# Collaborative Management Strategy for the Gulf of Maine Distinct Population Segment of Atlantic Salmon

2022 REPORT OF 2021 ACTIVITIES

# Chapter 1 Introduction

The Final Atlantic salmon recovery plan was released in 2019. The final plan incorporates the strategies and many of the associated actions that were developed through the Atlantic salmon framework process that was established in 2011. It also details recovery goals, objectives and criteria needed for recovery, with three Salmon Habitat Recovery Units (SHRUs) representing the spatial scale of recovery (Merrymeeting Bay, Penobscot Bay and Downeast Coastal SHRUs.) Each SHRU is expected to meet certain criteria before a down listing or delisting decision can be made.

In the fall of 2018 we initiated an internal review of the framework process aimed at aligning our governance structure with the Recovery Plan and addressing the challenges associated with communications and decision making. Ultimately, this review resulted in what is now called the Collaborative Management Strategy (CMS). The fundamental purpose of the CMS is to:

- Provide clarity on roles and responsibilities
- Provide clarity on where decisions are made
- Increase the speed of decision making
- Increase accountability and transparency
- Incorporate external partners

The CMS recognizes that the path to recovery in each of the SHRUs may be different based on land use patterns, habitat conditions, and the relative degree to which the specific threats identified in the recovery plan occur across the landscape. Therefore, the intent of the structure is to empower the different SHRU committees to coordinate recovery efforts in their geographic region. The SHRU teams are responsible for planning, coordinating and tracking recovery efforts in each SHRU; as well as developing and maintaining work plans that incorporate goals, priorities and actions, including stocking recommendations. Additionally, they are tasked with developing annual reports that describe progress towards meeting recovery goals. The 2020annual reports are contained within this annual report.

While the SHRU teams coordinate the recovery strategy in their respective regions, the implementation team (IT), which includes the management board, their support staff, and the SHRU chairs, ensures vertical and horizontal communications across SHRUs, across agencies, with the Tribe, and among leadership. The IT provides a venue for collaboration and communication on substantive issues that affect the program as a whole, or affect another agencies' ability to carry out its programs.

The CMS envisions that committees (ad hoc or standing) will be established that will conduct specific tasks geared towards providing essential information necessary for the Implementation Team to make informed decisions in respect to the direction of the program. The management board authorizes and sets the charge for committees, and each committee is guided by a terms-of-reference. In 2020, the management board determined that they would not stand up any additional standing committees until after the pilot year review. Therefore, only one standing

committee has been established to review studies associated with FERC projects in the GOM DPS. The annual report from this committee is included in this report (Attachment 1).

This report includes four sections. The first is a high-level summary of the status of the GOM DPS of Atlantic salmon in relation to the reclassification and delisting criteria laid out in the 2019 recovery plan. The remaining three sections provide additional information at the SHRU level, and are developed by the SHRU coordinating committees with significant input from stakeholders in their respective SHRUs.

# Chapter 2 GOM DPS Annual Summary

As detailed in the 2019 Final Recovery Plan, in order for the listing status of Atlantic salmon to change, each of the relevant biological criteria must be met in two (downlisting) or three (delisting) of the recovery units.

The biological criteria for reclassifying (downlisting) the GOM DPS of Atlantic salmon from endangered status to threatened status are:

1. ***Abundance:*** 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 2 of the 3 SHRUs having a minimum annual escapement of 500 naturally reared adults.

2. ***Productivity:*** Among the SHRUs that have met or exceeded the abundance criterion, the population has a positive mean growth rate greater than 1.0 in the 10-year (two-generation) period preceding reclassification.

3. ***Habitat:*** In each of the SHRUs where the abundance and productivity criterion 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.

The biological criteria for removing Atlantic salmon from the endangered species list are:

1. ***Abundance*****:** 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.

2. ***Productivity:*** Each SHRU has a positive mean population growth rate of greater than 1.0 in the 10-year (two-generation) period preceding delisting. *In addition,* 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.

3. ***Habitat:*** 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.

In the below sections, we summarize the return data and habitat accessibility data from 2019 in reference to the reclassification and delisting criteria.

## Abundance

In 2021, 676 prespawn salmon returned to the GOM DPS, of which 160 were wild or naturally reared (Table 2-1). Of the total, approximately 11% returned to the Downeast Coastal SHRU; 83% returned to the Penobscot Bay SHRU; and 6% returned to the Merrymeeting Bay SHRU. Of the 160 wild or naturally reared adults returning to the GOM, 57% returned to the Penobscot, 23% returned to the Downeast, and 20% returned to the Merrymeeting Bay. Although the

proportion of the total run that was naturally reared (24%) was higher than what has been seen on average over the last decade (21%), the total abundance of returning salmon was below the 10-year average (Table 2-2), (Figure 2-1). Regardless, the abundance of wild and naturally reared returns remain well below what is needed for either reclassification or delisting (Table 2-3).

*Table 2-1. Summary of adult returns for the GOM DPS in 2021 by SHRU. These numbers represent trap counts when available and redd based estimates of returns to the remaining rivers. Determination of origin is based on proration of adults at traps, smolts from corresponding cohort or primary lifestage stocked.*

| SHRU | Total Returns | Hatchery | Wild/naturally reared |
|---|---|---|---|
| Downeast Coastal | 74 | 37 | 37 |
| Merrymeeting Bay | 41 | 9 | 32 |
| Penobscot Bay | 561 | 470 | 91 |
| ***Total*** | ***676*** | ***516*** | ***160*** |

*Table 2-2. The 10-year average number (2012-2021) of adult returns to the GOM DPS by SHRU*

| SHRU | Total Returns | Hatchery | Wild/naturally reared |
|---|---|---|---|
| Downeast Coastal | 108 | 51 | 57 |
| Merrymeeting Bay | 46 | 10 | 36 |
| Penobscot Bay | 736 | 638 | 98 |
| ***Total*** | ***890*** | ***699*** | ***191*** |

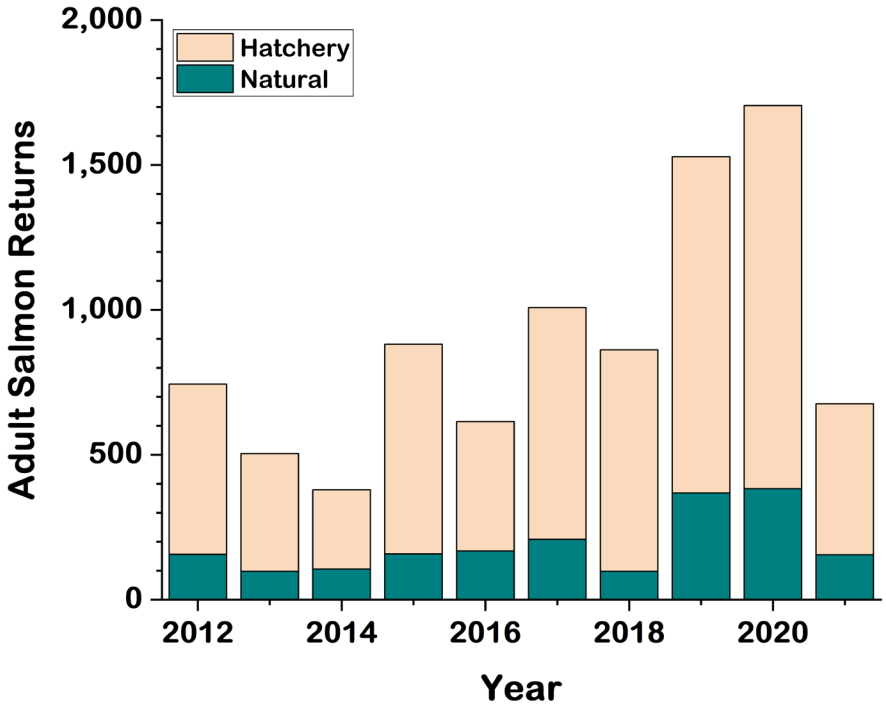


*Figure 2-1. Adult returns of Atlantic salmon from 2012 to 2021. Blue shaded area represents naturally reared origin salmon (wild, egg stocked or fry stocked). Pink shaded areas indicate hatchery origin salmon (fall parr, smolt, adult).*

*Table 2-3. The average number (2012-2021) of wild or naturally-reared returns to each SHRU in relation to the reclassification and delisting goals described in the 2019 Recovery Plan.*

| SHRU | Wild/natural reared returns (average) | % of Downlisting goal | % of Delisting goal |
|---|---|---|---|
| Downeast Coastal | 57 | 11.4% | 2.9% |
| Merrymeeting Bay | 36 | 7.2% | 1.8% |
| Penobscot Bay | 98 | 19.6% | 4.9% |

## Productivity

In 2021, the 10-year geometric mean population growth rate for the GOM DPS was 0.96 (95% CL 0.57 – 1.61), making it the first year since 2011 that the mean rate did not exceed 1.0 (Figure 2-2). The reclassification and delisting productivity criteria require that *each SHRU* sustain a geometric mean replacement rate of more than 1.0, in addition to meeting the relevant abundance criteria. As indicated above, no SHRU meets the abundance criteria. In 2021 the population growth rate was met in the Merrymeeting Bay SHRU, but not in either of the other two SHRUs. For more information, refer to the enclosed SHRU reports.

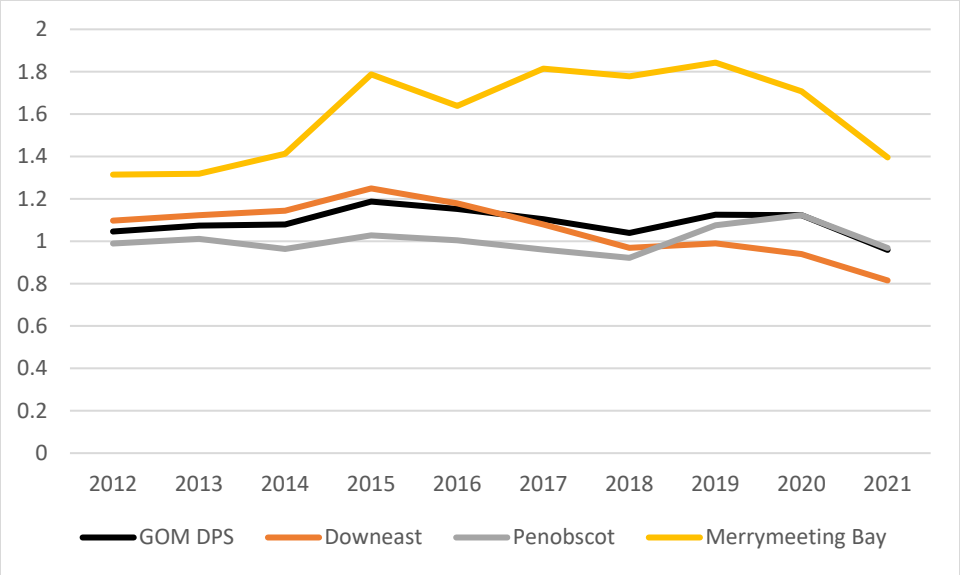


*Figure 2-2. Replacement rate of naturally-reared salmon in the GOM DPS and all three SHRUs from 2012 to 2021.*

## Habitat

In 2021, a minimum of 34 connectivity projects were conducted that improved access to 56 stream miles (Table 2-4). Not all of these improvements occurred in watersheds that are currently accessible to Atlantic salmon due to other passage obstructions downstream. For instance, a project located on a tributary that is upstream of an impassable dam will not make the habitat accessible to salmon in the context of our recovery criteria until the downstream barriers have been addressed. However, these types of projects will be critical for achieving the criteria once the downstream barriers have been made accessible.

*Table 2-4. The number of connectivity projects (culverts and dams) that have been reported in the SHRU annual reports for 2021, and the cumulative amount of stream habitat miles where access has been improved.*

| SHRU | Projects Reported | Stream Miles |
|---|---|---|
| Merrymeeting Bay | 5 | 7 |
| Penobscot Bay | 24 | 27 |
| Downeast Coastal | 5 | 22 |
| GOM DPS | 34 | 56 |

In years past, we have reported on the estimated total number of suitable and accessible habitat units. However, it has become apparent that our estimates of accessibility and suitability require considerable refinement. As we reported "accessibility" in previous reports, we did not fully factor in the effects of road-stream crossings, which are a considerable barrier to fish passage in many instances. Thus, the estimates we made were overly optimistic. Additional spatial analyses are needed before we can make a reliable estimate of the number of accessible habitat units in the three SHRUs. In addition, considerable uncertainty remains on what constitutes "suitable" habitat. The way we have done this in the past relies on simply estimating the number

of habitat units from the existing habitat model produced by Wright et al. (2008). Greater attention toward defining what constitutes "suitable" habitat is needed before we can make a reliable estimate of the number of suitable habitat units.

As described in the Final Recovery Plan (2019), the life history of the Atlantic salmon requires a high degree of access between freshwater, estuarine, and marine environments, and sufficiently suitable natural habitats must be available to support wild populations. Habitat access is categorized as: (1) Habitat with No Access, (2) Habitat with Impeded Access, (3) Habitat that is Accessible, and (4) Habitat that is Fully Accessible.

To ensure the long-term sustainability of wild populations, there must be sufficient access to suitable habitat to support spawning and juvenile rearing. Ultimately, returning adults will dictate the actual amount of habitat needed, however, the minimum amount of suitable habitat that must be accessible to returning adults to achieve delisting criteria is 30,000 Habitat Units per SHRU. Figure 2-3 shows areas within designated critical habitat that are unimpeded by dams. Currently, none of the FERC-licensed dams meet the minimum passage criteria necessary for upstream habitats to be considered "accessible" according to the definitions in the Final Recovery Plan.

