlantic salmon have a complex life history that includes territorial rearing in rivers and extensive feeding migrations on the high seas (Figure 3). During their life cycle, Atlantic salmon go through several distinct phases that are identified by specific changes in behavior, physiology, morphology, and habitat requirements.

Spawning

Adult Atlantic salmon return to rivers in Maine from the Atlantic Ocean and migrate to their natal streams to spawn. 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), but may enter at any time between early spring and late summer. Early migration is an adaptive trait that ensures adults have sufficient time to reach spawning areas (Bjornn and Reiser 1991). Salmon that return in early spring spend nearly five months in the river before spawning, often seeking cool water refuge (e.g., deep pools, springs, and mouths of smaller tributaries) during the summer months.

From mid-October to mid-November, adult females select sites in rivers and streams 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 and water velocity is increasing (McLaughlin and Knight 1987; White 1942). The female salmon creates an egg pit (redd) by digging into the substrate with her tail and then deposits eggs while male salmon release sperm to fertilize the eggs. After spawning, the female continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel. Females produce a total of 1,500 to 1,800 eggs per kilogram of body weight, yielding an average of 7,500 eggs per two sea-winter (SW) female (an adult female that has spent two winters at sea before returning to spawn) (Baum and Meister 1971).

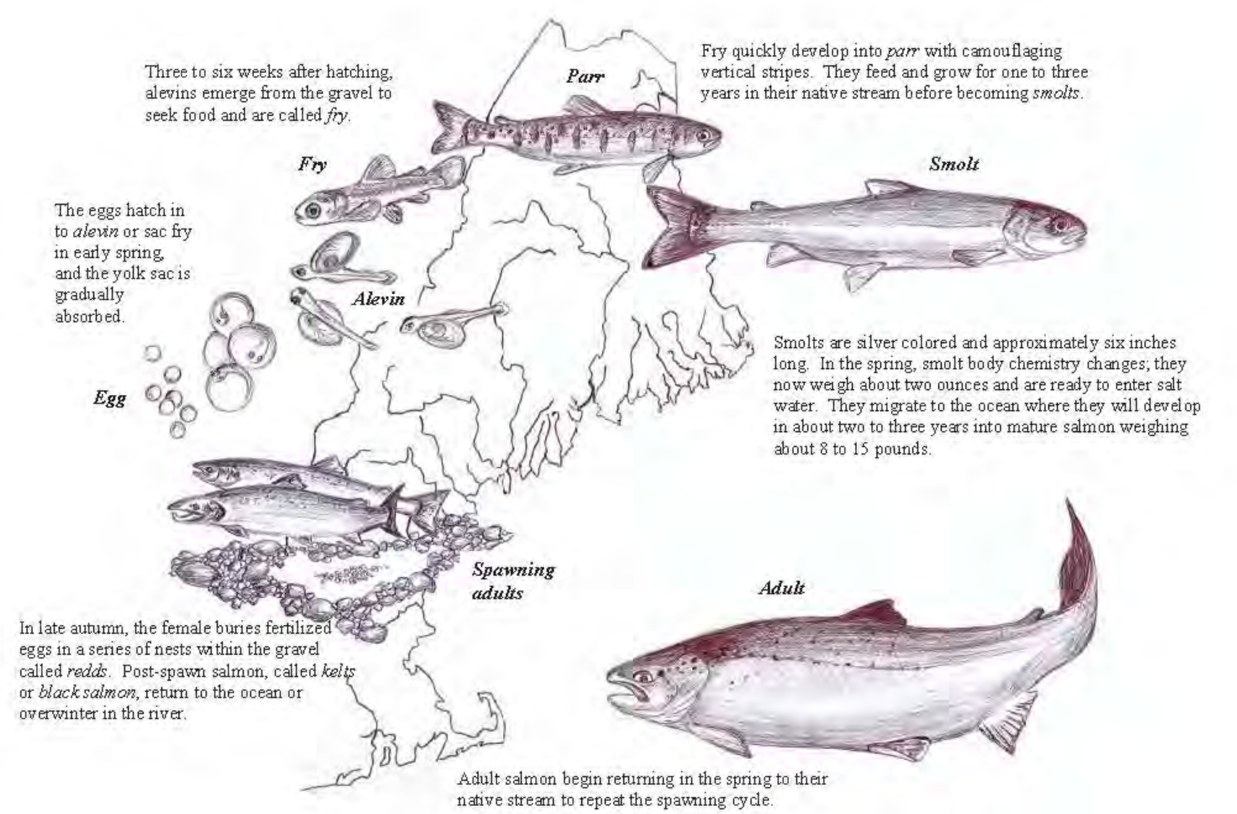

Figure 3. Life Cycle of the Atlantic salmon (diagrams courtesy of Katrina Mueller).

After spawning, male and female Atlantic salmon (“kelts”) either return to sea immediately or remain in fresh water until the following spring before returning to the sea (Fay *et al.* 2006).

Some migrate toward the sea immediately, either moving partway downstream or returning to the ocean (Ruggles 1980; Don Pugh, U.S. Geological Survey (USGS) personal communication). Most kelts, however, overwinter in the river and return to the sea in the spring. Kelts that remain in the river appear to survive well through the winter (Ruggles 1980; Jonsson *et al.* 1990). The relative survival of kelts, however, has not been calculated for Maine rivers. After reaching the ocean, few kelt survive as indicated by the lack of repeat spawners in the GOM DPS (NMFS and USFWS 2005).

Eggs
The fertilized eggs develop in the redd for a period of 175 to 195 days, hatching in late March or April (Danie *et al.*1984).

Alevins and Fry
Newly hatched salmon, also referred to as sac fry, remain in the redd for approximately six weeks after hatching and are nourished by their yolk sacs (Gustafson-Greenwood and Moring 1991). In three to six weeks, they consume most of their yolk sac, travel to the surface to gulp air to fill their swim bladders, and begin to swim freely at this point they are called "fry." Survival from the egg to fry stage in Maine is estimated to range from 15 to 35% (Jordan and Beland 1981).

Parr
When fry reach approximately 4 cm in length, the young salmon are termed "parr" (Danie *et al.* 1984). Most parr remain in the river for two to three years before undergoing smoltification, the process in which parr go through physiological changes in order to transition from a freshwater environment to a saltwater marine environment. Some male parr may not go through smoltification and will become sexually mature and participate in spawning with sea-run adult females. These males are referred to as "precocious parr."

Smolts
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). The spring migration of smolts to the marine environment takes 25 to 45 days. Most smolts migrate rapidly, exiting the estuary within several tidal cycles (Hyvarinen *et al.* 2006; Lacroix and McCurdy 1996; Lacroix *et al.* 2004, 2005).

Post-smolts
Smolts are termed post-smolts after ocean entry to the end of the first winter at sea (Allan and Ritter 1977). 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 some aggregation and common migration corridors related to surface currents (Hyvarinen *et al.* 2006; Lacroix and McCurdy 1996; Lacroix *et al.* 2004). Post-smolt distribution may reflect water temperatures (Reddin and Shearer 1987) and/or the major surface-current vectors (Lacroix and Knox 2005). Post-smolts travel mainly at the surface of the water

column (Renkawitz *et al.* 2012) and may form shoals, possibly of fish from the same river (Shelton *et al.* 1997). Post-smolts grow quickly, achieving lengths of 30-35 cm by October (Baum 1997). Post- smolts can experience high mortality during the transition to saline environments for reasons that are not well understood (Kocik *et al.* 2009; Thorstad *et al.* 2012). 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; Sheehan *et al.* 2012). Atlantic salmon located off Greenland are primarily composed of non-maturing first sea winter (1SW) fish, which are likely to spawn after their second sea winter (2SW), from both North America and Europe, plus a smaller component of previous spawners who have returned to the sea prior to their next spawning event (Reddin 1988; Reddin *et al.* 1988). The following spring, 1SW and older fish 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).

Adults

Some salmon may remain at sea for another year or more before maturing. After their second winter at sea, the salmon likely 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.

The average size of Atlantic salmon is 71-76 cm long and 3.6-5.4 kg after two to three years at sea. Although uncommon, adults can grow to be as large as 13.6 kg. The natural life span of Atlantic salmon ranges from two to eight years (ASBRT 2006).

Reproduction, Distribution and Abundance

The reproduction, distribution, and abundance of Atlantic salmon within the range of the GOM DPS have been generally declining since the 1800s (Fay *et al.* 2006). A comprehensive time series of adult returns to the GOM DPS dating back to 1967 exists (USASAC 2015; Figure 4). It is important to note that contemporary abundance levels of Atlantic salmon within the GOM DPS are several orders of magnitude lower than historical abundance estimates. For example, Foster and Atkins (1869) estimated that roughly 100,000 adult salmon returned to the Penobscot River alone before the river was dammed, whereas contemporary estimates of abundance for the entire GOM DPS have rarely exceeded 5,000 individuals in any given year since 1967 (Fay *et al.* 2006; USASAC 2015).

After a period of population growth between the 1970s and the early 1980s, adult returns of salmon in the GOM DPS peaked between approximately 1984 and 2001 before declining during the 2000s. Adult returns fluctuated over the last few years, with increases observed from 2008 to 2011, and a decrease again in 2012, 2013, and 2014. Presently, the majority of all adults in the GOM DPS return to a single river, the Penobscot, which accounted for over 90% of all adult returns to the GOM DPS over the last decade. The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from GLNFH (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 the 1990s and early 2000s. The increase in abundance of returning adult salmon observed between 2008 and 2011 may be an indication of improving marine survival; however the declines in 2012 - 2014 may suggest otherwise. Returns to U.S. waters in 2013 were only 611 fish, which ranks 43rd in the 47-year time-series (USASC 2014). A total of 450 adults returned to Maine rivers in 2014; the lowest for the 1991- 2014 time series. The largest numbers of adults returned to the Penobscot SHRU, 261 sea-run Atlantic salmon were captured during the 2014 season. This represents a 32% decrease from the 2013 catch of 381 sea-run salmon, and is considerably lower than the ten year average (2004-2013) of 1,379 fish. There was an increase in adult returns in 2015 with 881 adult fish documented within the GOM DPS rivers. However, despite consistent smolt production, there has been extreme variability in annual returns over the last five years (Figure 4).

