Atlantic salmon
(Salmo salar)

5-Year Review:
Summary and Evaluation

2020

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

U.S. Department of Interior
Fish and Wildlife Service
Ecological Services and Fisheries

5-YEAR REVIEW

Species reviewed: Atlantic salmon (*Salmo salar*)

TABLE OF CONTENTS

Contents

5-YEAR REVIEW
Atlantic salmon/*Salmo salar*

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1 INTRODUCTION

(Excerpted from the Final Atlantic Salmon Recovery Plan, 2019)

Atlantic salmon populations in the United States have been grouped into the Long Island Sound, Central New England, and Gulf of Maine (GoM) distinct population segments (Fay, et al., 2006). Under the Endangered Species Act (ESA), a distinct population segment (DPS) of a vertebrate species is treated as a species for listing and recovery purposes if it meets the qualifying criteria defined by the joint Distinct Population Segment policy of 1996 (61 FR 4722, February 7, 1996). This policy lays out three criteria, all of which must be met before a population segment can be listed as a DPS. These criteria include the discreteness of the population segment in relation to the remainder of the species to which it belongs, the significance of the population segment to the species to which it belongs, and the population segment's conservation status in relation to the ESA's standards for listing as endangered or threatened.

All native Atlantic salmon populations in the Long Island Sound and Central New England DPSs have been extirpated. Non-native Atlantic salmon continued to persist in the Central New England and Long Island Sound population segments as an artifact of a reintroduction program that existed in the Connecticut and Merrimack Rivers from 1967 to 2012. In 2013, the U.S. Fish and Wildlife Service (USFWS) discontinued the federally supported programs to rebuild these stocks. However, Atlantic salmon still persist in some rivers in the Long Island Sound and Central New England DPSs as a result of state-supported efforts to maintain Atlantic salmon presence in some rivers. These include the State of Connecticut's Atlantic Salmon Legacy program that supports a small stocking program in the Connecticut River, and the Saco River Salmon Club's hatchery program supported by the State of Maine's Department of Marine Resources (DMR). The Atlantic salmon used to support these programs are not part of the listed entity and therefore, are not protected under the ESA. Only the GoM DPS supports native wild salmon and meets the criteria for ESA listing; thus, it is the only one of the three population segments listed as endangered under the ESA.

The GoM DPS of Atlantic salmon was first listed by the USFWS and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) (collectively referred to as the Services) as endangered in 2000 (65 FR 69459, November 17, 2000). The GoM DPS as listed in 2000 included all naturally reproducing remnant populations of Atlantic salmon from the Kennebec River downstream of the former Edwards Dam site, northward to the mouth of the St. Croix River. At the time of the 2000 listing, there were uncertainties associated with biological and genetic relationships of Atlantic salmon inhabiting the Androscoggin River, Kennebec River, and Penobscot River to wild Atlantic salmon populations.

A subsequent status review (Fay et al., 2006) recommended that the GoM DPS be expanded to incorporate all naturally reproducing anadromous Atlantic salmon having a freshwater range in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys

River, including all associated conservation hatchery populations used to supplement these natural populations. The marine range, which remained unchanged from the 2000 listing, extends from the GoM throughout the Northwest Atlantic Ocean to the coast of Greenland. The Services jointly listed this expanded GoM DPS as endangered on June 19, 2009 (74 FR 29344, June 19, 2009), and concurrently designated its critical habitat (74 FR 29300, June 19, 2009).

2 GENERAL INFORMATION

2.1 Methodology used to complete the review:

NMFS Greater Atlantic Regional Fisheries Office (GARFO) led this 5-year review in cooperation with the Northeast Fisheries Science Center (NEFSC) and the USFWS. We began to collect information for this 5-year review around the time of publishing a draft Atlantic salmon recovery plan. In June 2017, we published a Federal Register (FR) notice (82 FR 28049, June 20, 2017) stating our intent to conduct a 5-year review and seeking any new scientific information that would inform the review process. In September 2018, we postponed the completion of the 5-year review until the final recovery plan was complete as the plan would provide the objective, measurable criteria for recovery that would support the 5-year review process. The final recovery plan was published in January 2019. Much of the information in this review is supported by the final recovery plan (USFWS Service and NMFS, 2019) and the 2006 Atlantic salmon status review (Fay, et al., 2006). The most up to date science and data on Atlantic salmon originated from the 2019 Atlantic Salmon Assessment Committee Report (USASC, 2019).

2.2 Background: Summary of previous reviews, statutory and regulatory actions, and recovery planning

2.2.1 <u>FR Notice citation announcing initiation of this 5-year review:</u>

(**82 FR 28049**) June 20, 2017, Endangered and Threatened Species; Initiation of 5-Year Review for the Gulf of Maine Distinct Population Segment of Atlantic salmon

2.2.2 <u>Listing History</u>

Candidate Species Designation:

Date: 1991
Entity: Five Atlantic salmon populations: Narraguagus, Pleasant, Machias, East Machias, and Dennys Rivers.

Original Listing:

FR notice: 65 FR 69459

Date listed: November 17, 2000
Entity listed: Gulf of Maine distinct population segment of Atlantic salmon (*Salmo salar*); defined as all naturally reproducing wild populations of Atlantic salmon having historical river-specific characteristics found north of and including tributaries of the lower Kennebec River to, but not including the mouth of the St. Croix River at the United States-Canada border and the Penobscot River above the site of the former Bangor Dam. Populations that met these criteria were found in the following rivers: Dennys, East Machias, Machias, Pleasant, Narraguagus, Sheepscot, Ducktrap, and Cove Brook.
Classification: Endangered

Revised Listing:

FR notice: 74 FR 29344
Date listed: June 19, 2009
Entity listed: Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*); defined as all anadromous Atlantic salmon in a freshwater range covering the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River and includes all associated conservation hatchery populations used to supplement these natural populations.
Classification: Endangered

Critical Habitat Designation:

FR notice: 74 FR 29300
Date Listed: June 19, 2009
Description: 45 specific areas occupied by Atlantic salmon at the time of listing that comprise approximately 19,571 km of perennial river, stream, and estuary habitat and 799 square km of lake habitat within the range of the GoM DPS and in which are found those physical and biological features essential to the conservation of the species.

2.2.3 Review History

Original Status Review:

FR notice: 64 FR 56297
Date: October 19, 1999
Reference:
Colligan, M. A., J. F. Kocik, D. C. Kimball, G. Marancik, J. F. McKeon, and P. R. Nickerson. 1999. Status Review for Anadromous Atlantic Salmon in the United States. National Marine Fisheries Service/ U.S. Fish and Wildlife Service Joint Publication. Gloucester, MA. 232 pp

Revised Status Review

FR notice: 71 FR 55431

Date: September 22, 2006

Reference:

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

2.2.4 Species' Recovery Priority Number at start of 5-year review

The GoM DPS of Atlantic salmon has a species' recovery priority number of 1C, based on the criteria in the Listing and Recovery Priority Guidelines (84 FR 18243, April 30, 2019)(Recovering Threatened and Endangered Species, FY 2017 -2019 Report to Congress. 2019)).

Priority Number: 1C

2.2.5 Recovery Plan or Outline

2005 Recovery Plan:

Citation: NMFS and USFWS. 2005. Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (*Salmo salar*). National Marine Fisheries Service, Silver Spring, MD. Available at: http://www.nmfs.noaa.gov/pr/pdfs/recovery/salmon_atlantic.pdf

2016 Draft Recovery Plan:

Citation: USFWS and NMFS. 2016. Draft recovery plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*). 61 pp.

2019 Final Recovery Plan:

Citation: USFWS and NMFS. 2019. Final recovery plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*). 74 pp.

3 REVIEW ANALYSIS: Application of the 1996 Distinct Population Segment (DPS) policy

The ESA was amended in 1978 to define a species as "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." The authority to list a ''species'' as endangered or threatened is thus not restricted to species as recognized in formal taxonomic terms, but extends to subspecies, and for vertebrate taxa, to distinct population segments (DPS). Three elements are considered in a decision regarding the status of a possible DPS as endangered or threatened under the Act: Discreteness of the population segment in relation to the remainder of the species to which it belongs; the significance of the population segment to the species to which it belongs; and, the population segment's conservation status in relation to the Act's standards for listing.

3.1 Application of the 1996 Distinct Population Segment (DPS) policy

3.1.1 Is the species under review a vertebrate?

YES

3.1.2 Is the species under review listed as a DPS?

YES

3.1.3 Was the DPS listed prior to 1996?

NO

3.1.4 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

Not applicable because 3.1.3 is no

3.1.5 Is there relevant new information for this species regarding the application of the DPS policy?

NO

The 2009 Final Rule (74 FR 29300, 2009) describes how the DPS policy was applied to determine the delineation of the GoM DPS. In summary, genetic data was used to inform our determination on the northern terminus of the GoM DPS. In doing so, it was clear that there are substantial differences in genetic structure between U.S. and Canadian populations of Atlantic salmon (Spidle et al., 2003). As described in the listing rule, we determined the southern terminus of the GoM DPS to be the Androscoggin River based on zoogeography rather than genetics because there are too few Atlantic salmon in southern rivers to inform a genetic analyses. In the absence of clear genetic data, ecological factors were used to define the southern boundary of the GoM DPS, including differences in zoogeographic history, physiographic conditions, climatic characteristics, and basic geography (Olivero, 2003). Since the publication of the listing determination, no new information has become available to suggest changes in our application of the DPS policy in respect to the GoM DPS of Atlantic salmon.

3.2 Recovery Criteria

The ESA requires recovery plans be developed for each listed species. Recovery plans must contain, to the maximum extent practicable, objective measurable criteria for delisting the species, site-specific management actions necessary to recover the species, and time and cost estimates for implementing the recovery plan.

3.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

_X__ **Yes**

____ **No**

3.2.2 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

__X__ **Yes**

_____ **No**

3.2.3 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

__X__ **Yes**

_____ **No**

3.2.4 List the recovery criteria as they appear in the recovery plan

Reclassification Objectives

- Maintain a sustainable, naturally reared population in at least two of the three Salmon Habitat Recovery Units (SHRU) and ensure access to sufficient suitable habitat in these SHRUs for these populations.
- Ensure that management options, if any, for marine survival are better understood.

- Reduce or eliminate those threats that either individually, or in combination, endanger the DPS.

Delisting Objectives

- Maintain self-sustaining, wild populations in each SHRU, and ensure access to sufficient suitable habitat in each SHRU for these populations.
- Ensure that necessary and available management options for marine survival are in place.
- Reduce or eliminate those threats that either, individually or in combination threaten the DPS.

Biological Reclassification Criteria:

Reclassification of the GoM DPS from endangered to threatened will be considered when all of the following biological criteria are met:

1a. Abundance (Resilience): The DPS has total annual returns of at least 1,500 adults originating from wild origin, or hatchery stocked eggs, fry or parr spawning in the wild, with at least two of the three SHRUs having a minimum annual escapement of 500 naturally reared adults.

1b. Productivity (Resilience): Among the SHRUs that have met or exceeded the abundance criterion, the population has a positive mean growth rate greater than one in the 10-year (two generation) period preceding reclassification.

