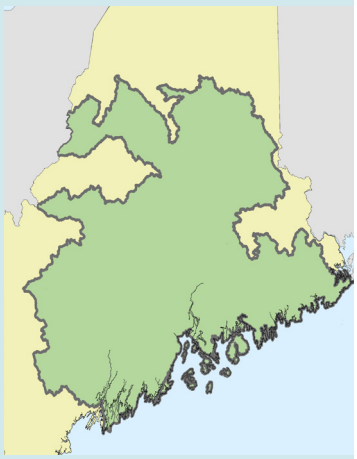
Description of Endangered Species Act (ESA) Listed Atlantic Salmon

The Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon consists of all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, an area that includes the Penobscot and Kennebec Rivers. Protections of the ESA also apply wherever these fish occur, whether in rivers, estuaries, or the marine environment. Hatchery fish used to supplement these natural populations are also included under this listing.

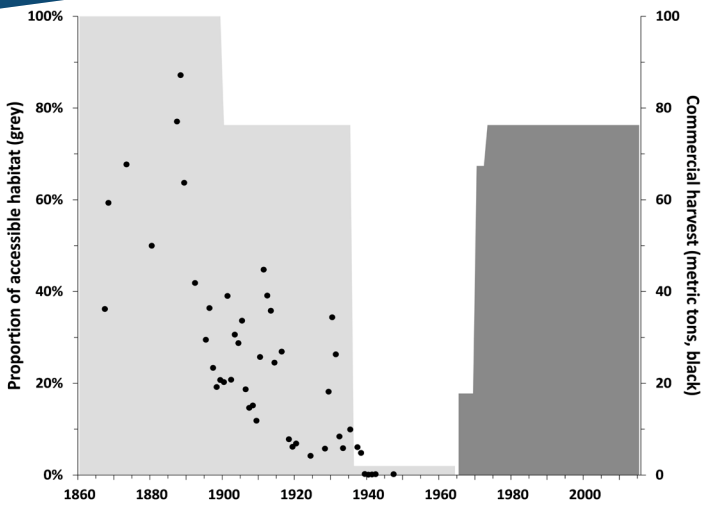


Maine's (yellow shading) freshwater range (green shading) of the Gulf of Maine Distinct Population Segment (GOM DPS) for Atlantic salmon.

What is the NEST?

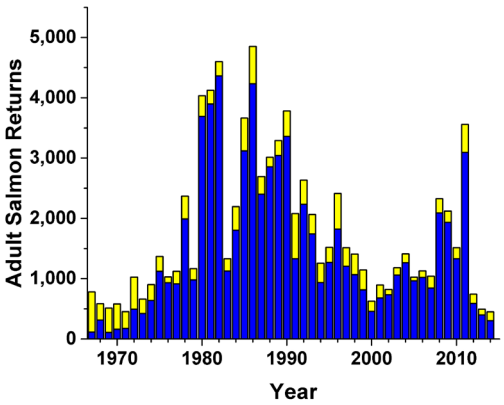
The Northeast Salmon Team (NEST) operates within the Greater Atlantic Region of NOAA's National Marine Fisheries Service (NOAA Fisheries). The NEST's goal is to recover Atlantic salmon populations and the ecosystems upon which their future sustainability depends. NEST is a small team comprised of fisheries managers and scientists based out of the Northeast Fisheries Science Center (NEFSC) and the Greater Atlantic Regional Fisheries Office in MA, and the Maine Field Station in Orono, ME.