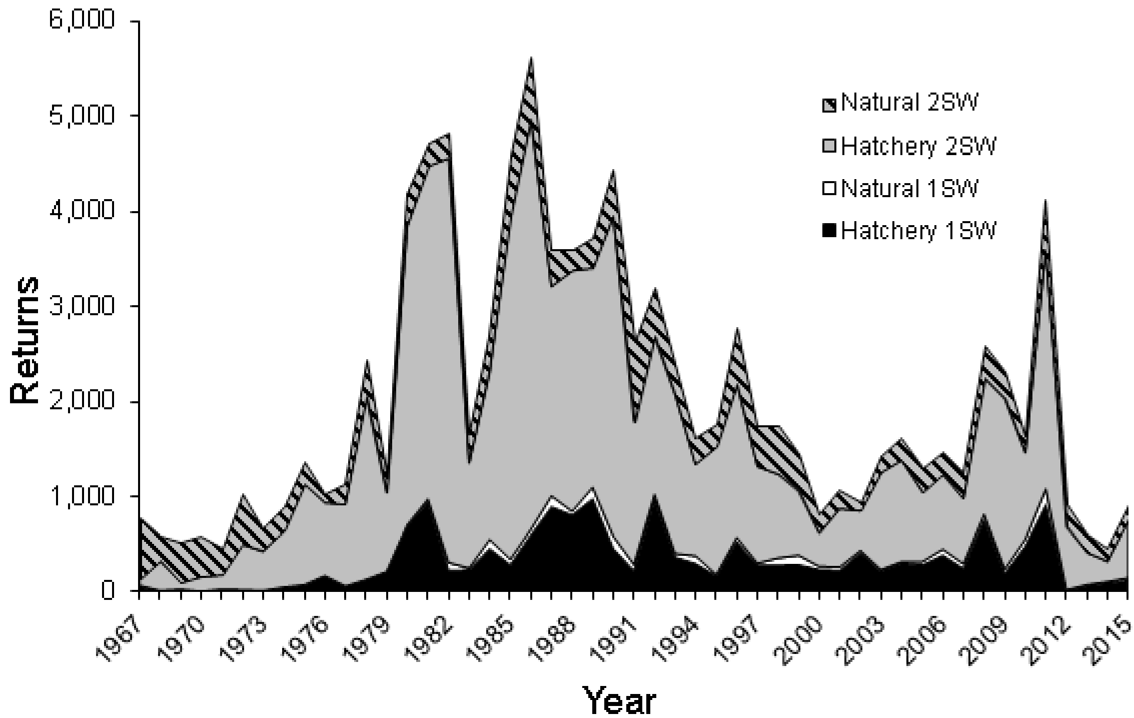

Figure 4. Summary of natural vs. hatchery adult salmon returns to the GOM DPS Rivers between 1967 and 2015 (USASAC 2016)

Since 1967 when records of adult returns were first documented, the vast majority of adult returns are the result of smolt stocking; only a small portion were naturally reared (Figure 4). Therefore, natural reproduction of the species is contributing to only a fraction of Atlantic salmon returns to the GOM DPS. The term naturally reared includes fish originating from both natural spawning and from stocked hatchery fry (USASAC 2012). Hatchery fry are included as naturally reared because hatchery fry are not marked, and therefore cannot be distinguished from fish produced through natural spawning. Low abundances of both hatchery-origin and naturally reared adult salmon returns to Maine demonstrate continued poor marine survival.

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

The historic distribution of Atlantic salmon in Maine has been described extensively by Baum (1997) and Beland (1984), among others. In short, substantial populations of Atlantic salmon existed in nearly every river in Maine that was large enough to maintain a spawning population. The upstream extent of anadromy extended far into the headwaters of even the largest rivers. Today, the spatial structure of Atlantic salmon is limited by obstructions to passage and also by low abundance levels and the majority of all adults return to the Penobscot River. Within the range of the GOM DPS, the Kennebec, Androscoggin, Union, and Penobscot Rivers contain dams that severely limit passage of salmon to significant amounts of spawning and rearing habitat. Atlantic salmon presently have unobstructed access to only ~5% of their historic habitat in the Penobscot River (NOAA 2009).

Threats Faced by Atlantic Salmon Throughout Their Range

Atlantic salmon face a number of threats to their survival which are described in the Recovery Plan (NMFS and USFWS 2005) and the latest status review (Fay *et al.* 2006). 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, throughout the Gulf of Maine. We consider the following to be the most significant threats to the GOM DPS of Atlantic salmon:

- Dams
- Inadequacy of existing regulatory mechanisms for dams
- Continued low marine survival rates for U.S. stocks of Atlantic salmon
- Lack of access to spawning and rearing habitat due to dams and road-stream crossings
- Degraded water quality
- Aquaculture practices, which pose ecological and genetic risks
- Climate change
- Depleted diadromous fish communities
- Incidental capture of adults and parr by recreational anglers
- Introduced fish species that compete or prey on Atlantic salmon

- Poaching of adults
- Recovery hatchery program (potential for artificial selection/domestication)
- Sedimentation of spawning and rearing habitat
- Water extraction
- Diseases
- Predation
- Greenland Mixed Stock Fishery

A wide variety of activities have focused on protecting Atlantic salmon and restoring the GOM DPS, including (but not limited to) hatchery supplementation; removing dams or providing fish passage; improving road crossings that block passage or degrade stream habitat; protecting riparian corridors along rivers; reducing the impact of irrigation water withdrawals; limiting effects of recreational and commercial fishing; reducing the effects of finfish aquaculture; outreach and education activities; and research focused on better understanding the threats to Atlantic salmon and developing effective restoration strategies. In light of the 2009 GOM DPS listing and designation of critical habitat, the Services are producing a new recovery plan for the expanded GOM DPS of Atlantic salmon and have announced a draft plan is out for public comment (81 FR 18639, March 31, 2016).

Starting in the 1960s, Greenland implemented a mixed stock Atlantic salmon fishery off its western coast (Sheehan *et al.* 2015). The fishery primarily takes 1 sea winter (1 SW) North American and European origin Atlantic salmon that would potentially return to natal waters as mature, 2 SW spawning adults or older. Because of international concerns that the fishery would have deleterious on the contributing stock complexes, a quota system was agreed upon and implemented in 1976, and since 1984, catch regulations have been established by the North Atlantic Salmon Conservation Organization (NASCO) (Sheehan *et al.* 2015). In recent years, Greenland had limited the mixed stock salmon fishery for internal consumption only, which in the past has been estimated at 20 metric tons.

In 2015, Greenland unilaterally set a 45 ton quota for a mixed stock Atlantic salmon fishery for 2015, 2016, and 2017 (Sheehan *et al.* 2015). Based on historic harvest estimates, it is estimated that on average, approximately 100 U.S. origin adult Atlantic salmon will be harvested annually under a 45 t quota. With recent U.S. returns of Atlantic salmon averaging less than 1,500 individuals per year, the majority of which originated from hatcheries, this harvest constitutes a substantial threat to the survival and recovery of the GOM DPS. The U.S. continues to negotiate with the government of Greenland and participants of the fishery both within and outside of NASCO to ultimately establish agreed upon measures that will curtail the impact of the fishery on U.S. origin fish.

As part of the 2009 GOM DPS listing and designation of critical habitat, we defined three Salmon Habitat Recovery Units (SHRU); the Merrymeeting Bay SHRU; the Penobscot Bay SHRU; and, the Downeast Coastal SHRU (Figure 2). As defined in the Endangered Species Consultation Handbook, a Recovery Unit is a “management subset of the listed species that is created to establish recovery goals or carry out management actions.” The NMFS Interim Recovery Plan Guidance goes on to state that recovery units are frequently managed as management units, though makes the distinction that recovery units are deemed necessary to both the survival and recovery of the species, whereas management units are defined as not always being "necessary" to both the survival and recovery. Spawning and rearing habitat units are a portion of the river habitat, measuring 100 square meters, suitable for the rearing of young salmon to the smolt stage.

4.1.1 Merrymeeting Bay SHRU

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.

4.1.2 Downeast Coastal SHRU

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.

4.1.3 Penobscot Bay SHRU

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 20 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. 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, we calculated these units to be the equivalent of nearly 66,300 functional units or approximately 20 percent of the historical functional potential.

4.1.4 Summary and Synthesis of the Current Status of the GOM DPS of Atlantic salmon

In light of the 2009 GOM DPS listing and designation of critical habitat, the Services issued a new recovery plan for Atlantic salmon on March 31, 2016 for public review and comment. The draft 2016 Recovery Plan presents a recovery strategy based on the biological and ecological needs of the species as well as current threats and conservation accomplishments that affect its long-term viability. The plan is based upon a planning approach recently endorsed by the USFWS and, for this plan, by NOAA Fisheries. The new approach, termed the Recovery Enhancement Vision (REV), focuses on the three statutory requirements in the ESA, including site-specific recovery actions; objective, measurable criteria for delisting; and time and cost estimates to achieve recovery and intermediate steps. The 2016 Recovery Plan is based on two premises: first, that recovery must focus on rivers and estuaries located in the GOM DPS until the Services have a better understanding of the threats in the marine environment, and second, that survival of Atlantic salmon in the GOM DPS will be dependent on conservation hatcheries through much of the recovery process. In addition, the scientific foundation for the plan includes conservation biology principles regarding population viability, an understanding of freshwater habitat viability, and threats abatement needs.