1c. Habitat (Redundancy and Representation): In each of the SHRUs where the abundance and productivity criteria have been met, there is a minimum of 7,500 units of accessible and suitable spawning and rearing habitats capable of supporting the offspring of 1,500 naturally reared adults.

Biological Delisting Criteria:

Delisting of the GoM DPS will be considered when all of the following criteria are met:

1d. Abundance (Resilience)**:** The DPS has a self-sustaining annual escapement of at least 2,000 wild origin adults in each SHRU, for a DPS-wide total of at least 6,000 wild adults.

1e. Productivity (Resilience): Each SHRU has a positive mean growth rate of greater than 1.0 in the 10-year (two-generation) period preceding delisting and at the time of delisting, the DPS demonstrates self-sustaining persistence, whereby the total wild population in each SHRU has less than a 50-percent probability of falling below 500 adult wild spawners in the next 15 years based on population viability analysis (PVA) projections.

1f. Habitat (Redundancy and Representation): Sufficient suitable spawning and rearing habitat for the offspring of the 6,000 wild adults is accessible and distributed throughout the designated

Atlantic salmon critical habitat, with at least 30,000 accessible and suitable Habitat Units in each SHRU, located according to the known migratory patterns of returning wild adult salmon. This will require both habitat protection and restoration at significant levels.

Threats-abatement Criteria:

The threats abatement criteria describe how the five listing factors will be addressed to determine whether the species warrants the protections of the ESA. The criteria focus first on primary threats to the DPS (including ongoing threats identified in the 2009 listing rule, and emerging threats). These criteria are followed by criteria for threats considered to be secondary on an individual basis but which, in combination, constitute a major threat.

There is uncertainty about the extent to which each threat factor must be reduced to reach and sustain the biological recovery criteria. This uncertainty will be resolved as recovery actions addressing threats are implemented, which will then allow us to frame more specific and quantitative threats abatement criteria.

Threats-abatement criteria for reclassification:

The following threats-abatement criteria must be met to the extent necessary to support a GoM DPS of Atlantic salmon that is no longer in danger of extinction. Completion of the recovery actions needed to meet these criteria will signal the end of phase 2 of the recovery process for the DPS as described in the Recovery Strategy section of the Final Recovery Plan (USFWS and NMFS, 2019).

Dams and road stream crossings (factor A): A combination of dam removals, passage improvements at dams, passable road crossing structures, and removal or redesign of any other instream barriers to fish passage provides salmon access to sufficient habitat needed to achieve the habitat criterion for reclassification (see Biological Criterion 1d, above).

Regulatory mechanisms for dams (factor D): FERC licenses for hydroelectric dams in designated Atlantic salmon critical habitat have been amended, or otherwise include, requirements to protect upstream and downstream migrating Atlantic salmon and minimize effects to habitat.

Climate change (factor E): A water quality monitoring program is established to track climate change trends and effects on: (a) freshwater, estuarine, and marine habitats, and (b) salmon health. This program includes adaptive management strategies to mitigate or protect salmon from any harmful effects associated with climate change. In addition, freshwater areas that have greater resilience to climate change are identified, quantified, and incorporated into recovery goals and actions.

Low marine survival (factor E): In combination with the climate change monitoring program, a program for identifying and quantifying additional anthropogenic threats in the marine environment is designed and implemented, and adaptive management strategies for mitigating the harmful effects of these threats, when possible, are developed. These factors include, but are not necessarily limited to, intercept fisheries and aquaculture management.

Loss of genetic diversity (factor E): Extant DPS family groups and genetic diversity are maintained at levels needed to support Biological Criteria 1a, 1b, and 1c, above, through adaptive hatchery practices and stock management strategies.

Threats-abatement criteria for delisting:

Because we have not met the criteria for reclassification, we are not doing an analysis of the threats abatement criteria for delisting in this document. For a complete list of threats abatement criteria for delisting, please refer to the final recovery plan (USFWS and NMFS, 2019).

3.2.5 <u>Discuss how each criterion has or has not been met, citing information</u>

Abundance and growth rate criterion:

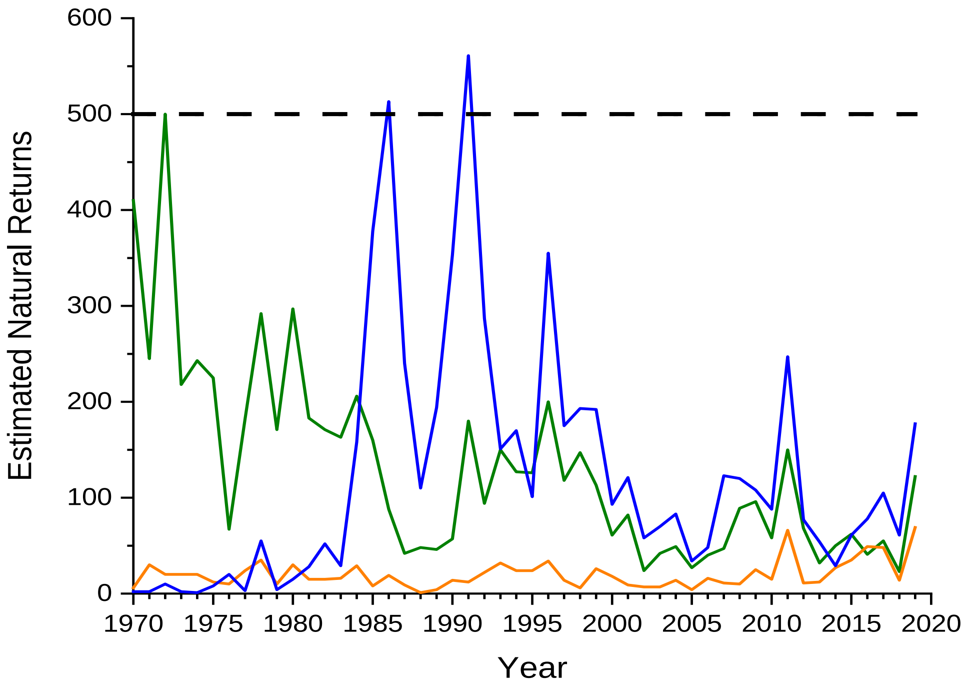

Figure 1. Time series of naturally reared adult returns to the Merrymeeting Bay (Orange), Penobscot Bay (Blue), and Downeast Coastal (Green) SHRUs from 1970 to present. Naturally reared interim target of 500 natural spawners is indicated for reference (USASC, 2019).

Neither the abundance nor population growth rate criteria in any of the three SHRUs have been met for reclassification. Naturally reared abundance levels are generally below 500 (figure 1) for each SHRU (USASC, 2019). Estimated replacement (adult-to-adult) rates of these returns to the DPS have been somewhat consistent since 1997 with lower error bounds at or below 1 (figure 2). Replacement rates have increased since 2008, but with naturally reared returns sometimes increasing from 5 to 10 (rate =2) in each SHRU, this index is quite sensitive at low abundance.

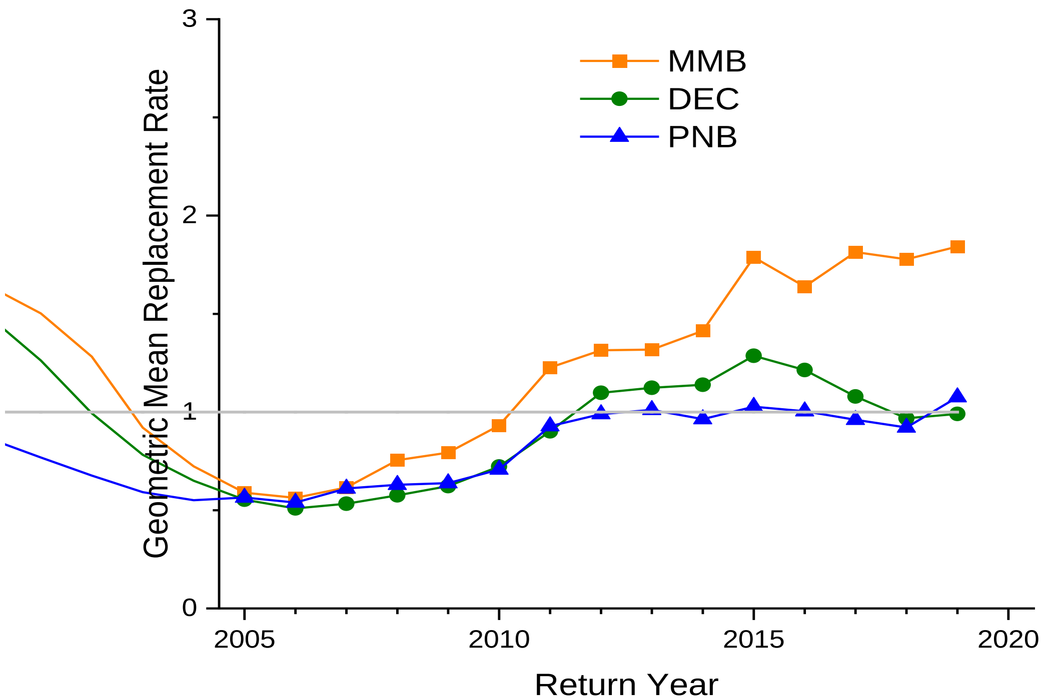

Figure 2. Ten-year geometric mean replacement rates for the GoM DPS of Atlantic salmon for Merrymeeting Bay (Orange), Penobscot Bay (Blue), and Downeast Coastal (Green) for each SHRU individually (USASC, 2019).

Habitat Criterion:

This criterion has been met for reclassification from endangered to threatened. Efforts are ongoing to fully enumerate the amount of accessible and suitable habitats in each of the SHRUs. The minimum amount of habitat necessary for reclassification is 7,500 units (a unit = 100m^2) of suitable spawning and nursery habitats in two of the three SHRUs, and 30,000 units in each SHRU for delisting. These habitat units must be assessed as "suitable" for spawning and rearing and accessible to Atlantic salmon (i.e., fish passage needs of all life stages of Atlantic salmon at any dams allows for both survival and recovery). These habitat requirements represent a minimum criterion for both reclassification and delisting. The actual amount of habitat needed to fully achieve all recovery criteria may be higher depending on overall productivity in different stream reaches and the degree in which the threats to survival are addressed, particularly those threats associated with dams. Using available information, all SHRUs have met the minimum reclassification threshold for accessible and suitable habitats. These estimates only consider the effects of dams and currently do not account for any loss of habitat attributed to culvert barriers and instream habitat degradation.

Habitat suitability is a function of habitat quantity and the qualitative factors that would limit the productive capacity of this habitat. These factors include predation/competition with invasive species, pollution, high water temperatures and the suitability and availability of physical habitat (depth, velocity, substrate, and cover). The habitat suitability of HUC 10 watersheds (figure 3) was determined during the Critical Habitat designation based on expert observations conducted by biologists that work in the watersheds within the range of the GoM DPS (74 FR 29300). Dams without safe, timely, and effective passage render even highest quality habitats unusable to salmon and other sea-run fish. Dams with inadequate fishways can still impede migration, slow movement or otherwise reduce survival of sea-run fish. Therefore, one way that dams reduce the productive capacity of upstream habitats is by limiting the number of spawning adults entering those reaches. Figure 4 reveals the degree in which watersheds are accessible throughout the GoM DPS using the accessibility criteria described in the Final Recovery Plan (USFWS and NMFS, 2019).