Status of Wild Atlantic Salmon

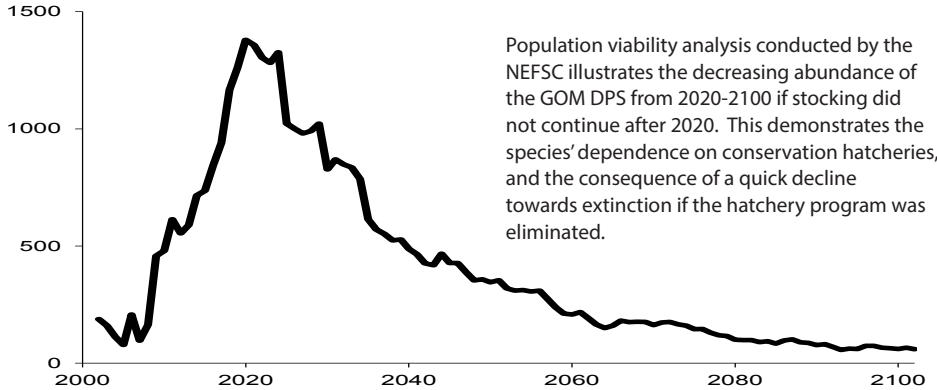


Estimated timeline of habitat loss (light grey) and commercial harvest (black dots) of Atlantic salmon from the Penobscot River, Maine. With the construction of numerous fishways, starting in the mid 1960's, habitat access improved (dark grey).

Historically, US Atlantic salmon ranged from the Canadian border to as far south as Long Island Sound. Currently, the only naturally-spawning populations of US Atlantic salmon are restricted to Maine and collectively form the endangered GOM DPS. These populations are at a very high risk of extinction and are listed as endangered under the Endangered Species Act (ESA). Prior to the turn of the 20th century, commercial harvest in the United States often exceeded 20 metric tons yearly. Dams, overfishing, and pollution led to substantial declines in salmon abundance resulting in the closure of the commercial fishery in 1948. Stocking from hatcheries and habitat improvements helped to rebuild populations to nearly 5,000 adults by 1985. However, modest habitat improvements were offset by a reduction in marine survival that resulted in a further population decline to a low of 628 adults in 2000. With less than 1,000 fish returning to Maine's rivers every year, the continued reliance on hatchery smolts (young Atlantic salmon) is essential. Hatcheries function as living gene banks by conserving the remnants of genetic diversity, with some populations having less than 20 spawners (reproducing adults) each year. Of the 9 stocks in existence at the time of ESA listing, two (Cove Brook and Ducktrap River) had no hatchery supplementation. Cove Brook was declared extirpated in 2011 and the Ducktrap River population has only single digit returns.



Time Series of Atlantic salmon adult returns to Gulf of Maine rivers for hatchery smolts (blue) and naturally-reared recruits (yellow)(1967-2014).



Population viability analysis conducted by the NEFSC illustrates the decreasing abundance of the GOM DPS from 2020-2100 if stocking did not continue after 2020. This demonstrates the species' dependence on conservation hatcheries, and the consequence of a quick decline towards extinction if the hatchery program was eliminated.

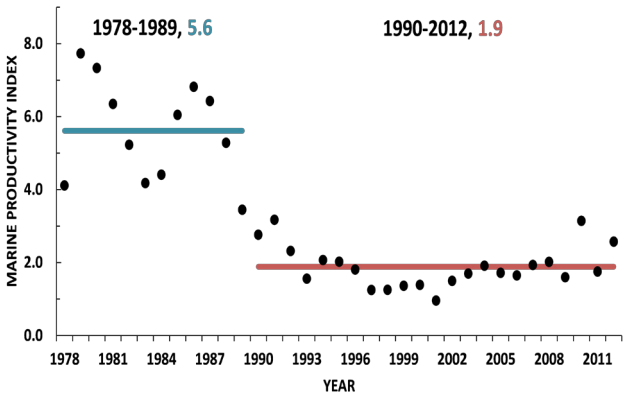
Federal Trust Responsibility

The US government and the governments of Federally recognized American Indian Tribes have a unique government-to-government relationship. Central to this relationship is the federal trust responsibility of the US government. Formal government-to-government consultation, as well as informal coordination and communication, is essential to support NOAA's efforts to fulfill its federal trust responsibility to Federally recognized Tribes. The Passamaquoddy Nation and the Penobscot Indian Nation have lands within the GOM DPS of Atlantic salmon and are critical partners in the conservation and recovery of Atlantic salmon and their associated ecosystems.

Maine Department of Marine Resources Grant

The work of the Maine Department of Marine Resources (ME DMR) Bureau of Sea Run Fish and Habitat is primarily funded by the NOAA-ME DMR Cooperative Agreement that supports the freshwater assessments of Atlantic salmon. This work assesses Atlantic salmon spawning and juvenile abundance, implements recovery actions to increase freshwater production, and strives to restore the diadromous species complex that co-exists with Atlantic salmon.

