

Program Highlights
Assessment of Gulf of Maine Atlantic Salmon
Data Collection, ESA Assessment to US Atlantic Salmon Assessment Committee

The **Gulf of Maine DPS (GoM DPS)** represents the last naturally spawning stocks of Atlantic salmon in the US, which are managed under an ESA recovery program (Anon 2005). The GoM DPS has been divided into three geographic Salmon Habitat Recovery Units (SHRUs): (i) Downeast Coastal; (ii) Penobscot Bay and (iii) Merrymeeting Bay. Five Downeast Coastal stocks (Dennys, East Machias, Machias, Pleasant, Narraguagus), one Penobscot Bay stocks (Penobscot), and one Merrymeeting Bay stock (Sheepscot) have ongoing hatchery-supplementation programs that use river-specific broodstock. ESA recovery programs using donor stocks are ongoing in the Union, Kennebec, and Androscoggin Rivers. The Ducktrap River stock in the Penobscot Bay SHRU has no hatchery component but a small wild run persists. Conservation hatcheries play a key role in recovery and unfed fry stocking makes up the majority of conservation hatchery inputs to most rivers. In the Penobscot and selected river systems however, smolt stocking is a major contributor that results in returns for broodstock collection and natural spawning. While at low levels, natural reproduction still represents an important element of the management system, and redd surveys both document this contribution and facilitate management of stocked fish to protect naturally spawned offspring. Primary threats to the GoM DPS are dams (Figure 1) and reduced marine survival; information on both of these threats is developed annually in the process of stock assessment. Most Atlantic salmon returning to Maine rivers are actually counted and handled at fish passage facilities associated with 5 mainstem dams located relatively close to the head-of-tide.

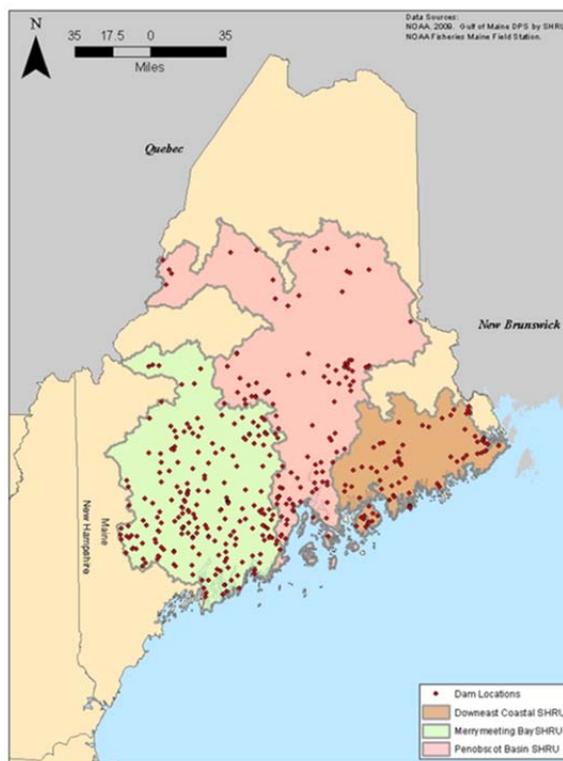


Figure 1. Locations of 460 dams in the GoM DPS historical habitat from Merrymeeting Bay (green), Penobscot Bay (red), and Downeast Coastal (orange).

FIELD DATA COLLECTION AND ARCHIVAL DATABASES

The majority of field survey data for Atlantic salmon in Maine is funded by NOAA Fisheries and collected by Maine’s Division of Sea Run Fish and Habitat in the Department of Marine Resources (DMR). With teams of biologists located in each of the three SHRUs, they tend adult

traps and smolt traps seasonally and conduct electrofishing surveys of parr late in the summer and early autumn and conduct redd surveys in late autumn.