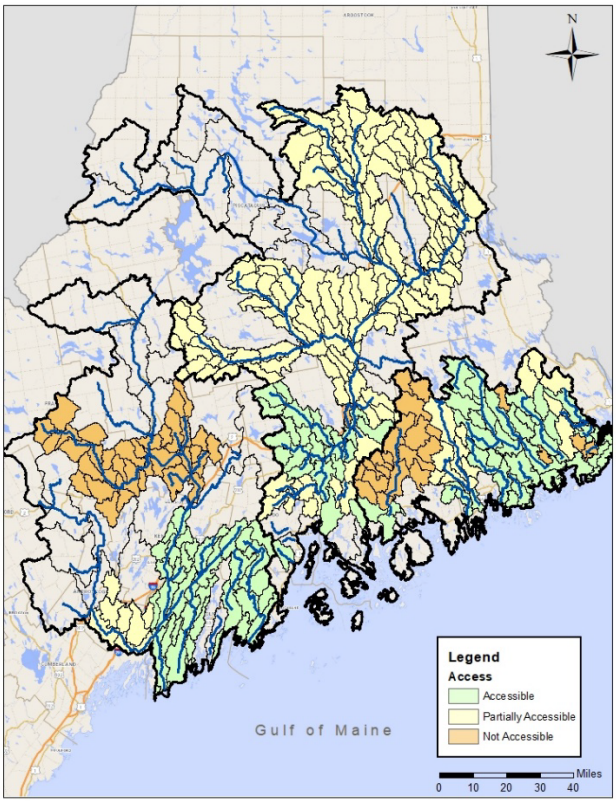


*Figure 2-3. Watersheds that have been determined to be accessible in 2021. Accessible watersheds have no mainstem dams, or else have dams that have fishways that have been evaluated and determined to be highly effective. The habitat in these watersheds meet our recovery criteria for accessibility. Partially accessible watersheds are above dams that have fishways that have yet to be evaluated. Not accessible watersheds are above dams that do not have swim through fishways. Watersheds above impassable dams where adult salmon are trucked are not considered accessible in terms of recovery. This map does not consider the effect of road stream crossings.*

# Chapter 3 Annual Report for the Downeast Recovery Unit – Calendar year 2021 activities

This report summarizes progress toward achievement of recovery goals for the Downeast Salmon Habitat Recovery Unit (Downeast SHRU) in 2021.

## Abundance and population trends

Naturally and hatchery reared adult returns of Atlantic salmon to the Downeast SHRU for 2021 (74) were much lower than 2020 (194; Figure 3-1). The naturally reared (NR) adult-to-adult replacement rate in 2021 was 0.90. This is a decrease from the NR adult-to adult replacement for 2020 that was estimated to be 1.27 (Figure 3-2.). The 10-year geometric mean of NR adult-to-adult replacement is estimated at 0.81 (0.51 – 1.30). The percentage of the SHRU management objective, 2000 was 1.85%. The adult return information and replacement rate presented below is from the work of the U.S. Atlantic Salmon Assessment Committee (USASAC 2022); therefore, the definition of "naturally reared" salmon does not include adults resulting from parr and/or smolt stocking.

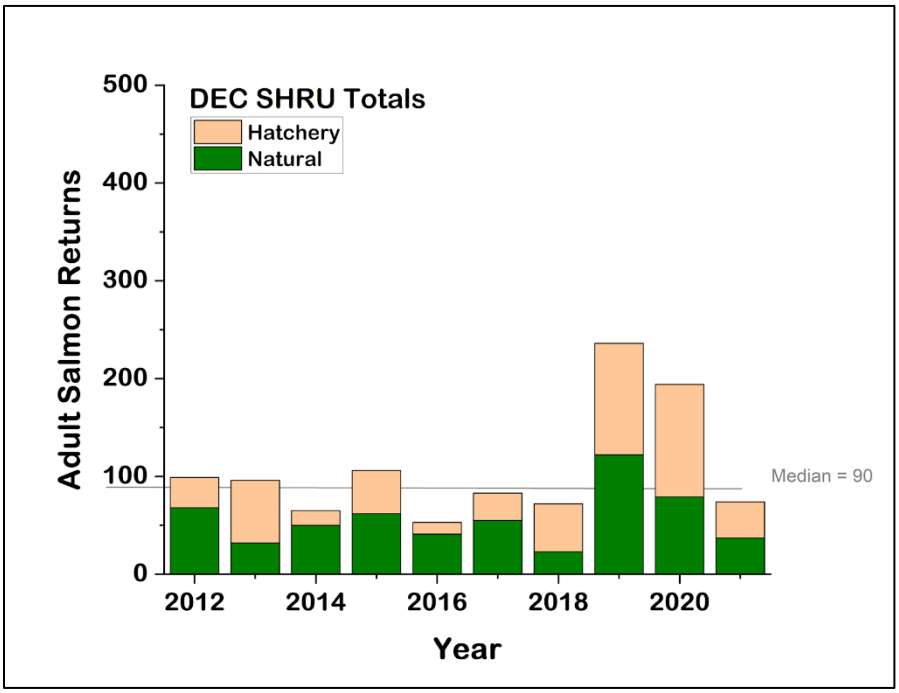


*Figure 3-1. Adult returns of Atlantic salmon from 2012 to 2021. Green shaded area represents naturally reared origin salmon (redd, egg, or fry). Tan shaded area indicates hatchery-origin salmon (fall parr, smolt, adult; USASAC 2022). The term "DEC SHRU" refers to the Downeast SHRU.*

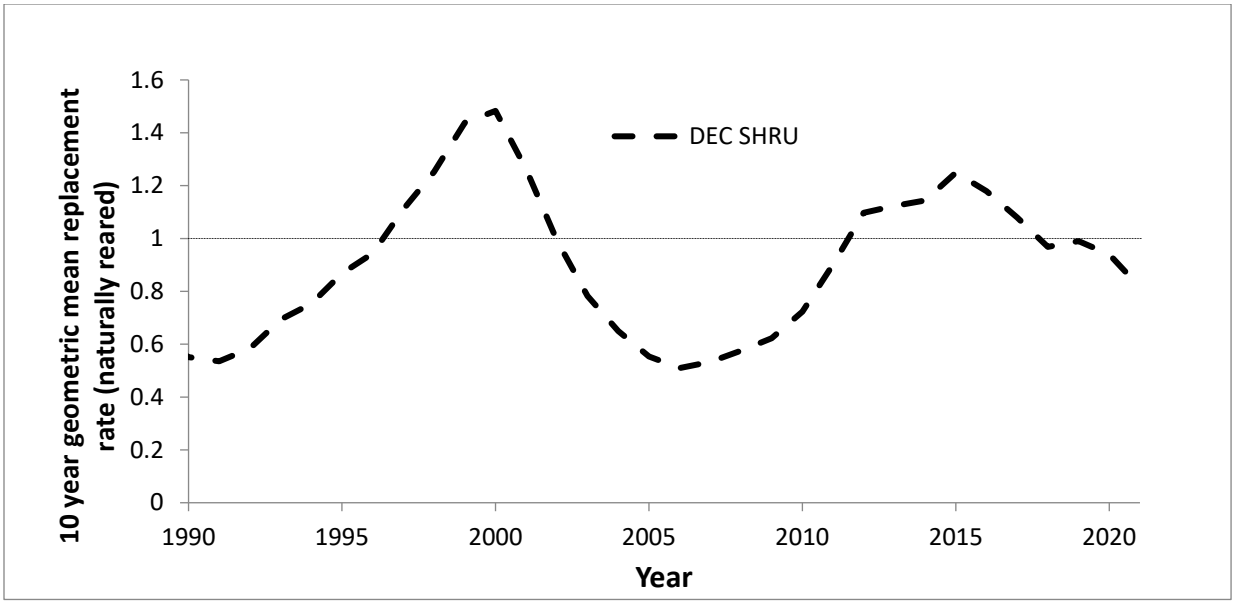


*Figure 3-2. Replacement rate of naturally reared salmon in the Downeast SHRU from 2011 to 2020. Solid horizontal reference line indicates a spawner-to-spawner replacement rate of 1 based on a 5-year lifecycle (USASAC 2022). The term "DEC" refers to the Downeast SHRU.*

*Table 3-1. Summary of adult returns for the Downeast SHRU in 2021. These numbers represent trap count from the Narraguagus and Union Rivers and redd-based estimates of returns to the remaining rivers. Determination of origin is based on proration of adults at traps, smolts from corresponding cohort or primary lifestage stocked.*

| River | Adult returns | % Naturally reared | % Hatchery origin |
|---|---|---|---|
| Union | 0 | NA | NA |
| Narraguagus | 25 | 24% | 76% |
| Pleasant | 14 | 100% | 0% |
| East Machias | 19 | 5% | 95% |
| Machias | 16 | 100% | 0% |
| Dennys | 0 | NA | NA |

## Spatial Distribution

In previous years, the coordinating committee for the Downeast SHRU has reported the number of suitable and accessible habitat units. However, it has become apparent that estimates of accessibility and suitability require considerable refinement. As "accessibility" was described in previous reports the effects of road-stream crossings, which are a considerable barrier to fish passage in many instances, were not factored in. Thus, the accessibility estimates made were overly optimistic. Additional spatial analyses are needed before a reliable estimate of the number of accessible habitat units in the Downeast SHRU can be made.

In addition, considerable uncertainty remains on what constitutes "suitable" habitat. Previous calculations of suitability relied on simple estimates of the number of habitat units from the existing habitat model produced by Wright et al. (2009). Greater attention toward defining what is truly "suitable" habitat is needed before a reliable estimate of the number of suitable habitat units exist in the Downeast SHRU can be made.

Contemporary spatial distribution of Atlantic salmon in the Downeast SHRU is closely correlated with stocking activities since abundance levels are so low. A total of 1,914,978 salmon were stocked into the Downeast SHRU in 2021 (Table 3-2). Of these, the majority were stocked as fry (1,068,000) or eyed eggs (544,000). The Peter Gray Hatchery has increased their production capacity and can now provide age 0+ parr for the Narraguagus River in addition to the East Machias.

*Table 3-2. Summary of salmon stocked in the Downeast SHRU by river in 2021.*

| River | Life stage | Number |
|---|---|---|
| Union | Fry | 1,000 |
| Narraguagus | Eyed egg | 283,000 |
| | Fry | 280,000 |
| | Parr | 113,000 |
| Pleasant | Eyed egg | 178,000 |
| | Fry | 165,000 |
| Machias | Eyed egg | 40,000 |
| | Fry | 290,000 |
| | Parr | 17,000 |
| East Machias | Fry | 19,000 |
| | Parr | 172,000 |
| Dennys | Eyed egg | 43,000 |
| | Fry | 313,000 |

Captive spent (post-spawn) adult broodstock were also released in the Downeast SHRU in 2021: Dennys, 196; East Machias, 218; Machias, 181; Narraguagus, 172; Pleasant, 212. However, as these fish are unlikely to contribute to future generations they are not included in estimates of occupancy.

One way to visually represent spatial distribution is with occupancy maps. While still at only modest occupancy, the Downeast SHRU has a generally broad distribution of juveniles in the Dennys, East Machias, Machias, Narraguagus, and Pleasant Rivers (Figure 3-3).

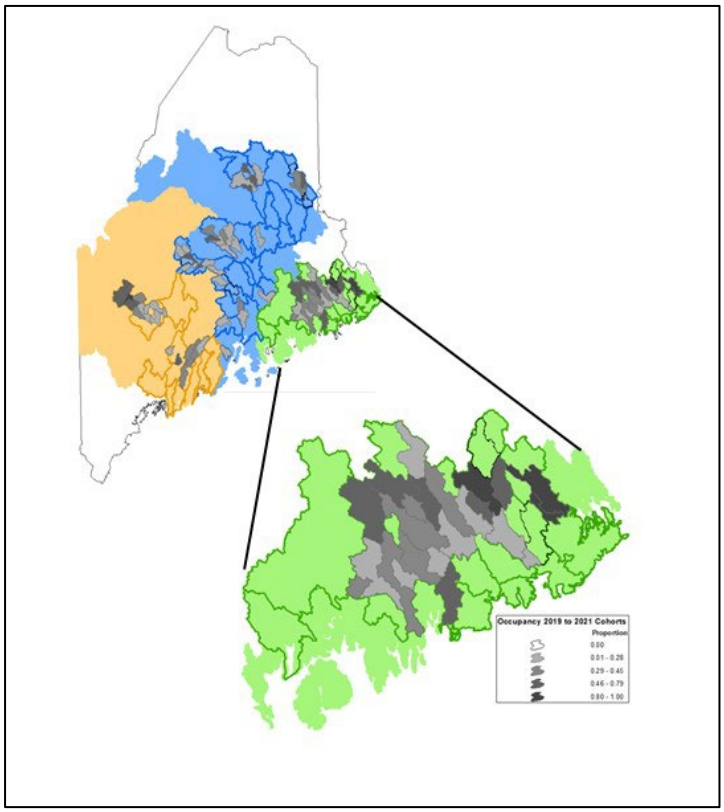


*Figure 3-3. Mean occupancy across three cohorts (2019 to 2021) as of December of 2021 that will contribute to 2022 smolt production in the Downeast SHRU. Occupancy is the ratio of rearing habitat occupied by at least one salmon to the estimated rearing habitat.*

Barriers to fish passage continue to limit the spatial distribution of Atlantic salmon in the Downeast SHRU to some extent. For example, the Cherryfield Dam in the Narraguagus River and the remnants of the fishway at Saco Falls in the Pleasant River limit fish passage. Thus, reconnecting 30,000 units of suitable habitat remains a top priority in the Downeast SHRU. However, fish passage barriers are much less common in the Downeast SHRU in comparison to other SHRUs. In particular, many improvements at road-stream crossings have been completed throughout much of the Downeast SHRU largely through collaboration and partnerships involving Project SHARE, DSF, The Nature Conservancy in Maine, many municipalities, and the Maine Department of Transportation. In 2021, there were five projects that were completed that improved connectivity in the Downeast SHRU (Table 3-3). The primary projects involved in these projects were DSF, Project SHARE, Maine Department of Transportation, and the Maine Department of Marine Resources.

*Table 3-3. Summary of fish passage projects completed in the Downeast SHRU in 2021.*

| River | Project name | Passage improvement type (fully accessible vs accessible vs partially accessible*) | Stream miles made accessible (according to RP criteria) | Lake/pond acres made accessible |
|---|---|---|---|---|
| Union | Half Mile Pond Brook | Accessible | None, but 5.5 miles of upstream habitat with improved access | |
| Narraguagus | Schoodic Brook | Accessible | None, but 10.0 miles of upstream habitat with improved access | |
| Dennys | Meddybemps Powerhouse removal | Accessible | 0.1 miles of upstream habitat with improved access | Improved access to 6765 acres (Meddybemps Lake) |
| Dennys | Curry Brook | Accessible | 3.9 miles of improved access to upstream habitat | |
| Dennys | Preston Stream | Accessible | 2.0 miles of improved access to upstream habitat | |

** To be considered fully accessible, the habitat above the project must be consistent with the criteria in part 2f of the final recovery plan.*

## Diversity

For each broodstock within the Downeast SHRU, a target of 200 parr to collect and retain for broodstock use was implemented starting with the 2017 collection year. Results below represent the mean number of alleles per locus (based on 18 microsatellite loci) for each population, measured within the most recent collection of parr for broodstock (in this case, the 2019 collection) (Figure 3.1). Allelic diversity (Figure 3.1) of the five broodstocks in the Downeast SHRU remain relatively stable over the time period measured. Estimates of allelic diversity are slightly above average (Dennys), or slightly below average (East Machias, Machias, Narraguagus, and Pleasant) but within the range of previous variation. Continued monitoring of estimates of genetic diversity is very important as the Downeast SHRU contains

five of seven river-specific Atlantic salmon broodstocks remaining in the United States. More detailed summaries of genetic diversity are found in the USASAC report.

