SPECIES in the SPOTLIGHT

Priority Actions 2021–2025

NOAA FISHERIES

Atlantic Salmon
(*Salmo Salar*)

Adult Atlantic salmon in the Sandy River in western Maine. Credit: Atlantic Salmon Federation.

Cover: Credit: Nick Hawkins

The *Species in the Spotlight* Initiative

In 2015, the National Marine Fisheries Service (NOAA Fisheries) launched the *Species in the Spotlight* initiative to provide immediate, targeted efforts to halt declines and stabilize populations, focus resources within and outside of NOAA on the most at-risk species, guide agency actions where we have discretion to make investments, increase public awareness and support for these species, and expand partnerships. We have renewed the initiative for 2021-2025.

The criteria for *Species in the Spotlight* are that they are endangered, their populations are declining, and they are considered a recovery priority #1C (84 FR 18243, 4/30/2019). A recovery priority #1C species is one whose extinction is almost certain in the immediate future because of rapid population decline or habitat destruction, and because of conflicts with construction, development, or economic activity.

As of January 2021, the following nine species are our *Species in the Spotlight*.

- Atlantic salmon Gulf of Maine distinct population segment (DPS)
- Central California Coast coho salmon evolutionarily significant unit (ESU)
- Cook Inlet beluga whale DPS
- Hawaiian monk seal
- North Atlantic right whale (added in 2019)
- Pacific leatherback sea turtle
- Sacramento River winter-run Chinook salmon ESU
- Southern resident killer whale DPS
- White abalone

For some of these species, their numbers are so low that they need to be bred in captivity; others are facing human threats that must be addressed to prevent their extinction. In most cases, we understand the limiting factors and threats to these species, and we know that the necessary management actions have a high probability of success. In some cases, we are prioritizing research to better understand the threats so we can fine-tune our actions for the maximum effect. We know we can't do this alone. A major part of the *Species in the Spotlight* initiative is to expand partnerships and motivate individuals to work with us to get these species on the road to recovery.

Priority Action Plans

The 5-year action plan is part of a strategy to marshal resources for species listed under the Endangered Species Act of 1973 (ESA) for which immediate, targeted efforts are vital for stabilizing their populations and preventing their extinction.

In its first 5 years, the *Species in the Spotlight* initiative has been successful at raising awareness, increasing partnerships, and prioritizing funding—providing or leveraging more than $113 million toward projects that will help stabilize these highly at-risk species.

We renewed the *Species in the Spotlight* initiative for 2021-2025, and have updated the priority action plans that outline what we need to do to prevent their extinction.

The 2021-2025 5-year action plans build upon existing action, recovery, or conservation plans and detail the focused efforts needed over the next 5 years to reduce threats and stabilize population declines. We

will continue to engage our partners in the public and private sectors in actions they can take to support this important effort. We will report on our progress through the Biennial Recovering Threatened and Endangered Species Report to Congress, and on our Species in the Spotlight web pages.

This strategy will continue to guide agency actions where we have the discretion to make critical investments to safeguard these most endangered species. The strategy will not divert resources away from the important and continued efforts to support all ESA-listed species under our authority. Many of our species have long-standing conservation programs supported by multiple partners. We remain committed to those programs.

This action plan builds on the success of the past 5 years, and highlights the actions that can be taken by us, other federal and state resource agencies, environmental organizations, Native American tribes, and other partners to work toward turning the trend around for this species from a declining trajectory toward recovery. We appreciate all of our current partners and collaborators, as the steps we need to take to stabilize these species would not be possible without them.

NOAA Fisheries Contact

If you are interested in working with us, or if you have questions about any of the priority actions contained in this plan, please contact:

Dan Tierney, Atlantic Salmon Recovery Coordinator, Protected Resources Division, Greater Atlantic Regional Fisheries Office, Maine Field Station, Dan.Tierney@noaa.gov, 207-866-3755

Atlantic Salmon Status

The Gulf of Maine DPS of Atlantic salmon was selected as one of the species under this initiative because of its critically low abundance and its continuing decline. Atlantic salmon are anadromous fish, spending the first half of their life in freshwater rivers and streams in Maine and the second half maturing in the seas between Northeastern Canada and Greenland. In the United States, Atlantic salmon populations historically extended as far south as Long Island Sound. Before 1900, southern populations were extirpated due to habitat loss, hydropower development, freshwater habitat impairment, and overharvest. Beginning in the 1970s, the abundance of salmon in New England rivers increased. However, in the 1990s marine mortality increased, which has led to a reversal of earlier population gains. Since that time, restoration efforts in southern New England (e.g., Connecticut River) ended and the Gulf of Maine DPS was listed under the ESA.

The DPS at listing included the nine remnant populations in central and eastern Maine. These populations are adapted to specific conditions in their natal rivers. Unfortunately, one of these river specific populations was recently extirpated and another is on the brink of being lost. This has led to growing concern about the status of the DPS as a whole. River specific populations still persist in the Sheepscot, Penobscot (including the Ducktrap), Narraguagus, Pleasant, Machias, East Machias, and Dennys rivers.

Marine survival is a limiting factor to Gulf of Maine salmon populations. However, identifying management measures that would result in increased marine survival is challenging. Additional research is needed to better understand the causes of decreased survival, potential measures to address poor marine survival, and identification of potential emerging threats that may result from new ocean development. With too few spawners and available freshwater nursery habitat, there are opportunities to increase the number of smolts that leave these rivers, which can help counter the consequences of low marine survival. Related management actions include increasing the number of wild/naturally reared smolts and the quality of hatchery-origin smolts entering the ocean. These actions will increase juvenile abundance and maintain genetic diversity. It will also be important to consider genetic rescue approaches that could improve adaptability and resilience. We cannot afford to lose any of the locally adapted populations that remain or the irreplaceable genetic diversity they embody.