Under the 2016 Recovery Plan, reclassification of the GOM DPS from endangered to threatened will be considered when all of following criteria are met:

1. The DPS has a total annual escapement of at least 1,500 naturally reared adults spawning in the wild, with at least 2 of the 3 SHRUs having at least 500 naturally reared adults.
2. The population in each of at least two of the three SHRUs has a population growth rate of greater than 1.0 in the 10-year period preceding reclassification.
3. Adults originating from hatchery-stocked eggs, fry, and parr are included when estimating population growth rates.
4. Sufficient suitable spawning and rearing habitat for the offspring of the 1,500 naturally reared adults is accessible and distributed throughout designated Atlantic salmon critical habitat, with at least 7,500 accessible and suitable habitat units (HUs) in each of at least two of the three SHRUs, located according to the known and potential migratory patterns of returning 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, NASWG ICES). 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.

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 2014). 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.

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 later in the environmental baseline section, 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.

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

4.2 Designated Critical Habitat

In designating critical habitat for Atlantic salmon, we identified areas in the GOM DPS that contained the physical and biological features necessary for the conservation of the species. Within the GOM DPS, these features included: 1) sites for spawning and rearing, and 2) sites for migration (excluding marine migration[1]). Critical habitat was only in designated in areas (HUC-10 watersheds) considered currently occupied by the species (Figure 2). Designated critical habitat includes all perennial rivers, streams, and estuaries and lakes connected to the marine environment within the range of the GOM DPS, except for those areas that have been specifically excluded as critical habitat. Critical habitat 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.

Threats to Critical Habitat

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. There are a combined total of twenty FERC-licensed hydropower dams in the Penobscot SHRU and a number of these dams continue to 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.

[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.

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.

5.0 ENVIRONMENTAL BASELINE

The environmental baseline for a biological opinion includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). An environmental baseline that does not meet the biological requirements of a listed species may increase the likelihood that adverse effects of the proposed action will result in jeopardy to a listed species or in destruction or adverse modification of designated critical habitat. In addition, the environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species and may affect critical habitat in the action area.

5.1 Impacts of Federal Actions that have Undergone Formal or Early Section 7 Consultation

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

A formal consultation was completed with the USACE 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 USACE 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. Since 2003, there has been very limited take (4 documented fish) associated with this ITS, if the ITS level is exceeded, the USACE must reinitiate Section 7 consultation for these aquaculture sites.

On December 23, 2009, we issued an Opinion to FERC on the surrender of licenses for the Veazie, Great Works and Howland Projects. The projects were decommissioned and purchased by the Penobscot River Restoration Trust. The Trust's intent is to restore migratory access and habitat for multiple species of diadromous fish in the Penobscot River. To accomplish these goals, the Trust proposes to decommission and remove the Veazie and Great Works Projects and decommission and build a nature-like fishway at the Howland Project. The Opinion considered: 1) the effects removing the Veazie and Great Works Projects on listed Atlantic salmon and shortnose sturgeon; 2) the effects of construction a nature-like fish bypass around the Howland Dam; and 3) the short term operation of each project until the projects were decommissioned In the Opinion, we concluded that the proposed action was not likely to jeopardize the continued existence of listed Atlantic salmon or shortnose sturgeon. The ITS accompanying the Opinion exempted the incidental take of Atlantic salmon smolts and adults in the action area. The ITS also exempted the incidental take of larvae and juveniles shortnose sturgeon.

On November 29, 2012, we issued an updated Opinion to NOAA's Restoration Center regarding the effects of their proposed funding to remove the Veazie Dam and construct the nature-like bypass at Howland on newly listed Atlantic sturgeon. The Opinion analyzed the effects of pre-removal, removal, and post-removal of the Veazie Dam on Atlantic sturgeon. The Opinion also analyzed the effects of the proposed bypass reach at Howland on the Atlantic salmon migration in the action area. In the Opinion, we concluded that the proposed action was not likely to jeopardize the continued existence of listed Atlantic salmon, Atlantic sturgeon, or shortnose sturgeon. The ITS accompanying the Opinion exempted the incidental take of Atlantic salmon smolts and adults in the action area. The ITS also exempted the incidental take of larvae, juveniles, and adult shortnose and Atlantic sturgeon.

On April 25, 2012, we issued an Opinion to the NMFS Northeast Fisheries Science Center, Maine Field Station on the impacts to listed species from the proposed Penobscot Estuarine Fish Community and Ecosystem Survey. The NEFSC is continuing to develop and refine a long term study plan to evaluate the feasibility of various capture methods with the goal of establishing a comprehensive ecosystem survey to document the distribution and relative abundance of aquatic species in estuarine and nearshore environments of the Penobscot River. The purpose of the proposed research survey is to develop consistent sampling methods and test efficacy of a variety of sampling techniques and gear types at numerous sites to measure estuary fish communities with a focus on diadromous fish species. We concluded that the proposed action was not likely to jeopardize the continued existence of listed Atlantic salmon, shortnose sturgeon or Atlantic sturgeon. The ITS accompanying the Opinion exempted the incidental take of juvenile Atlantic sturgeon and juvenile and adult shortnose sturgeon.

On August 31, 2012, we issued an Opinion to FERC concerning the applications to amend the licenses for the construction of new powerhouses at the Stillwater (2712) and Orono (2710) Projects, as well as the incorporation of protection measures for Atlantic salmon and other listed species at the Orono, Stillwater, Milford (2534), West Enfield (2600) and Medway (2666) Projects. The Opinion considered the direct and indirect effects of construction the new powerhouses as well as their subsequent operation on listed species in the action area. In addition, the Opinion analyzed the effects of proposed Species Protection Plans for Atlantic salmon at each project and sturgeon handling plans at the Milford and Orono Projects. In the Opinion, we concluded that the proposed action was not likely to jeopardize the continued existence of listed Atlantic salmon, shortnose sturgeon, or Atlantic sturgeon. The ITS exempts the incidental taking of Atlantic salmon adults, smolts, and kelts from activities associated with the construction of the new powerhouses, ongoing operations of the hydroelectric facilities, and upstream and downstream passage and survival studies. It also exempts the trapping of one shortnose and Atlantic sturgeon per year at the proposed fish traps at the Orono and Milford Projects; as well as the stranding of one Atlantic sturgeon a year in the bypass reach of the Orono Project when water levels are dropped to allow for flashboard maintenance and replacement.

On September 17, 2012, we issued an Opinion for the Federal Energy Regulatory Commission's (FERC) proposed amendment of the license held by Hydro Kennebec LLC (HK LLC) for their Hydro Kennebec project (FERC No. 2611). The license is being amended to incorporate the provisions of an Interim Species Protection Plan (ISPP). The ITS exempts the incidental taking of Atlantic salmon smolts and kelts from activities associated with the ongoing operation of the hydroelectric facility as well as upstream and downstream passage and survival studies. The project is located on the Kennebec River in Maine.

On June 19, 2013, we issued an Opinion for FERC’s authorization of FPL Energy Maine Hydro LLC's (FPL Energy) proposal to incorporate the provisions of a seven year (2013-2019) Interim Species Protection Plan (ISPP) at the Lockwood (2574), Shawmut (2322), and Weston (2325) Projects on the Kennebec River, and the Brunswick (2284) and Lewiston Falls (2302) Projects on the Androscoggin River in Maine. The ITS exempts the incidental taking of Atlantic salmon smolts and kelts from activities associated with the ongoing operation of the hydroelectric facilities as well as upstream and downstream passage and survival studies. The ITS specifies Reasonable and Prudent Measures (RPMs) and implementing Terms and Conditions necessary to minimize the impact of these activities on listed species. The take level for Atlantic salmon was estimated based on the likelihood of the species occurring in the action area during the time period proposed for the project (7 years).

On June 20, 2013, we issued an Opinion to FERC on the amendment of license for the Weldon Project. The FERC proposed to amend the license for the Weldon Project to incorporate provisions of an Interim Species Protection Plan for Atlantic salmon. In the Opinion, we concluded that the proposed action was not likely to jeopardize the continued existence of listed

Atlantic salmon. The ITS exempted the incidental taking of Atlantic salmon smolts and kelts from activities associated with the ongoing operation of the hydroelectric facility as well as upstream and downstream passage and survival studies for a six year period.

5.2 Scientific Studies permitted under Section 10 of the ESA

Atlantic salmon

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

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

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

Other Federally Authorized Activities in the Action Area

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

5.3 State or Private Activities in the Action Area

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

State of Maine stocking program

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 (S*alvelinus 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 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).

6. 0 CLIMATE CHANGE

The discussion below presents background information on global climate change and information on past and predicted future effects of global climate change throughout the range of the listed species considered here. Additionally, we present the available information on predicted effects of climate change in the action area and how listed salmon may be affected by those predicted environmental changes over the life of the proposed action. Climate change is relevant to the Status of the Species, Environmental Baseline and Cumulative Effects sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion. Consideration of effects of the proposed action in light of predicted changes in environmental conditions due to anticipated climate change are included in the Effects of the Action section below (Section 7.0).