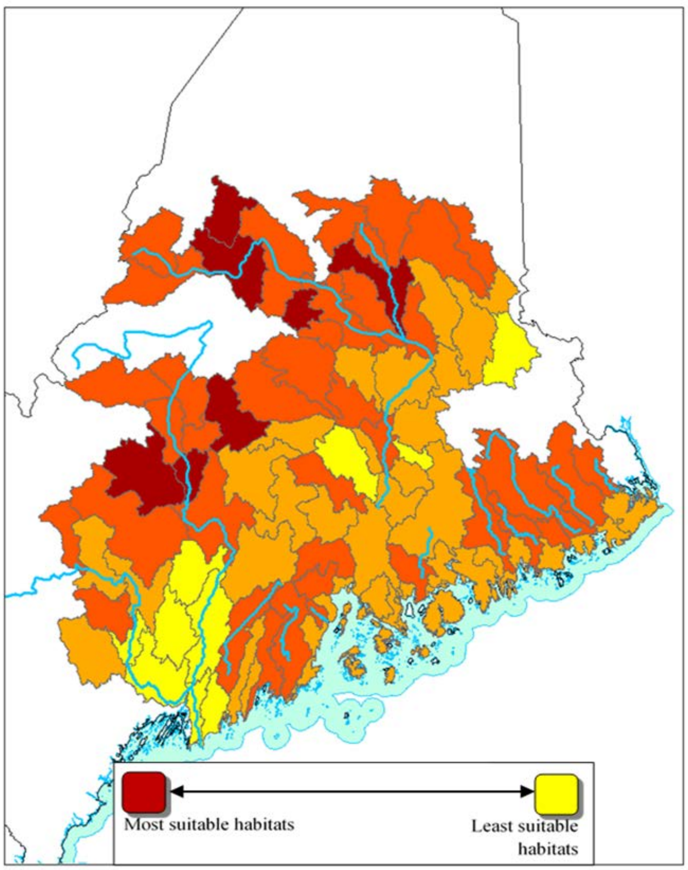

Figure 3: Distribution of suitable habitats throughout the GoM DPS

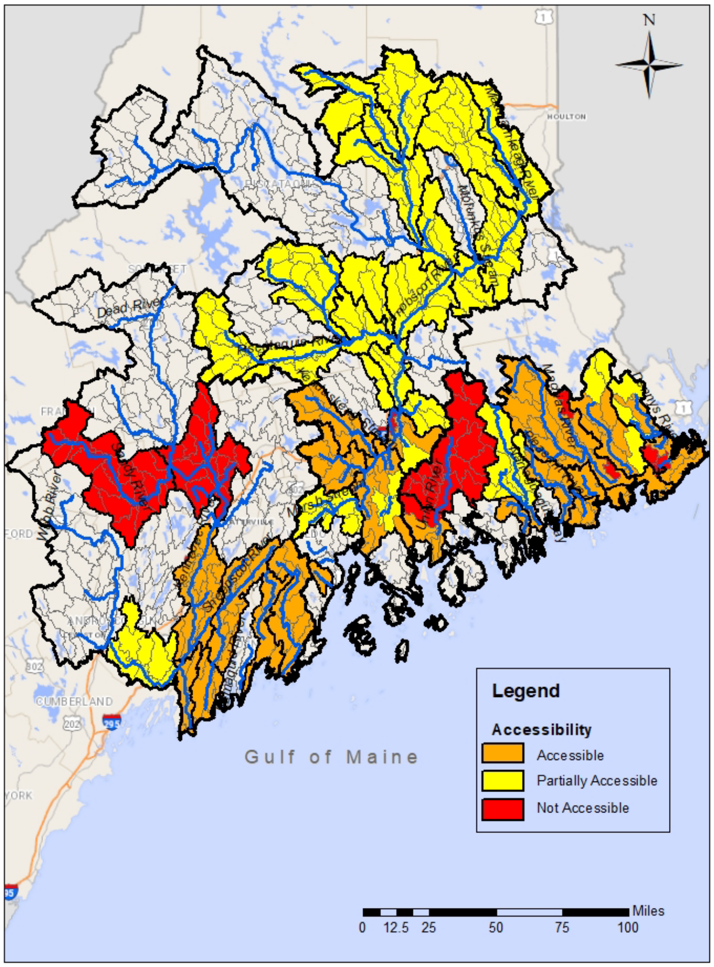

Figure 4. Distribution of accessible habitats within designated critical habitat according to the accessibility definitions in the final Recovery Plan for Atlantic salmon. This map shows the accessibility of critical habitat areas in respect to dams but does not account for stream segments within these areas that may be blocked or impeded by culverts (*see* figure 6).

Summary:

- Populations of Atlantic salmon remain at critically low abundance. The average 10-year return of naturally reared salmon is below 100 adult spawners in each of the three SHRUs. These very low populations can significantly increase risk to genetic fitness, loss of adaptive traits, and reduced ability to withstand catastrophic events.
- Growth rate has improved in recent years to where the 10-year average across SHRUs and within SHRUs has error bounds that encompass 1 (a stable population).
- Dam removals and improvements in fish passage have increased the quantity of habitat that is both suitable and accessible for spawning and juvenile rearing. All SHRUs meet the habitat requirements needed to consider down listing. None of the SHRUs meet the habitat requirements necessary to consider delisting.

- The reclassification and delisting objectives are expected to be achieved by meeting all reclassification and delisting criteria respectively. (See figure 5 for summary of recovery metrics).

				Recovery Metrics		
SHRU	**Hatchery Returns (10 yr avg.)**	**Total Returns (10 yr avg.)**		**Wild/naturally reared Returns (10 yr avg.)**	**10 year geometric mean growth rate of natural spawners**	**Suitable and Accessible Habitat**
Downeast Coastal	54	120		66	0.99	28,594
Merrymeeting Bay	21	56		35	1.87	12,423
Penobscot Bay	973	1071		98	1.08	18,583
all	***1048***	***1247***		***199***	***1.12***	***59,600***

Figure 5. Progress towards achieving recovery metrics for Atlantic salmon (as of 2019). Although the metrics for population growth rate and accessible habitat are near or above the criteria for down-listing, the abundance of naturally reared returns is well below the criteria. All criteria must be met for down-listing and delisting to occur (*See* 4.2.4).

Biological criteria for delisting:

Because we have not met the criteria for reclassification, we are not doing an analysis of the biological criteria for delisting in this document.

3.3 Threats Based Criteria: Review of the major actions taken towards addressing the significant threats identified at the time of listing

Section 4(a)(1) of the ESA requires the Services to determine whether a species is endangered or threatened because of any of the following factors (or threats) alone or in combination:

A. The present or threatened destruction, modification, or curtailment of its habitat or range;

B. Overutilization for commercial, recreational, scientific, or educational purposes;

C. Disease or predation;

D. Inadequacy of existing regulatory mechanisms to address identified threats; or

E. Other natural or human factors.

The 2009 listing rule (74 FR 29344) called particular attention to three major threats to Atlantic salmon: dams, inadequacy of regulatory mechanisms related to dams, and low marine survival. The rule also identified a number of secondary stressors, including activities or actions that pertain to habitat quality and accessibility, commercial and recreational fisheries, disease and predation, inadequacy of regulatory mechanisms related to water withdrawal and water quality, aquaculture, artificial propagation, climate change, competition, and depleted diadromous fish communities. Collectively, these stressors constitute a fourth major threat. The Final Recovery Plan (USFWS and NMFS, 2019) identified a number of new and emerging threats, all of which constitute significant impediments to recovery, include road stream crossings that impede fish passage, international intercept fisheries, and new information about the effects of climate change. Below we describe the status of these threats in the context of the five listing factors, with emphasis on those identified as a major threat to the survival and recovery of the species.

3.3.1 <u>Factor A: Present or threatened destruction, modification or curtailment of its habitat or range:</u>

<u>Summary Statement:</u> The destruction and modification of in-river resources that effect habitat complexity, water quality and water quantity contributes to the endangered status of the GoM DPS. Dams and road stream crossings constitute a major threat that negatively affects the availability and suitability of spawning and rearing habitat and impact the fitness of individual salmon.

3.3.1.1 Analysis of the threat of dams and other barriers to fish passage:

Approximately 400 unregulated, non-power generating dams remain in the GoM DPS. Additionally, 54 hydroelectric dams regulated by the Federal Energy Regulatory Commission (FERC) in the GoM DPS. The direct, indirect, and delayed mortality associated with these dams and their associated ecological effects continue to constitute a significant threat to the recovery of the GoM DPS of Atlantic salmon. Together with dams, lack of access to suitable freshwater habitat due to road stream crossings has become a major concern with regard to recovery of the GOM DPS of Atlantic salmon. Fish passage barriers continue to prevent fish from reaching essential spawning and rearing habitat and these barriers impair ecological complexity and increase the salmon’s vulnerability to higher rates of extinction from demographic, environmental, and genetic stochasticity.

3.3.1.2 Actions taken since the time of listing to address the threat of dams and other barriers to fish passage:

In the Final Recovery Plan (2019), we concluded that a number of actions were necessary in order to address threats associated with dams and road stream crossings in order to reclassify the species from endangered to threatened. These actions include a combination of dam removals, passage improvements at dams, passable road crossing structures, and removal or redesign of any other instream barriers to fish passage to ensure salmon access to sufficient habitat needed to achieve the habitat criterion for reclassification. The information below summarizes efforts related to dams and road stream crossings since the time of listing that move us towards these goals.

Migration delays and mortality associated with dams:
Since the time of listing, a number of studies have been conducted to help inform ESA and FERC regulatory measures described in Factor D (Section 3.3.4). Paramount to this effort has been research directed at measuring direct and indirect mortality from dams. Research has quantified site-specific mortality patterns and found that emigrating smolts experience critically high mortality through challenges associated with downstream passage at dams (Holbrook et al., 2011; Stitch, 2014; Stich et al., 2014). Holbrook et al. (2011) estimated the survival of out-migrating Atlantic salmon smolts through a large reach of the Penobscot River (Penobscot River and estuary up to Weldon dam) in 2005 and 2006. This study provides a snapshot of total survival through the river along with some indications of causes of mortality (e.g., direct and indirect mortality from dams, predation, disease, and stress from handling during the research and assessment). An extensive telemetry array in the river, coupled with release of smolts with sonic transmitters, allowed researchers to determine survival rates in specific reaches, including those with dams and those without dams. The authors also noted that survival rates of emigrating Atlantic salmon smolts in river reaches with dams varies considerably depending on flow conditions and dam operations during the smolt migration window. Holbrook et al. (2011) found that in the Penobscot River, smolt survival in reaches with dams ranged between 0.52 - 0.94 per km whereas smolt survival exceeded 0.95 per km in river reaches without dams. Stitch et al. (2015) found that smolt survival was high through unimpeded reaches (0.995 per kilometer) of the Penobscot, estimating that smolts emigrating from the upper reaches of the Penobscot watershed would have a 0.60 chance of survival to the estuary absent any dams in the system. When factoring in the mainstem dams on the Penobscot River (Milford, Orono, Stillwater, Gilman Falls, Veazie, Great Works, West Enfield, and Weldon) and the mainstem dams on the Piscataquis river (Howland, Browns Mills, Moosehead, and Guilford), the mean cumulative probability of survival of Atlantic salmon smolts from the upper reaches of the Penobscot to the estuary was 0.47 (based on dam operating conditions at the time of the study). Thus, the cumulative impact of dams contributes about 30 percent of the freshwater mortality of Penobscot River smolts before they reach the estuary. Furthermore, Stich et al. (2015) concluded that the latent effects of dam passage accounted for as much as 40 percent of estuarine mortality for smolts in the Penobscot, although the specific causal mechanisms of this mortality is unknown but is suspected to be related to impacts of migratory delay, physiological stress, and/or sublethal injuries.