In the last several decades, we have gained a better understanding of the consequences of losing species; not only to biodiversity and ecosystem function but also to society. Abundant diadromous fish populations provide a variety of ecosystem goods and services such as food for people, linking freshwater and marine ecosystems, and supporting marine food chains that are desirable to society (Limburg and Waldman 2009). For example, many diadromous species are important prey items for commercially valuable marine species. The declines of river herring in the Gulf of Maine watersheds have been hypothesized to be linked to the declines of nearshore stocks of cod in the area (Ames 2004).

Atlantic salmon are an integral component of these formerly well-connected ecosystems. These connections between freshwater, estuarine, and marine ecosystems can and must be re-established if we are to stem the

Atlantic salmon are an integral component of these formerly well-connected ecosystems. These connections between freshwater, estuarine, and marine ecosystems can and must be re-established if we are to stem the tide of extinction of salmon and potentially other diadromous fish.

tide of extinction of salmon and potentially other diadromous fish. Many of the rivers of Maine offer the last best hope of recovering not only Atlantic salmon but the entire 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, sea-run brook trout, and ESA-listed Atlantic and shortnose sturgeon. In a survey of restoration potential for East Coast rivers, Martin and Apse (2011) note the tremendous potential of many rivers in Maine (most notably, the Penobscot) relative to others on the East Coast. Thus, restoring connections in salmon rivers in Maine will serve us well if we wish to prevent further declines and potential extinctions of other diadromous species.

When a river is clean and well connected, its salmon population can thrive if marine conditions are also favorable. As seen in other countries, when salmon populations are abundant, they can support lucrative recreational fishing opportunities. Atlantic salmon are also of great cultural importance to Native American tribes in Maine and historically supported important sustenance fisheries for the tribes. If this iconic species goes extinct, the extensive services it once provided to the American people will be lost forever.

Atlantic Salmon Key Conservation Efforts/Challenges

NOAA Fisheries and the U.S. Fish and Wildlife Service (collectively, the Services) issued a new Recovery Plan for Atlantic salmon in 2019. The Recovery Plan presents a recovery strategy based on the biological and ecological needs of the species as well as current threats and conservation accomplishments that affect its long-term viability. The Recovery Plan is based on two premises: first, that recovery must focus on rivers and estuaries located in the Gulf of Maine DPS while the Services work to better understand the threats in the marine environment and, second, that survival of Atlantic salmon in the Gulf of Maine DPS will be dependent on conservation hatcheries through much of the recovery process. The scientific foundation for the plan includes conservation biology principles regarding population viability, an understanding of freshwater habitat suitability, and threats-abatement needs.

The Recovery Plan identifies the primary threats that must be addressed to allow for the reclassification of the species from endangered to threatened and eventually to be removed from the list of threatened or endangered species. Those threats are:

- Dams and road stream crossings.
- Inadequacy of regulatory mechanisms for dams.
- Climate change.
- Low marine survival.
- Loss of genetic diversity.

In freshwater, the primary threat to Atlantic salmon recovery is dams. The population level effects of dams are acute and well documented:

- Dams directly limit or block access to otherwise essential habitats, and diminish the capacity of habitat to produce smolts.
- Dams directly kill or injure a significant number of migrating salmon.
- Dams compound the effects of climate change by limiting Atlantic salmon's access to cool water habitats that are most prevalent in higher elevation areas in northern and western Maine.
- Dams have reduced both the amount and diversity of available habitat, resulting in the loss of life history and genetic diversity essential to providing population resilience to the challenges above and marine survival.
- Dams limit the amount of marine-derived nutrients adult salmon and other species return to the system, which provide critical resources to feed the next generation of fish.

The Services issued their new 5-year review of the status of Atlantic salmon in 2020 (NMFS and USFWS 2020). The review echoed the conclusions of the Recovery Plan by identifying the same major ongoing

threats to Atlantic salmon survival and recovery. Given the scale of these threats, the Services did not recommend changing the classification of the Gulf of Maine DPS of Atlantic salmon.

Although the status of the Gulf of Maine DPS is dire, the tremendous collaborative effort and work of the State of Maine, the Penobscot Indian Nation, a broad coalition of non-governmental organizations, the federal agencies, and Maine's congressional delegation has led to significant and meaningful accomplishments in restoring the ecosystems upon which the DPS depends.

Since 1988, dam removals have restored access to lower sections of many mainstem rivers as well as increased access to other rivers and streams. These removals have reduced the number of barriers that salmon and other diadromous fish must navigate through to access high-quality habitats. Since 2009, more than 25 dams in the Gulf of Maine DPS have been removed. Of particular note are the dam removals associated with the Penobscot River Restoration Project. The removal of the Great Works and Veazie mainstem dams helped reduce the cumulative impact that dams have on survival of all species during their migration between the ocean and freshwater habitats while restoring complete access to about 22 kilometers before the next dam in Milford, Maine.

Barrier removals have resulted in substantial benefits to the full suite of co-evolved diadromous fish in Maine. For example, following the removal of Fort Halifax Dam (2008) and the Edwards Dam (1999), documented returns of river herring to the Kennebec River increased from less than 100,000 in 2006 to more than 5.8 million in 2018. Following the removals of Great Works and Veazie dams on the Penobscot River (and improved passage at other upstream dams), documented returns of river herring increased from 2,000 in 2011 to over 2 million in 2020.