6.1 Background Information on Global climate change

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

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

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

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

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

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

6.2 Potential Effects of Climate Change to Atlantic Salmon and Critical Habitat

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

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

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

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

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

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

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

6.3 Effects of Climate Change to Atlantic Salmon and Critical Habitat in the Action Area

Information on how climate change will impact the action area is extremely limited. According to Fernandez et al. 2015, the Intergovernmental Panel on Climate Change (IPCC) models predict that Maine's annual temperature will increase another 3.0–5.0 °F (1.7–2.8 °C) by 2050. The IPCC models predict that precipitation will continue to increase across the Northeast by 5–10% by 2050, although the distribution of this increase is likely to vary across the climate zones (Fernandez et al. 2015); model predictions show greater increases in precipitation in interior Maine. Total accumulated snow is predicted to decline in Maine especially along the coast where total winter snow loss could exceed 40% relative to recent climate (Fernandez et al. 2015). Since 2004, sea surface temperatures in the Gulf of Maine have accelerated to 0.41 °F (0.23 °C) per year; a rate that is faster than 99% of the world's oceans (Fernandez et al. 2015). According to the most recent National Climate Assessment (Melillo *et al*. 2014), a global sea level is projected to rise an additional 0.5 to 2.0 feet (0.2 to 0.6 meters) or more by 2050. Rising sea levels would shift the salt wedge in the Penobscot River and other rivers in the GOM DPS.

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on Atlantic salmon.

In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of seasonal migrations for the GOM DPS of Atlantic salmon in Maine. There could be shifts in the timing of spawning; presumably, if water temperatures stay warm further in the fall, and water temperature is a primary spawning cue, spawning migrations could occur earlier in the year and spawning events could occur later. However, because salmon spawning is not triggered solely by water temperature, but also by day length (which would not be affected by climate change) and river flow (which could be affected by climate change), it is not possible to predict how any change in water temperature or river flow alone will affect the seasonal movements of salmon throughout the action area.

Atlantic salmon are cold water fish and have a thermal tolerance zone where activity and growth is optimal (Decola 1970). Temperature can be a stimulant for salmon migration, spawning, and feeding (Elson 1969). Temperature can also significantly influence egg incubation success or failure, food requirements and digestive rates, growth and development rates, vulnerability to disease and predation, and may be responsible for direct mortality (Garside 1973; Spence *et al.* 1996; Peterson *et al.* 1977, Whalen *et al.* 1999b). When temperatures exceeded 23^{o}C, adult Atlantic salmon can ceased upstream movements. Salmon mortalities were associated with daily average temperatures of 26^{o}C to 27^{o}C. Thus, increasing sea and river temperatures could have a significant impact on Atlantic salmon abundance, reproduction, and numbers in the Penobscot Bay, Merrymeeting Bay and Downeast Coastal SHRUs.

Any forage species that are temperature dependent may also shift in distribution as water temperatures warm. However, because we do not know the adaptive capacity of these individuals or how much of a change in temperature would be necessary to cause a shift in distribution, it is not possible to predict how these changes may affect foraging sturgeon or salmon.

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

7. 0 EFFECTS OF THE ACTION

This section of the Opinion analyzes the direct and indirect effects of the proposed action on the GOM DPS of Atlantic salmon and their designated critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused 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 (50 CFR 402.02; see also 1998 FWS-NMFS Joint Consultation Handbook, pp. 4-26 to 4-28). We have determined that the operation of the inland hatcheries that raise the fish that are stocked in the pens are an interrelated action; this is because the hatcheries are part of the larger action (authorizing the marine pens which allow rearing and grow out of the fish to market size) and depend upon the larger action for their justification.

7.1 USACE Special Conditions to be Included in the RHA Section 10 Permit

The USACE has special conditions in place for the protection of the GOM DPS of Atlantic salmon from activities supporting commercial Atlantic salmon aquaculture in Maine. These special conditions will be included as mandatory conditions of the permit to be issued to Cooke. These conditions are expected to significantly reduce, but will not eliminate, the potential for losses (escapes) of farmed fish from net pens at the proposed Calf Island 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 U.S. cages have been attributed to all of these causes.

The Atlantic salmon farming industry in Maine is required to implement protective measures to minimize the risk from farmed fish interactions. These specific measures 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. 5). 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. Figure 5 5illustrates the audit verification process in place to validate the USACE special conditions implemented to reduce impact to wild Atlantic salmon from commercial aquaculture operations in Maine.

The following section describes the special conditions that the USACE will include in the permit. These conditions are consistent with conditions resulting from a Biological Opinion conducted between the USACE and NMFS in 2003 and 2011 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 USACE and MDEP.

d. Prior to the transfer of any eggs from individual family lots, the permittee shall submit to the USACE and MDEP confirmation from the Services demonstrating compliance with Special Condition 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 USACE 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 USACE. No alternative salmonid species shall be stocked without prior written approval from the USACE.

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 USACE and the Services. The first annual audit shall be conducted within 1 year of stocking the facility. The USACE, 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 USACE, 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 USACE. The facility shall notify the USACE 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 USACE.

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: 207-469-7300 ext 1118 and NMFS: 207-866-7342) and the USACE (207-623-8206). Other escape events must be logged according to the CMS and provided to the USACE 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 Appendix B).

a. Prior to marking fish to be stocked, the facility shall submit to the USACE 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 USACE 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 USACE 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 in Habitat Conservation division at 978-281-9277 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 Calf 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: Jolie Harrison, Division Chief Permits and Conservation Division, Office of Protected Resources,
1315 East-West Highway, F/PR1 Room 13805,
Silver Spring, MD 20910
Jolie.Harrison@noaa.gov

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.

The USACE special conditions proposed to be included in Cooke's proposed Calf Island site lease permit are specifically designed to address the effects of aquaculture on the endangered Atlantic salmon, as discussed above. State of Maine MEPDES permits have similar requirements for the Calf Island marine site in addition to specific CMS requirements for each of the supporting freshwater hatchery facilities. These include escape prevention, reporting and disease free certification of the fish being reared and stocked into the marine sites. Escape prevention at each of the hatcheries includes a redundant barrier system with two and three barriers required at different life stages being reared. The CMS plans also require daily monitoring and reporting of escapes from these facilities. Since 2005, there have been no reported breaches of containment from the inland facilities supporting the commercial Atlantic salmon marine sites in Maine. Based on the information provided herein this BO, we would not anticipate any escapes from these inland supporting hatchery facilities, however, even if the procedures described in the USACE special conditions are implemented as required at the Calf Island aquaculture 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. Consequently, while implementation of the proposed permit modifications significantly reduces the likelihood of interaction between farmed and wild fish, it is still reasonable to expect at least occasional escapes from the Calf Island aquaculture site and therefore, effects to NMFS listed species.

7.2 Efficacy of protective measures to minimize risk from aquaculture activities

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

7.2.1 Use of North American Stocks to Minimize Risk from Genetic Introgression

Special Condition No. 1 (Genetic Restrictions) 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 Calf 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 the larger the 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 transfer of fish pathogens and other undesirable ecological interactions exists, regardless of the genetic strain utilized by Cooke Aquaculture at the Calf Island marine site.

7.2.2 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 at the Calf Island marine site.

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 in this Opinion, competition for mates, food and habitat is reasonably certain to impair essential behavioral patterns of wild Atlantic salmon including breeding (included in the concepts of harm and harass, which are included in the definition of take) if escapes of farmed origin fish were to occur.

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 USACE 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 Calf Island site, which in turn will result in a reduction in the frequency and magnitude of escapees entering GOM DPS rivers (Table 2). 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 escapes that is needed for comparison purposes (Table 2). As established in the November 19, 2003 biological Opinion prepared in response to the USACE'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 Calf Island marine site that would otherwise occur under normal operation conditions (NMFS 2003).

This anticipated 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 consistently enter a GOM DPS 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 (DFO 2013). 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. As such, we would anticipate a slight increase in losses of farmed fish (up to 4 for the term of this permit) as a result of the Calf Island marine site that could contribute to the annual intrusion of farmed origin fish entering GOM DPS rivers.

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. Only two reported breach of containment events have occurred since initiating this specific reporting requirement. The information learned from this isolated event was used to improve the fish husbandry practices that led to the breach and potential fish escape. Subsequently, only four U.S. farmed origin fish were captured at any fishways or weirs within the GOM DPS rivers following these reported events.

7.2.3 Permit requirements for reporting breaches of containment, escapes and detection of pathogens to minimize competition and disease transfer.

Special Condition No. 5 will allow us to determine if there has been a loss of farmed fish from the Calf Island marine site. The USACE permit requires 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 this facility 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 escape events resulting 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 8ºC, and monthly when water temperatures are between 6ºC and 8ºC. 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. 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.