Return Estimates. Atlantic salmon adults returning to Maine rivers are counted using two methods – trap counts and redd counts (Figure 2). Trap counts are a direct census of all fish handled at trapping facilities located on mainstem waters of the Narraguagus, Union, Penobscot, Kennebec, and Androscoggin Rivers. Passage efficiency is not currently taken into account in return estimates. The rationale being that these are minimal estimates of returns and fish passage issues are addressed in other management fora. Redd count are visual surveys of spawning grounds conducted by canoe or on foot. To determine returns from redd counts, a regression equation was developed from trap counts on the Narraguagus, Dennys, and Pleasant rivers. This relationship and associated error bounds are used to estimate returns in all rivers without traps. Redd surveys range in coverage from about 70% to complete spatial coverage. No extrapolation for coverage has been developed to date and as such estimates are considered minimal. Where marine survival estimates can be calculated, there is strong coherence between rivers with trap counts and those with redd counts suggesting both similar marine survival patterns and estimates of management utility given low abundance levels. Efforts to increase coverage and estimation techniques are an ongoing goal of the assessment program. All adult trap count, redd count, and age-structure data is audited for quality control by an interagency data review and then archived in the Maine Atlantic Salmon Information System databases in Microsoft Access.

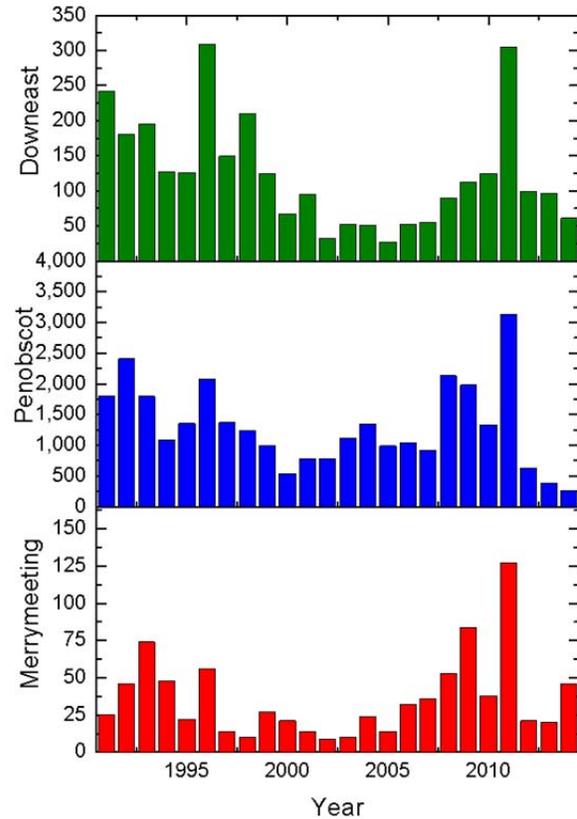


Figure 2. Time series of estimated adult salmon returns to the 3 SHRUs since 1991. Returns are the sum of counts at all traps and estimated returns from redd counts in smaller rivers (note different abundance scales)

Smolt Estimates. NEFSC and DMR have conducted seasonal field activities assessing Atlantic salmon smolt populations using Rotary Screw Traps (RSTs) in selected Maine rivers since 1996. Smolt population assessments are conducted annually using a Darroch maximum likelihood model with either one or two-site mark-recapture techniques are used. Trapping begins in mid to late April depending on ice conditions. The longest time series are for the Narraguagus,