A fully functioning riverine ecosystem (i.e., an ecosystem in which the co-evolved diadromous species are abundant and resilient) is essential to the recovery of Atlantic salmon. Accumulating scientific evidence suggests that the co-evolved suite of diadromous fish can provide benefits to the Gulf of Maine DPS of Atlantic salmon by providing important ecological services at key points in the Atlantic salmon life cycle. These services include being prey for salmon, "conditioning" rearing and spawning habitats, serving as alternative prey for predators of salmon, and delivering nutrients and energy from the marine environment to freshwater habitats. Passage improvements and active management of other species are therefore important for the recovery of Atlantic salmon and their ecosystems.

Despite many recent restoration success stories, more than 90 percent of rivers and streams in the Gulf of Maine DPS remain impacted by dams. Over 400 dams still exist along the rivers and streams that currently support Atlantic salmon in Maine, and only 75 of these dams have fishways. Even dams with fishways can cause significant delays in migration and direct or indirect mortality due to interaction with dam infrastructure or increased predation around dams. These problems are particularly acute at dams with hydroelectric turbines. Recent studies have demonstrated that the experience of individual salmon in rivers affects the likelihood of a successful transition to the marine environment. Juvenile salmon that have to navigate through multiple dams experience increased early marine mortality compared to individuals that have passed fewer dams during their downstream migration, meaning that fewer of these individuals will survive in the ocean to return to the rivers to spawn as adults.

Since Atlantic salmon was designated as a Species in the Spotlight in 2015, measurable progress has been made toward improving connectivity within the Gulf of Maine DPS. Barrier removal and fish passage projects over the past 5 years have improved access to over 500 miles of stream and river habitat. In 2018 and 2019, the Atlantic Salmon Federation removed one dam (Coopers Mills Dam) and breached another (Head Tide Dam) on the Sheepscot River, which reconnected 60 miles of suitable

Rotary screw traps fishing below the Head Tide Dam on the Sheepscot River. These traps allow biologists to capture migrating fish with minimal injury to conduct population estimates and sample fish size, age, and condition. Credit: NOAA Fisheries.

juvenile rearing habitat. The Sheepscot is a particular focus of restoration efforts as it hosts the only river specific stock of Atlantic salmon in the Merrymeeting Bay recovery unit and is the southernmost stock in the Gulf of Maine DPS. In 2015, a nature-like fishway was constructed around the Howland Dam on the Piscataquis River, a major tributary to the Penobscot River. This was a component of the Penobscot River Restoration Project, which also included the removals of the Veazie and Great Works dams. The new fishway significantly improved passage to more than 300 miles of habitat in the Penobscot River watershed.

Progress has been made in improving upstream and downstream fish passage at multiple hydroelectric dams over the past 5 years. Through the FERC relicensing process, new fishways have been required at five dams in the Gulf of Maine DPS. Additionally, operational changes at some hydroelectric projects have significantly improved downstream survival for juvenile salmon.

High mortality rates in the marine environment continue to limit the potential for recovery. Low marine survival has propelled already low populations of Atlantic salmon in U.S. waters toward extinction. Not all of the causes of low marine survival are well known. Threats like climate and ocean regime changes, shifts in predator and prey abundance and distribution (and even in energy content of one key prey item—capelin) appear to be important factors influencing salmon survival at sea.

One source of marine mortality is the mixed stock fishery in West Greenland. Contrary to many years of scientific advice that there be no fishery off West Greenland, Greenland continues a small Atlantic salmon fishery. International efforts to control and better manage foreign fisheries to reduce the impacts of these fisheries on Atlantic salmon of U.S. origin occur primarily through the North Atlantic Salmon Conservation Organization (NASCO). In our 2015 action plan, we highlighted concerns over a new 3-year regulatory measure (2015-2017) for the mixed stock salmon intercept fishery at West Greenland. U.S.-origin Atlantic salmon are captured in this fishery (approximately 2 U.S.-origin salmon per metric ton harvested), and the more fish that are harvested in the fishery, the higher the risk for U.S.-origin salmon. The 2015-2017 measure did not include an agreed-upon catch limit. Rather, Greenland unilaterally set a 45-ton quota for all components of the fishery. Our concerns were driven by the absence of an agreed-upon catch limit, the portion of the landings being reported as sold to factories, and the high degree of non-reporting resulting in a significant underestimate of the total harvest, with the actual harvest potentially as high as 96 tons. Considerable progress was made at the 2018 annual meeting of NASCO where a new 3-year regulatory measure for this fishery was adopted (NASCO 2018). The measure set the total allowable catch for all components of the Atlantic salmon fishery at West Greenland to 30 tons annually and included a payback provision for any overharvest, whereby the quota for a subsequent year will be reduced by any overharvest the previous year. The measure also maintains the prohibition on exports of Atlantic salmon from Greenland and includes enhanced licensing requirements with mandatory catch reporting. Despite these improvements, Greenland continues to exceed its fishery quota, mostly due to late reporting by fishers/municipalities, and work will need to continue to reduce the risk to U.S.-origin Atlantic salmon in this fishery.

Key Actions Needed 2021-2025

The key actions that follow represent a subset of the recovery actions identified in the Recovery Plan and represent actions NOAA Fisheries and partners can take in the next 5 years to promote recovery of the species. This list of potential partners is not comprehensive, and we welcome partnering with others not identified within this plan.

Reconnect the Gulf of Maine with Headwater Streams

Description and Background: Atlantic salmon require a diverse array of well-connected habitat types. In freshwater, dams and culverts limit access to important spawning and nursery habitats, particularly "thermal refugia" that salmon seek out in summer when temperatures rise. High-quality habitats, including cool water rivers and tributaries, still exist throughout the State of Maine; however, the Gulf of Maine DPS of Atlantic salmon only has unimpeded access to 8 percent of its historic freshwater habitat. In 2019, a climate scenario planning exercise helped reveal that restoring access to as many habitats as possible within the range

of the DPS will make this species more resilient to the effects of climate change (Borggaard et al. 2019). To recover salmon, it is essential that connections among these habitats and the Gulf of Maine be restored.