7.2.4 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 Calf 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 USACE 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. The Services firmly believe 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 (Table 1). Annual Quality Assurance and Quality Control (QA/QC) is guided by protocols developed in consultation with the Services (Appendix B) and annual audits validate mark detection rates and Chain of Custody documentation in freshwater hatcheries and immediately following stocking into marine net pens (Fig. 5). 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 1. 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
2010	88%	CUSA	Offspring B
2011	95%	CUSA	Cervus/Offspring
2012	95%	CUSA	Offspring
2013	100%	CUSA	Offspring
2014	98%	CUSA	Offspring

*Data provided from Annual reports submitted by Cooke Aquaculture (2005-2014)

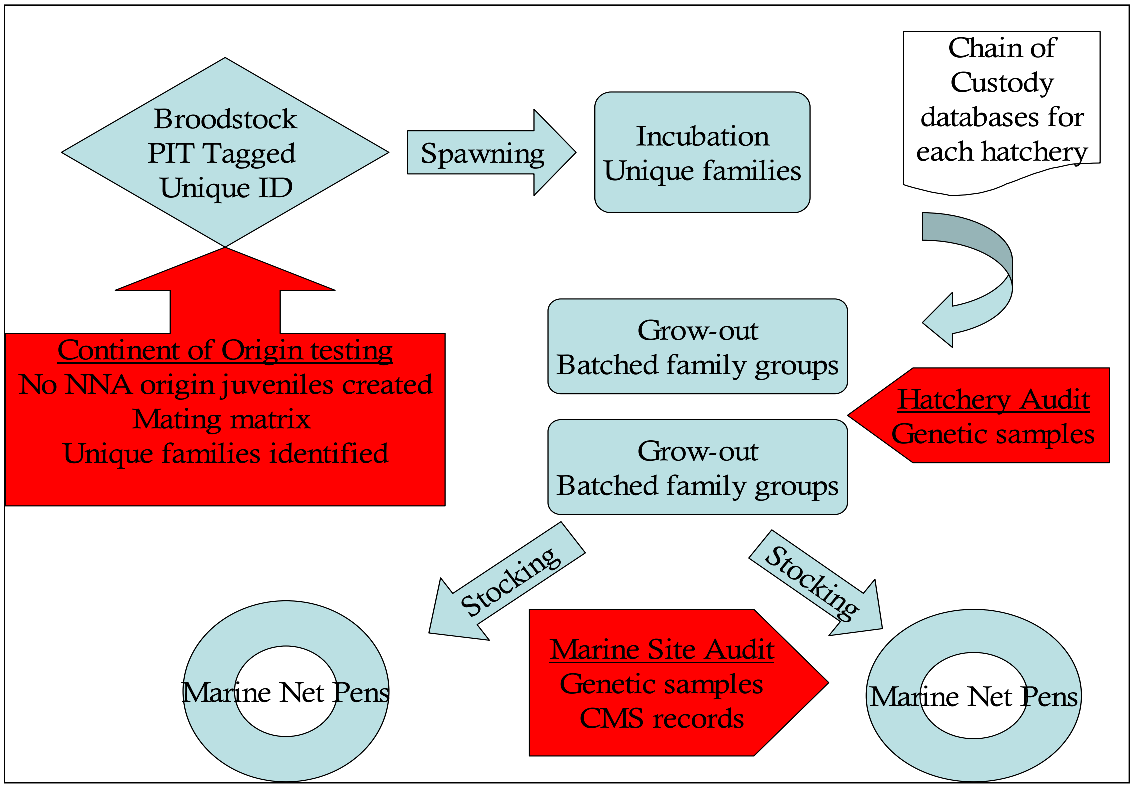

Fig. 5. QA/QC Program schematic of audit verification points

7.2.5 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 Calf 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.

7.2.6 Additional Protections provided to GOM DPS Atlantic salmon through State permits and cooperative agreements between salmon farming interests and neighboring 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 high, the magnitude of these impacts to the population is anticipated to remain low over time due to the USACE 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 at the Calf Island marine site for production.

Background Information on Effects of Salmon Aquaculture Operations

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 USACE, MDMR and MDEP. The Atlantic salmon is the primary species of finfish under cultivation, with other species being reared in previous 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.

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 (Figure 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. The number of active aquaculture finfish sites stocked with Atlantic salmon has fluctuated significantly over the last two decades with a peak of 31 sites in 2001. 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 diameter net pens in the water. Although there are not significant data to analyze gear related escape events, past escape reports in the U.S. 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.

Table 2. Annual production for Maine Atlantic salmon farming industry (2000-2015) from active lease sites and suspect adult aquaculture origin fish captured in GOM DPS rivers in Maine. In the table below, harvest totals that have been estimated have ***. In 2007, the * in the captures row indicates a dead aquaculture origin fish found on the trash rack of a hydro dam.

Year	Total Salmon Stocked (smolts + fall parr + clips)	RV clipped fish stocked	Harvest total (metric tons)	Suspect aquaculture origin captures (Maine DPS Rivers)
2000	4,511,361		16,460.936	31
2001	4,205,161		13,202.049	65
2002	3,952,076		6,798.368	14
2003	2,660,620		6,007.113	2
2004	1,580,725		8,514.717	0
2005	294,544		5,262.776	12
2006	3,030,492	252,875	4,673.790	6
2007	2,172,690	154,850	2,715.268	0*
2008	1,470,690		9,014.387	0
2009	2,790,428		6,027.774	0
2010	2,156,381	128,716	11,127.047	0
2011	1,838,642	45,188	6,031.228***	3
2012	1,947,799	137,207	5,397***	7
2013	1,329,371	170,024	5,079***	0
2014	2,285,000	0	5,189***	0
2015	1,983,850	446,129	4,570***	0

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 2.

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 USACE 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 2, documented farmed origin salmon entering US GOM DPS Atlantic salmon rivers have decreased significantly since the full implementation of these measures in 2005.

7.3 Documentation of Escapes from Marine Aquaculture Facilities

Escapes of farmed origin fish from commercial marine aquaculture facilities

The detection of escapees in a weir or trap on the Penobscot, Kennebec, Union, 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. The best available historic information indicates 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.

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. 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). Since 2005, 16 aquaculture origin fish have been documented in GOM DPS rivers; only four of these fish (captured in 2012) have been positively identified through genetic marking as coming from several U.S. farm sites (Table 2).

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 1,500 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.

There has been little historic information available to evaluate the disposition or distances that escaped farmed salmon have moved in Maine because: (1) aquaculture fish have not previously been marked, either in Maine (prior to 2005) or Canada and; (2) reporting of escape events has not been required for all provinces. Despite these prior inadequacies, we have sufficient information to document aquaculture origin fish in several GOM DPS rivers. A study funded by NMFS in 2004 addressed information gaps on escaped farmed Atlantic salmon in the Northeast. Whorisky *et al.*, (2006) 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.

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 escapes attributed to Maine's commercial salmon farming industry 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. Even though the data for escape occurrence is incomplete, the probability of capturing an aquaculture origin farmed Atlantic salmon within a GOM DPS river is very high considering over 90% of the current and historic returning adult Atlantic salmon are captured and handled at existing fishways.

7.4 Effects to the GOM DPS from Calf Island Aquaculture Site

7.4.1 Gear Installation and Construction

According to the USACE, suspended sediments and underwater noise as a result of anchor and pen placement at the site may displace fish in the action area. Net pen placement could occur at the time of year when salmon are present in the action area. However, these effects are anticipated to be short-term and will only occur during the time the gear is being set in place (< 1 week). The USACE does not anticipate any long-term effects to endangered Atlantic salmon resulting from the installation and construction of net pens at the proposed Calf Island site. The installation of the net pens will result in a very small, temporary increase in suspended sediment due to placement of the anchoring system. Due to the minor and temporary nature of this increase, effects to any Atlantic salmon exposed to this increase in suspended sediment will be insignificant. The footprint of the net pen site is extremely small when compared to the area available in Eastern Bay for migrating Atlantic salmon; therefore, even if salmon were displaced from the area where the net pens were being installed, effects would be insignificant.

7.4.2 Operation and maintenance effects

The effects associated with routine operations and maintenance occur from rearing farmed Atlantic salmon include 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. Through state fish health regulations, fish being stocked into the Calf

Island site will be certified free of diseases of concern and come from certified hatcheries. 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 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.

Considering recent improvements in fish feeding technologies, fish husbandry practices, fish health protocols and Bay management areas, we do not anticipate any adverse effects to occur as a result of the daily operations and maintenance of the Calf Island marine site. Any potential effects to benthic resources from the placement of gear and daily feeding of the fish will be minor and will be restored to existing conditions within one fallow period between grow out cycles as required by permit. Furthermore, due to the existing state and federal regulations, we do not anticipate any additional effects to the environment from rearing practices that involve treatments, cleaning or maintenance of gear at the Calf Island marine site. Based on this, effects to listed species are extremely unlikely to occur and are therefore, discountable.

7.4.3 Interactions between Aquaculture Escapees and Wild Salmon in GOM DPS rivers

Despite adherence to all of the special permit conditions, we expect a small number of escape events to occur over the ten year life of the permit. We calculated the number of farmed fish we could anticipate entering GOM DPS rivers from this project in four steps. First, we determined, using data from 2006 through 2015,[2] (the aquaculture industry began full implementation of USACE special conditions and Cobscook Bay management plan), that the mean number of escaped aquaculture salmon detected annually in GOM DPS rivers with weirs and traps was 1.6 per year. Second, we determined that the mean number of stocked aquaculture salmon from 2006 through 2015 was 2,092,517 fish per year. Third, we divided the number of salmon that will be stocked at the Calf Island Site (540,000 fish/year) by the mean number of salmon stocked from 2006 through 2015 (2,092,517 fish/year). From this we determined that the number of smolts stocked at the Calf Island Site will be approximately 26% of the mean stocked salmon from 2006 through 2015. Fourth, we determined, based on the assumption that escaped fish detected in GOM DPS rivers would be proportional to number of fish stocked, that Calf Island would result in 26% of the annual average escaped aquaculture salmon detected from 2006 through 2015 for a total of 0.4 Calf Island fish detected per year. Consequently, over the 10 year duration of the permit, we expect that four Calf Island aquaculture salmon will be detected 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. It is important to note that because the effects on the wild population have not been well studied or documented in Maine, we use the information from other studies conducted in

2 This ten year period was selected because the aquaculture industry began full implementation of USACE special conditions and the Cobscook Bay management plan in 2005 and consequently 2006 represents the first full year of management under these restrictions.

laboratories, natural environments and in the wild to describe the potential effects similar interactions could have on the GOM DPS population if escaped farmed Atlantic salmon from the Calf Island site interact with GOM DPS Atlantic salmon.