With respect to upstream migration of adults, Sigourney et al. (2015) used passive integrated transponder (PIT) tags to assess passage of returning adults at dams during their upstream migration. They found site-specific differences in the extent of delays in passage at dams. Additional information suggests that larger salmon are less successful in reaching headwater spawning habitat as a result of “size-selective” passage at dams (Sigourney et al. 2015, Maynard et al. 2017).

The survival studies described above helped inform a watershed-scale Dam Impact Analysis (DIA) model that was developed to predict ecological and demographic responses of diadromous fish populations to passage barriers on the Penobscot River, Maine (Nieland, et al., 2013; Nieland et al., 2015). This model was used to support Atlantic salmon-specific efforts through the FERC regulatory process for numerous facilities located on the Penobscot River. Model results indicated that abundance, distribution, and the number and proportion of wild-origin fish in the upper reaches of the Penobscot watershed increased when dams were removed or passage efficiency was improved. Increasing indirect latent mortality parameters lowered survival, as suggested by field studies (Stitch et al., 2015). Abundance increased as marine or freshwater survival rates were increased, but the increase in abundance was larger when marine survival was increased than when freshwater survival was increased demonstrating the importance of improvements in marine survival to Atlantic salmon recovery.

A series of studies funded by NMFS and The Nature Conservancy in Maine have evaluated fish communities in the Penobscot River before and after the removal of two dams and decommissioning of a third dam as part of the Penobscot River Restoration Project. In short, these evaluations reveal that dams: limit the movements of river resident fish; change distributions of diadromous fish; and, consequently lead to measurable changes in fish community structure (Kleinschmidt Associates, 2009a; Kleinschmidt Associates, 2009b; Kiraly et al., 2014a; Kiraly et al., 2014b, Watson et al. 2018).

<u>Restore habitat connectivity through dam removal:</u> Dams block or impede the movements of adult and juvenile Atlantic salmon that are necessary to complete all elements of their life history. Thus, dam removal and fish passage improvements where dam removal is not possible are critical to allowing for the survival and recovery of Atlantic salmon in Maine (National Research Council, 2004). Since 2009, at least 27 dams in the Gulf of Maine DPS have been removed. Many of these removals have restored access to nursery habitats that benefit sea-run Atlantic salmon, as well as the co-evolved suite of sea-run fish that are part of the native biological community that salmon depend on, including alewives, blueback herring, American shad, rainbow smelt, sea lamprey, American eel, and sea-run brook trout. The dam removals associated with the Penobscot River Restoration Project represent one of the most significant achievements. The removal of Great Works and Veazie Dams restored complete access to about 10 river miles before the next dam in Milford, Maine, and the removal of these dams helped reduce the cumulative impact that dams have on survival of all species that must pass multiple dams on their migration between the ocean and freshwater habitats.

<u>Improve habitat connectivity through fishway improvements and construction:</u> Dam removal is typically considered the biologically preferred alternative in restoring sea-run fish, including Atlantic salmon. There are, however, circumstances where dam removal is not a viable option (e.g., where dams provide a renewable source of electricity and/or other socio-economic benefits

or where dam removal is prohibitively expensive or not feasible given flooding concerns or regulatory constraints). In these situations, we seek opportunities for significant improvements in fish passage at dams through the construction and operation of state of the art fishways designed to provide safe, timely, and effective upstream and downstream passage. Since 2009 there have been at least 19 fishway improvement or construction projects in the GoM DPS improving passage for Atlantic salmon and other sea-run fish.

A significant part of this effort includes ongoing efforts to work with dam owners to improve fish passage in the GoM DPS. Most hydroelectric dams require a license issued by the FERC. We have worked to improve fish passage by exercising our authorities under section 18 of the Federal Power Act and section 7 of the Endangered Species Act. Significant structural changes have been required through dam relicensing, and license amendments, as well as through compliance with NMFS' Biological Opinions. Since 2012, in addition to the new swim-through fishways constructed at Milford and Hydro-Kennebec, new upstream fishways are required by FERC licenses or anticipated to be required in pending relicensings at seven dams in the GoM DPS (including Lower Barker, Lockwood, Shawmut, Weston, Ellsworth, Graham Lake, and Weldon). Additional downstream structural improvements have been, or will be, made at these dams as part of these completed or pending license proceedings, including the construction of new downstream fishways, and the installation of guidance structures and narrow-spaced racks to limit entrainment in turbines. In many of these cases, the licenses require, or will require compliance with performance standards, that is, an identified survival rate and/or amount of delay. Monitoring survival and delay is essential to evaluating the long-term impacts of these dams and associated fishways. NMFS carries out section 7 consultations with FERC for all licensing actions that may affect Atlantic salmon; this has resulted in a number of new Biological Opinions since 2009 that consider effects of FERC licensed dams on Atlantic salmon and their critical habitat. All of these Biological Opinions contain Incidental Take Statements that exempt a certain amount of lethal and non-lethal take of Atlantic salmon and require robust monitoring to document the actual amount of take that occurs on an annual basis.

An important part of working to attain performance standards often includes major operational changes in addition to structural changes. For example, spilling water (i.e., water that is not used to produce power) at hydroelectric dams during the smolt outmigration is often required to reduce migratory delay and to provide safer routes of passage. Such a program was implemented in the Penobscot River (at the Milford, Orono, Stillwater, and West Enfield Dams) in 2016. Studies conducted at these projects between 2016 and 2018 suggest that the spill program has substantially reduced migratory delay of smolts, with 92.5 percent to 100 percent of the smolts passing each project within 24 hours (Normandeau Associates, Inc., 2019). The average smolt survival at these projects generally exceeds 96%; whereas, the average smolt survival was 89 percent in 2015 prior to the implementation of this spill program. A similar approach has been implemented at other dams in the GoM DPS, including the three lowermost dams on the

Androscoggin River. The project licenses at Brunswick, Pejepscot, and Worumbo have been amended to ensure that there is flow (either through gates or over the spillway) during the smolt migration to maximize survival and minimize delay. At the first dam on the river (the Brunswick Dam), survival increased from an average of 87 percent (based on studies conducted between 2013 and 2015) to 95 percent with the implementation of spill (Normandeau Associates, Inc., 2019b).

However, there remain substantial challenges in attaining performance standards at every dam in the GoM DPS. No hydroelectric facility in Maine is fully attaining all performance standards identified for that facility. Work will continue to develop and implement measures at these projects that are necessary to minimize injury and mortality and to reduce delay.

Road stream crossings

Road stream crossings were identified at the time of listing as a lesser stressor, which in conjunction with other lesser stressors constituted a significant threat to the species. In the recovery plan, the threat of road crossings was identified as an emerging significant threat to the species (USFWS and NMFS, 2019). This reflects our increased understanding of the impact of road crossings on the habitat of Atlantic salmon. Corrugated metal, plastic, or cement culverts, rather than bridges or bottomless arch culverts, are frequently installed at road crossings to reduce costs. In the GoM DPS, as of 2019, 10,169 road crossings have been assessed for fish passage effectiveness. Of these, there are approximately 3,259 impassible culverts, 3,677 culverts that are a partial barrier to fish passage, and another 1,803 where passage effectiveness is unknown (A. Abbott personal communications, 8-2017 and Bob Houston, 7-2019). Most of those road crossing barriers are found on the smaller first and second order streams within a watershed (figure 6). Actions that we have taken since the time of listing to address the threat of road crossing barriers are described below.

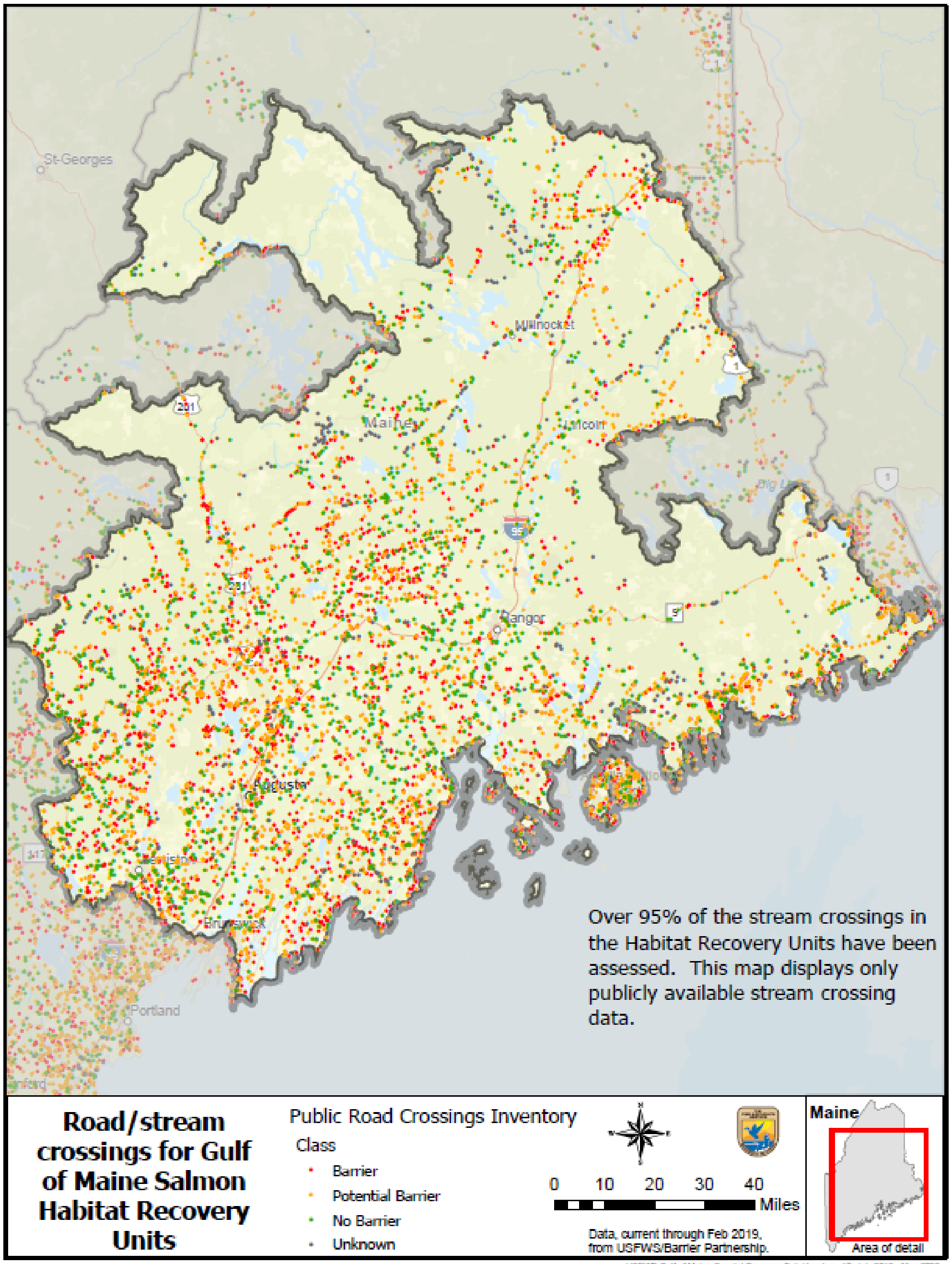

Figure 6

Programmatic Consultation to streamline regulations on Maine Department of Transportation Projects:

The USFWS, Maine Department of Transportation (Maine DOT), Federal Highway Administration (FHWA), U.S. Army Corps of Engineers (ACOE), and Maine Turnpike Authority (MTA) set out to streamline the ESA consultation process in 2013, aided by a $250,000 Second Highway Strategic Research Program Eco-Logical Implementation Assistance grant from FHWA. The resulting consultation, finalized on January 23, 2017, covers activities that involve work in streams to construct, preserve, and maintain the state transportation system that meet identified standards. The agencies have committed to specific design standards that seek to improve connectivity within habitats for endangered salmon, with benefits to other fish and wildlife.