High-quality habitats, including cool water rivers and tributaries, still exist throughout the State of Maine; however, the Gulf of Maine DPS of Atlantic salmon only has unimpeded access to 8 percent of its historic freshwater habitat.

The removal of the Coopers Mills Dam on the Sheepscot River in Maine. Credit:Tim Swan

Efforts over the next 5 years will focus on the following:

1. **Removal of dams that no longer support communities' needs**: Many of the small, non-hydropower dams that remain in Maine were constructed in the late 1800s and early 1900s to support log drives or power mills. Many of these small dams in Maine lie dormant, have deteriorated significantly, and are identified by Maine's Emergency Management Agency as being a hazard to critical infrastructure and possibly to human lives. There are few regulatory mechanisms available to require the removal of barriers, and funding to implement such projects is limited. Therefore, additional resources are needed to remove dams or otherwise restore fish passage at dams and road crossings. Dams that no longer support communities' needs should be prioritized for removal. These smaller barriers are pervasive throughout the State of Maine, and we need our partners to continue, and expand, their efforts to address this significant threat. As we have seen on the Penobscot and Sheepscot Rivers, a multi-party approach can be successful at making meaningful changes. These types of concerted partnerships are needed to make significant progress in addressing the threat posed by dams in Maine.
2. **Ensure effective fish passage at hydroelectric dams undergoing FERC relicensing**: The hydroelectric dams on the Androscoggin, Kennebec, Penobscot, and Union rivers significantly affect the abundance and distribution of Atlantic salmon throughout the Gulf of Maine DPS. Due to passage inefficiencies, dams limit access to adults migrating to upstream spawning grounds and lead to the injury and death of smolts and post-spawn adults as they migrate back out to the sea. During the next 5 years, 18 dams within the freshwater range of the Gulf of Maine DPS of Atlantic salmon will be in the FERC relicensing process. Of these, nine occur within habitat currently accessible to Atlantic salmon. These facilities are a significant impediment to upstream and downstream passage of all diadromous fish, and the relicensing process elevates them as a top priority as this process affords a unique opportunity to consider and address impacts from the dams on Atlantic salmon and other diadromous species.
3. **Prioritize actions to improve connectivity in the Collaborative Management Strategy work plans:** Through the new Collaborative Management Strategy for Atlantic salmon, the state, federal, and tribal governments have established Salmon Habitat Recovery Unit-specific teams that are developing work plans that identify priority actions for salmon recovery. These work plans will include a short list of projects that have the most potential to result in a significant impact on survival and recovery of the species over a 5-year period. Among other priorities, we anticipate that these plans will emphasize the improvement of connectivity in designated critical habitat within the following watersheds: the Narraguagus River in the Downeast Coastal recovery unit, the Piscataquis River in the Penobscot Bay recovery unit, and the Sandy River (including full access to it through the mainstem Kennebec River) in the Merrymeeting Bay recovery unit. Taking actions within these watersheds provides the best opportunity over the next 5 years for restoring abundant, suitable, climate-resilient habitat that will be necessary to support juvenile life stages of Atlantic salmon as global temperatures continue to rise.

Expected Benefits to the Species:

- Restore the productive capacity of freshwater habitats by restoring free flowing rivers, water quality, and fish communities (including marine-derived nutrients from returning anadromous fish) altered by dams, road crossings, and other barriers.
- Restore the connection between the freshwater and marine habitats that is essential for supporting the anadromous life cycle of Atlantic salmon, as well as the other co-evolved diadromous species.
- Increase resilience to the negative impacts from climate change by improving connectivity within watersheds and providing salmon and other diadromous species with access to thermal refugia.

Source: Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*).

- Connectivity Actions (C1.0-C7.0).

Atlantic salmon (*Salmo salar*) 5-Year Review: Summary and Evaluation.

- By 2025, restore access to high-quality spawning and nursery critical habitats to within 80% of our habitat goals. This would occur by implementing recovery actions C2.0 through C5.0.

Location: Throughout the freshwater and estuarine range of the Gulf of Maine DPS of Atlantic Salmon, with a focus on streams and rivers in designated critical habitat.

Partners: Non-governmental organizations (such as The Nature Conservancy, Atlantic Salmon Federation, Downeast Salmon Federation, Project SHARE, Maine Audubon, Maine Coast Heritage Trust, Maine Rivers), Penobscot Indian Nation, Passamaquoddy Tribe, U.S. Fish and Wildlife Service, Maine Department of Marine Resources, U.S. Army Corps of Engineers, U.S. Department of Agriculture's Natural Resources Conservation Service, Maine Department of Transportation, landowners and municipalities, Federal Energy Regulatory Commission, and dam owners within the freshwater range of the Gulf of Maine DPS.

Opportunities for Partners:

- We encourage all partners to seek opportunities for dam and other barrier removals and/or projects to improve fish passage.
- We encourage all partners to actively engage in the hydropower dam relicensing process with the Federal Energy Regulatory Commission to ensure that every effort is made to restore effective passage at hydroelectric dams within the Gulf of Maine DPS.