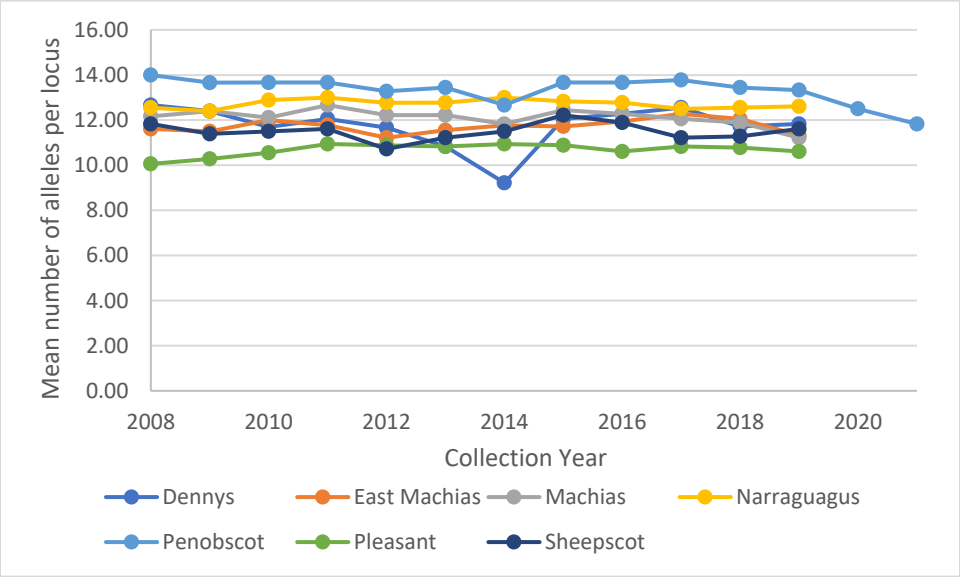


*Figure 3-4. Graph of the mean number of alleles per locus for the five Downeast SHRU broodstocks, based on parr collected annually for broodstock collection surveys from 2008 to 2018. Also included are allelic diversity estimates for the other captively-spawned Atlantic salmon broodstocks for reference. Because the Penobscot broodstock is obtained from returning adults, there is a two- year difference in collection time due to the life stage being collected (adults versus parr). For all broodstocks, results represent the mean number of alleles per locus (based on 18 microsatellite loci) for the parr broodstock collected annually.*

## Emerging issues and priorities

Collaboration on restoring connectivity and ecological conditions in the Narraguagus River will remain a top priority in 2022. The work being done in the Narraguagus is an encouraging example of collaboration among diverse groups hoping to advance salmon recovery. In the lower Narraguagus, progress on the feasibility of improving fish passage at the Cherryfield Dam (i.e., Stillwater Dam) occurred in 2021; much of this work was facilitated by the Downeast Salmon Federation. This work is critical because the Cherryfield Dam is the only remaining mainstem dam on the Narraguagus River and the only mainstem dam on any river containing river-specific salmon in the Downeast SHRU. Once improvements are made at that site, Atlantic salmon and the full suite of diadromous fish will hopefully have full access to the entire Narraguagus River. Further upstream, Project SHARE has developed a habitat restoration program that has already restored connectivity in the upper Narraguagus and is now enhancing suitability of rearing habitat and restoring natural stream processes in the focus areas by adding instream complexity using wood and boulders.

Other ongoing priorities for our efforts to recover Atlantic salmon and the ecosystem upon which they depend include:

- The DSF will continue to raise Narraguagus-origin salmon 0+ parr at the Peter Gray Hatchery with funding and support from the U.S. Fish and Wildlife Service.

- The future of the Ellsworth Dam in the Union River remains uncertain as the Department of Environmental Protection denied the water quality certification for the facility. Such certification is required for the Federal Energy Regulatory Commission to issue a new license.
- The Maine Department of Transportation continues to evaluate that future of the Machias Dyke Bridge. This affords opportunities to re-evaluate the project purpose and need as well as to reconsider a larger range of alternatives including alternatives with improved fish passage and habitat conditions.

## Stakeholder input

The following section is input solicited from some of the primary partners involved in Atlantic salmon recovery efforts in the Downeast SHRU. The input is provided directly from each organization.

Maine Coast Heritage Trust – Jacob van de Sande and Bob Deforrest

Maine Coast Heritage Trust (MCHT) is a statewide land trust that works on land protection in coastal Maine. Our work on salmon habitat restoration focuses on the Narraguagus River and Orange River, though we partner on projects throughout the Downeast SHRU. All of our work is undertaken in collaboration with partners including DSF, USFWS, Project SHARE, MIFW, DMR, TNC, NOAA, and others. A primary focus of our rivers work is on riparian land protection to maintain natural buffers on rivers and stream and protect cold-water inputs.

In 2021, the MCHT partnered to complete two riparian protection projects in the Narraguagus River watershed: an 85-acre project on the main stem with DSF, and TNC's purchase of the Spring River Narraguagus project, which includes over 12,000 acres of forests and riparian habitat along the West Branch. MCHT continues working with partners to assess options for improved fish passage at the Cherryfield Ice Control Dam. A study completed by the Cold Regions Research and Engineering Lab in 2021 provides the necessary groundwork to begin a multi-stakeholder discussion of fish passage options. MCHT also continues to support Project SHARE habitat restoration work in the upper watershed, and large wood additions along the main stem.

In the Orange River watershed, MCHT continues to work with DSF, the Town of Whiting, MIFW and other partners to assess fish passage options at three dams that are current barriers to fish passage. Restoring fish passage would re-connect hundreds of acres of alewife habitat, significantly enhancing the availability of forage fish in Whiting and Cobscook Bay. In 2021, MCHT also completed two land protection projects that protect over 240 acres of forests and wetland within the watershed and enhance recreational access. An additional 715-acre project adjacent to Moosehorn National Wildlife Refuge closed in early 2022.

In addition to work in those two watersheds, MCHT is also involved in efforts to restore fish passage on the Middle River (Machias) and the West Branch of the Pleasant (Addison). We continue to coordinate with partners to move those projects forward.

## Work plan for the next calendar year

- Finalize connectivity priority maps for the Downeast SHRU

    - On April 7, 2022, the Downeast coordinating committee hosted a virtual workshop on connectivity in the Downeast SHRU. The main goals of the workshop were to (1) review recent progress on connectivity and (2) exchange information related to the development of updating priorities for future work related to enhancing connectivity in the Downeast SHRU. The meeting was well attended by various stakeholder groups and other collaborators. Following the workshop, the coordinating committee will be updating the priority maps for connectivity improvements in hopes they are useful in generating support for progress toward enhanced connectivity in our salmon rivers of Downeast Maine.
- Cherryfield Dam
    - Work will continue improving fish passage at the Cherryfield Dam that partially obstructs the Narraguagus River. Work includes a study into the feasibility of alternate structures that will satisfy the U.S. Army Corps of Engineers' need to manage ice damage at the same time improving upstream and downstream passage for all diadromous species.
- Habitat complexity Project at Route 9
    - Located just downstream of the Route 9 crossing of the Narraguagus River above Beddington Lake. Project SHARE will be conducting an intensive stream rehabilitation project involving mechanized equipment. This work aims to add sinuosity and structure to a 200meter reach.
- 0+ parr stocking in the Narraguagus River
    - The Downeast SHRU committee supported a proposal that river-specific parr (age 0+) raised at the Peter Gray Parr Hatchery be stocked in the Narraguagus River. The DSF has acquired permits and funding that will allow them to continue to raise parr for the Narraguagus.
- Wrap up work at Meddybemps Powerhouse Removal
    - This year work will continue with in stream work aimed at improving fish passage past the old dam. Weir pools and structure will be added to rehabilitate passage at this spot.
- Improve fish passage at Saco Falls in the Pleasant River
    - The planning process is under way to restore full fish passage at Saco Falls. At certain flows, passage is possible through the falls but due to human caused changes, access is limited. The goals are to evaluate alternatives including rebuilding the existing fishway and with hopes of having designs and planning done in 2022.

## List of Reports and Publications resulting from Projects within SHRU

- Lombard, P. J., R.W. Dudley, M.J. Collins, R. Saunders, and E. Atkinson. 2021. Model estimated baseflow for streams with endangered Atlantic Salmon in Maine, USA. River Research and Applications 37:1254-1264.

## References

USASAC (United States Atlantic Salmon Assessment Committee). 2022. Annual Report of the U.S. Atlantic Salmon Assessment Committee Report No. 34 -2021 Activities. United States Atlantic Salmon Assessment Committee.

Wright, J., J. Sweka, A. Abbott, and T. Trinko. 2009. GIS-Based Atlantic Salmon Habitat Model In: Biological valuation of Atlantic salmon habitat within the Gulf of Maine Distinct Population Segment. Appendix C, NOAA's National Marine Fisheries Service, Gloucester, Ma.

# Chapter 4 Annual Report for the Penobscot Recovery Unit – Calendar year 2021 activities

This report summarizes progress toward achievement of recovery goals for the Penobscot Salmon Habitat Recovery Unit (Penobscot SHRU) in 2021.

## Summary of adult returns and redd counts for the previous year (abundance and population trends)

The number of returns to the Penobscot SHRU in 2021 was 561 (91 naturally reared and 470 hatchery origin); the lowest since 2016 (Table 4-1). All documented returns were at the Milford Trap. No returns were documented in lower river tributaries or Cove Brook, though redd count surveys were limited. Neither the 2021 naturally reared returns nor the 10 year average of naturally reared returns met the minimum abundance criterion of 500 needed for downlisting from endangered to threatened (USFWS and NMFS 2018). However, over the last 10 years the trend in both hatchery and naturally reared returns continues to slightly increase. The proportional contribution of hatchery fish to the returning adults in the Penobscot SHRU remains high (86.7%).

The 10 year geometric mean replacement rate for the Penobscot SHRU is now slightly less than 1 (mean replacement rate was 0.97 (Range 0.47 – 2.02); down from being slightly more than 1 in 2020 (Figure 4-2). A minimum 10 year geometric mean replacement rate of greater than 1 is needed for downlisting from endangered to threatened. As part of the reclassification criteria, additional parameters specific to habitat accessibility are also required.

The broodstock collection targets of 400 (200 females, 170 males and 30 grilse), established in 2020, was maintained in 2021. Despite this target, only 147 broodstock were collected. CBNFH capped the number of broodstock per day at 40 to facilitate disease sample processing [see *Infectious Salmonid Anemia Monitoring* below], although the highest number of fish captured in a single day did not exceed 20. In addition, no collections were made on weekends or holidays. Broodstock collections were initiated on May 18$^{th}$, and concluded on July 26$^{th}$. Of the 147 adults collected two were removed prior to acceptance into the broodstock population [see *Infectious Salmonid Anemia Monitoring* below] and three died of natural causes prior to spawning.

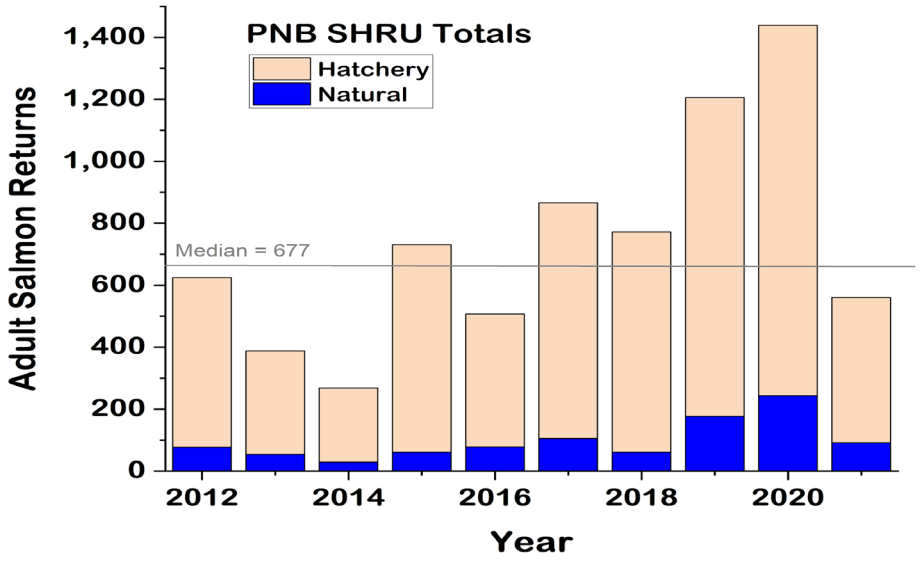


*Figure 4-1. Graph of adult returns for the last 10 years (from 2012 to 2021).*

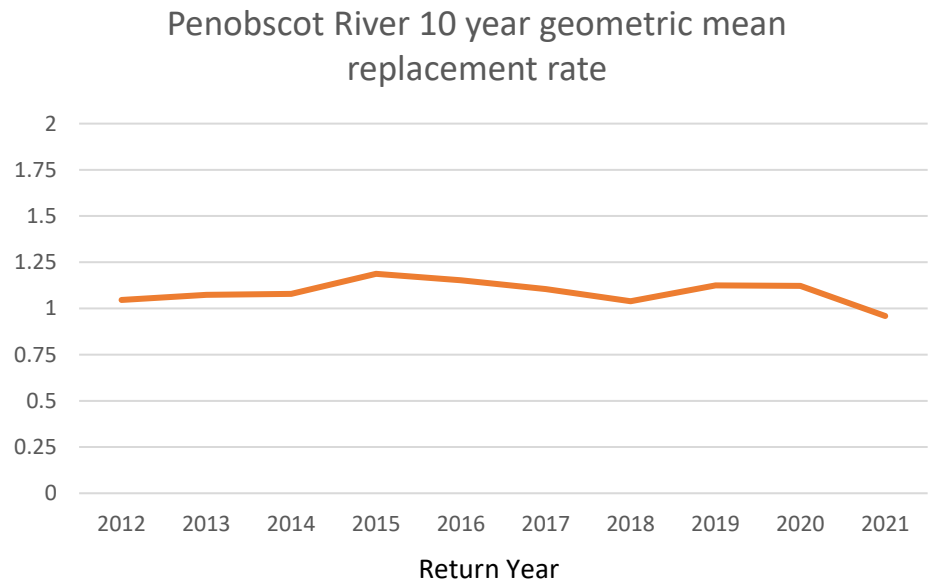


*Figure 4-2. The 10 year geometric mean replacement rate for the Penobscot SHRU from 2012 to 2021. For 2021 the replacement rate was 0.96. The replacement rate reflects only naturally reared Atlantic salmon, and the average replacement rate for naturally reared fish in the Penobscot SHRU*