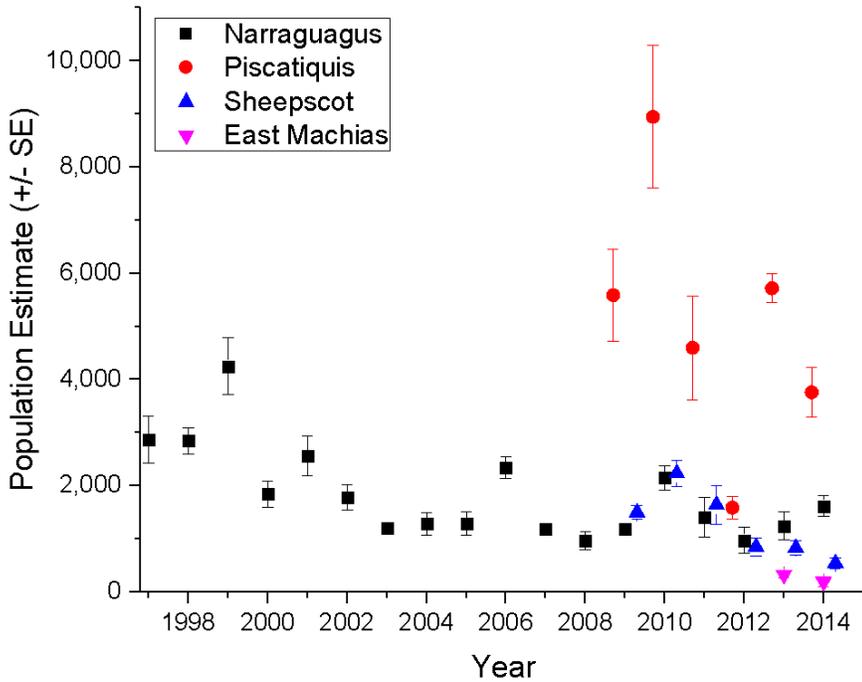


Figure 3. Population Estimates (\pm Std. Error) of emigrating naturally-reared smolts in the Narraguagus, Sheepscot, Piscataquis, and East Machias rivers, Maine, (1997-2014).

Sheepscot, and Piscataquis Rivers, providing an index population in each SHRU. A new smolt monitoring site in the Downeast Coastal SHRU was started in partnership with the NGO the Downeast Salmon Federation in 2013. This site will monitor smolt production that results from a more “nature-like” rearing process that produces fall fingerlings. All smolt estimates in these four rivers are stratified by rearing origin – naturally reared, fall fingerlings, or

smolts. For comparative purposes in this summary, data are presented for naturally reared fish only as these are most comparable and longest time-series (Figure 3).

Estimates suggest these rivers are producing less than the expected 2-3 smolts per unit of rearing habitat. Smolt estimates for other rivers supplement these longer time series and typically track the two primary metrics. Further analysis of smolt population dynamics is ongoing and examines other abundance indices, size and age distributions, and run timing. Because these indices track natural production of smolts, the general coherence in trends indicated that common environmental factors may influence smolt recruitment on a regional basis in many years. Identification of these factors would enhance the ability to predict and understand smolt production dynamics. Analysis of population estimate error rates under current monitoring regimes suggests indicates an 80% chance of detecting a 40% change in smolt production.. Accordingly, since smolt production is about 20-30% of production targets, adequate monitoring is in place to detect achievement. However, efforts are ongoing to improve trap efficiency and continuity. All smolt data is audited for quality control by an interagency data review and then archived in the Maine Atlantic Salmon Information System databases in Microsoft Access.

Parr Estimates. Electrofishing surveys have been used in the GoM DPS since the 1950s. An examination of average densities (# per 100 m² habitat units) from 2008 to 2012 showed

generally higher densities in Gulf of Maine DPS (3.7), relative to Central New England (1.7) and Long Island Sound (1.6) but with substantial inter-annual variability. However, densities in the Gulf of Maine, while still variable, were higher in the past five years and may be trending upward. While insightful, a more thorough examination of these data relative to other factors, such as elevation, temperature, and stocking practices is still needed to provide additional insights into environmental influences and best management practices. Although this index of parr density from the mixed random effects model was useful in examining trends in parr density through time, the index was terminated in 2013. Changes in the overall Connecticut River and Merrimack River programs resulted in many fewer sites being electrofished by state and federal agencies and data to support comparative analysis are no longer collected. Sampling in the Gulf of Maine DPS has shifted to a Generalized Random Tessellated Stratified (GRTS) design. This design incorporates annual fixed site samples as was typically done in the

past and sites that are randomly selected each year based upon stratification according to stream width categories. GRTS sampling requires a single electrofishing sampling pass which decreases the time spent at each site and allows a greater number of sites to be sampled within a given year. The advantage of this design over historic sampling methods is that greater spatial coverage is achieved in a more statistically robust sampling design allowing for better generalization of trends in parr abundance for the GOM DPS as a whole. In future assessments, abundance indices generated from