Threats



Marine productivity index for the GOM DPS. Prior to 1989, approximately 5.6 marine fish resulted from each spawning fish. Post-1990, approximately 1.9 marine fish are produced per spawning fish, as a result of large-scale changes within the North Atlantic Ocean. These changes have also been documented with other marine species, as well as salmon stocks in Europe.

Habitat needs to improve in order to restore freshwater productivity and downstream passage efficiency past barriers to allow as many young salmon as possible to get out to sea. It is also very important to understand and manage marine mortality. Both the Status Review and National Academies of Science review suggest that the two biggest threats to GOM DPS recovery are poor marine survival and dam-related mortality. As illustrated by this graph, a shift occurred in 1990 that resulted in a significant decrease in marine productivity, which greatly increased the difficulties of sustaining the last remaining wild Atlantic salmon in the United States. NEST works towards recovery of the GOM DPS and the restoration of habitat by employing an integrated science-based management approach, where life stage-specific barriers to recovery are addressed through specific management actions.

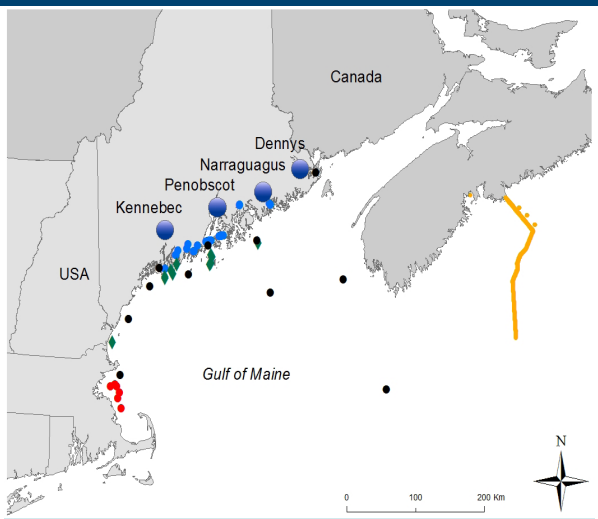
NOAA's Role in an Integrated Program

The GOM DPS is co-managed by NOAA, US Fish and Wildlife Service (USFWS), ME DMR, and the Penobscot Indian Nation (PIN) which represents all of the tribes in Maine. This management structure works cooperatively with stakeholders and other partners. Federal roles are separate but integrated as neither agency has the resources or expertise to address all of the threats to the GOM DPS.

A joint Statement of Cooperation defines roles and responsibilities of the two federal agencies; thereby, avoiding duplication and ensuring efficient and effective federal action. USFWS has responsibility for recovery plan development, conservation hatchery operations, and freshwater section 10 and section 7 implementation under the ESA. Federal agencies are required by section 7 of the ESA to consult with NMFS (or FWS) when actions they fund, authorize or carry out may affect an ESA-listed species. Under section 10 of the ESA, individuals planning to conduct any activity resulting in the "take" of an endangered or threatened species, whether or not deliberate, may be issued a permit to perform that activity. NOAA has responsibility for international management and science, designating critical habitat, minimizing dam impacts, and estuary and marine section 10 and section 7 implementation under the ESA.

To sustain a coordinated program and conserve resources, the partnering agencies developed the Maine Atlantic Salmon Framework. This Framework defines a shared goal of significantly increasing the abundance of wild Atlantic salmon, with fish distributed over a wide geographic range. Necessary to achieving recovery is re-establishing functioning diadromous ecosystems and preserving the GOM DPS's genetic, life history, and morphological diversity. The Framework is implemented by interagency action teams aligned with the following five strategies: (1) increase marine and estuarine survival; (2) increase connectivity; (3) maintain genetic diversity through the conservation hatchery; (4) increase adult spawners through the conservation hatchery; and (5) increase adult spawners through increasing freshwater production.