Competition

Several studies have documented competition between aquaculture Atlantic salmon and wild salmon. For example, 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. 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.

Based on available studies and existing data showing that escaped aquaculture salmon have travelled to GOM DPS spawning rivers, we anticipate that proposed action will result in a small increase in resource competition between escaped aquaculture salmon and GOM DPS salmon.

Effects of genetic introgression within GOM DPS rivers

In this section, we describe the genetic risks associated with interactions between domesticated Atlantic salmon of aquaculture origin and wild origin GOM DPS Atlantic salmon. 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].

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).

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).

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 U.S. (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 Atlantic salmon that are not part of the GOM DPS. 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.

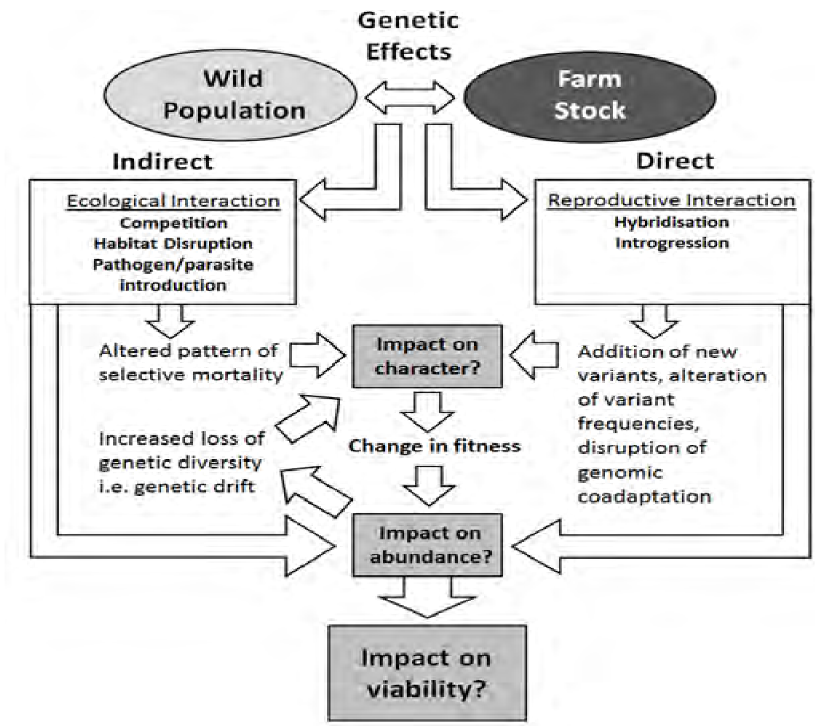

Figure 6. Diagram describing the pathways underlying genetic effects from interactions between wild and farmed Atlantic salmon (DFO 2013)

The potential for genetic introgression to occur throughout all life stages poses a significant risk to the GOM DPS (Figure 6). The examples presented below would be representative of the mechanisms involved if a farmed Atlantic salmon from the Calf Island site spawned with a wild GOM DPS fish. The biggest risk is amplification of deleterious genes and disruption of gene complexes that support local adaptation and may affect immunological responses as a result of 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.

Because the genetic effects on the GOM DPS wild population have not been well studied or documented in Maine, we use the information from other peer reviewed studies conducted in laboratories, natural environments and in the wild in this Opinion to describe the potential effects similar interactions could have on the GOM DPS population if escaped farmed Atlantic salmon from the Calf Island site interact with GOM DPS Atlantic salmon. Based on this information we anticipate that the proposed action will result in a small increase in adverse genetic affects to the GOM DPS population. Adverse genetic impacts will be extremely minor because only a small number of escaped farmed fish are expected to reach spawning habitat (four over 10 year permit period) and those escaped fish will only be able to access approximately 6% of spawning habitat (the remaining approximately 94% is above fishways, weirs, and traps that would screen out aquaculture fish). Additionally, adverse genetic effects are minimized by the use of North American aquaculture stocks .

Redd superimposition and deleterious interactions on the spawning grounds

If farmed fish occur on the spawning grounds during or after spawning, they may have a direct effect on the viability of the eggs deposited within redds; particularly 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 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, in 2005, escapees entering the Dennys river 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.

Summary of Interactions between Aquaculture Escapees and Wild Salmon

We anticipate that the proposed action will result in a small number of escaped aquaculture salmon. We also anticipate that four of those escaped aquaculture salmon will interact with wild salmon in the spawning rivers. Further, we anticipate that interactions between aquaculture salmon and wild salmon will adversely affect GOM DPS salmon through: (1) competition between escaped aquaculture salmon and wild salmon for food and mates, (2) genetic introgression, and (3) redd superimposition. As described above, we anticipate that, given the small number of escaped aquaculture salmon interacting with GOM DPS salmon (as described above, we anticipate only four escaped aquaculture salmon will interact with GOM DPS salmon, as a result of the proposed action, over the 10 year term of the permit), and that the effects will primarily impact individual wild salmon and will not have population level impacts.

7.4.4 Effects of Diseases and Parasites

Transmission from farms to local wild stocks

The transfer of pathogens from farmed fish to wild fish was identified as a threat to the persistence of the GOM DPS in a previous Opinion issued to the USACE on the issuance of permits for the maintenance and installation of marine net pens in coastal Maine waters (USFWS 2003); however since that time substantial improvements have been made in aquaculture practices. Migrating GOM DPS Atlantic salmon can be exposed to and infected by close proximity to infected aquaculture sites or directly 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[3] 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 pathogens 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.

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. Many different pathogens are known to infect Atlantic salmon, but historically, Maine wild salmon populations are infrequently affected by them (Baum 1997). The potential fish health risks from disease transfer are difficult to assess with great accuracy and confidence. However, while there is little evidence that impacts have manifested themselves in the wild salmon population to date, the threat from the transfer of disease pathogens remains as long as the aquaculture industry continues to operate in the geographic range of the GOM DPS. More recently, outbreaks of ISA have raised concerns over disease transfers from aquaculture operations (see below).

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[3] 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.

*Infectious Salmon Anemia Virus (*ISAV*)*
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 ISA 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. More recently, outbreaks of ISAV (2005 and 2006) on farm sites located in both Maine and Canada raises concern over escapees potentially transmitting the ISA virus. ISA 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 ISA in Cobscook Bay and the close proximity of several fish farms to GOM DPS rivers also 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 ISA in Canada, but these wild fish were confined for a period in a trapping facility with infected aquaculture salmon (Whoriskey 1999). While it is possible commercial salmon farms and farmed fish 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.

On December 18, 2001, the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) implemented an ISA 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 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, 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 ISA 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 the Calf Island marine site being used for commercial Atlantic salmon production 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 ISA, 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 ISA 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 ISA 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 ISA has not been observed to be a problem for wild stocks, we are concerned that ISA 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 has reduced the disease risk that aquaculture salmon pose to wild stocks.

Sea Lice

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 8ºC, and monthly when water temperatures are between 6ºC and 8ºC. 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.

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 pathogens, 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 well 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.

Additional information from recent research investigating fish community structure in Cobscook Bay provided valuable information on sea lice levels found on resident fish which can be inferred for outmigrating smolts that pass through nearshore waters populated with salmon farms. 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. A recent publication on work conducted by University of Maine (UM) graduate students investigating lice loads on wild fish in Cobscook Bay (Jensen *et. al.,* 2015) found that 10 different species captured in their survey gear were infested with *Caligus elongatus* with at least 1 louse per fish, but overall, among all of the fish sampled, a very low prevalence rate (approximately <5%). Fish collection was conducted monthly between March and November (with the exception of July) in 2012 with sites distributed among inner, outer and middle bays using stationary and mobile gear types such as beach seines, fyke nets, pelagic trawl, and benthic trawl, sampling over 6,000 fish. No Atlantic salmon were captured in any gear type throughout the study period. Researchers used DNA sequencing on 175 individual lice (34% of the total number of sea lice collected) to confirm sea lice species and verify visual observations, overall, only *Caligus elongatus* was found, no individuals were identified as *Lepeophtheirus salmonis* for all fish species collected. These results were in contrast to another study being conducted with sentinel cages in Cobscook bay where the PI had reported observing high levels of infestation by *L. salmonis* in late summer and fall during peak water temperatures (I. R. Bricknell, University of Maine, personal communication in Jensen *et al.*, 2015). The authors have a few explanations for this in light of having an active salmon farming industry within Cobscook Bay. One supporting fact was the bay received a 30 day fallow period in 2012, immediately prior to conducting the study, typically the bay would support up to 14 active sites (Maine Department of Marine Resources 2012). In this paper, the authors had suggested "by removing all cultured Atlantic salmon from the bay, the fallowing may have disturbed *L. salmonis* dynamics associated with the pens, with the cultured fish subsequently having minimal influence on infestations among the wild fish assemblage (Jensen *et. al.*, 2015)." This would certainly be the intent of the fallow period and this study may provide some data supporting the effectiveness of bay-wide fallowing as a way to reduce lice loads on the wild fish assemblages inhabiting the bay.

In 2015, another sea lice study being conducted by UM in which researchers are placing sentinel cages stocked with juvenile Atlantic salmon in Cobscook Bay; suffered a minor set-back when one of the cages accidentally opened and allowed all of the test fish to escape into the wild. The primary investigators for this study reported over 70 fish were lost during this incident. Unfortunately, no preliminary information is available at the time of this consultation.