Incorporated into this programmatic approach is the ability for Maine DOT to request designs that do not fully meet the standards put forth. In these instances, with review and approval by the USFWS, Maine DOT can pay a fee in-lieu of other forms of mitigation. To provide a vehicle for this fee, the ACOE developed the "Atlantic Salmon Restoration and Conservation Program In-lieu Fee Instrument." This instrument is not limited to Maine DOT projects and can be utilized by other projects that require an ACOE permit. Fees paid into this program will be used to offset instream Impacts to aquatic resources in the State of Maine.

Programmatic Consultation to streamline regulations for proactive recovery efforts to address fish passage at non-DOT managed road crossings:

Similarly, in 2017 the USFWS, the Federal Emergency Management Agency (FEMA), and the ACOE completed a programmatic section 7 consultation for proactive recovery efforts to address fish passage at non-DOT road crossings throughout the GoM DPS. This programmatic process embraces the design principles of the U.S. Forest Service's "Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings." Further, all crossings must be sized to pass a 100-year flood and must be at least 1.2 times the stream's bankfull width.

The USFWS and the Natural Resources Conservation Service have had programmatic section 7 consultations in place since 2010 that also encourage recovery of Atlantic salmon and streamline the consultation process. The primary use of these programmatic consultations has been for replacement road crossings on agricultural and forestry roads. Design requirements are similar to the USFWS/FEMA/ACOE programmatic consultation, and completed projects have resulted in improvements to both aquatic organism passage and stream habitat quality throughout the GoM DPS.

3.3.1.3 Analysis of the threat of habitat complexity, water quantity and water quality

Some forestry, agricultural, land use, and development practices continue to effect the quantity and quality of both water and physical habitats (USFWS & NMFS, 2019). Furthermore, many of the rivers and streams have reduced habitat quality and quantity as a consequence of past land use and development practices. Reductions in habitat quantity and quality reduces the availability and productivity of freshwater habitats that Atlantic salmon require. As long as Atlantic salmon populations remain at critically low abundances, land-use and development activities that effect habitat will continue to effect Atlantic salmon's survival and recovery.

Conclusion to factor A:

Land use and development activities continue to affect the quality and quantity of both water and physical habitats and therefor, these activities will continue to affect salmon survival and recovery. Dams and road crossings continue to be a major threat to Atlantic salmon by blocking or impairing access to historic Atlantic salmon spawning and rearing habitat. Atlantic salmon smolts, adults, and kelts attempting to pass through dams can experience direct, indirect, and delayed mortality, as well as decrease the fitness of individuals through delay. While progress has been made since the time of listing to reduce the threat of dams and road stream crossings, this threat remains significant and the GoM DPS continues to be endangered by the destruction, modification, or curtailment of its habitat or range.

3.3.2 Factor B: Over Utilization for Commercial and Recreational Purposes

Summary statement: The 2009 listing rule identified overutilization for recreational and commercial purposes as stressors that contributed to the historical declines of the GoM DPS. Of particular concern is the West Greenland fishery, a mixed-stock fishery prosecuted since the 1960s. At its height in the 1970s, over 2,000 metric tons of North American and European Atlantic salmon were harvested annually in this fishery. Over several decades of negotiation and collaboration through the North Atlantic Salmon Conservation Organization (NASCO), the effects on U.S.-origin salmon were substantially reduced with the internal-use fishery estimated at roughly 20 metric tons by 2000. During the 2000s, reported landings averaged approximately 20 metric tons, although the accuracy of reporting during this time is unknown. In 2012, a new fishery was authorized by the Government of Greenland that allowed an additional 35 metric tons of Atlantic salmon to be harvested and sold to factories in Greenland. Through further international collaboration at NASCO, the factory quotas were reduced and ultimately ceased by 2015. This is reflected in the current multi-annual regulatory measure for the West Greenland Fishery (2018-2020) that prohibits the sale of Atlantic salmon to factories and includes substantial improvements to catch accountability for other components of the internal-use fishery. The Final Recovery Plan identified the fishery in West Greenland as an emerging major threat to the species given the substantial changes to the fishery in recent years. The harvest of U.S. origin Atlantic salmon in the West Greenland fishery continues to contribute to the endangered status of the GoM DPS.

3.3.2.1 Analysis of the threat of foreign fisheries on endangered Atlantic salmon:

Although direct fisheries for Atlantic salmon have been greatly reduced or eliminated, mixed stock fisheries targeting Atlantic salmon off the coast of St. Pierre èt Miquelon, Labrador, and West Greenland remain. These fisheries continue despite advice from the International Conference for the Exploration of the Seas (ICES) that there be no directed fishing for Atlantic salmon (ICES, 2020). Though all these fisheries have the potential to intercept U.S. origin fish, the intercept fishery at West Greenland poses a significant challenge to recovery of the GoM DPS due to the number of individual fish of U.S. origin that are potentially harvested and ongoing challenges related to monitoring and reporting. Previous work has estimated that approximately two U.S. origin fish are harvested within every ton reported at Greenland, although this estimate may vary annually (ICES, 2015; Bradbury, et al. 2016). This suggests that an average of at least 76 U.S. origin salmon were harvested annually in the West Greenland fishery from 2009 to 2018.

3.3.2.2 Actions taken since the time of listing to address the threat of the West Greenland Fishery

In an effort to address the threat posed by the Greenland fishery, the U.S. has engaged annually through the NASCO to negotiate measures that protect U.S. Atlantic salmon. The most recent regulatory measure for the intercept mixed stock salmon fishery at West Greenland was adopted at the 2018 annual meeting of the NASCO (WGC(18)11, 2018). The measure set the total allowable catch for all components of the Atlantic salmon fishery at West Greenland to 30 metric tons annually. In the event of any overharvest in a particular year, the total allowable catch for the following year would be reduced by an equal amount with no corresponding ability to carry forward any under-harvest into the future. The measure maintains the prohibition on exports of Atlantic salmon from Greenland. The new measure also includes enhanced licensing requirements for all fishers with mandatory catch reporting. The 2020 fishing year is the final year of this regulatory measure; we expect that a new regulatory measure will be negotiated through NASCO for implementation in the 2021 fishing season. While compliance with this regulatory measure should result in a decrease in the amount of U.S. origin Atlantic salmon harvested in this fishery (due to controls on the total fishery), it does not eliminate the harvest of U.S. origin salmon.

3.3.2.3 Analysis of the threat of recreational fisheries and poaching

Recreational angling of many freshwater species occurs throughout the range of the GoM DPS, and the potential exists for the incidental capture and misidentification of both juvenile and adult Atlantic salmon. The State of Maine has enacted fisheries regulatory measures, including minimum and maximum size limits on landlocked salmon that are identical in appearance to searun salmon, and increased outreach and education on species identification. Despite these measures, incidental capture and misidentification of fish still occur, this can result in direct or indirect mortality even in fish that are caught and released as a result of injury or stress. Incidence of poaching, or the illegal capture and killing of Atlantic salmon also continues to occur within the GoM DPS. As long as Atlantic salmon populations are at critically low abundances the effects of recreational fishery and poaching will continue to effect Atlantic salmon’s survival and recovery.

Conclusion to factor B:

Although the directed harvest of Atlantic salmon has decreased as a result of a negotiated regulatory measure with West Greenland and state enacted regulatory measures that decrease the incidence of accidental capture and killing of Atlantic salmon, the Greenland fishery, along with the Labrador and St. Pierre and Miquelon fishery, continue to effect Atlantic salmon survival and recovery. The West Greenland fishery is of particular concern as this fishery intercepts appreciable numbers of U.S. origin Atlantic salmon despite ICES recommendation for no targeted fishery. Therefore, overuse for commercial and recreational purposes continues to be a major threat that continues to contribute to the endangerment of the GoM DPS.

3.3.3 Factor C: Disease and Predation

Summary Statement: The 2009 listing rule (74 FR 29344) identified disease and predation as important stressors to the survival and recovery of Atlantic salmon. These stressors continue to contribute to the endangerment of the GoM DPS.

3.3.3.1 Analysis of the threats of disease and predation

Although not identified as a significant threat, disease and predation are considered stressors that impede Atlantic salmon recovery efforts. In the North American Commission Annual Report (NAC(20)06) it was reported that in 2019, several U.S. commercial salmon farms in Maine tested positive for bacterial kidney disease (BKD) requiring therapeutic treatments. In addition, 17 wild sea-run Atlantic salmon collected from the Penobscot River for broodstock tested positive, via Polymerase Chain Reaction method (PCR), for the non-pathogenic strain of Infectious Salmon Anemia (ISAv). All 17 were released back to the river. This is a dramatic increase in the number of suspects in the Penobscot; this annual total of 17 is more than the previous 10 years combined. An additional salmon tested positive, via PCR and gene sequencing, for an unknown variant of the pathogenic strain of ISAv. This individual was culled from the population. Disease outbreaks such as this, whether they occur in nature or hatchery environment, have the potential to cause negative population-wide effects, and therefore require close attention and continued monitoring.

The impact of predation on the GoM DPS is important because of the imbalance between the very low numbers of adults returning to spawn and the increase in population levels of many native predators including double-crested cormorants, striped bass, seals, and nonnative predators, such as smallmouth bass. At this time, we do not have sufficient information to know the extent in which predation may be impeding recovery.

Conclusion to Factor C:

While disease(s) can have devastating population-wide effects when they occur, there are efforts in place to prevent and manage disease outbreaks in conservation hatcheries and aquaculture facilities. However, the efforts in place to manage this risk cannot completely eliminate the potential for disease outbreak. Further, if a large outbreak were to occur, it could have significant impacts on the GoM DPS.

Although we do not know the extent that predation is effecting survival and recovery of Atlantic salmon, the impact of predation on the GoM DPS of Atlantic salmon continues to be an important stressor because of the imbalance between the very low numbers of adults returning to spawn and the increase in population levels of both native and non-native predators.