*Table 4-1. The number of returns to the Penobscot SHRU and their origin (hatchery or naturally reared) between 2012 and 2021.*

| Return Year | Number hatchery reared | Number of naturally reared |
|---|---|---|
| 2012 | 547 | 77 |
| 2013 | 334 | 54 |
| 2014 | 239 | 29 |
| 2015 | 670 | 61 |
| 2016 | 429 | 78 |
| 2017 | 761 | 105 |
| 2018 | 711 | 61 |
| 2019 | 1028 | 177 |
| 2020 | 1196 | 243 |
| 2021 | 470 | 91 |

*Table 4-2. Summary of adult returns for the Penobscot SHRU. (Table 5.1.1 from USASAC 2022)*

| River | Adult returns | # Naturally reared | # Smolt stocked |
|---|---|---|---|
| Cove Brook | 0 | | |
| Ducktrap | 0 | | |
| Penobscot (Above Milford) | 561 | 91 | 470 |
| Kenduskeag | 0 | | |
| Souadabscook | 0 | | |

## Spatial Distribution

Spatial distribution of Atlantic salmon in the Penobscot SHRU is relative to habitat connectivity and natural spawning, as well as areas that are stocked. Occupancy of unstocked habitats are determined through redd count surveys and electro-fishing. Given the size of the Penobscot SHRU, not all areas are surveyed so the information below only provides an estimate of occupancy based on the best available information.

## Connectivity

In years past, we have reported on the estimated total number of suitable and accessible habitat units. However, it has become apparent that our estimates of accessibility and suitability require considerable refinement. As we reported "accessibility" in previous reports, we did not fully factor in the effects of road-stream crossings which are a considerable barrier to fish passage in many instances. Thus, the estimates we made were overly optimistic. Additional spatial analyses are needed before we can make a reliable estimate of the number of accessible habitat units in the Penobscot SHRU. In addition, considerable uncertainty remains on what constitutes "suitable" habitat. The way we have done this in the past relies on simply estimating the number of habitat units from the existing habitat model produced by Wright et al. (2008). Greater attention toward defining what is truly "suitable" habitat is needed before we can make a reliable estimate of the number of suitable habitat units exist in the Penobscot SHRU.

As described in the Final Recovery Plan (2018), the life history of the Atlantic salmon requires a high degree of access between freshwater, estuarine, and marine environments, and sufficiently suitable natural habitats must be available to support wild populations. Habitat access is categorized as: (1) Habitat with No Access, (2) Habitat with Impeded Access, (3) Habitat that is Accessible, and (4) Habitat that is Fully Accessible.

To ensure the long-term sustainability of wild populations, there must be sufficient access to suitable habitat to support spawning and juvenile rearing. Ultimately, returning adults will dictate the actual amount of habitat needed. But the minimum amount of suitable habitat that must be accessible to returning adults to achieve delisting criteria is 30,000 Habitat Units per SHRU. Figure 4-1 shows areas within designated critical habitat that are unimpeded by dams. Currently, none of the FERC license dams meet the minimum passage criteria necessary for upstream habitats to be considered "accessible" according to the definitions in the Final Recovery Plan.

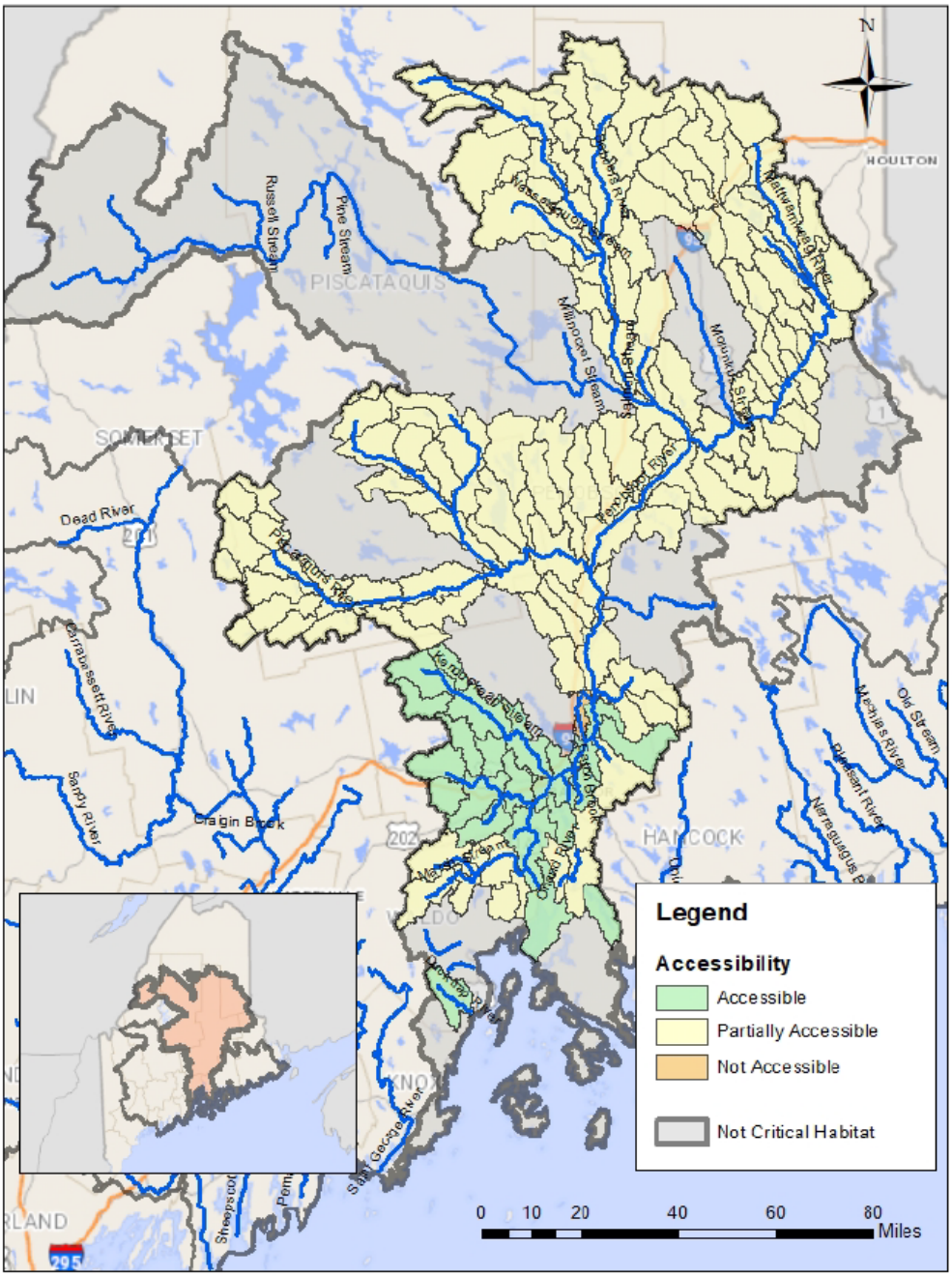


*Figure 4-3. Map of habitat within designated Critical Habitat that is unimpeded by Dams. This does not fully account for habitats blocked or impeded by culverts.*

***The Final Recovery Plan (2018) provides definitions for habitat accessibility**:*
***Habitat with Impeded Access (partially accessible):** Habitat above a barrier that temporarily blocks or impairs a salmon's natural ability to pass (e.g., a culvert or dam with a fishway with limited function).*

***Habitat that is Accessible:** At a minimum, the habitat must allow for movement of parr that seek out suitable habitats for feeding and sheltering, downstream movements of smolts during the spring migration, and upstream and downstream movement of adults that seek out habitats for spawning and resting. To meet this standard, habitat must be either: (1) Accessible above a dam with upstream and downstream passage that does not preclude recovery, or (2) accessible above road stream crossings set at the correct elevation using the Stream Simulation methodology.*

***Habitat that is Fully Accessible:** Habitat where there is no artificial barrier between it and the ocean*

## 2021 Connectivity Projects

In the Penobscot SHRU there are approximately 125 dams and 2,284 road stream crossings that are barriers or potential barriers to Atlantic salmon. In respect to dams, since 2000, there has been at least 5 dam removals and 14 fishway projects (including rock ramp projects) aimed at improving passage for sea-run fish. In 2021, 23 road crossing projects and 1 nature-like fishway project improved habitat access to approximately 27 stream miles, 221 acres of lakes, and 544 units of salmon habitat (Table 4-3).

*Table 4-3. Summary of fish passage projects completed in 2021. In 2021, 24 connectivity projects improved access to 30 stream miles and 221 acres of lakes. The total Atlantic salmon habitat units made accessible according to Recovery Plan criteria in 2021 was 554 units. Partners involved include: Appalachian Mountain Club, The Nature Conservancy, Natural Resource Conservation Service, Katahdin Woods and Water, Maine Audubon, Maine Inland Fisheries and Wildlife.*

| HUC 10 Name | Project Type | Most limiting Barrier downstream (if known) | Stream Miles Opened | Lake area opened (acres) | Salmon habitat units upstream to next barrier |
|---|---|---|---|---|---|
| Sebec River | culvert to bridge | no access | 0.73 | 0 | 0 |
| Pleasant River | culvert to bridge | Impeded Access | 1.42 | 0 | 61 |
| Pleasant River | culvert to bridge | Impeded Access | 1.03 | 0 | 58 |
| Pleasant River | culvert to bridge | Impeded Access | 1.15 | 0 | 59 |
| Pleasant River | culvert to bridge | Impeded Access | 0.69 | 0 | 42 |
| Pleasant River | culvert to bridge | Impeded Access | 1.00 | 0 | 66 |
| Pleasant River | culvert to bridge | Impeded Access | 2.59 | 0 | 212 |
| Pleasant River | culvert to bridge | Impeded Access | 0.14 | 0 | 8 |
| Pleasant River | culvert to bridge | Impeded Access | 0.41 | 0 | 23 |
| Seboeis River | culvert to arch | Impeded Access | 0.25 | 0 | * |

| | | | | | |
|---|---|---|---|---|---|
| Seboeis River | culvert to arch | Impeded Access | 0.25 | 0 | * |
| Middle East Branch Penobscot River | culvert to bridge | Impeded Access | 1.65 | 0 | 29 |
| Middle East Branch Penobscot River | failed bridge to bridge | Impeded Access | 2.2 | 0 | 67 |
| Lower East Branch Penobscot River | culvert to arch | Impeded Access | 0.25 | 0 | * |
| Lower East Branch Penobscot River | culvert to bridge | Impeded Access | 1.86 | 0 | 65 |
| Middle Piscataquis River | culvert to bridge | no access | 0.8 | 0 | 6 |
| Upper Piscataquis | culvert to bridge | Impeded Access | 1.76 | 0 | 150 |
| Bagaduce River | Remnant Dam to Nature like fishway | Accessible | 0 | 66 | 0 |
| Bagaduce River | Culvert Replacement | Accessible | 5.5 | 155 | |
| West Branch Mattawamkeag | Culvert replacement | Partially Accessible | 0.16 | 0 | 5 |
| Upper Piscataquis | culvert replacements | Partially Accessible | 0.1 | 0 | 0.3 |

| | | | | | |
|---|---|---|---|---|---|
| Upper Piscataquis | culvert replacements | Partially Accessible | 1.03 | 0 | 10 |
| Upper Piscataquis | culvert replacements | Partially Accessible | 0.94 | 0 | 0 |
| Marsh River | Culvert Replacement | Accessible | 1.08 | 0 | 0 |

## Estimates of Occupancy

The U.S. Atlantic Salmon Assessment Committee (USASAC) estimated December 2021 mean proportion occupancy attributed to stocking of juveniles and documented natural reproduction for each of the 3 SHRUs at a HUC-12 resolution (*see* USASAC 2022, Figure 2.4.1.2). While the three SHRUs vary in size and number of HUC-12 units, the amount of occupied juvenile rearing area is typically around 8,800 to 13,600 units of habitat in each SHRU. The Penobscot SHRU with 148 HUC-12 areas had cohort occupancy of between 10,300 and 18,400 units for the 3 cohorts in 22 areas (15%) where these 3 cohorts had a proportion occupancy above 0.01 (Figure 4-4).

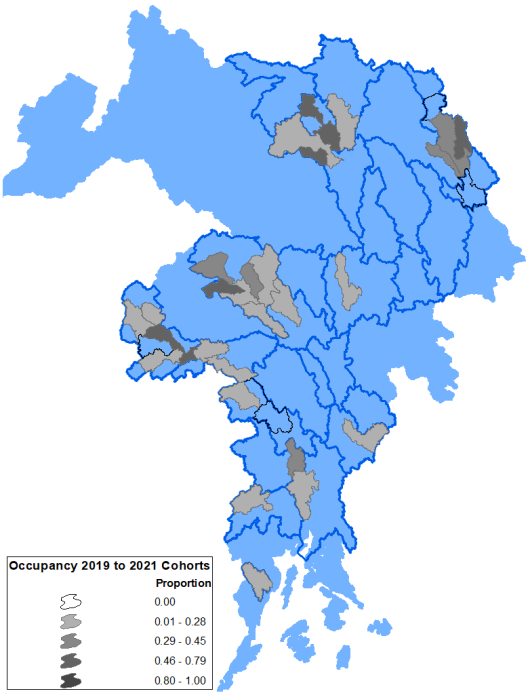


*Figure 4-4. Map for mean occupancy across the 2019 to 2021 cohorts as of December 2021. This does not include the 2022 cohort from last fall's wild spawning. Taking the mean across these three cohorts ties to potential sources of smolts for 2022. Also, the proportion is the total amount of habitat that has at least one salmon, divided by the total available rearing habitat based on the Wright et al. (2008) Salmon habitat model.*

## Stocking

In 2021, approximately 1.3 million Atlantic salmon of various lifestages (eggs, fry, parr and smolts) were stocked into the Penobscot SHRU (Table 4-4).