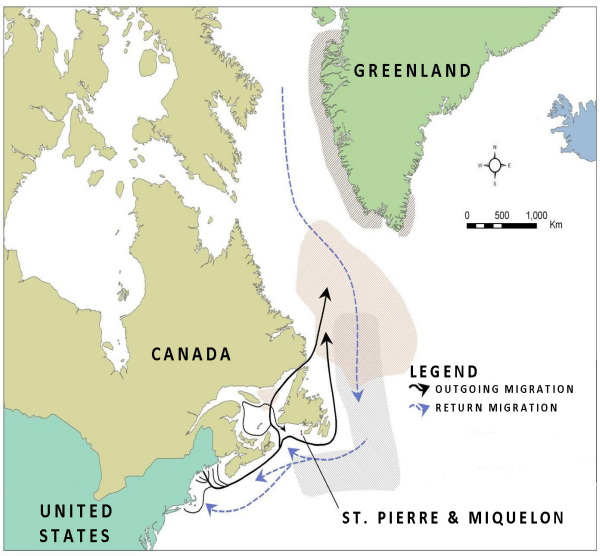
This integrated program is critical to the recovery of the species, as the removal of any one partner from the program will leave a gap that cannot be filled by another. The current program avoids duplication, allows agencies to focus their effort within their own areas of expertise and facilitates fiscal responsibility because no agency could support the entire recovery program alone.



Map of NOAA acoustic receiver locations in multi-unit arrays showing NEFSC estuary and bay networks (large blue circles), individual Gulf of Maine nodes in partnership with Integrated Ocean Observing Systems (black circles), commercial lobster gear (green diamonds), coastal arrays (smaller blue circles), and marine autonomous recording units (red circles). The Ocean Tracking Network's Halifax line is shown with yellow circles.

The Research Vessel Alfred Needler during a collaborative marine survey between NEST and Department of Fisheries and Oceans Canada.

Monitoring Atlantic Salmon in the Marine Environment



Generalized migration routes of Atlantic salmon.

Atlantic salmon spend almost half of their life in the marine environment, but little is known about their marine ecology. Significant declines in GOM DPS marine survival in the North Atlantic have reduced the overall productivity of the species. This may be a result of reduced river-ocean connectivity (dams and other barriers), pollution, overfishing, and other anthropogenic impacts. An integrated science and management approach has worked to identify stage-specific and habitat-specific challenges as young salmon transit mainstem dams and migrate through local estuaries and coastal oceans on their migration to the West Greenland feeding grounds.

Since 1996, NEST monitoring activities in three river systems have estimated the number of young Atlantic salmon (smolts) that are migrating to the sea. These estimates are essential to determining freshwater production for stock assessments. Monitoring also provides a sampling platform for fish health and physiology studies and, since 1997, have provided fish for migration tracking studies.

Telemetry

Collaborative telemetry programs involve salmon and other species (e.g., federally listed Atlantic and shortnose sturgeon) across seven river systems. NEST scientists partnered with numerous domestic and international, federal, university, and non-governmental organizations, including the Ocean Tracking Network, and now have tracking data for salmon migrating from Maine to coastal Nova Scotia and Newfoundland, hundreds of miles away from their natal rivers. Information gained from these activities has been used to determine the optimum timing to prevent smolt loss for projects as diverse as bridge construction and dredging under ESA Section 7 consultations. NOAA funds tagging programs that have provided information to allow near real-time emigration data which provides for increased flexibility in project design and implementation. This has allowed for the conservation of diadromous fish while reducing construction costs.

Tagging

NOAA funded tagging programs have documented GOM DPS catches in Canada and Greenland, and managers continue efforts to reduce risk to GOM DPS populations through the North Atlantic Salmon Conservation Organization. All Atlantic salmon commercial fisheries in Canada have been closed. NEST marine survey programs have studied high-seas Atlantic salmon ecology through numerous collaborative projects in US, Canadian, and International waters.

These tagging and survey program efforts have:

- added greatly to our understanding of marine salmon ecology;
- allowed for suggested improvements for hatchery product development and use;
- identified ecosystem components that may be critical to salmon productivity; and
- provided additional spatial and temporal information supporting Section 7 consultations under the ESA.