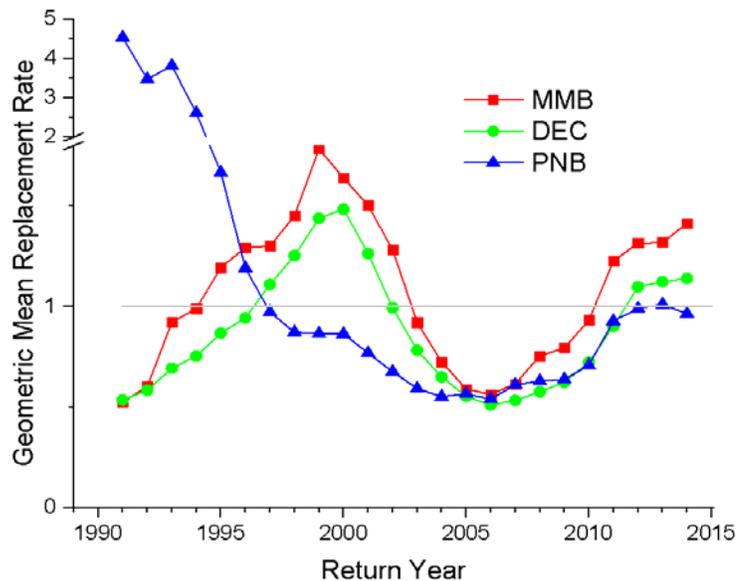


Figure 4. Geometric mean (10-year) of the replacement rate of each SHRU: Merrymeting Bay (MMB), Downeast Coastal (DEC), and Penobscot Bay (PNB)..

the GRTS design will be used to evaluate trends in parr abundance. All juvenile electrofishing data is audited for quality control by an interagency data review and then archived in the Maine Atlantic Salmon Information System databases in Microsoft Access.

The first level of data analysis for GoM DPS data occurs in the **Recovery Framework Stock Assessment Team**, an assessment group of scientists from Maine’s Division of Sea Run Fish and Habitat in the Department of Marine Resources (DMR), NOAA Northeast Fisheries Science Center, and US Fish and Wildlife Service. Analysis of the above status and trends data is

summarized and current year's assessments are evaluated and compared to historic time series. Metrics produced are population size for returning adults and population growth rate. The growth rate is indexed by the 10-year geometric mean of the replacement rate (a 5-year one-generation lag; Figure 4).

The second tier of analysis occurs at the **US Atlantic Salmon Assessment Committee (USASAC)**, a team of state and federal biologists tasked with compiling data on the species throughout New England and reporting population status. Currently, population status of all US salmon management areas is determined by incorporating GoM DPS assessments with those of other states to produce a US assessment. In addition to adult census, the USASAC is continuing its efforts to develop metrics to examine juvenile production of large parr (pre-smolts), abundance estimates of emigrating smolts, and marine survival metrics for monitored populations. Information related to other aspects of Atlantic salmon ecology and restoration is also reviewed by the USASAC and compiled within their annual report. The annual report serves three primary purposes: (i) provides an annual archive and assessment of Atlantic salmon population status, data and restoration efforts for the US, (ii) compiles US Atlantic salmon population status and data for input into international stock assessment effort through the International Council for the Exploration of the Seas' Working Group on North Atlantic Salmon and (iii) information the US Delegation to the North Atlantic Salmon Conservation Organization (NASCO) as to the status of US Atlantic salmon populations prior to the NASCO annual meeting where regulatory measures are negotiated for mixed-stock fisheries in the North Atlantic.