3.3.4 Factor D: Inadequacy of Existing Regulatory Mechanisms

Summary Statement: The GOM DPS is protected by numerous international, national, regional, and local regulations. A number of Federal laws were enacted that contributed to Atlantic salmon conservation, including the Water Pollution Control Act of 1948, which subsequently became the Clean Water Act of 1972 (CWA), and the Anadromous Fish Conservation Act of 1965. At a state level, fishing for Atlantic salmon was closed statewide in 2000, though a catch and release fishery on the Penobscot River was allowed for short durations in 2006, 2007 and 2008. Although many of these laws allowed Atlantic salmon to persist in some Maine rivers for many decades, we concluded at the time of listing that the regulatory mechanisms for dams were still largely inadequate and constituted a significant threat to the species. Additionally, the inadequacy of existing regulatory mechanisms for water withdrawals and water quality were significant factors contributing to the poor status of the GoM DPS (74 FR 29344).

We reviewed the threat of dams and ongoing recovery actions in considerable detail in section 3.3.1 of this document. In respect to Factor D, dams remain a major threat to the DPS, in-part due to inadequate implementation, monitoring, and enforcement of regulatory mechanisms, while the inadequacy of regulatory mechanisms related to water use and water quality remain important factors in the survival and recovery of Atlantic salmon. Since the time of listing, while we have identified ways to work within the regulatory framework of the ESA to make progress towards addressing these threats, there have been no changes to the regulatory mechanisms for dams or water withdrawals that have increased protections for salmon and their habitat or otherwise contributed to decreasing the threats to this species. In the listing, we determined that existing regulatory mechanisms for dams and water quality were inadequate. We noted that existing regulatory mechanisms do not provide a timely and dependable means to eliminate the effects of dams on salmon and their habitat and that the lack of compliance with existing water quality standards and with regulations to reduce sedimentation from forestry activities was a threat to the GOM DPS.

3.3.4.1 Analysis of the threat of inadequate regulatory mechanisms for dams

The primary regulatory mechanism for dams is the Federal Power Act; other relevant regulations include the Clean Water Act (as administered by the States through Section 401 Water Quality Certificates). To date, there have been no changes to the regulatory mechanisms related to dams. However, we have found ways to work within the existing regulatory framework to implement changes at individual dams that will reduce the threat of these dams to salmon and their habitat. In the final recovery plan, we concluded that in order to reclassify the species from endangered to threatened that FERC licenses for hydroelectric dams in designated Atlantic salmon critical habitat must be amended, or otherwise include requirements to protect upstream and downstream migrating Atlantic salmon and minimize effects to habitat (USFWS and NMFS, 2019). Through a combination of the Federal Power Act's license amendment process and the ESA section 7 consultation process, NMFS and the USFWS have worked with FERC licensees to amend a number of FERC licenses for dams within the DPS. These license amendments require monitoring and studies to identify rates of mortality and delay and require compliance with performance standards for upstream and downstream passage that are designed to minimize mortality and reduce migratory delay. Measures have also been required to minimize the effects of dam operations on the features of Atlantic salmon critical habitat. These performance standards and related measures were implemented as a result of licensee's proactively requesting license amendments and subsequent consultation pursuant to section 7 of the ESA. We also continue to work through the Federal Power Act when dams come up for relicensing to prescribe upstream and downstream fishways to provide safe, timely, and effective upstream and downstream passage. Despite the modifications of a number of FERC licenses since the time of listing, as stated above, there remain substantial challenges in regulating the effects of dams on Atlantic salmon and ensuring attainment of performance standards at every dam in the GoM DPS. At present, no hydroelectric facility in Maine is fully attaining all the performance standards determined to be necessary for the survival and recovery of the species identified for that facility. Furthermore, the progress that has been made to require performance standards at dams has been facilitated by the listing of the species under the ESA, and not through changes in the Federal Powers Act, the primary existing regulatory mechanism that govern the operations of FERC licensed dams.

Regarding the inadequacy of regulatory mechanisms in respect to water quality, the State of Maine maintains four standards for the classification of rivers and streams. Since the time of listing there have been some amendments to Maine's water quality standards that do provide additional protections to Atlantic salmon, including identifying some specific protections to Atlantic salmon in waters classified as AA and A, and the reclassification of some water bodies to higher standards where Atlantic salmon live. Many larger rivers, including the Kennebec, Androscoggin, and Penobscot rivers continue to maintain lower classifications of either Class B or Class C waters, which subsequently have lower protections. These water quality standards may not provide sufficient protections to Atlantic salmon, particularly in circumstances where Atlantic salmon migrations are delayed or blocked by dams, and therefore have prolonged exposure to conditions that may impact their survival. Furthermore, the effectiveness of these standards in providing adequate protection to Atlantic salmon is contingent upon compliance monitoring. At this time, we do not have enough information to fully evaluate the extent that Atlantic salmon rivers are in compliance with their classification standards or the extent that improved regulatory measures for water quality are sufficiently protective of Atlantic salmon.

3.3.4.2 Actions taken since the time of listing that address the regulatory mechanisms for dams:

Work with Hydro Developers to Amend FERC Licenses that Ensure Protections of Atlantic Salmon:

Since the time of listing, FERC licenses have been amended for the Milford, Orono, Stillwater, and West Enfield hydroelectric projects on the Penobscot River to require compliance with performance standards for upstream and downstream passage that are designed to minimize mortality and reduce migratory delay. Measures have also been required to minimize the effects of dam operations on the features of Atlantic salmon critical habitat. These performance standards and related measures were implemented as a result of license amendments and subsequent consultation pursuant to section 7 of the ESA. These requirements will remain in place for the duration of the license. NMFS is working to engage with Licensees for the remaining hydroelectric projects within designated critical habitat to ensure their operations provide adequate protections to Atlantic salmon and their habitats. Additionally, NMFS continues to work to address impacts to Atlantic salmon during FERC relicensing by exercising our authorities under the Federal Power Act and the Endangered Species Act.

Develop species protection plans through section 7 of the ESA that establish fish passage performance measures that ensure Atlantic salmon survival and recovery:

Species Protection Plans at 13 FERC licensed hydroelectric dams in designated critical habitat either have been developed or are being developed. These plans are developed by a FERC licensee and are submitted to FERC as a proposed license amendment with the goal of identifying measures that can be incorporated into a project license that will identify and reduce impacts of the project on Atlantic salmon and their critical habitat. Several of these plans have resulted in amended FERC licenses that require compliance with upstream and downstream passage standards and other performance measures that are designed to improve passage and survival of Atlantic salmon at individual hydroelectric projects. The license amendment is a Federal action requiring ESA section 7 consultation; thus, we can ensure that these actions are not likely to jeopardize the continued existence of the species or destroy or adversely modify critical habitat. Most plans have also included studies to measure survival rates and adaptive management measures to improve passage and survival to meet management targets. Survival studies are still underway and project design and operational changes are still being made that are necessary to achieve the survival criteria that will allow for survival and recovery of Atlantic salmon. To date, the FERC license amendments that have occurred as a result of species protection plans have resulted in the construction of state-of-the-art upstream and downstream fishways at two hydro-electric dams in the Penobscot River, and one in the Kennebec River. It is anticipated that another ten fishways will be constructed or improved over the next 10 years.

Conclusion to factor D:

While progress has been made since the time of listing to reduce the threat of dams through the use of existing regulatory mechanisms, much of this progress has been facilitated by the species' listing as endangered under the ESA; were the species not listed under the ESA, further progress would be significantly impaired. The threat of the inadequacy of regulatory mechanisms related to water use continues as no changes in the regulations have been made since the time of listing, while the inadequacy of regulatory mechanisms related to water quality is undetermined as we have insufficient information to evaluate the effectiveness of new regulations and compliance monitoring of those regulations. Therefore, we conclude that the inadequacy of existing regulatory mechanisms of dams and water use continues to contribute to the endangerment of the species, whereas the adequacy of existing regulatory mechanisms of water quality is now unknown.

3.3.5 Factor E: Other Natural and Manmade Factors:

Summary Statement: The threat of marine survival was identified as a significant threat to the species at the time of listing. The Final Recovery Plan identified climate change as an emerging significant threat to GoM DPS Atlantic salmon. Marine survival of GoM DPS continues to be very low. Factors other than fisheries that effect marine survival include climate variability, shifting foodweb dynamics, and climate change. Currently, far fewer adult salmon are returning from the sea than what is needed to sustain the population and therefore, we conclude that these factors continue to constitute a major threat to the species.

Threats associated with aquaculture (e.g., escapees, disease and parasites), as well as threats to genetic diversity from captive rearing programs are ongoing stressors to the recovery of Atlantic salmon that warrant continued close attention and monitoring. Although not major threats to the species, these activities continue to impede recovery efforts.

3.3.5.1 Analysis of the threat of marine survival and climate change to the recovery of endangered Atlantic salmon

Poor marine survival of Atlantic salmon continues to be a significant threat to the species. As described in the listing, salmon populations have been declining throughout the North Atlantic range, particularly since the early 1990s when a significant decline (e.g., phase shift) in marine productivity occurred. Population declines of other species in the North Atlantic also occurred at this time. The hypothesized cause of the change in productivity is large-scale climate forcing factors that altered thermal, salinity, and oceanographic regimes, which altered the flow of energy through the ecosystem (Dixon et al., 2012). The resulting increased mortality due to these processes have been particularly acute for the two sea winter components of populations whereas the abundance of one sea winter adults (i.e. 1SW returns) have remained relatively stable over time. Thus, the second year at sea is a hypothesized survival bottleneck for many populations, particularly for southern populations given their demographic reliance on a high

proportion of two-sea-winter females (i.e., 2SW returns). Approximately 100 percent of U.S. origin females return after two winters at sea and increased mortality for this life history strategy can have major consequences for the population dynamics of the U.S. stock complex.
At the time of listing there was reasonable certainty that climate change was affecting Atlantic salmon in the GoM DPS (e.g., National Research Council, 2004, Fay et al. 2006), but there was uncertainty about how and to what extent. Since listing, new and emerging science has led to a better understanding of climate change effects and its impact on salmon. Recent information indicates that climate change is having significant impacts on the habitats that Atlantic salmon depend on and, in turn, is affecting the overall survival and recovery of Atlantic salmon (Mills et al. 2013, Renkawitz, 2015).