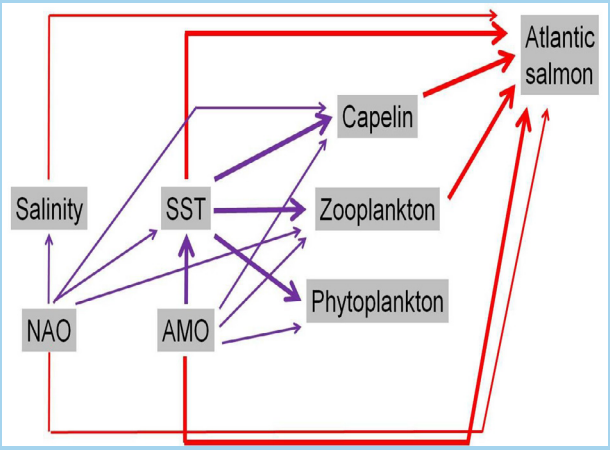
Estuary trawl catch demonstrates the overlap of the diadromous community with Atlantic salmon smolts (red circles) and adult and juvenile river herring (Alosa spp.) captured together during a spring survey.

Atlantic salmon smolts experience high mortality as they migrate through estuaries and transition to life at sea. A better understanding of the nearshore environment that smolts migrate through will inform science-based adaptive management actions to help increase the survival of these migrating fish. The Penobscot Estuary Fish Community Survey was designed to investigate the estuarine and nearshore diadromous community using various methods including: hydro acoustic surveys, pelagic trawl surveys, and water quality sampling.

Sampling Atlantic salmon for sale in Greenland.

Collaborative Partnerships

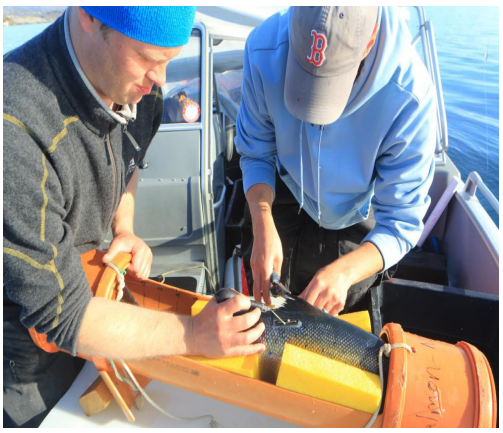
NEST also supports collaborative work with universities and Non-Governmental Organization (NGO) partners. New insights on the migration dynamics of the GOM DPS have been developed as well as an ecosystem view of the mechanisms behind the declines in Atlantic salmon abundance across the Northwest Atlantic. NOAA, collaborating with numerous international partners, has contributed greatly to understanding these broad continental level declines and has proposed specific mechanisms responsible for the declines. This represents a major breakthrough in our understanding of the ocean ecology of salmon and provides us with a basis to develop an indicator system and predictive tools to aid in salmon management into the future.



Ecosystem linkages that affect salmon abundance and productivity can be direct (red), indirect (purple), strong (thick), or weak (thin). Direct climate effects are evident with Atlantic salmon, but these effects appear to be through physical and biological characteristics of the marine ecosystem including salinity, the North Atlantic Oscillation (NAO), Atlantic Multidecadal Oscillation (AMO), sea surface temperature (SST), and food sources like capelin, zooplankton, and phytoplankton.

International Science and Research

As a critical feeding area for salmon from North America and Europe, Greenland waters are vital to global stocks. NEST scientists have been active in maintaining the international sampling program for the West Greenland Atlantic salmon fishery; thereby, providing critical data to support international stock assessment efforts. In addition, NEST scientists have used this sampling program to develop an essential research initiative. NEST scientists are leading both sampling and research in West Greenland. This is an international and cooperative research effort designed to improve our understanding of the migration and distribution of salmon at sea. NEST staff are also involved in satellite tagging and tracking efforts of salmon in Greenland. This generates data on movement patterns, migration behaviors, winter locations, and environmental conditions experienced during return migrations from Greenland to natal rivers.



Tim Sheehan (NOAA Fisheries, right) and Rasmus Nygaard (Greenland Institute of Natural Resources, left) fitting an Atlantic salmon captured off the coast of West Greenland with a pop-off satellite tag.