Current Status: Efforts continue throughout the Gulf of Maine DPS to identify and minimize the effect of barriers to Atlantic salmon migration. Efforts are currently underway to develop plans and secure funding to remove or improve passage at the Walton's Mill Dam on Temple Stream in the Sandy River watershed and the Cherryfield Ice Control Dam on the Narraguagus River. Additionally, consultations under the FPA and ESA are ongoing between the resource agencies, FERC, and the operators of multiple lower river hydroelectric dams on the Penobscot, Kennebec, and Androscoggin rivers to develop strategies for improving upstream and downstream passage effectiveness. We are also undertaking a programmatic ESA section 7 consultation with the U.S. Army Corps of Engineers and NOAA's Restoration Center for small dam removals and fishway projects that will help to streamline the environmental review process for these projects.

Resources: Funding is needed to support the removal of small dams and the construction of effective fishways at dams where removal is not feasible. The costs associated with these types of projects include the cost of feasibility and alternatives analyses, engineering design, construction, and post-construction monitoring. These types of projects also take a considerable amount of time and effort on the part of our partners that manage them, including work to obtain community support and extensive fundraising. Total costs associated with a single non-hydropower dam removal are expected to range from $250,000 to $1 million. Providing fish passage at a dam likely falls within the same range. Given the number of barriers to passage within the Gulf of Maine DPS, the investment of time and resources needed to make progress on this action is significant. Effective engagement during FERC relicensing requires adequate staffing from agency biologists and engineers as well as support from partners and stakeholders. Resources are also needed to support the continued development of the knowledge base regarding the impacts of dams to ensure management decisions are based on the best available scientific information.

Improve Habitat Productivity to Increase the Number of Fish Successfully Entering the Marine Environment

Description and Background: In addition to restoring connectivity between marine and freshwater habitat, we need to produce more juvenile Atlantic salmon in freshwater habitat to increase the number of wild smolts that migrate into the marine environment. While the majority of smolts migrating in Maine rivers are currently of hatchery origin, the recovery of the species is dependent on the reestablishment of a wild salmon population. Wild smolt production remains low for a variety of reasons, including problems with connectivity and habitat quality.

Historical practices such as log drives, poor forestry and agriculture practices, pollution, and construction of road networks damaged rivers and tributaries. The legacy of these impacts include straightened and simplified stream channels, embedded substrates, reduced off-channel habitat, and diminished access to habitat. We are also coming to understand that the amount of coldwater habitat (i.e., thermal refugia) may substantially limit production potential of smolts, particularly during warm summers, through reduced growth potential and increased mortality from predation. Improved land management practices and laws that increase protections of riparian areas have substantially reduced the acute effects of many of these threats. However, the legacy effects of damaged habitats not only diminish current smolt production but also reduce the resilience and thermal refugia available to support future population growth.

Historical practices such as log drives, poor forestry and agriculture practices, pollution, and construction of road networks damaged rivers and tributaries. The legacy of these impacts include straightened and simplified stream channels, embedded substrates, reduced off-channel habitat, and diminished access to habitat.

Efforts over the next 5 years will focus on the following:

1. **Increase smolt production through process-based restoration:** Increased smolt production in freshwater remains a key way to mitigate the risk to the DPS given contemporary levels of marine survival (Hansen et al. 2012). With a long-term goal of increasing smolt production in freshwater, the principles of process-based restoration were described by Beechie et al. (2010). This paper highlighted four process-based restoration principles that ensure sustainable river restoration: 1) restoration actions should address the root causes of degradation, 2) actions must be consistent with the physical and biological potential of the site, 3) actions should be at a scale commensurate with environmental problem, and 4) actions should have clearly articulated expected outcomes for ecosystem dynamics. Projects consistent with these principles and the tenets of adaptive management will, over the long term, increase smolt production in freshwater and provide the opportunity to learn which projects provide the greatest benefit. Activities that are consistent with these principles (such as protecting headwater areas and restoring access to as many habitats as possible within the range of the DPS) are expected to help the species become more resilient to climate change. One example of an ongoing effort that is following these principles is the project in the upper Narraguagus River, where Project SHARE is installing large wood and boulder structures in degraded river habitat with the intent of increasing habitat complexity and, thus, smolt production. This project will evaluate the potential of this strategy as a management tool and will improve our understanding of how similar projects could contribute to recovery. Over time, a process-based restoration strategy should allow riparian corridor function to recover and lead to greater habitat complexity. These more complex habitats should provide thermal refugia that are needed for summer shelter, and decreasing the spacing between these habitat features should increase summer survival. Similarly, complex habitat in pools also increases overwintering habitat.
2. **Complete a study to identify climate-resilient habitats across the freshwater range of the Gulf of Maine DPS:** This action includes the identification of climate-resilient habitats across the freshwater range of the Gulf of Maine DPS. In response to the conclusions of a 2016 climate vulnerability analysis (Hare et al. 2016), we conducted an Atlantic salmon 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

Juvenile Atlantic salmon in a freshwater stream. Credit: Nick Hawkins.

(Borggaard et al. 2019). These efforts have led to science and management actions that include efforts to identify climate-resilient habitats within the range of the Gulf of Maine DPS and to develop strategies to ensure access to, and protection of, these habitats. We will advance these efforts by completing an ongoing study to identify river reaches that are rich in baseflow during summer low-flow periods, and thus have the potential to be high-value Atlantic salmon habitat.

3. **Complete a study to assess how non-native fish species (such as smallmouth bass) may constrain smolt production in the Gulf of Maine DPS:** A multi-year assessment of the effects of predation on the survival of juvenile Atlantic salmon has been funded by NOAA Fisheries. This study will include a field study to assess the effect of predation by smallmouth bass on salmon smolts in the impoundments of hydroelectric dams, as well as the development of a spatial model that will quantify the degree to which predation and competition by bass in rearing habitat may constrain smolt production. This model will also consider whether global climate change may affect rearing habitat in such a way as to favor smallmouth bass at the expense of Atlantic salmon. Information from this study will help to inform future management actions that could help improve freshwater productivity by managing threats to smolts.