**Eggs:** 306,000 eggs were planted in January and February in the Piscataquis, Kenduskeag and Marsh Stream drainages. Egg planting targeted areas with no natural spawning, based on spawning surveys conducted the previous fall, and areas where fry would not be stocked. These eggs were from Green Lake National Fish Hatchery's (NFH) age 4 domestic broodstock.

**Fry:** 239,000 fry were stocked in late April and early May, indicative of an early spring, into the East Branch Mattawamkeag and mainstem Piscataquis rivers by canoe and other locations by foot. The fry were reared at Craig Brook NFH from eggs produced by Green Lake NFH's age 4 domestic broodstock. In addition, there were a few sea-run origin fry from eggs that remained at Craig Brook NFH.

**Parr:** Green Lake NFH stocked 112,000 Penobscot River origin age 0 parr. These parr were stocked in the Pleasant, East Branch Pleasant, West Branch Pleasant, and Piscataquis rivers on September 28, 29 and 30 of 2021. Green Lake NFH also transferred 108,000 Penobscot River origin age 0 parr to Nashua NFH as part of a smolt program for the Merrymeeting Bay SHRU.

**Smolts:** Green Lake NFH stocked 620,500 Penobscot River origin age 1 smolts into the Penobscot River downstream of the Milford Dam and French Island from Sandy Point Road. Smolt stocking began on April 12, 2021 and ended on April 27, 2021. Green Lake NFH transferred just over 5,000 Penobscot River origin age 1 smolts to the University of Maine Cooperative Center for Aquaculture Research for the Maine Department of Marine Resources' Salmon for Maine Rivers marine rearing project. Green Lake NFH also provide 100 Penobscot River origin age 1 smolts to the Maine Cooperative Fish and Wildlife Research Unit at the University of Maine, Orono for research.

*Table 4-4. Summary of salmon stocked by river in 2021 in the Penobscot SHRU.*

| River | Eggs | Fry | Parr | Smolt |
|---|---|---|---|---|
| Mainstem Penobscot | | | | 620,500 |
| Middle Branch Pleasant River | 89,000 | | | |
| West Branch Pleasant River | | | 74,500 | |
| West Branch Piscataquis River | 39,500 | | | |

| | | | | |
|---|---|---|---|---|
| Mainstem Piscataquis River | 98,000 | 107,500 | 37,500 | |
| Kingsbury Stream | | 32,500 | | |
| Kenduskeag Stream | 49,500 | | | |
| Marsh Stream | 30,000 | | | |
| East Branch Mattawamkeag | | 99,000 | | |
| **Total** | **306,000** | **239,000** | **112,000** | **620,500** |

## Diversity

Of the six river-specific broodstocks maintained for the DPS Atlantic salmon populations, the Penobscot River broodstock represents the largest number of individuals spawned and estimates of genetic diversity are higher than any of the other six broodstocks. In 2021, estimates of allelic diversity in the sea-run broodstock decreased in comparison to previous years; the average number of alleles per locus in the 2021 Penobscot broodstock was 11.83 (Figure 4-5). This decrease was likely due to the low number of broodstock collected due to the decreased number of returning adults. In 2021, 147 Atlantic salmon were collected in 2021 for the Penobscot River broodstock. Other metrics of genetic diversity such as estimates of effective population size also decreased from previous years ($N_e$=358.8) and was below the 10-year average observed between 2009 and 2021 (average $N_e$=439.1). More detailed summaries of genetic diversity are found in the USASAC report. Continued monitoring of estimates of genetic diversity is very important as the Penobscot SHRU contains the largest number of returning adults in any of the Maine populations, and it represents the largest river-specific Atlantic salmon broodstock remaining in the United States.

Table 4-5 shows the proportion of returns to the Penobscot relative to sea-age as well as naturally reared returns. Mixing across year classes is an important element of diversity for Atlantic salmon.

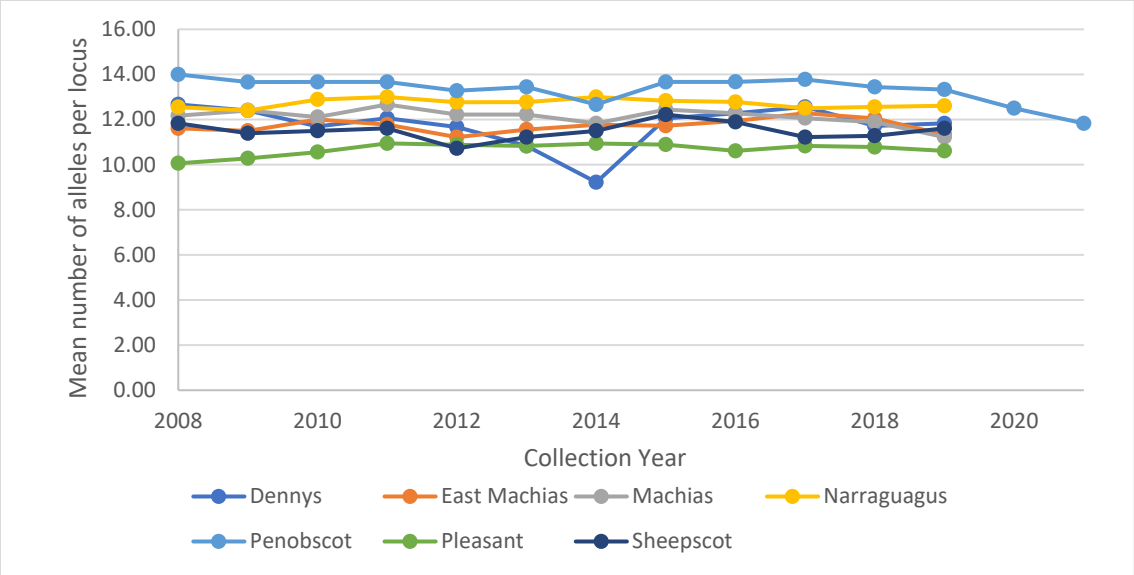


*Figure 4-5 Graph of the mean number of alleles per locus for the sea-run Penobscot River broodstock based on the adults sampled at Milford Dam for transport to Craig Brook National Fish Hatchery from 2008 to 2021. Also included are allelic diversity estimates for the other captively-spawned Atlantic salmon broodstocks for reference. Because the Penobscot broodstock is obtained from returning adults, there is a two- year difference in collection time due to the life stage being collected (adults versus parr). For all broodstocks, results represent the mean number of alleles per locus (based on 18 microsatellite loci) for the sea-run broodstock collected annually.*

*Table 4-5. Life history attributes from adult returns in the Penobscot in 2021 including age class distribution and percent naturally reared.*

| River | %1SW | %2SW | %3SW | %Repeat spawners | % naturally reared |
|---|---|---|---|---|---|
| Penobscot | 36.8% | 61.1% | 1.2% | 0.7% | 16.2% |

## Emerging issues and priorities

In 2020, the Management Board requested each SHRU provide "must-do" projects that were of priority for the upcoming year. In developing the Penobscot SHRU work plan, six Keystone Issues were identified among the multiple actions within the work plan that were of highest priority for the Penobscot SHRU team. In 2022, though we have retained the original 6 keystone actions we have modified our list of keystone actions to account for all ongoing and upcoming FERC relicensing's and ESA consultations. The current keystone actions are as follows:

1. **Comprehensive Marking Program:** The Penobscot SHRU Team is continuing to explore the feasibility of implementing a basin-wide marking program such that hatchery origin fish and project specific fish (e.g. Salmon for Maine's Rivers fish) can be easily distinguished from naturally reared returns. Marking of fish is a priority to account for the returns and escapement of naturally reared and wild origin spawners that contribute towards downlisting and delisting criteria.
2. **Piscataquis River:** The Penobscot SHRU Team continues to prioritize recovery efforts in the Piscataquis River sub-basin aimed at increasing escapement and natural reproduction in the Piscataquis River. Increasing access into the Piscataquis was a focus of the Penobscot River Restoration Project and remains a priority for the Penobscot SHRU team given the abundance of high quality habitat in the basin. Increased focus will be on addressing fish passage at three dams on the Piscataquis and increasing escapement of Piscataquis origin adult returns.
3. **Salmon for Maine's Rivers:** Although the Salmon for Maine's Rivers project in the East Branch Penobscot River has encountered some setbacks, the project remains a priority for the SHRU Team to encourage that sufficient resources are provided to support assessment and monitoring needed to gauge project effects and its utility towards supporting recovery efforts.
4. **Stocking Plan:** The Penobscot SHRU Team is working to complete a stocking plan for the Penobscot SHRU. The plan aims to align stocking efforts with the goals and priorities set forth by the Penobscot SHRU Team.
5. **Lower River Tributaries:** The Penobscot SHRU Team agreed to give greater attention to the coastal streams and lower Penobscot River tributaries recognizing that these areas are not impacted by hydro-electric dams and they may provide our best opportunity to further recovery until passage issues at mainstem dams are resolved.
6. **FERC Actions:** All ongoing or upcoming (anticipated to commence in 2022) hydro-relicensing's and ESA Consultations on dams in the Penobscot SHRU are a priority for the Penobscot SHRU. We prioritize this work to emphasize connectivity as a priority and to highlight the importance that all project operations aim to avoid any ecosystem impacts (which includes ensuring passage for all native species), and any impacts that may hamper or preclude Atlantic salmon recovery efforts. Below is a list of ongoing or upcoming FERC related actions:

   <u>FERC relicensing's (Federal Power Act)</u>:

   - West Enfield (Mainstem)
   - Pumpkin Hill (Passadumkeag River)
   - Ripogenus and Penobscot Mills Dams (West Branch Penobscot)

ESA consultations/re-initiations

- Milford (Mainstem) (re-initiation for failing to achieve performance standards related to delay)
- Browns Mills (Piscataquis)
- Mattagamon (Pending future developments)

## Stakeholder input (contributions provided by AMC, TU, ASF)

**Piscataquis River**

We are pleased to see that increasing Atlantic salmon escapement and natural reproduction in the Piscataquis River is a keystone issue in the Penobscot SHRU 5-year Work Plan. The Piscataquis is critically important for the recovery of Atlantic salmon and the inadequate fish passage at the three dams on the mainstem needs to be resolved. In addition to addressing this long-standing threat, there are significant opportunities in the Piscataquis for large-scale land conservation that would permanently protect many areas of high-quality salmon habitat.

The Piscataquis drainage is a largely intact forest landscape situated mostly in the unorganized territories with little or no development. The Piscataquis contains the Maine Highlands region, with the defining 100 Mile Wilderness Mountain Range, and its headwater streams provide extensive coldwater refugia in an area that will offer good climate resiliency as long as it remains forested. About 25% of the land area is currently in some form of conservation and there is enormous potential to expand upon this given the many large blocks under single ownership. The Piscataquis offers one of the best opportunities in Maine for landscape level conservation of headwater forests reconnected to sea-run fish populations.

The Pleasant River area of the Piscataquis offers even higher climate resilience, owing to its higher elevation, higher proportion of conserved forest land, and the extensive connectivity restoration work undertaken by the Appalachian Mountain Club (AMC) on the roughly 90,000 acres they own and manage in the Pleasant's West Branch and Middle Branch. In addition, a five-year partnership among AMC, Trout Unlimited, and the USDA Natural Resources Conservation Service is working to enhance habitat complexity and quality through addition of large wood to streams in the Middle Branch. Today the Pleasant is almost fully reconnected and accessible to Atlantic salmon and other sea-run fish species.

**Milford Dam**

Brookfield wrote in their 2021 Annual Report for their Atlantic Salmon SPP that they plan to consult with NMFS and USFWS regarding the Milford Dam Project's "previously unforeseen effects to listed species" in 2022, and that following this consultation they will revise their SPP (and submit a draft Biological Assessment) to address potential impacts of Milford on "Atlantic salmon and designation of critical habitat on the Penobscot River." What are these previously unforeseen effects? What role will the public be able to have in this process? There has been a tremendous financial investment in the restoration of the Penobscot River by state, federal, and tribal governments and NGOs and the work is far from over. Habitat connectivity and restoration work is happening in all corners of the watershed, and most of the completed and pending projects have been above Milford. It is essential that Milford works not just for salmon, but for all other sea-run fish species that need to get past the dam. Several million fish return to Milford now and that number will increase significantly over the next decade.

**Co-Evolved Species**

The SHRU Work Plan has little mention of co-evolved diadromous species, and when these species are mentioned in the Site Specific Threats and Recovery Activities, it is for projects in the lower Penobscot River or other rivers within the SHRU, never for anything above Milford (except one mention when it comes to passage at the three dams on the Piscataquis). This is an important part of recovery and warrants more discussion in the Work Plan.

In the next few years, fish passage projects will restore access to another 10,000+ acres of historic alewife habitat above Milford. These projects in the Mattawamkeag (Crooked Brook Flowage and Baskahegan Lake) and Passadumkeag (Eskutassis Pond) will eventually add more than 2 million additional adult alewives that will need to pass Milford each year (most of these adults will also have to pass the West Enfield Dam). These projects will contribute to a priority recovery action and provide several recovery benefits, so they should be included within the Work Plan along with other projects focused on the co-evolved species.

## Work plan for the next calendar year

A number of anticipated projects aimed at improving fish passage within the Penobscot SHRU have been identified and are planned for 2022 (Table 4-6). These habitat improvement activities include participation from a variety of partners including NRCS, TNC, Maine DMR, ASF, and Maine Audubon.