NOAA Fisheries Role in International Management and Research for Atlantic Salmon

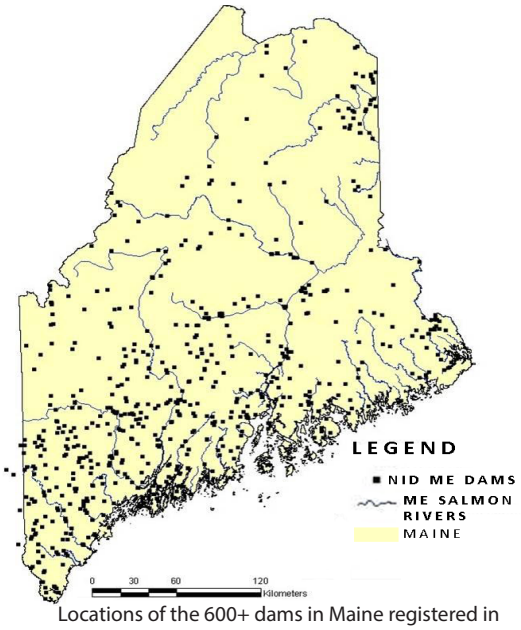
The United States is a signatory to the "Convention for the Conservation of Salmon in the North Atlantic Ocean" which entered into force in October 1983. The Convention created a new inter-governmental organization, the North Atlantic Salmon Conservation Organization (NASCO), to ensure that the burden of Atlantic salmon conservation was shared by both States of Origin and Distant Water Countries. NASCO is a treaty organization formed to promote the conservation, restoration, enhancement, and rational management of salmon stocks in the North Atlantic Ocean through international cooperation. NASCO has six members, which include Norway, the United States, European Union (EU), Canada, the Russia Federation, and Denmark (in respect of the Faroe Islands and Greenland). The United States is represented at NASCO by scientists and managers from NOAA Fisheries, as well as staff from the Department of State, other Federal and non-Federal agencies, and private sector advisors. NOAA's role is to work to reduce impacts to US stocks from distant water fisheries, and seek to hold ourselves and other countries accountable for the protection and conservation of Atlantic salmon.

NEST scientists compile and analyze data on the status of the GOM DPS and take this information to the International Council for the Exploration of the Sea (ICES) Working Group on North Atlantic Salmon. This group takes and analyzes data from throughout the North Atlantic to provide scientific advice to NASCO. NEST scientists coordinate and participate in the international sampling effort for the Greenland internal use-only fishery, which has harvested upwards of 40 mt (88,184 lb) in recent years. The sampling program is supported by cooperation from the Parties of NASCO's West Greenland Commission. The data collected under this program are critical to international stock assessments.

Dams

Dams are identified as a primary threat causing the GOM DPS of Atlantic salmon to be in danger of extinction. Within the GOM DPS, there are 83 Federal Energy Regulatory Commission (FERC) regulated dams and 392 non-FERC dams. Dams negatively impact Atlantic salmon via direct and indirect mortality associated with:

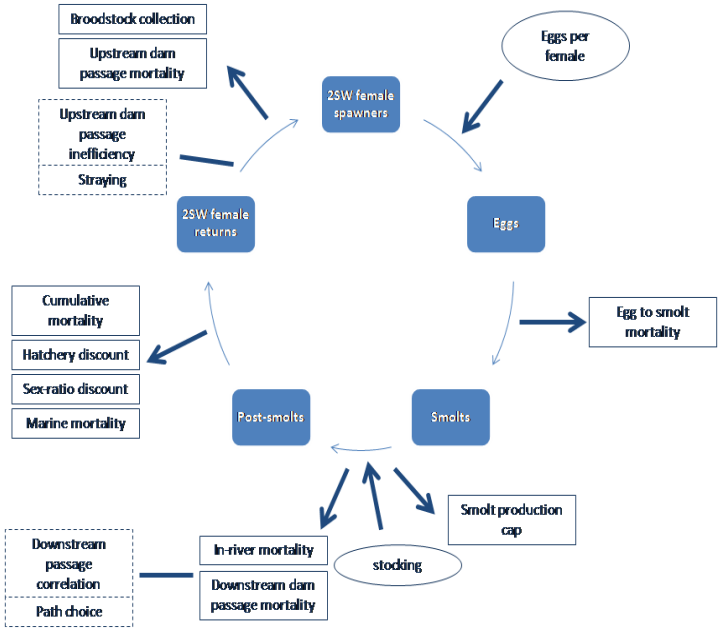
- migrating through or over a dam,
- loss of production habitat from impoundments and inundation,
- altered river hydrology and geomorphology,
- interrupted sediment and debris transport processes,
- altered temperature regimes, and
- altered aquatic community structure and function.