Expected Benefits to the Species:

- Restore smolt production capacity of freshwater habitats through process-based restoration.
- Increase the abundance of naturally reared smolts entering the marine environment, which will consequently lead to an increase in the abundance of returning adults, even during periods of poor ocean survival.

Increased smolt production in freshwater remains a key way to mitigate the risk to the DPS given contemporary levels of marine survival

Installation of large wood by Project SHARE into degraded habitat in the Narraguagus River in eastern Maine. Credit: Project SHARE.

- Increase abundance of native freshwater and diadromous fish by restoring properly functioning ecosystems, thereby reestablishing the ecosystem services these species provide to Atlantic salmon.
- Increase the life history diversity that makes use of different habitat types, providing resilience to dynamic environmental conditions.

Source: Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*).

- Freshwater Action (F3.0).

Location: Opportunities to increase smolt production (such as projects that could increase the capacity of habitat to produce more juvenile salmon) should be evaluated in each salmon river in the Gulf of Maine DPS. These efforts will have the greatest benefit in areas where connectivity has been restored.

Partners: Non-governmental organizations (such as the National Fish and Wildlife Foundation, The Nature Conservancy, Maine Audubon, Atlantic Salmon Federation, Project SHARE, Downeast Salmon Federation, and Trout Unlimited), U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Department of Agriculture Natural Resources Conservation Service, Penobscot Indian Nation, landowners, and municipalities.

Opportunities for Partners:

- We encourage all partners to seek opportunities for watershed-level restoration of natural stream processes and other projects to improve natural fish production.
- We encourage the U.S. Fish and Wildlife Service, the State of Maine, and non-governmental organizations to increase the overall production of Gulf of Maine DPS stocks to enable full utilization of all critical habitat for natural smolt production bolstering both genetic conservation resources and overall abundance of freshwater stages.

Current Status: Efforts to protect and restore habitat are ongoing throughout the Gulf of Maine DPS, but are particularly concentrated in the Downeast Coastal Salmon Habitat Recovery Unit, where there are fewer barriers to passage and where the habitat connectivity goal described by the 2019 Recovery Plan has almost been achieved. Project SHARE leads an innovative project in the upper Narraguagus River to augment the productive capacity in areas with degraded habitat. The project involves a strong science component involving a diverse suite of partners including Connecticut College, U.S. Fish and Wildlife Service, and the Maine Department of Marine Resources.

Resources: Funding is needed to implement adaptive management projects aimed at increasing abundance and distribution of Atlantic salmon within recently opened-up habitats stemming from dam removals and improved fish passage as well as associated monitoring of the success of these projects. Funding is also needed to identify climate-resilient habitat and to adequately restore and protect it. Resources are also needed to support research on measures that may increase the productivity of freshwater habitats and to identify and reduce associated threats.

Increase Our Understanding and Ability to Improve Survival in the Marine Environment

Description and Background: Decreased marine survival is the primary factor driving the decline of Atlantic salmon populations throughout their southern range and impedes recovery of Gulf of Maine populations. The marine habitat of U.S. salmon extends from the Maine coast though Canada to Greenland. NOAA Fisheries works with domestic and international partners to document catch in fisheries and better understand what is affecting overall marine survival. Our Atlantic salmon assessment and research provide estimates of harvest and natural marine survival while working to refine estimates of mortality through each migration stage (i.e., estuary, coastal, and at-sea).

Decreased marine survival is the primary factor driving the decline of Atlantic salmon populations throughout their southern range and impedes recovery of Gulf of Maine populations.

Efforts over the next 5 years will focus on the following:

1. **Research the causes of poor marine survival and measures for improving it:** We have helped to identify important climate drivers and an ocean regime change, informed models of post-smolt migration to Canada, and documented food web changes that play a role in decreased ocean productivity of salmon. Over the next 5 years, we will prioritize the following research actions:
   - Continue to describe adult salmon ocean migration routes/timing.
   - Quantify prey energy dynamics at Greenland feeding areas to assess the impact of a changing climate on marine growth, survival, and productivity.
   - Quantify shifts in forage base energetics to better characterize how food web disruption is impacting marine productivity in the Northwest Atlantic.

   This research will support the identification of causes of poor marine survival, assess future threats (such as potential effects of offshore energy development) proactively, and help identify strategies to support salmon resiliency to dynamic ocean conditions.
2. **Work to reduce mortality of U.S.-origin salmon in the mixed-stock fishery off of West Greenland:** To minimize impacts on salmon caught in foreign fisheries, the United States works through NASCO with Canada, Denmark (in respect of the Faroe Islands and Greenland), the European Union, the United Kingdom, Norway, and Russia to conserve, restore, enhance, and rationally manage Atlantic salmon. Since 2002, the scientific advice has been that there be no fishery off West Greenland given the stated management objectives for the stock complex. However, Greenland has allowed a commercial Atlantic salmon fishery to operate annually.

The most recent regulatory measure for this fishery was adopted at the 2018 annual meeting of NASCO (NASCO 2018), which was a considerable improvement over the previous regulatory measure set in 2015. Despite this, the fishery continues to operate and to capture and kill Atlantic salmon from the Gulf of Maine DPS, directly reducing the number of adults that return to Maine rivers to spawn.

Other mixed-stock fisheries exist off Canada and St. Pierre and Miquelon (an overseas territory of France), which have historically been documented to take small numbers of U.S.-origin Atlantic salmon. We will continue to work through NASCO to ensure that these mixed fisheries are managed in a way to eliminate or reduce to the maximum extent possible any take of U.S.-origin salmon.