*Table 4-6. Table of proposed actions for next calendar year*

| Watershed | Threat | Activity | Recovery Action | Location |
|---|---|---|---|---|
| Mattawamkeag | Barrier | Fishway Construction | Improve fish passage for alewives | Danforth |
| East Branch Penobscot | partial barrier | Replace 5 road crossings with fish friendly designs | Improve fish passage | Katahdin Woods and Water National Monument |
| Passadumkeag | barrier | Improve passage at the Eskutassis' outlet dam and grist mill dam | Improve fish passage for alosines | Burlington, Maine |
| Passadumkeag | natural barrier | Assess fish passage at Grand Falls | Passage assessment | Passadumkeag River |
| Passadumkeag | Partial barrier | Lowell Tannery hydro dam relicensing | Improve fish passage | Enfield |

| | | | | |
|---|---|---|---|---|
| Penobscot | Partial barrier | Improve passage at Leonards Mills Dam | Improve fish passage | Blackman Stream in Bradley |
| West Branch Penobscot | Barriers | Engage in Penobscot Mills/Ripogenus hydro relicensing | | West Branch Penobscot River |
| Penobscot River | Partial Barrier | Milford Dam Section 7 reinitiation | Performance standard attainment | |
| Penobscot River | Partial Barrier | Engage in West Enfield Dam Hydro relicensing | | Enfield |

## List of Reports and Publications resulting from Projects within SHRU


Leach, L., Simpson, M., Stevens, J. R., & Cammen, K. (2022). Examining the impacts of pinnipeds on Atlantic salmon: The effects of river restoration on predator–prey interactions. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *32*(4), 645-657.

Lombard, P. J., Dudley, R. W., Collins, M. J., Saunders, R., & Atkinson, E. (2021). Model estimated baseflow for streams with endangered Atlantic Salmon in Maine, USA. *River Research and Applications*, *37*(9), 1254-1264.

Molina-Moctezuma, A., Peterson, E., & Zydlewski, J. D. (2021). Movement, Survival, and Delays of Atlantic Salmon Smolts in the Piscataquis River, Maine, USA. *Transactions of the American Fisheries Society*, *150*(3), 345-360.

Rubenstein, S. R. (2021). *Energetic impacts of passage delays in migrating adult Atlantic Salmon*. The University of Maine.

Sheehan T. F., M. Payne Wynne, G. Aponte Clarke, S. Coghlan, M. Collins, A. Kelley, R. Kelshaw, D. Kusnierz , J. Royte, R. Saunders, C. Schmitt, K. Wilson, G. Zydlewski, J. Zydlewski. Implementing a Monitoring Framework and Data Archive for Dam Removal: Pre-project Ecological Monitoring of the Lower Penobscot River, Maine USA. NOAA Technical Memorandum NMFS-NE-272. December, 2021.

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Wright, J., J. Sweka, A. Abbott, T. Trinko. 2008. GIS-based Atlantic salmon habitat model. https://www.researchgate.net/profile/Jed-Wright/publication/238053462_GIS-Based_Atlantic_Salmon_Habitat_Model/links/544a4e660cf2f6388084ffbb/GIS-Based-Atlantic-Salmon-Habitat-Model.pdf Appendix C

# Chapter 5 Annual Report for the Merrymeeting Recovery Unit – Calendar year 2021 activities

Effective coordination of planning and implementation efforts throughout the Gulf of Maine Distinct Population Segment (DPS) is required for the successful restoration of Atlantic salmon. An effective governance structure is key to charting a comprehensive long-term recovery program that facilitates interagency and intergovernmental cooperation along with the strategic involvement of a full range of partners and interested parties. The Collaborative Management Strategy is the current Atlantic salmon governance structure. Implemented in the fall of 2019, it is the result of significant stakeholder and agency input and collaboration.

The Collaborative Management Strategy for the Gulf of Maine Atlantic Salmon Recovery Program, which is subject to change, includes Salmon Habitat Recovery Unit (SHRU) Teams for each major geographical area identified in the Recovery Plan for Atlantic Salmon in GOM. The SHRU Teams, in part, develop five-year work plans that include SHRU specific projects aimed at the goal of recovery of Atlantic salmon. This is a report of the 2021 activities of the Merrymeeting Bay (MMB) SHRU Team.

## Abundance and Adult Population Trends

In the past ten years within the MMB SHRU, the adult population has increased, however it also has been highly variable. The increase in adult returns to the MMB SHRU is largely due to increases in the Kennebec River. This is likely a result of an increase in supplementation to the Sandy River that began in 2010 as well as improvements to marine survival, and improvements in downstream passage. The other shift that has occurred in the Kennebec River is the decreased proportion of adult returns that are of hatchery origin. Hatchery origin adults captured in the Kennebec River are likely strays from other programs that have smolt releases as part of their supplementation programs. Since 2014, the proportion of hatchery origin adults has decreased to two or less annually. The change in proportions is partially a result of the increase in wild and naturally reared adults; however, other factors such as stocking practices in other watersheds likely play a role. The Androscoggin River has not seen a positive population trend in the past 10 years. Likely due to the lack of supplementation program, the Androscoggin sees few returning adults. Like the Kennebec River, the number of hatchery fish documented on the Androscoggin has declined in the past five years. The reasons for this decline are not entirely clear but could be the result of changes to the stocking practices in other rivers. The Androscoggin River's proximity to the Kennebec River, in Merrymeeting Bay would make it a likely destination for straying Kennebec River salmon. In turn, as the population in the Kennebec River increases, an increase in adult returns to the Androscoggin River is also expected. The Sheepscot River has not displayed any major changes in adult returns.

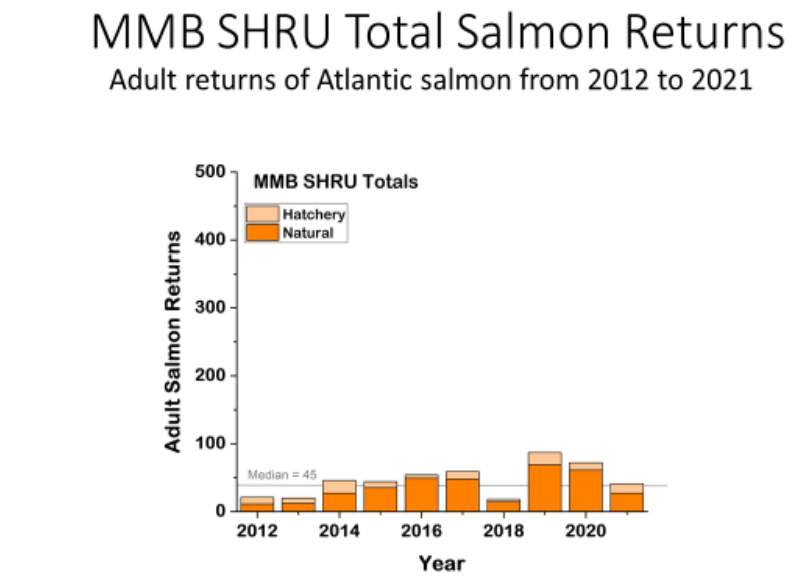


*Figure 5-1. Adult returns of Atlantic salmon in the Merrymeeting Bay SHRU for the last 10 years.*

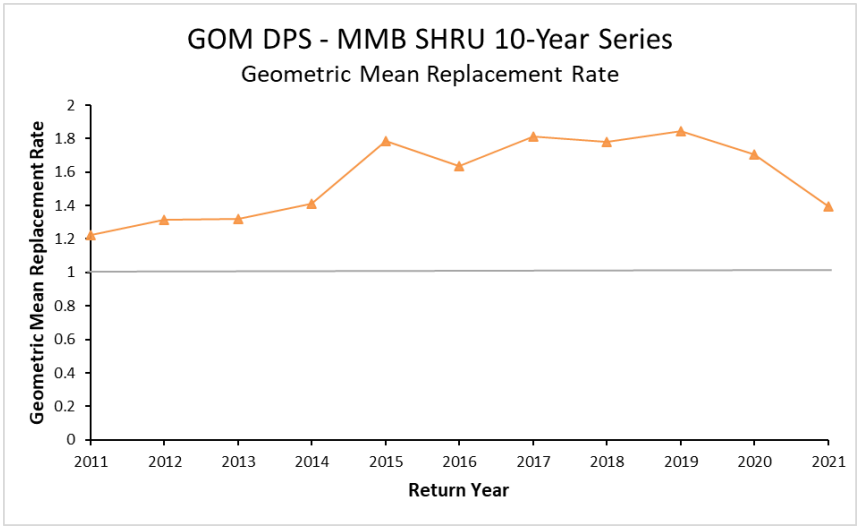


*Figure 5-2. The geometric mean replacement rate for the Merrymeeting Bay SHRU.*

## Adult Returns in 2021

*Androscoggin River*

The Brunswick fishway trap was operated from 30 April to 15 November 2021 by a combination of MDMR and Brookfield Renewable Partners (BRP) staff. Five adult Atlantic salmon were passed at the Brunswick fishway trap. Of the five, 1 sea-winter accidentally got trapped behind the crowder screen in the hopper chamber and subsequently died. Due to its injuries, it appears that it may have become wedged between the crowder and the wall as the crowder moved to the hopper. This gap in the crowder was sealed during a maintenance shutdown in August.

The sea age distribution was comprised of one two sea-winter (2SW) Atlantic salmon and four one sea-winter. All of the one sea-winter returns were likely from a new smolt stocking program on the Kennebec River. The single multi sea-winter adult was likely naturally reared from the Androscoggin River. The count could exceed five due to the possibility of adults ascending Brunswick and being passed while the fishway trap is being cleaned. As Atlantic salmon enter the fishway trap while DSRFH-A and/or BREP staff is cleaning only observational data is collected through the viewing window.

Occasionally an adult Atlantic salmon will pass undetected through the fishway at Brunswick during maintenance/cleaning, so a minimal redd count effort was conducted. Three small sections of the Little River where redds have been documented in past years were surveyed for redd presence, totaling 1.0 river kilometers covered. No redds or test pits were found in this section of river.

*Kennebec River*

The Lockwood Dam fish lift was operated by BRP staff from 1 May to 31 October 2021. Twenty-Three adult Atlantic salmon were captured at the lift. In addition, due to the dam's configuration, adults occasionally need to be rescued from a set of ledges in the bypass canal. In July one additional salmon was captured in the bypass channel. An additional fish was sighted by electrofishing crews and determined to be a salmon. Given how late in the season it was documented, it was added to the sea run returns for the river bringing the total returns to the Kennebec River to 25. Biological data were collected from all returning Atlantic salmon in accordance with Maine Marine Resources (MDMR) protocols, and the presence of marks and tags were recorded. Of the 24 returning Atlantic salmon, 16 (66.7%) were 2SW, 8 (33.3%) were grilse (1SW). Of the returning adults 5 (20.8%) grilse were of hatchery origin. Twenty redds were observed in the Sandy River and none in Bond Brook or Togus Stream in the Kennebec Drainage. A total of 63.39 river kilometers were surveyed which contained 55.57% of the spawning habitat in the Sandy River drainage. Togus Stream surveys covered 100% of the spawning habitat and the Bond Brook surveyed covered 86.3% of the spawning habitat.

Sebasticook River at Benton Falls fish lift facility was operated by MDMR staff from 01 May to 31 October 2021. No Atlantic salmon were captured.

*Sheepscot River*

There were 7 redds observed in the Sheepscot River; five were observed in the mainstem and two were observed in the West Branch. The 7 redds were likely from sea-run adults. A total of 29.75 river

kilometers were surveyed which contained 78.2% of the spawning habitat in the drainage. The Redds Based Returns model estimate was 11 (4 – 29). Using the estimate, the MMB SHRU had 41 adult returns.

*Table 5-1. Adult returns to rivers where traps are used in the Merrymeeting Bay SHRU in 2021. Most adult salmon are caught at the Lockwood fishlift on the lower Kennebec River, Benton Falls fishlift on the Sebasticook River and Brunswick fishlift on the lower Androscoggin River.*

| | Hatchery Origin | | | | | Naturally Reared Origin | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| River | 1SW | 2SW | 3SW | Repeat | | 1SW | 2SW | 3SW | Repeat | Total |
| Kennebec River | 5 | 0 | 0 | 0 | | 3 | 17 | 0 | 0 | 25 |
| Sebasticook River | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 |
| Androscoggin River | 4 | 0 | 0 | 0 | | 0 | 1 | 0 | 0 | 5 |

## Distribution within the Merrymeeting Bay SHRU

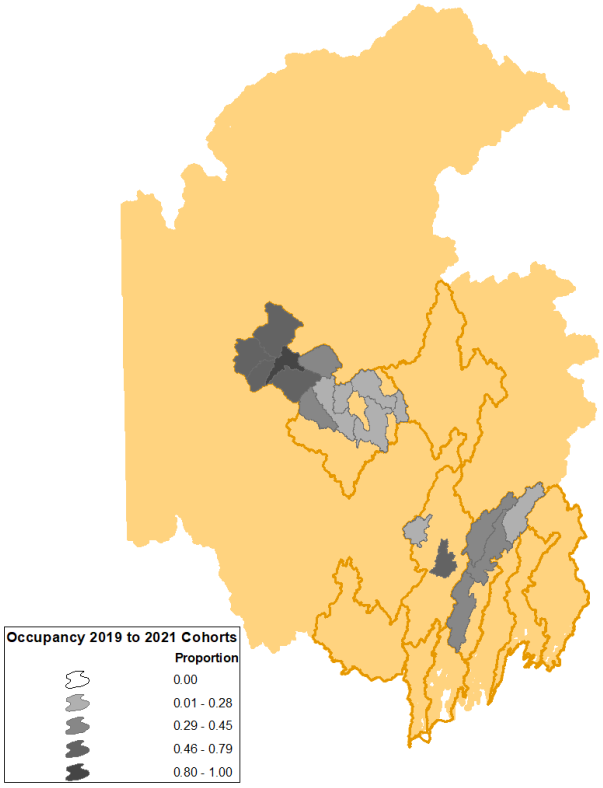


*Figure 5-3. Map of designated Critical Habitat highlighting the relative proportion of river habitat occupied for the MMB SHRU (see figure legend) by the 2019-2021 cohorts at a HUC-12 watershed summary level. Production is a synthesis of modeled distributions from spawning surveys of Atlantic salmon in 2020, winter 2021 egg planting and spring 2021 fry stocking.*

The stocking effort in the MMB SHRU is focused in the Sandy River and the Sheepscot River with four age classes of juveniles (Figure 5-4 and Table 5-2). The primary supplementation strategy in the MMB SHRU is the planting of eyed eggs. In the Sandy River 759,290 eggs were planted between January and February. In addition to eggs the Kennebec River received 100,082 smolts in the spring of 2021. The smolts are part of an effort to boost wild reproduction and releases are expected to continue annually for the next several years. In the Sheepscot River 263,632 eggs were planted during the same timeframe. Eggs are generally divided between mainstem and tributaries according to the amount of juvenile rearing habitat in the vicinity of the planting site as well as estimated emergence rates. In the Sheepscot River a small number of fry are released annually in areas of the river where winter access may be preventative for egg planting. In 2021, 28,277 fry were released in the upper West Branch and the mainstem Sheepscot River above Sheepscot Pond. In addition, 0+parr were released at Kings Mills in Whitefield. In September 19,261 0+parr were released.