Locations of the 600+ dams in Maine registered in the National Inventory of Dams (NID)(http://geo.usace.army.mil).

NEST has adapted an approach from the NOAA Fisheries' Northwest Region to work with hydro-electric companies to draft species protection plans, which result in amendments to licenses and offer an opportunity for a section 7 consultation under the ESA. Through these consultations, performance standards are imposed, informed by dam impact analysis modeling conducted by the NEFSC.

The Dam Impact Analysis (DIA) model is a population viability analysis that was developed to help better understand the impacts of dams on the production potential of Atlantic salmon. The DIA is integral to the collaborative process that NEST scientists and managers employ to conduct section 7 consultations under the ESA. Model outputs enable quantitative assessments of the risks that dams pose to the recovery of Atlantic salmon and are allowing result-driven performance metrics to be incorporated into the species' protection plans for these FERC re-licensed facilities. A survey of owners of non-FERC dams has been conducted and a General Conservation Plan, under section 10 of the ESA, was developed to provide an efficient and streamlined process for dam owners to remove these barriers. This, coupled with rigorous monitoring programs to assess compliance of performance measures, are providing the strongest protections to the species possible.



Schematic of the processes detailed within the DIA Model. Rounded rectangles indicate life cycle stages, ovals indicate additions to the population, and rectangles indicate subtractions from the population. Dashed rectangles are neither additions or subtractions to the population, but represent dynamics incorporated into the model.

Saving Salmon Together

During a recent dry and warm summer, fishery scientists found nine dead adult Atlantic salmon that had been using the mouth of Meadow Brook, a small Penobscot River tributary, as a thermal refuge. Unfortunately, sedimentation altered the habitat and, at low tide, fish became stranded. Federal and state managers worked with local officials and landowners to rapidly respond to the issue. Together, they planned, permitted, and fixed the problem within days. This combined action saved fish in the short-term and improved refuge habitat for the future.

Before (left) and after (right) images of the Meadow Brook restoration on the Penobscot River, Maine.

Pre- and Post- Dam Removal Monitoring

Dam removal has become an important restoration option for affected rivers. Unfortunately, resources to study the ecological consequences of these actions are limited, resulting in a missed opportunity to learn how affected systems recover after a dam removal. The Penobscot River Restoration Project (PRRP), one of the largest river restoration projects in our nation's history, has resulted in the removal of the lower two dams (removed in 2012 and 2013) and eventual bypassing of a third on the Penobscot River, Maine. This project will greatly improve access to important upper river habitat for ESA listed Atlantic salmon, shortnose and Atlantic sturgeon, as well as American shad, alewife, and six other species of sea-run fish. NOAA is a significant contributor to this effort, and NEST staff have been involved in many different levels of this project, specifically in designing and implementing monitoring activities to evaluate the ecological effects of this large-scale dam removal.

Understanding the effectiveness of a dam removal requires systematic project monitoring and data reporting. NOAA staff oversee numerous monitoring programs evaluating the following:

- fish community structure and function
- passage and survival through impacted areas
- the assemblage of diadromous species
- the transfer of marine derived nutrients
- vertical and horizontal channel adjustments
- sediment grain size distribution changes
- channel configuration changes
- basic water quality
- benthic macroinvertebrate community structure
- wetland and riparian plant communities

NMFS recognizes the importance of documenting the ecological effectiveness of the PRRP, from which we expect large ecological effects and benefits to the American people. NEST staff members are part of a close collaboration with staff from the Penobscot River Restoration Trust and The Nature Conservancy to facilitate and fund nine longitudinal studies that have collected at least two years of "pre-removal data." Six of the nine studies are focused on diadromous fish response, which is a level of fisheries monitoring not matched at a dam removal site anywhere in the country. This level of investment is warranted because the PRRP restores passage and habitat for eleven diadromous species. It is critical that we address these knowledge gaps since all eleven species have reduced populations compared to historical conditions, and some are federally listed under the ESA. Our nine studies, many of which are complimentary, are designed to address many of these research gaps while also evaluating the response of ecosystem components to large-scale restoration.

Removal of the Veazie Dam, Penobscot River, Maine.

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www.nefsc.noaa.gov/salmon