3. **Evaluate the effectiveness of stocking adult salmon to increase production of naturally reared smolts:** Resilience to poor marine survival appears to be based in freshwater life history, with naturally reared smolts having a survival rate four times greater than hatchery-reared fish. Currently, the benefits of abundant natural production are limited by the challenges defined in the two previous actions. In an effort to provide additional opportunity for increased marine survival, NOAA Fisheries has partnered with and invested in Maine DMR's Salmon for Maine's Rivers adult rearing program. This project will evaluate the efficacy of rearing Atlantic salmon from smolts to adults in sea cages using modern aquaculture practices and the benefits of stocking the resulting pre-spawn adults in vacant habitat in terms of naturally reared smolt production. The goal of the project is to evaluate whether this innovative effort can effectively increase natural smolt production, marine derived nutrients, and ultimately marine returns. This project will evaluate the potential of this strategy as a management tool and will improve our understanding of how similar projects could contribute to recovery.

Expected Benefits to the Species:

- Provide science-based evaluations of marine survival.
- Identify management options based on the best science available to maximize marine survival.
- Reduce to the maximum extent possible directed harvest of U.S.-origin salmon.

Source: Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*).

- Marine and Estuary Action (M1.0 and M2.0)

Atlantic salmon (*Salmo salar*) 5-Year Review: Summary and Evaluation. Recommendations under recovery actions M1.0 and M2.0.

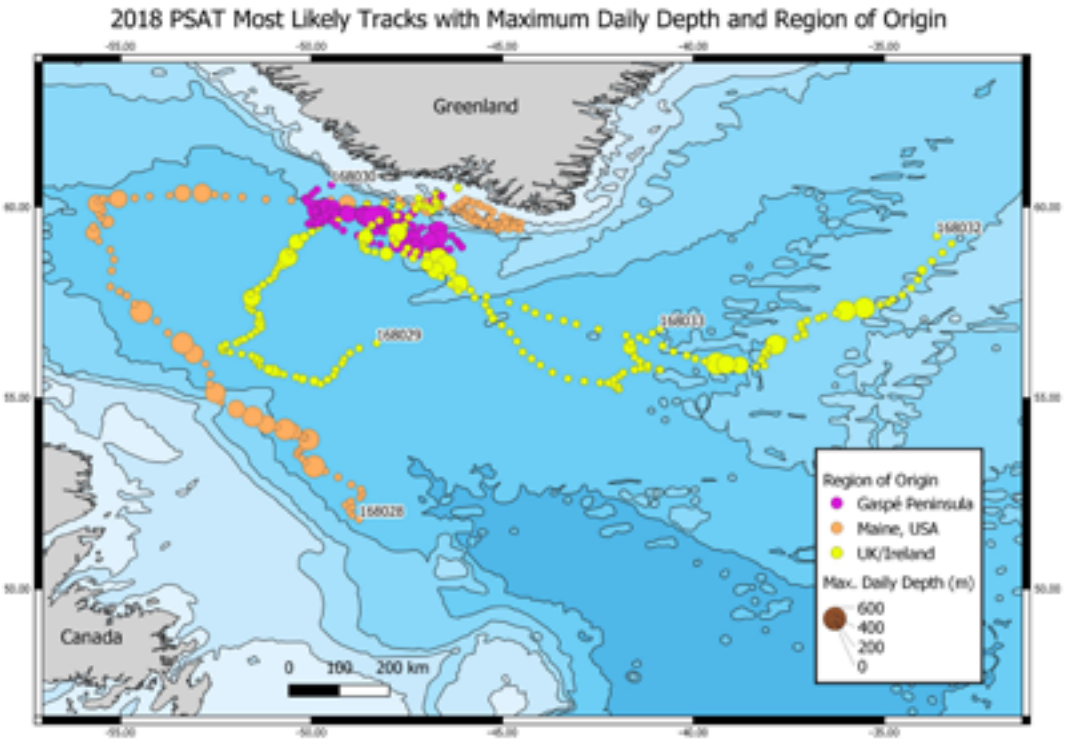
- Reduce mortality of U.S.-origin salmon in mixed-stock fisheries by remaining active in the West Greenland Commission and the North American Commission of the North Atlantic Salmon Conservation Organization.
- Monitor ecosystem process changes in estuary and coastal migration corridors to understand dynamic interactions of migrating salmon with other species (e.g., predator-prey dynamics).
- 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.

Location: Northwest Atlantic Ocean

Partners: Maine Department of Marine Resources, U.S. Fish and Wildlife Service, Canada's Department of Fisheries and Oceans, Ocean Tracking Network, NASCO, Northwest Atlantic Fisheries Organization, Gulf of Maine Research Institute, Atlantic Salmon Federation, Bureau of Ocean Energy Management, the U.S. Navy.

Opportunities for Partners:

- We encourage partners to collaborate on a monitoring and assessment program to assess mortality of U.S.-origin fish in distant water fisheries and quantify impacts on recovery potential.
- We encourage the government of Greenland and participants of the fishery, other Parties to NASCO's West Greenland Commission, and other concerned organizations both within and outside of NASCO to continue to work collaboratively to minimize the impact of the intercept fishery on U.S.-origin fish.
- We encourage partners to explore alternative hatchery methods to reduce the survival gap between hatchery and naturally reared smolts.
- We encourage partners to engage in evaluation, outreach, and education activities associated with MDMR's Salmon for Maine River's Project. Activities should educate the public about the project, but also increase their understanding of the role they play in salmon recovery and encourage them to make more informed decisions about how their actions may affect the ecosystems upon which salmon depend.