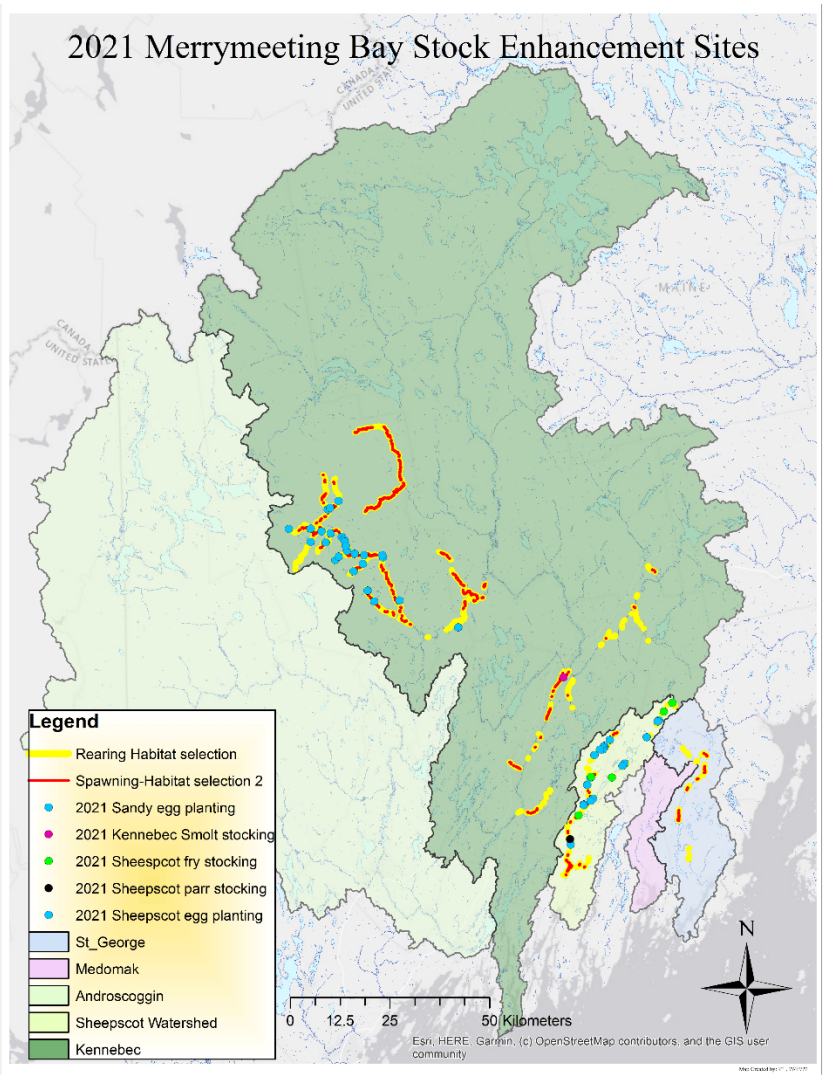


*Figure 5-4. Map of stocking locations in the Merrymeeting Bay SHRU.*

*Table 5-2. Atlantic salmon released in the Merrymeeting Bay SHRU.*

| 2021 Merrymeeting Bay Atlantic Salmon Released | | | | | |
|---|---|---|---|---|---|
| **Drainage** | **Watershed** | **Eyed Egg** | **Fry** | **Fall Parr** | **Smolts** |
| Kennebec | Sandy River | 759,290 | | | |
| | Mainstem | | | | 100,082 |
| Sheespcot | All | 263,632 | 28,277 | 19,261 | |

*Table 5-3. Fish passage projects completed in 2021 in the Merrymeeting Bay SHRU. If blank, values for river/stream miles opened or the number of salmon habitat units opened was not provided.*

| Stream Name | HUC 10 Name | Project Type | Barrier Class Before | Barrier Class After | Stream Miles Opened | Salmon habitat units upstream to next barrier |
|---|---|---|---|---|---|---|
| Cummings | Middle Sandy River | culvert to | impeded | fully accessible | 3.6 | 60.92 |
| Outlet | Lower Sebasticook River | dam | impeded | Accessible | 1.30 | 230 |
| Medomak | Medomak | Culvert | Partially | Accessible | 2.2 | 20 |
| Wilson | N/A | Bridge | Accessible | Accessible | N/A | N/A |
| Culvert | Sheepscot River | Partially | Accessible | Accessible | 0 | N/A |

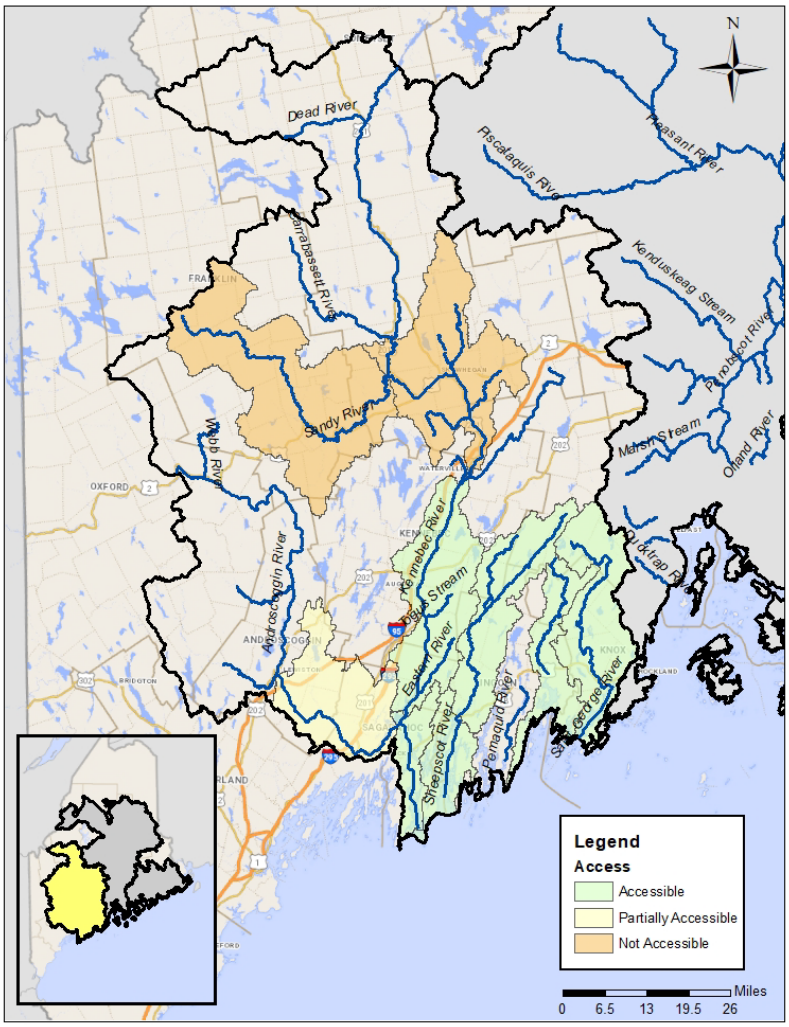


*Figure 5-5. Map of the MMB SHRU showing river and stream reach accessibility for Atlantic salmon. Accessible watersheds have no mainstem dams, or else have dams that have fishways that have been evaluated and determined to be highly effective. The habitat in these watersheds meet our recovery criteria for accessibility. Partially accessible watersheds are above dams that have fishways that have yet to be evaluated. Not accessible watersheds are above dams that do not have swim through fishways. Watersheds above impassable dams where adult salmon are trucked are not considered accessible in terms of recovery. This map does not consider the effect of road stream crossings.*

## Diversity

**Genetic diversity for: Merrymeeting Bay SHRU 2022 Report**

Meredith Bartron, USFWS

For each broodstock within SHRU's, a target of 200 parr to collect and retain for broodstock use was implemented starting with the 2017 collection year. Results below represent the mean number of alleles per locus (based on 18 microsatellite loci) for the 2019 collection of Sheepscot River broodstock (Figure Y). Also included are the other captively spawned broodstocks for comparison. For the 2019 parr collection, allelic diversity slightly increased over the previous collection year estimate (2018 collection year) and is slightly higher than the 10-year average (of mean number of alleles = 11.48). More detailed summaries of genetic diversity are found in the USASAC report. Continued monitoring of estimates of genetic diversity is very important as the Merrymeeting SHRU contains only one of the seven river-specific Atlantic salmon broodstocks remaining in the United States.

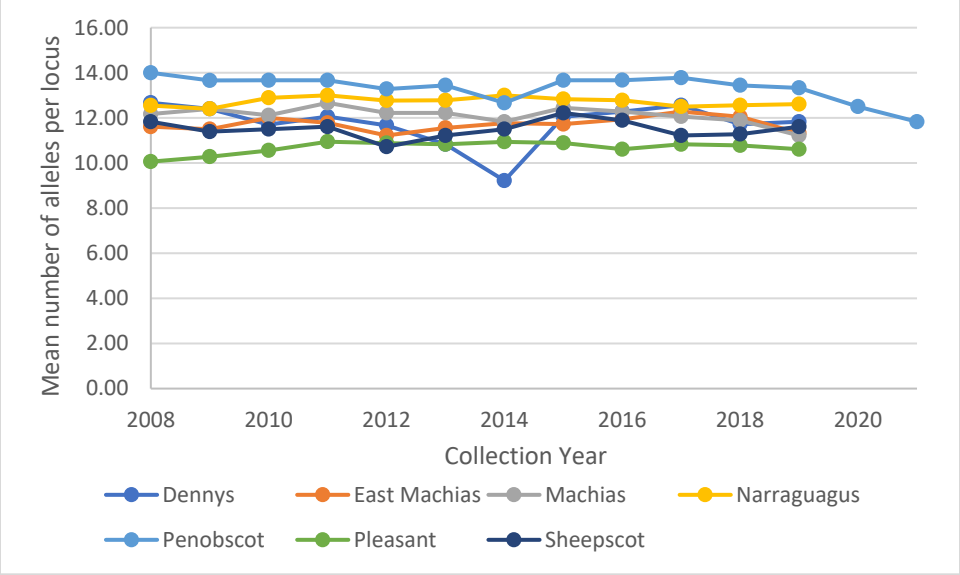


*Figure 5-6. Graph of the mean number of alleles per locus for the Sheepscot broodstock, based on parr collected annually for broodstock collection surveys from 2008 to 2019. Also included are allelic diversity estimates for the other captively-spawned Atlantic salmon broodstocks for reference. Because the Penobscot broodstock is obtained from returning adults, there is a two-year difference in collection time due to the life stage being collected (adults versus parr). For all broodstocks, results represent the mean number of alleles per locus (based on 18 microsatellite loci) for the parr broodstock collected annually.*

*Table 5-4. Age and origin of adults returns in the Merrymeeting Bay to rivers that are trapped. Most adult salmon are caught at the Lockwood fishlift on the lower Kennebec River and Brunswick fishlift on the lower Androscoggin River*

| Adult Returns to the Kennebec and Androscoggin Rivers | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total Adult Returns to** | Hatchery Origin | | | | | Naturally Reared Origin | | | | |
| **the Kennebec** | **1SW** | **2SW** | **3SW** | **Repeat** | **Total** | **1SW** | **2SW** | **3SW** | **Repeat** | **Total** |
| 25 | 5 | 0 | 0 | 0 | 5 | 3 | 17 | 0 | 0 | 20 |
| | *20.00%* | *0* | *0* | *0* | *20.00%* | *12.00%* | *68.00%* | *0.00%* | *0.00%* | *80.00%* |
| **Total Adult Returns to** | Hatchery Origin | | | | | Naturally Reared Origin | | | | |
| **the Androscoggin** | **1SW** | **2SW** | **3SW** | **Repeat** | **Total** | **1SW** | **2SW** | **3SW** | **Repeat** | **Total** |
| 5 | 4 | 0 | 0 | 0 | 4 | 0 | 1 | 0 | 0 | 1 |
| | *80.00%* | | | | *80.00%* | | *20.00%* | | | *20.00%* |

## Emerging Issues and Priorities

Addressing climate change continues to be a priority for the State of Maine and for many, if not all, members of the SHRU Team. In March 2022 it was reported that the Gulf of Maine continued its warming trend, with 2021 being the warmest year observed to date. The Gulf of Maine is warming faster than 96 percent of the world's oceans, increasing at a rate of 0.09 degrees per year over the past four decades. This new information reinforces the concerns for Atlantic salmon survival.

Coordination among the recovery and conservation community is a top priority in 2022. The Bipartisan Infrastructure Law, also referred to as the Infrastructure Investment and Jobs Act, includes billions of dollars that can be utilized for infrastructure projects in Maine that will benefit the ecosystems that Atlantic salmon depend on and significantly improve recovery efforts. This is a once in a generation opportunity that will benefit from thinking and implementing recovery efforts on a large scale.

Advancing the rapid geomorphic assessment for the Sheepscot is a key priority along with aligning land protection efforts within the SHRU. Significant progress has been made to date, and a continued emphasis on these two workplan priorities will continue in 2022.

Yellow bullhead, a non-native species with no prior detections in Maine was collected in the Sheepscot River as well as one of its tributaries. Multiple year classes were caught, indicating that they have been in the river for a while. The fish were found in riffles and runs meaning that there is an overlap in habitat preference with Atlantic salmon. It's possible that the yellow bullhead is an aggressive exotic.

Uncertainties associated with COVID 19 may continue to impact efforts to recover Atlantic salmon in 2022. Public health trends are positive at the time of this report, however an increase in cases and hospitalizations along with state or federal efforts to curtail the virus' spread may impact project fundraising, planning, and execution.

## Stakeholder Input

The stakeholders were invited to share any issues that were not part of this reports emerging issues and priorities. Here is what was added by John Burrows of the Atlantic Salmon Federation.

1. Hydropower dams continue to be our biggest concern in the MMB SHRU. Recovery in the SHRU is dependent on having a self-sustaining population of Atlantic salmon that can get into and out of the Sandy River and we simply will not achieve that without removing dams and their impoundments from the mainstem.