Disease summary

It is difficult to assess the impact indigenous and non-indigenous diseases have had on the GOM DPS of Atlantic salmon. Since implementation of regulations, and, improvements in fish husbandry; the risks associated with the transfer of endemic diseases from active farms and farmed escapees appear to be low; however, the consequence of transmission of exotic diseases could be severe. While it is possible commercial salmon farms and farmed fish escapees may affect wild stocks within the GOM DPS through the transfer of disease pathogens, as a result of USACE and Maine permit conditions (e.g., required fallow period, disease free certification for smolts, required sea lice testing, required disease screening), the transfer of pathogens or parasites to wild salmon from the Calf Island aquaculture pens is extremely unlikely.

7.5 Effects from Interrelated activities

Hatchery Escapement

There are currently two active commercial hatcheries in Maine owned by Cooke Aquaculture (Gardner Lake and, Bingham) that supply juvenile salmon for commercial grow-out in cage sites in Maine, as well as Canada. These two hatcheries will be providing juvenile salmon for stocking at Calf Island marine site and are located on rivers within the Atlantic salmon GOM DPS; East Machias and Kennebec Rivers respectively.

The Bingham hatchery and the Gardner Lake hatchery will be providing salmon smolts to stock into the Calf Island marine site. Recent improvements (e.g., installation of drum filter and containment screens) have been made at both of these hatcheries to help minimize escapement and comply with MEPDES permit conditions. Moreover, the two hatcheries have also implemented a hatchery CMS plan for each facility that includes an analysis (Hazard Analysis

Critical Control Point (HAACP)) that follows the hatchery production cycle from captive rearing broodstock, hatching eggs to smolt transport. The effectiveness of CMS plans, drum filters, and redundant screens in eliminating escapes from these 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). However, as a result of hatchery improvements to comply with CMS plans and MEPDES permit requirements, escape events are not likely to occur. In light of this, we have determined that escapes of aquaculture fish from commercial hatcheries, although possible, are extremely unlikely to occur. Consequently, we do not anticipate any escapes from these two hatcheries during the ten year term of this lease permit.

7.6 Effects to GOM DPS Critical Habitat

The action area contains both spawning and rearing critical habitat and migration critical habitat. We discuss effects to the necessary physical and biological features constituting critical habitat.

7.6.1 Spawning and Rearing Critical Habitat

The necessary physical and biological features constituting spawning and rearing critical habitat include: Seven habitat features essential to these types of habitat spawning and rearing:

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

The proposed aquaculture pens do not occur in designated spawning and rearing critical habitat. Consequently the installation and maintenance of aquaculture pens will have no effect on listed spawning and rearing critical habitat. However, we anticipate that up to four escaped aquaculture salmon from the Calf Island aquaculture site to enter GOM DPS rivers where spawning and rearing critical habitat occurs.

Even though a limited number of escaped aquaculture salmon are anticipated to enter GOM DPS rivers where spawning and rearing critical habitat occurs, the effects to critical habitat will be insignificant for several reasons. First, escaped aquaculture salmon adverse effects occur predominantly through their interaction with individual wild salmon through various mechanisms: (1) competition for food or for mates, (2) genetic introgression, and (3) redd superimposition. Escaped aquaculture salmon do not, directly or indirectly, reduce the quantity or quality of the physical or biological features of spawning and rearing habitat. Even redd superimposition does not affect habitat quality, instead redd superimposition acts directly up preexisting eggs (this is accounted for as take), without permanently or temporarily impacting habitat quality. Second, because of existing fishways, traps, and weirs, escaped aquaculture salmon would only have access to approximately 6% of all spawning and rearing critical habitat within the GOM DPS. Escaped aquaculture salmon that move outside of this 6% will be detected at fishways, weirs, or traps and removed from the system. For these reasons, escapes of aquaculture salmon are not likely to adversely affect critical habitat.

7.6.2 Migration Critical Habitat

The essential features identified for migration critical habitat in the action area are:

1) Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations;
2) Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation; and
3) Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.

The proposed aquaculture pens occur in migration critical habitat, however the effects of aquaculture pen installation and maintenance will be insignificant for the following reasons. Because of the relatively small size of the project, it will not result in a physical migration barrier as the installation of net pens would not prevent fish from passing through the nearshore marine environment of the Calf Island site. The project will not alter the migration habitat in any way that would increase the risk of predation because the action will not interfere with the natural functioning of any foraging habitat, nor will the action have any long-term effect on the species' ability to detect and avoid any potential predators. Lastly, although net pen installation may temporarily increase sedimentation, any effects to the water column will be limited and below a level that we would expect to impact wild salmon. For these reasons, net pen installation and maintenance are not likely to adversely affect critical habitat.

7.7 Summary of Effects to GOM DPS of Atlantic salmon

In summary, the proposed action is expected to adversely affect individual Atlantic salmon within the Merrymeeting Bay, Penobscot and Downeast SHRUs through fish escaping from this facility and entering the GOM DPS rivers and streams without weirs or traps and resulting in redd superimposition, competition for food, habitat and mates and genetic introgression. Information from relevant scientific studies, escape reports from the aquaculture industry and the detection of aquaculture fish in GOM DPS rivers all discussed in this Opinion clearly establish that the anticipated impacts are reasonably certain to occur. As explained above, escape events are expected to be rare and limited in number over the 10-year life of the permit. While we cannot predict the exact number of escape events or the exact number of fish that will escape from the pens or where they will go, we expect that no more than 4 escaped Atlantic salmon from the Calf Island marine site will be captured in a GOM DPS river over the 10- year life of the permit. Given the limited amount of interactions between escaped aquaculture and wild fish, we anticipate that these interactions will largely impact individual GOM DPS salmon and will not have population level impacts.

8. 0 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.

Agriculture
Agricultural production within the Merrymeeting Bay, 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) was 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 has helped reduce effects to salmon that would otherwise 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.

Forestry
We do 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.

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.

Recreational Fishing
In December 1999, the State of Maine adopted regulations prohibiting all angling for sea-run salmon statewide. 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.

Pollution from point and non-point sources has been a major problem in this river system, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons). Atlantic salmon are vulnerable to impacts from pollution and are also likely to continue to be impacted by water quality impairments in the GOM DPS. Because the GOM DPS area encompasses a large portion of rural areas dominated by small scale agriculture, silviculture, and standing forests, we do not anticipate any significant changes in land use that could potentially impact the action area.

As noted above, impacts to listed species from all of these activities are largely unknown. However, this Opinion assumes effects in the future would be similar to those in the past and are, therefore, reflected in the anticipated trends described in the status of the species/environmental baseline sections.

9.0 INTEGRATION AND SYNTHESIS OF EFFECTS

The best available scientific data and commercial information indicates that the issuance of a RHA Section 10 permit to Cooke Aquaculture for the Calf Island site by the USACE is reasonably certain to result in adverse effects to Atlantic salmon that will occur when aquaculture salmon escape from the marine net pens. These effects would likely occur when escaped aquaculture salmon compete for food and habitat, disrupt redds and interbreed; thus disrupting breeding of wild Atlantic salmon. Appropriate management and regulations in place should significantly reduce the transfer of disease pathogens and parasites to wild salmon. As such, we do not anticipate any adverse effects to wild salmon from the transfer of pathogens or parasites to GOM DPS Atlantic salmon.

The special conditions proposed by the USACE are designed to reduce the impacts of the proposed Calf Island 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 USACE special conditions reduce the potential for future impacts by reducing the number and severity of escape events and 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.

The USACE permit conditions minimize the potential 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 USACE permit conditions are implemented is not anticipated to have a population level impact on the Atlantic salmon GOM DPS.

Based on the information provided above, the interactions of up to four adult GOM DPS Atlantic salmon over ten years will not appreciably reduce the likelihood of survival of the GOM DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery). The action will not affect GOM DPS Atlantic salmon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic salmon from completing their entire life cycle or completing essential behaviors including reproducing, foraging and sheltering. We base this determination on the following factors:

(1) Although GOM DPS Atlantic salmon abundance is low relative to historic data, recent trends are relatively stable or only slightly decreasing and the proportion of fish that are of natural origin in the spawning rivers is also stable;
(2) The proposed Calf Island aquaculture project will increase the number of interactions between escaped aquaculture fish and wild GOM DPS Atlantic salmon, but the overall threat that aquaculture poses to GOM DPS Atlantic salmon has decreased substantially over the past decade (meaning even with the proposed Calf Island project, impacts associated with aquaculture to the GOM DPS will be less than they were historically). This decrease in potential aquaculture impacts is demonstrated by:
    a. There are fewer aquaculture salmon along the Maine coast than historically. Current aquaculture stocking levels are 1,983,850 farmed salmon down from 4,511,361 farmed salmon in 2000.
    b. As a result of gear type and pen material improvements, CMS plans, and other requirements, the number of escaped farmed salmon documented in GOM DPS rivers has dropped significantly from highs of 31 and 65 fish in 2000 and 2001, respectively, to zero in 2013, 2014, and 2015.
    c. All Maine aquaculture salmon are currently from North American stocks, this reduces the impacts of gene introgression on the GOM DPS.
    d. As a result of mandatory permit requirements and voluntary programs, Maine salmon aquaculture facilities have improved disease and parasite prevention and control measures to the point that we do not anticipate the transfer of disease or parasites from the Calf Island site to GOM DPS salmon during the 10-year life of the permit.
    e. Improvements to hatcheries associated with aquaculture have resulted in no documented hatchery escapes since 2005 and we do not anticipate any hatchery escapes during the 10-year life of the permit.
(3) We anticipate that only four Calf Island aquaculture salmon will interact with GOM DPS salmon. These interactions will primarily affect individual GOM DPS salmon but will not result in mortality of any adult salmon. We do not expect interactions from four individuals to affect the levels of genetic heterogeneity in the GOM DPS, particularly because the aquaculture fish are of North American stocks and not foreign or transgenic stocks.
(4) Finally, the USFWS's river specific captive broodstock and stocking program continues to maintain the genetic structure, diversity, and abundance of the GOM DPS population and supports the demographics and distribution for seven GOM DPS rivers, which minimizes genetic changes to the GOM DPS stocks in captivity and helps to offset the extremely low number of adult returns. In addition, the action will have no effect on the ability of GOM DPS Atlantic salmon to shelter and forage in the marine environment.