Telemetry tracks and maximum daily depth of adult Atlantic salmon migrating from the coast of Greenland towards natal rivers to spawn. Salmon were tagged and released at Greenland in 2018 and originated from the US, the UK and Canada. This is a joint project between NOAA Fisheries, Fisheries and Oceans Canada and the Atlantic Salmon Federation.

Current Status: Our priority actions are focused on identifying measures to improve survival and increase population resiliency. NOAA Fisheries leads efforts to assess marine survival and ecology to inform international and domestic management by: 1) monitoring marine survival in index rivers, 2) partitioning emigration by estuary/coastal zones and identifying migration routes/timing, 3) describing return migration from Greenland, and 4) quantifying changes in prey abundance and energetics. Understanding locations of salmon at sea is critical to finding mortality hot spots and providing baseline information that can inform siting and environmental reviews for ocean development. NOAA Fisheries activities support the development of new ocean tracking tools, migration modeling, and bioenergetics through international partnerships. Cost sharing and partnerships are key to expanding these efforts. Monitoring marine survival of hatchery and wild populations allows us to gage effectiveness of recovery actions. We also continue to work to quantify and address threats in freshwater, such as latent fish passage effects that reduce estuary-marine survival. We are also working with partners to support and evaluate a new project to mitigate high marine mortality by rearing smolts to adult stage in ocean pens and releasing these adults for natural spawning.

Greenland is in the process of developing an entirely new fisheries management plan for Atlantic salmon that would be effective for the 2021 fishing season. Through NASCO, the United States will carefully assess Greenland's harvest and implementation of management measures and work to negotiate a new multi-year management measure for the fishery that further reduces risk to U.S.-origin Atlantic salmon. Compliance with these regulatory measures will result in a decrease in the amount of U.S.-origin Atlantic salmon harvested in this fishery (due to controls on the total fishery); however, it will not eliminate the harvest of U.S.-origin salmon altogether.

Resources: Funding is needed for monitoring and assessment, including ocean tracking and survival. Funding is also needed to support U.S. participation in and coordination of the Atlantic salmon fisheries sampling program at West Greenland, which is needed to provide data for assessment and management advice. Resources are also needed to support science to identify threats in the estuarine and marine environment that affect marine survival and to develop management measures to increase the resiliency of the populations to poor oceanic conditions.

Atlantic salmon parr emerging from streambed. Credit: E. Peter Steenstra, U.S. Fish and Wildlife Service.

References

Ames, E. P. 2004. Atlantic cod stock structure in the Gulf of Maine. Fisheries 29(1): 10-28.

Beechie, T. J., D.A. Sear, J.D. Olden, G.R. Pess, J. M. Buffington, H.Moir, P. Roni, and M.M. Pollock. 2010. Process-based principles for restoring river ecosystems. BioScience 60(3): 209-222.

Borggaard, D. L., et al. 2019. Atlantic Salmon Scenario Planning Pilot Report. Greater Atlantic Region Policy Series [19-05]. NOAA Fisheries Greater Atlantic Regional Fisheries Office www.greateratlantic.fisheries.noaa.gov/policyseries. 89 p.

Daily, G. C., Alexander, S., Ehrlich, P. R., Goulder, L., Lubchenco, J., Matson, P. A., Mooney, H.A., Postel, S., Schneider, S.H., Tilman, D., Woodwell, G.M. 1997. ECOSYSTEM SERVICES: Benefits Supplied to Human Societies by Natural Ecosystems. Issues in Ecology. No. 2.

Hansen, L. P., P. Hutchinson, D. G. Reddin, and M. L. Windsor. 2012. Salmon at sea: Scientific advances and their implications for management: An introduction. ICES Journal of Marine Science 69(9):1533–1537

Hare, J. A., Morrison, W. E., Nelson, M. W., Stachura, M. M., Teeters, E. J., Griffis, R. B., . . . Bell, R. J. (2016). A vulnerability assessment of fish and invertebrates to climate change on the Northeast US continental shelf. PLoS One, 11(2).

Limburg, K.E. and J.R. Waldman. 2009. "Dramatic declines in North Atlantic diadromous fishes." BioScience 59(11): 955-965.

Martin, E. and C. Apse. 2011. Session C4-Northeast aquatic connectivity assessment.

NASCO (North Atlantic Salmon Conservation Organization). 2018. Report of the Thirty-Fifth Annual Meeting of the West Greenland. Tromsø, Portland, Maine USA, 12-15 June 2018.

Renkawitz, M.D., Sheehan, T.F., Dixon, H.J. and Nygaard, R., 2015. Changing trophic structure and energy dynamics in the Northwest Atlantic: implications for Atlantic salmon feeding at West Greenland. Marine Ecology Progress Series, 538, pp.197-211.

Ruffo, S., and P.M. Kareiva. 2009. Using science to assign value to nature. Frontiers in Ecology and the Environment 7(1): 3-3.

Trinko Lake, T. R., Ravana, K. R., & Saunders, R. (2012). Evaluating changes in diadromous species distributions and habitat accessibility following the Penobscot River Restoration Project. *Marine and Coastal Fisheries, 4*(1), 284-293.

Back Cover: Credit: Nick Hawkins

U.S. Secretary of Commerce
Gina M. Raimondo

Deputy Under Secretary for Operations Performing the duties of Under Secretary of Commerce for Oceans and Atmosphere
Benjamin Friedman

Acting Assistant Administrator for Fisheries
Paul Doremus

MARCH 2021

www.fisheries.noaa.gov

OFFICIAL BUSINESS

National Marine Fisheries Service
1315 East West Highway
Silver Spring, MD 20910