3.3.5.2 Actions taken to address the threat of marine survival and climate change:

Increasing our understanding of the threats in the marine environment:
Since the time of listing, significant advances have been made to identify and quantify anthropogenic threats in the marine environment. To improve on a broad understanding of the ocean ecology of Atlantic salmon and factors that influence survival, domestic and international collaborations have been undertaken. Salmon at Sea (SALSEA) was a large scale international collaborative and multi-disciplinary marine research program designed to follow cohorts of fish from natal rivers to marine feeding grounds and back to spawning grounds on both sides of the Atlantic (ICES, 2012). Pelagic ecosystem surveys in the Labrador Sea (SALSEA North America) were conducted during 2008 and 2009 to sample post-smolts and immature adults originating from North American rivers (Sheehan et al. 2012). While catches were low, multiple smolt cohorts were captured, indicating that post-smolts and returning adults from different rivers in North America have similar autumnal habitat requirements. Post-smolts were only caught at night suggesting they may use deeper habitats during the day as a predator avoidance strategy. Irrespective of life stage, the consumption of diverse and similar prey species and the presence of significant parasite loads suggested Atlantic salmon foraged opportunistically on the available prey base and may have had compromised health via parasitic infestation. A second aspect of SALSEA was a NMFS led sampling of immature adult salmon at West Greenland (SALSEA Greenland) from 2009 to 2011 to gain insights into the origin, age, growth, diet, trophic ecology, and health (disease and parasite) at their summer feeding grounds. Total consumption and diet composition varied among years but not between North American and European stock complexes (*reviewed in* Dixon et al., 2017). A variety of prey were consumed (primarily capelin and *Themisto* sp.) over a broad size spectrum that was similar to historic data from 1965-1971 (Renkawitz et al. 2015). While stable isotope analyses indicated Atlantic salmon are omnivorous, the species has high dependence on the pelagic food web at sea from which they sequester most of their carbon (Dixon et al. 2012, Dixon et al. 2019).

Early investigations into the trophic ecology and resource quality available to Atlantic salmon expanded as understanding of marine dynamics evolved. Across the North Atlantic, salmon populations have experienced concurrent declines in abundance despite diverse population structures and management regimes (ICES, 2020). Although decreased marine survival resulting from the regime shift is considered a major driver of population abundance, there are many additional factors that may influence marine survival on regional scales. For example, thermal and osmotic stress in the early marine phase, especially during the freshwater to marine transition, is known to influence survival through direct and indirect effects associated with decreased predator avoidance or foraging success (McCormick et al. 1998). Fish health (disease, infections, and parasites) may also influence marine survival and may be naturally occurring or of increased prevalence due to anthropogenic activities such as salmonid aquaculture. Additionally, indirect latent and cumulative impacts from hydroelectric facilities are also known to decrease marine survival directly and indirectly through the absence of ecosystem processes provided by co-occurring healthy diadromous species complexes (Stich et al., 2015).

Increasing our understanding of the threat of climate change:

At the time of the expanded listing in 2009, although there was reasonable certainty that climate change was affecting Atlantic salmon in the GoM DPS (e.g., National Research Council, 2004, Fay, et al., 2006), there was uncertainty about how and to what extent. Since then, new and emerging science has led to a better understanding of climate change effects and its impact on salmon. Recent information indicates that climate change is having significant impacts on the habitats that Atlantic salmon depend on and their prey base (Mills et al., 2013; Renkawitz et al, 2015). As such, we concluded in the final recovery plan that climate change is a significant threat to the species. We also concluded that in order to address climate change such that we could reclassify the species from endangered to threatened, a water quality monitoring program needs to be established to track climate change trends and effects on freshwater, estuarine, and marine habitats, as well as salmon health. This program needs to include adaptive management strategies to mitigate or protect salmon from any harmful effects associated with climate change. Furthermore, freshwater areas that have greater resilience to climate change needed to be identified, quantified, and incorporated into recovery goals and actions. Ongoing efforts with SHRU specific recovery teams are conducting stream surveys to identify cold water areas and implementing habitat protection and restoration activities geared towards protecting sensitive areas and increasing habitat resilience to climate change (Collaborative Management Strategy for the GoM DPS of Atlantic salmon, 2020).

In 2016, a climate vulnerability analysis for 82 managed species of fish and invertebrates in the Northeast United States concluded that Atlantic salmon, along with other sea run fish, are among the most vulnerable species to climate change (Hare, et al. 2016). In response to the conclusions of the vulnerability analysis, NMFS prioritized Atlantic salmon for undergoing a climate scenario planning exercise to help identify “no regret” science and management actions to address climate change across a range of plausible, alternative, but uncertain future scenarios (Borggaard et al., 2019). Priority actions that came from this exercise were integrated into the

Atlantic Salmon Final Recovery Plan (USFWS and NMFS, 2019). These efforts have led to science and management actions that are currently underway. These efforts include conducting a range-wide habitat analysis (freshwater and marine) to identify specific habitat requirements that Atlantic salmon need as they relate to climate factors, and mapping sources of cold water refugia and watershed areas that may have greater resilience to climate change.

3.3.5.3 Analysis of the threats of Aquaculture and genetic diversity:

Aquaculture

Concerns about the effects of aquaculture on wild Atlantic salmon continue in the GoM DPS, but recent advances in containment and marking of aquaculture fish offer more control over these threats and reduce the risk of negative impacts of aquaculture fish on the GoM DPS. To address the threat of aquaculture on the GoM DPS NMFS and USFWS completed a programmatic Section 7 consultation on commercial net pen aquaculture activities permitted by the U.S. Army Corps of Engineers (ACOE) in Maine. This consultation aimed to address containment factors and risk factors associated with disease and genetic integration. As agreed upon through the consultation process, permits issued by the ACOE and Maine Department of Environmental Protection require genetic screening to ensure that only North American-strain salmon are used in commercial aquaculture; marking to facilitate tracing fish back to the source and cause of the escape; containment management plans and audits; and rigorous disease screening. While aquaculture is now a reduced threat on the GoM DPS, these measures do not eliminate the risk aquaculture fish pose to wild Atlantic salmon but serve to reduce the potential for negative impacts. It is important to note that currently, equally protective requirements regarding salmon aquaculture do not exist on the Canadian side of the border. Fish held in Canadian cages, or those that may escape from Canadian cages, can still pose disease, genetic, and ecological risks to U.S. Atlantic salmon.

Genetic Diversity

Four facilities (Craig Brook National Fish Hatchery, Green Lake National Fish Hatchery, Pleasant River Hatchery, and Peter Gray Hatchery) currently operate as part of a conservation hatchery program to prevent the extinction and facilitate population recovery of Atlantic salmon in Maine. These facilities produce eggs, fry, parr, and smolts that are released annually into Maine rivers to help slow the decline in abundance and maintain genetic diversity. The hatchery strategy for Atlantic salmon focuses on increasing redundancy, resiliency, and representation among the locally adapted stocks that constitute the DPS.

The current hatchery program uses a “hatchery supplementation” strategy aimed at capturing a sufficient number of fish that have spent time in the wild to supplement brood-lines in an effort to prevent further loss of family groups and maintain the effective population size. This strategy is an effective means of incorporating resilience within brood-lines by capturing fish that have at least undergone some natural selection for a portion of their life history. The primary objective of hatchery supplementation is to increase natural exposure of hatchery stocks to allow some natural selection to occur through wild experience. This program is supported by Mobrand et al. (2005), who describes an integrated hatchery framework whereby wild-origin fish (offspring from natural reproduction) are incorporated into brood-lines during broodstock collection of parr or adults, and any individuals not assigned to hatchery origin through genetic parentage analysis are then considered to be wild-origin. Incorporation of wild fish into brood-lines can help increase effective population size as well as incorporate additional resilience by capturing fish that have undergone selection across all life stages.

The advantages for an integrated hatchery approach over a segregated system (where hatchery lines are maintained independent of wild stocks) are that fish resulting from hatchery propagation are exposed to natural selection during at least a portion of their lives to help minimize some genetic effects of artificial selection from the captive rearing environment (i.e., domestication selection). Although hatchery supplementation programs may potentially be effective at maintaining population size and providing added protections against demographic variability and catastrophic losses, captive breeding programs increase the potential for altering unique genetic characteristics of the natural population (Berejikian & Ford, 2004). Christie et al. (2014) reviewed six studies across four species of salmonids and found that even hatchery fish that originate from predominately wild-origin parents averaged only half the reproductive success of their wild-origin counterparts when spawning in the wild. Christie also found that the reduction in reproductive success was more severe for males than for females, and that all species showed reduced fitness due to hatchery rearing.

Currently the hatchery program maintains brood lines from six genetic stocks that exist in the GoM DPS. Existing hatchery capacity has been sufficient in supporting existing programs, including maintaining the diversity of these genetic stocks over time necessary to prevent the species extinction. If demands for hatchery resources continue to grow, hatchery capacity may represent a challenge in providing sufficient numbers of fish to support upstream survival studies at dams, and re-establishing stocks in areas where the local genetic stock has been extirpated.

3.3.5.4 Analysis of the threat of Competition and Depleted Diadromous Fish Communities

Depleted Diadromous Fish Communities

Many co-evolved diadromous species have experienced dramatic declines throughout their ranges and current abundance indices remain a fraction of historical levels. It is believed that the dramatic decline in diadromous species has negative impacts on Atlantic salmon populations through the depletion of an alternative food source for predators of salmon, reductions in food available for juvenile and adult salmon, nutrient cycling, and habitat conditioning (Saunders et al. 2006). Science and research since the time of listing has further increased our understanding of the role and importance that the co-evolved sweet of diadromous fish serve as a prey buffer, nutrients that support Atlantic salmon survival, and how they condition habitat that salmon benefit from (Guyette 2012; Guyette et al. 2013; Guyette et al. 2014; O'Malley et al., 2017). Information gathered from this science is being used to inform consultations through Section 7 of the ESA, and to inform decision and prioritize proactive restoration efforts.

Competition

Prior to 1800, the resident riverine fish communities in Maine were made up of native species. Today, Atlantic salmon coexist with a diverse array of nonnative resident fishes, including brown trout, largemouth bass, smallmouth bass, and northern pike. The range expansion of these nonnative species is of particular concern, because they often require similar resources and can exclude salmon from preferred habitats, reduce food availability, and increase predation. The impact of competition on the GoM DPS is important because of the imbalance between the very low numbers of adults returning to spawn and the increase in population levels of these nonnative species. At this time though we have limited evidence and knowledge to know the extent in which predation may be impeding recovery.

Conclusion to factor E:

Climate change and marine survival remain a significant threat to the continued survival and recovery of Atlantic salmon. While science has increased our understanding of the threats of climate change and threats within the marine environment there remain limited management actions that can be taken to address them. Our best options to address these significant threats are to increase resiliency within the population by increasing spatial distribution; continued protection and maintenance of remaining genetic diversity; and exercising diverse hatchery strategies aimed at minimizing domestication and optimizing natural selection. Because of Atlantic salmon's low abundance, genetic diversity, aquaculture, depleted diadromous fish communities and competition continue to represent a challenge to the recovery of Atlantic salmon that warrants continued consideration in ongoing management and recovery efforts. Therefore, these threats continue to contribute to the endangerment of Atlantic salmon.

3.4 Synthesis

The GoM DPS of Atlantic salmon was originally listed as endangered in December 2000 (65 FR 69459, 2000) and encompassed salmon populations in eight river systems along the Maine coast. Subsequently, new data led to expansion of the GoM DPS to include nine distinct breeding populations covering a more extensive geographic area, including the Androscoggin, Kennebec, and Penobscot watersheds. The final rule for the expanded DPS was published in June 2009 (74 FR 29344, 2009). The 2009 listing rule called attention to three major threats to Atlantic salmon, as well as a number of secondary stressors that together, constituted a fourth major threat. The three major threats identified at the time of listing included dams, inadequacy of regulatory mechanisms related to dams, and low marine survival. Since 2009, our understanding of threats to the DPS has continued to grow. New and emerging threats, all of which are considered to constitute significant impediments to recovery, include road stream crossings that impede fish passage, international intercept fisheries, and climate change. In the 2009 listing, we determined that there were relevant threats associated with each of the five listing factors. As noted above, while progress has been made to reduce or better understand many of those threats, each of the five factors continues to contribute to the endangerment of the species.