Therefore, we have determined that the issuance of a RHA Section 10 permit to Cooke Aquaculture for the Calf Island site with the proposed USACE special conditions is not 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 USACE special conditions in the project description. Furthermore, as all effects to Atlantic salmon critical habitat will be insignificant and discountable.

10. CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under our jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is 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. We have also determined that the proposed action is not likely to adversely affect shortnose sturgeon or any DPS of Atlantic sturgeon and that all effects to critical habitat designated for the GOM DPS of Atlantic salmon will be insignificant and discountable.

11.0 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of carrying out an otherwise lawful activity is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by USACE so that they become binding conditions for the exemption in section 7(o)(2) to apply. USACE has a continuing duty to regulate the activity covered by this Incidental Take Statement. If USACE (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to grants, permits and/or contracts as appropriate, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, USACE or the applicant must report the progress of the action and its impact on the species to the NMFS as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)] (See U.S. Fish and Wildlife Service and National Marine Fisheries Service's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

11.1 Amount or Extent of Anticipated Take

The take level for Atlantic salmon was estimated based on the likelihood of commercially reared Atlantic salmon from the Calf Island marine site occurring in the action area during the time period considered in the USACE permit and the Opinion (i.e., through 2026). As explained in the effects of the action section, we anticipate no juvenile salmon to escape from the freshwater hatcheries and a small number of Atlantic salmon to escape from the Calf Island marine site during the term of this permit. Some or all of these escapees will enter rivers where ESA listed Atlantic salmon are present. Take will occur when an escaped Atlantic salmon interacts with an ESA listed Atlantic salmon in the form of harm or harassment, through competition for food, mates and space, redd superimposition and/or genetic introgression. No injury or mortality of any Atlantic salmon is anticipated.

As explained in the Effects of the Action section, we calculated the number of farmed fish we could anticipate entering GOM DPS rivers from this project in four steps. First, we determined, using data from 2006 through 2015,[4] (the aquaculture industry began full implementation of USACE special conditions and Cobscook Bay management plan), that the mean number of escaped aquaculture salmon detected annually in GOM DPS rivers with weirs and traps was 1.6 per year. Second, we determined that the mean number of stocked aquaculture salmon from 2006 through 2015 was 2,092,517 fish per year. Third, we divided the number of salmon that will be stocked at the Calf Island Site (540,000 fish/year) by the mean number of salmon stocked from 2006 through 2015 (2,092,517 fish/year). From this we determined that the number of smolts stocked at the Calf Island Site will be approximately 26% of the mean stocked salmon from 2006 through 2015. Fourth, we determined, based on the assumption that escaped fish detected in GOM DPS rivers would be proportional to number of fish stocked, that Calf Island would result in 26% of the annual average escaped aquaculture salmon detected from 2006 through 2015 for a total of 0.4 Calf Island fish detected per year. Consequently, over the 10 year duration of the permit, we expect that four Calf Island aquaculture salmon will be detected in GOM DPS rivers.

The USACE special conditions proposed as part of this action requires a site specific mark for aquaculture salmon placed at the Calf Island site. As such, it will be possible to distinguish between escapes from Calf Island and other aquaculture sites in Maine captured at GOM DPS rivers with weirs and traps.

We anticipate that the presence of aquaculture fish in a GOM DPS river will result in take, because 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 potentially interbreeding with wild Atlantic salmon would result in genetic introgression and modifications to the wild population genotypes (Bourrett *et al.* 2011). These genetic modifications will decrease the ability of the offspring of these wild fish 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 (Bourrett *et al.* 2011). 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

4 This ten year period was selected because the aquaculture industry began full implementation of USACE special conditions and the Cobscook Bay management plan in 2005 and consequently 2006 represents the first full year of management under these restrictions.

aquaculture fish will harm or harass native wild salmon and/or salmon eggs through mechanisms described above. Furthermore, the impact of an escape event at the proposed Calf Island 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. 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 identified to the Calf Island marine site captured in any GOM DPS rivers will serve as a surrogate measure of take for this Incidental Take Statement (ITS).

When salmon escape from this Calf Island aquaculture facility, some proportion of those escapees is likely to enter or attempt to enter a GOM DPS river within the Merrymeeting Bay, Penobscot Bay and Downeast Coastal SHRUs. Escaped salmon may enter or try to enter both GOM DPS rivers with weirs or traps and those without. It is not possible to prevent all escapes from the proposed Calf Island site, and therefore we expect escapes to occur even with full compliance with the USACE special conditions. Escapes are not always detectable at the net pet site. Even if we were able to detect all escaped salmon entering rivers where salmon are present, we would not be able to document all interactions between wild salmon and aquaculture salmon. In cases where we cannot directly observe the take, it is appropriate to use a surrogate. We will 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 and a surrogate for take. Detection levels at the rivers with weirs and traps are indicative of proportional entries into all GOM DPS rivers, and of anticipated take from escaped aquaculture salmon considered in this Opinion. Because escaped fish are marked and identifiable, we will be able to reliably monitor for the presence of escaped fish from the Calf Island site at rivers with weirs and traps. As explained throughout, escape events are expected to be rare and occur only in extraordinary circumstances such as predator attacks or extreme weather. In 2015, the majority (>95%) of U.S. adult sea run fish returned to the rivers within the GOM DPS, and approximately 87% returned to large rivers that have an existing fishway or weir (USASAC 2015). Therefore, we would also anticipate any escapes from the Calf Island site would also return to these rivers at a similar proportion. As such, the current screening and reporting protocols in place for putative aquaculture origin fish captured in Maine, would be sufficient to determine if the ITS has been exceeded or if the applicant is on a trajectory to exceed the amount of take exempted over the term of the permit. We would also anticipate an exchange of information from each individual event to better understand the cause of the escapes and this information can be used to refine current protocols to reduce the likelihood of the escape occurring in the future. We expect that no more than four escaped Atlantic salmon from the Calf Island site will be detected at weirs or traps in the GOM DPS during the term of this 10 year permit. Therefore, we will consider the ITS exceeded if more than four escaped Atlantic salmon attributable to the Calf Island site are detected over the ten year permit.

11.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

11.3 Reasonable and Prudent Measures

Reasonable and prudent measures are those measures necessary and appropriate to minimize and monitor incidental take of a listed species. We believe the following reasonable and prudent measures are necessary and appropriate for USACE to minimize and monitor impacts of incidental take of Atlantic salmon. Please note that these reasonable and prudent measures and terms and conditions are in addition to the measures that USACE has committed to include as part of the permit (see the Description of the Proposed Action). We consider a failure to implement the measures identified as part of the proposed action a change in the action that may necessitate reinitiation of consultation.

The USACE will ensure that these reasonable and prudent measures are 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. Prevent and minimize the likelihood of incidental take from the escape of aquaculture salmon.
2. Prevent and reduce risk of pathogen or parasite transfer from salmon aquaculture.
3. Monitor and report on the implementation of the USACE special conditions.

11.4 Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the ESA, the USACE must comply 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. Any incidental taking that is in compliance with the terms and conditions specified in this Incidental Take Statement shall not be considered a prohibited taking of the species concerned (ESA Section 7(o)(2)). These terms and conditions are non-discretionary.

1. To implement the above Reasonable and Prudent Measure (1), the USACE will adhere to the guidelines and reporting procedures established in Atlantic Salmon Microsatellite Analysis Protocol (Appendix A) and Quality Assurance/Quality Control procedures (Appendix B) to ensure the appropriate implementation of special conditions.
2. To implement the above Reasonable and Prudent Measures (3), the USACE will promptly notify the NMFS if the permittee fails to comply with any of the special conditions.
3. To implement the above Reasonable and Prudent Measure (3), the USACE will complete an annual report and send it to the 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.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. Specifically, these RPMs and Terms and Conditions will keep us informed of when stocking and harvesting activities are taking place and will require USACE and the applicant to report any escapes in a reasonable amount of time. Term and Condition 1 is specifically designed to minimize loss of farmed fish and any resulting effects if an aquaculture fish escapes. Genetic information is also important in determining where the fish has originally been reared to determine the possible site where it may have escaped. Term and Condition 2 will insure that all special conditions are implemented to minimize the potential for loss of farmed fish at the Calf Island marine site. Term and Condition 3 will further reduce any loss by providing information to evaluate the efficacy of containment measures in place. Although we do not anticipate any lethal take, the implementation of Terms and Conditions 1-3 are necessary and appropriate to prevent the loss of farmed Atlantic salmon from the Calf Island marine site and supporting hatcheries to minimize any potential for take to occur. Term and Condition 3 is required to complete the annual take reporting requirement.

12.0 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. We recommend the USACE use their authorities to carry out the following:

1. The USACE 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 USACE 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 USACE 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 Eastern Bay;
- information on other activities in the bay; and
- coordination with Canada as appropriate.

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

13.0 REINITIATION NOTICE

This concludes formal consultation concerning the USACE's proposed issuance of RHA Section 10 permit to Cooke Aquaculture for the proposed Calf Island marine aquaculture site. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

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APPENDIX A

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.

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APPENDIX B

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