The GoM DPS of Atlantic salmon remain at critically low abundance with the average 10-year return of naturally reared salmon being below 100 adult spawners in each of the three SHRUs. This is well below the minimum abundance threshold needed for reclassification. In fact, the annual variability in adult returns often exceeds that of the total population size for any SHRU in any given year. The very low population sizes constitutes a significant risk to the resiliency of the species through increasing losses in genetic fitness, loss of adaptive traits, and reduced ability to withstand catastrophic events. Population growth rate of naturally reared fish has improved in recent years to where the 10-year average across SHRUs and within SHRUs has error bounds that encompass 1 (a stable population). Although these growth rates fall within the goals for reclassification, they are overshadowed by the small population sizes. The minimum reclassification requirements for habitat has been met, and is even exceeded, in all three SHRUs as dam removals and improvements in fish passage have increased the quantity of habitat that is both suitable and accessible for spawning and juvenile rearing.

The objective for delisting is to maintain self-sustaining, wild populations with access to sufficient, suitable habitat in each SHRU, and ensure that necessary management options for marine survival are in place. In addition, we must reduce or eliminate all threats that, either individually or in combination, pose a risk of endangerment to the DPS. Although we have made progress in some areas of these objectives, the progress in reducing the major threats such that they no longer pose an imminent risk of extinction has so far been insufficient to allow for either a reclassification or delisting of Atlantic salmon at this time.

4 RESULTS

The demographic risks to Atlantic salmon remain high. The three SHRUs have 10-year average abundance of less than 100 natural spawners per SHRU. Of the eight locally adapted populations that remain in the GoM DPS, seven are supported by conservation hatcheries that act to buffer extinction risk. The eighth, the Ducktrap River, is at very high risk of extirpation. With naturally reared populations being very low, the geometric mean population growth rates have been, as can be expected, highly variable. Given the high degree of variability in the population growth rates and the very low population abundances of naturally reared fish, we will need to continue to monitor population trajectories very carefully.

While hatcheries are essential in preventing the extinction of Atlantic salmon, they can also pose a significant risk to the genetic health of the population. Broodstock selection practices can introduce adverse genetic threats to listed populations through: (1) loss of within population genetic diversity, mediated through loss of effective population size (N_e) and inbreeding depression; (2) loss of population identity (i.e., genetic variability among populations) due to outbreeding or inclusion of aquaculture escapees; and (3) domestication (National Research Council, 2004). Current broodstock selection and hatchery practices at Craig Brook and Green Lake National Fish Hatcheries are designed to reduce these specific risks. However, we will need to continue rigorous genetic monitoring on an annual basis to ensure that genetic threats are adequately weighed and mitigated.

The major threats to Atlantic salmon survival and recovery are low marine survival, the direct and indirect effects of dams and road stream crossings, the West Greenland harvest, and climate change.

U.S. jurisdiction exists in management or protective actions to address the significant threat of dams and road stream crossings. We have seen upstream and downstream survival of both adults and smolts increase at some dams in recent years as a result of ongoing recovery actions that have resulted in the incorporation of new requirements in FERC licenses designed to avoid and minimize take of Atlantic salmon. Likewise, proactive efforts facilitated by stakeholders and supported by NMFS and the USFWS have removed many non-regulated dams, improved passage at hundreds of road/stream crossings and installed many fishways at dams that cannot be removed that help ensure passage of juvenile and adult Atlantic salmon to critical habitats. Although considerable progress has been made in some areas in addressing the threat of dams, there is still considerable work that needs to be done to both better understand the indirect effects of dams and how they contribute to poor freshwater and estuarine survival, and how those effects can be minimized or mitigated.

Domestic harvest of Atlantic salmon is within U.S. jurisdiction and has been prohibited by regulation since the time of listing. U.S. origin salmon are intercepted in low numbers in the

West Greenland and St. Pierre and Miquelon fisheries. While these fisheries are outside of U.S. jurisdictional authority, the recommendation from ICES to NASCO is for zero harvest of U.S. origin fish. The U.S. supports these recommendations and continues to actively engage through NASCO to eliminate, to the extent possible, the impact that these fisheries have on U.S. populations.

Because of these factors **no change is recommended to the classification of the GoM DPS of Atlantic salmon.**

4.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (Indicate reasons for delisting per 50 CFR 424.11):
____ Extinction
____ Species does not meet the definition of a threatened or endangered species
____ Listed entity does not meet the definition of a species
__X__ No change is needed

5 RECOMMENDATIONS FOR FUTURE ACTIONS

Connectivity

- By 2025, restore access to high quality spawning and nursery critical habitats to within 80% of our habitat goals for delisting by:
  - o Removing dams, installing fishways, removing culverts, decommissioning roads, and upgrading road-stream crossings; and
  - o Improve fish passage at hydroelectric dams through dam removal or construction of fishways, and the implementation of adaptive management strategies to achieve passage efficiency and survival targets for dams that cannot be removed.

- Promote and enhance communication with towns, municipalities, and local land owners on the importance of fish passage and connectivity through outreach efforts and demonstrations

Recovery Plan actions that the future recommended actions address:

C2.0[1]: Remove dams to ensure access to habitats necessary for Atlantic salmon Recovery.

C3.0: Improve Fish Passage at Dams to ensure access to habitats necessary for Atlantic salmon recovery.

C4.0: Improve Fish Passage at Road Crossings.

C5.0: Implement connectivity projects that ensure access to the co-evolved suite of diadromous fish that are part of the ecosystem that Atlantic salmon depend on.

O1.0: Inform stakeholders and the public of sea-run fish resources in Maine and the importance of protecting and restoring the ecosystems upon which they depend.

Freshwater Conservation

- Develop and implement a geographically explicit freshwater protection, restoration, and enhancement strategy for the GoM DPS that will explicitly consider protection of climate-resilient spawning and rearing habitats in the face of climate change.
- Reduce stocking of non-native salmonids in the freshwater range of endangered salmon to ensure that predatory and competitive effects are minimized.
- Implement adaptive management projects aimed at increasing abundance and distribution of Atlantic salmon among recently opened up habitats stemming from dam removals and improved fish passage.
- Communicate with stakeholders and NGOs when funding opportunities become available that promote freshwater conservation actions.

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[1] Note that these codes match the coding of actions identified in the 2019 Recovery Plan

- Educate audiences how climate related changes impact Atlantic salmon and the habitat on which they depend and provide actions that can be taken to improve understanding of climate related impacts.

Recovery Plan actions that the future recommended actions address:
F3.0: Identify, maintain, protect and restore priority freshwater habitats for Atlantic salmon.

F4.0: Implement methods to minimize predation pressures and angling pressures on Atlantic salmon.

O2.0: Fulfill the conservation goals of the ESA by engaging with stakeholders and the public to guide the implementation of actions necessary for the recovery of Atlantic salmon.

O3.0: Provide training and opportunities for stakeholders to increase capacity in implementing recovery efforts.

Marine and Estuary

- Reduce mortality of U.S. origin salmon in mixed-stock fisheries by remaining active in the West Greenland Commission and the North American Commission of the North Atlantic Salmon Conservation Organization.
- Reduce mortality of Atlantic salmon by (1) maintaining closures for all directed fisheries for Atlantic salmon consistent with existing Fishery Management Plan under the Magnuson-Stevens Fisheries Conservation and Management Act and (2) reducing bycatch of Atlantic salmon in fisheries for other species to the maximum extent possible.
- Monitor ecosystem process changes in estuary and coastal migration corridors to understand dynamic interactions of migrating salmon with other species (e.g. predator-prey dynamics).
- Develop and support scientifically credible recommendations for smolt stocking (e.g. environmentally-based timing and locations) that mirror, but do not interfere or alter, river produced smolt migrations. These efforts will help to limit extreme environmental transitions between environments (e.g. temperatures) and optimize smolts entering the GoM.
- Map the marine migration from natal rivers to and from the Labrador Sea to further our understanding of the drivers of marine productivity and to provide managers with detailed migration maps to support risk analysis associated with natural resource exploitation.

Recovery Plan actions that the future recommended actions address:
M1.0: Continue ongoing international negotiations and partnerships to ensure U.S. interests in Atlantic salmon conservation are understood and considered.

M2.0: Continue ongoing research and monitoring to further understand the ecological conditions that allow Atlantic salmon to succeed in the estuary and marine environment and the factors that impede their survival.

Federal/Tribal Coordination

- Continued support and involvement in educational programs and outreach events with Tribal partners and students.

Recovery Plan actions that the future recommended action addresses:
T1.0: Continued Federal/Tribal Engagement and Coordination.

O1.0: Inform stakeholders and the public of sea-run fish resources in Maine and the importance of protecting and restoring the ecosystems upon which they depend.

Hatcheries/Genetic Diversity/Aquaculture

- Conduct estimates of genetic diversity on remaining wild populations, such as allelic variability (i.e., number of alleles per locus, allelic diversity), and heterozygosity at conservation hatcheries on an annual basis to implement breeding programs that reduce or eliminate further losses diversity.
- Minimize effects to wild salmon from genetic introgression from escaped aquaculture-origin salmon by ensuring that containment measures are maintained at 100% of all salmon farms each year.
- Aquaculture: Minimize sea lice loads on commercial aquaculture fish being reared in marine net pens to reduce risks to salmon in the wild each year. This will be accomplished by mandatory fallowing, monitoring of lice levels, and mandatory treatments when thresholds for sea lice counts are exceeded.
- Include messaging in outreach and education materials that discusses the differences between hatchery raised, aquaculture, and wild Atlantic salmon.

Recovery Plan actions that the future recommended actions address:
H1.0: Implement methods necessary to maintain and promote genetic diversity of salmon populations in the hatcheries.

G.1.0: Annually characterize all Atlantic salmon collected for use as broodstock for origin determination and genetic variation.

G2.0: Use of genetic data to evaluate and inform recovery.

F5.0: Minimize escapes and the effects of escaped aquaculture Atlantic salmon on local populations.

O1.0: Inform stakeholders and the public of sea-run fish resources in Maine and the importance of protecting and restoring the ecosystems upon which they depend.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW
Atlantic Salmon *(Salmo salar)*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist

_X_ No change needed

REGIONAL OFFICE APPROVAL:

Assistant Regional Director - Ecological Services, North Atlantic-Appalachian Region, U.S. Fish and Wildlife Service

Approve SHARON MARINO Digitally signed by SHARON MARINO Date: 2020.11.22 19:41:48 -05'00' Date_______

NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW
Atlantic salmon (*Salmo salar)*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X_ No change is needed

LEAD OFFICE APPROVAL:

Regional Administrator, Greater Atlantic Regional Fisheries Office

Approve: ____ Date: September 22, 2020

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA's National Marine Fisheries Service

_____Concur _____ Do Not Concur

OLIVER.CHRISTOPHER.WAYNE.1408430670 Digitally signed by OLIVER.CHRISTOPHER.WAYNE.1408430670 Date: 2020.11.05 19:41:38 -05'00'

Signature____ Date_______