2. We have had success with the removal of several non-hydropower dams in the SHRU in recent years, but the agencies and NGO community only have the human and financial resources to address a few dams at a time. Dam removal has a unique set of social, economic, and environmental issues associated with it and it often takes many years to address these to the satisfaction of the dam owner, local community, and stakeholders – and there's zero guarantee you will get their approval at the end of the day. When you do, it then takes many more years of work and a lot of money to implement the project. Even with the substantial amount of federal funding that is currently available for projects, we won't be able to increase the pace of restoration given capacity limitations and the lack of tools that could help to realize projects faster than we've been able to do to date.

3. The ongoing stocking of non-native salmonids in the SHRU is another ongoing concern. For example, 2,900 brown trout were stocked in the Sandy River in Farmington and New Sharon in 2021, and they were also stocked in several ponds across all corners of the Sandy drainage, including some as far upriver as Avon (Mount Blue Pond) and Phillips (Lufkin Pond) that flow into streams with high-quality salmon habitat (that are also occupied by juvenile salmon). While there are established wild brown trout populations in some portions of the upper Sandy River, adding hatchery brown trout only worsens the issues around competition, predation, and hybridization, and it will likely allow brown trout to access and colonize areas of habitat that are re-opened due to dam removal and culvert replacement projects.

## Work Plan 2022

*Table 5-5. Proposed actions for 2022.*

**Sheepscot Focus Area**

| Project | Action | Partners |
|---|---|---|
| Branch Pond Dam | Install fish passage at the Branch Pond outlet dam to allow for unimpeded passage of river herring | Dam owner, Atlantic Salmon Federation, NRCS, MDMR, USFWS, NOAA, NGOs |
| Taylor Road Bridge | Remove bridge remnants | Property owner, MDMR, USFWS, NOAA, NGOs |
| Inadequate culvert (Trout Brook) | Replace culvert | Road Owner, NRCS, NGOs |
| Culverts | Identify and perform outreach. | Road owners, MEDMR, USFWS, NOAA, NGO's |
| Land Protection | Sheepscot River watershed is one of the most subdivided salmon watersheds. This | Midcoast Conservancy |

| Project | Action | Partners |
|---|---|---|
| | may help to protect valuable habitat from future anthropogenic effects. | |
| Inventory of anthropogenic structures in river | The Sheepscot River has many anthropogenic effects via log drives, agriculture, remnant stream crossings that impact the flow of the river that need to be inventoried and surveyed. | MDMR, Midcoast Conservancy, USFWS, DEP, MCHT, ASF |
| Hatchery Supplementation | Consider alternative to replace eliminated 0+ parr stocking program | USFWS, DMR |

**Kennebec Focus Area**

| Project | Action | Partners |
|---|---|---|
| Lockwood Dam | Restore up- and downstream accessibility (accessible or fully accessible) via dam removal or by implementing safe, timely, and effective upstream and downstream passage. | Dam owner, FERC, NOAA, MEDMR, USFWS, NGOs, MEDEP, MEIFW |
| Hydro Kennebec Dam | Restore up- and downstream accessibility (accessible or fully accessible) via dam removal or by implementing safe, timely, and effective upstream and downstream passage. | Dam owner, FERC, NOAA, MEDMR, USFWS, NGOs, MEDEP, MEIFW |
| Shawmut Dam | Restore up- and downstream accessibility (accessible or fully accessible) via dam removal or by implementing safe, timely, and effective upstream and downstream passage. | Dam owner, FERC, NOAA, MEDMR, USFWS, NGOs, MEDEP, MEIFW |
| Weston Dam | Restore up- and downstream accessibility (accessible or fully accessible) via dam removal or by implementing safe, timely, and effective upstream and downstream passage. | Dam owner, FERC, NOAA, MEDMR, USFWS, NGOs, MEDEP, MEIFW |
| Walton's Mills Dam (Temple Stream) | Remove the dam to allow for unimpeded passage and restoration of stream banks. | Dam owner, Atlantic Salmon Federation, MEDMR, USFWS, NOAA, NGO's |
| Henry Mitchell Brook (Temple Stream) | Collaborate with stakeholders to design replacement road crossings to accommodate 100-year flow and provide better passage to Atlantic salmon critical habitat. | Road owner, MEDMR, USFWS, NOAA, NGO's, Atlantic Salmon Federation, Maine Audubon |
| Sandy River Culverts | Work with towns of Temple, Phillips, Avon, and Madrid to complete existing conditions site surveys at priority culverts. Assess and | Road owners, MEDMR, USFWS, NOAA, NGO's |

| Project | Action | Partners |
|---|---|---|
| | design feasible options for road crossing replacements. | |
| Chesterville Dam | Complete feasibility study to assess options to restore upstream and downstream fish passage | Maine IFW, MEDMR, USFWS, NOAA, NGOs, Atlantic Salmon Federation |
| Cobboseecontee Connectivity | Work with owners of the three mainstem dams to explore opportunities for dam removal or installation of fish passage for river herring, | MDMR, NOAA, USFWS, Maine Rivers |
| Comprehensive Plans | Develop or finalize comprehensive/management plans. | MDMR,USFWS,NOAA, MDIFW, MEDEP |
| Smolt Trap | Operate smolt trap and collect biological and population data as detailed in the Atlantic Salmon Freshwater Assessments and Research | MDMR, NOAA |
| Smolt Stocking | Conduct smolt stocking to maximize survival and increase adult returns | MDMR, USFWS, NOAA, Universities |
| Land Protection | Establish conservation easements, purchase or acquire property rights, etc. | USFWS, NGOs including TNC, HPA, etc. |

**Androscoggin Focus Area**

| Project | Action | Partners |
|---|---|---|
| Sabattus River Connectivity | Work with dam owners to explore dam removal or fish passage improvements that maximize the production potential of river herring in Sabattus Pond, and allow for the survival and recovery of Atlantic salmon | Dam Owners, NGOs, MDMR, NOAA |
| Pejepscot | Participate in FERC relicensing; request studies, provide comments, recommendations, terms and conditions, section 18 prescriptions, WQC conditions. | Dam owner, FERC, NOAA; Partners: MDMR, USFWS, MIFW, MEDEP, NGOs |
| Worumbo | Participate in FERC relicensing; request studies, provide comments, recommendations, terms and conditions, section 18 prescriptions, WQC conditions. | Dam owner, FERC, NOAA; Partners: MDMR, USFWS, MIFW, MDEP, NGOs |
| Upper Barker | Participate in FERC relicensing; request studies, provide comments, recommendations, terms and conditions, section 18 prescriptions, WQC conditions. | Dam owner, FERC, NOAA; Partners: MDMR, USFWS, MIFW, MEDEP, NGOs |

| Project | Action | Partners |
|---|---|---|
| Hackett Mills | Participate in FERC relicensing; request studies, provide comments, recommendations, terms and conditions, section 18 prescriptions, WQC conditions. | Dam owner, FERC, NOAA; Partners: MDMR, USFWS, MIFW, MDEP, NGOs |
| Oxford (Little Androscoggin) | Grade control structure | |

**MMB SHRU Team Actions**

| Project | Action |
|---|---|
| Annual Report | Submit Annual Report in accordance with CMS guidelines |
| Annual Meeting | Conduct Annual SHRU Team meeting in accordance with CMS guidelines. |
| FERC Sub-Committee | Convene FERC sub-committee to: 1) track and maintain information regarding the status of FERC processes; 2) encourage coordination, planning, and participation in FERC relicensing processes; and 3) to encourage coordination, planning, and participation in the post-license compliance monitoring and adaptive management of FERC projects in an effort to achieve the best possible passage outcomes. |
| Mapping/GIS | 1) Compile or develop maps that depict mapped/predicted salmon habitat, barriers, and critical landscape elements and integrate this effort with similar initiatives (e. g. NOAA USGS); 2) Provide tools through the Maine Stream Habitat View or other interface to make the information available for use within the SHRU Team. |

*Table 5-6. New Activities added to the Merrymeeting Bay SHRY work plan.*

**Kennebec River**

| Activity | Description | Partner |
|---|---|---|
| Black Brook | The lowermost barrier culvert was replaced in 2021 (15066 in the MSHV). Two town-owned crossings (15063 and 15061), two privately owned crossings (15186 and 15188), and a DOT owned crossing (15058) persist as barriers to passage upstream and downstream. Collaborate with stakeholders to replace road crossings to accommodate 100-year flow and provide better passage to Atlantic salmon | ASF, NOAA, USFWS, MDMR, DOT |

| Activity | Description | Partner |
|---|---|---|
| | critical habitat. Crossings #15063, 15186 and 15188 expected to be replaced in 2023 | |
| DOT Crossings | Collaborate with DOT and stakeholders to replace road crossings to accommodate 100-year flow and provide better passage to Atlantic salmon critical habitat. | DOT and stakeholders |

*Table 5-7. Modified activities amending the Merrymeeting Bay SHRU work plans.*

| Activity | Revision | Partner |
|---|---|---|
| Smolt stocking *for the evaluation of safe, timely, and effective upstream passage in the lower Kennebec River* | Conduct smolt stocking *upstream of the Weston Dam to ensure 200+ returning adults in the Kennebec River, necessary to complete the "Adult Studies" workplan task.* | USFWS, MDMR, NOAA |

## Reports and Publications from the Merrymeeting Bay SHRU


Craig, Scott D. 2020. MEFWCO Final Branch Pond Report for 2020 activities.

Craig, Scott D. 2020. Quantabacook MEFWCO Annual Report 2020.

Eisenhauer, Z. J., P. M. Christman, J.-M. Matte, W. R. Ardren, D. J. Fraser, and J. W. A. Grant. 2020. Revisiting the restricted movement paradigm: the dispersal of Atlantic salmon fry from artificial redds. Canadian Journal of Fisheries and Aquatic Sciences 11(November):1–11.

Rubenstein, S. R. 2021. Energetic Impacts of Passage Delays in Migrating Adult Atlantic Salmon. University of Maine, Orono.

# Chapter 6 Update on Marine Survival – Calendar year 2021

The USASAC updates marine survival metrics for Penobscot River hatchery origin smolts and naturally reared smolts produced in the Narraguagus, Sheepscot, and East Machias Rivers. Previously, all systems used total smolts stocked or estimated emigration and subsequent adult returns by sea age to generate a smolt-to-adult return rate (SAR). For the Penobscot River a revised estimate was developed that used the methods of Stevens et al. (2019) to decouple losses of smolts in-river and in the estuary to provide an estimate of postsmolts entering the Gulf of Maine. This method accounts for both stocking location and flow-specific mortality. This postsmolt estimate was then applied to subsequent adult returns to calculate a postsmolt to adult survival rate (PSAR) for the Penobscot. The USASC discussed the concept and agreed it would provide a better estimate of marine survival and recommended adoption of the PSAR metric for use in marine survival work for the Penobscot River hatchery component. With the removal of in river, dam, and estuary mortality PSAR is generally higher than SAR but follows similar trends of substantially lower marine survival after 1991 (Figure 6-1). This figure also illustrated the conservation benefit of stocking smolts above as few dams as practical for management goals.

Population estimates of naturally-reared smolts are available for 3 additional Maine Rivers. These estimates are derived from mark-recapture population estimates. When combined with redd-based adult population estimates or trap counts by age, these provide additional indices of marine survival for Maine populations. It is important to note that for these 3 estimates, ambient-temperature reared parr are included in naturally reared smolt estimates. These parr were reared at Craig Brook National Fish Hatchery for the Sheepscot and Narraguagus and the Peter Gray Parr Hatchery for the East Machias. The longest time series is for the Narraguagus River starting with the 1997 smolt cohort. Most of the adult return data for this population comes from trap counts of adults at the Cherryfield Dam. In years of high flow (more fish bypass the trap), redd counts are used as they more accurately reflect total returns. All these age-based adult estimates are in USASAC databases. Sheepscot River smolt monitoring started in 2009 and East Machias monitoring in 2013. When adult returns are estimated from redd counts, ages are pro-rated by standard methods used by USASAC.

Marine survival for 2SW salmon in the last decade for the Penobscot Hatchery population has a PSAR averaging 0.22% (Figure 6-2). This is substantially lower than estimated average SAR for the Narraguagus River (1.25%) and Sheepscot River (0.57%). For the East Machias, only a 6 year time series is available but this averages 1.93%. While the intern annual variability is larger in these smaller populations, these data suggest much better marine production for naturally-reared smolts. For 2020 returns (2018 smolt cohort), measured Penobscot PSAR was 0.22%, Narraguagus SAR was 2.65%, Sheepscot was 0.72%, and East Machias was 2.01.

Marine survival for 1 SW salmon showed similar trends in the last decade for the Penobscot Hatchery population has a PSAR averaging 0.07%. This is only 20% of the estimated average SAR

for the Narraguagus River (0.35%) and about 45% of the Sheepscot River (0.57%) SAR. For the East Machias, only a 6 year time series is available but this averages 0.53%. Again, these data suggest much better marine production for naturally-reared smolts. For 2020 returns, grilse estimate are not yet available for the 2019 smolt cohort for Penobscot PSAR. For the Narraguagus grilse SAR was 0.26%, the Sheepscot was 0.21%, and East Machias was 0.32%.

These entire time series suggest that marine survival of naturally reared fish is often higher than hatchery reared smolts (Figure 6-2). Future work will focus on the variability of these estimates and continuing these time series to better understand overall marine survival and differences between hatchery and naturally-reared smolts. In the future, PSAR estimates will be reviewed for their utility in the Narraguagus River population where telemetry estimates of lower river and estuary survival are available for 8 years of the time series. Marine survival remains a primary threat to the recovery of all Gulf of Maine Atlantic salmon stocks. However, improvements in PSAR the last 3 years provide some encouragement. Reviews of marine survival indicate the best short-term strategy to address current ocean conditions is to maximize the production of wild or naturally reared smolts. Given the amount of vacant habitat across the DPS, there is habitat capacity to rear more smolts. Additional hatchery capacity is needed for that approach or a more aggressive spatial management scheme. However, action can be taken now to increase adult returns by a) increasing natural production in the all rivers (additional stocking and improved downstream passage) and b) by closing the marine performance gap of hatchery reared and naturally-reared smolts. Innovation in habitat improvement, hatchery product quality and release schemes, and fish passage are needed to address this challenge.

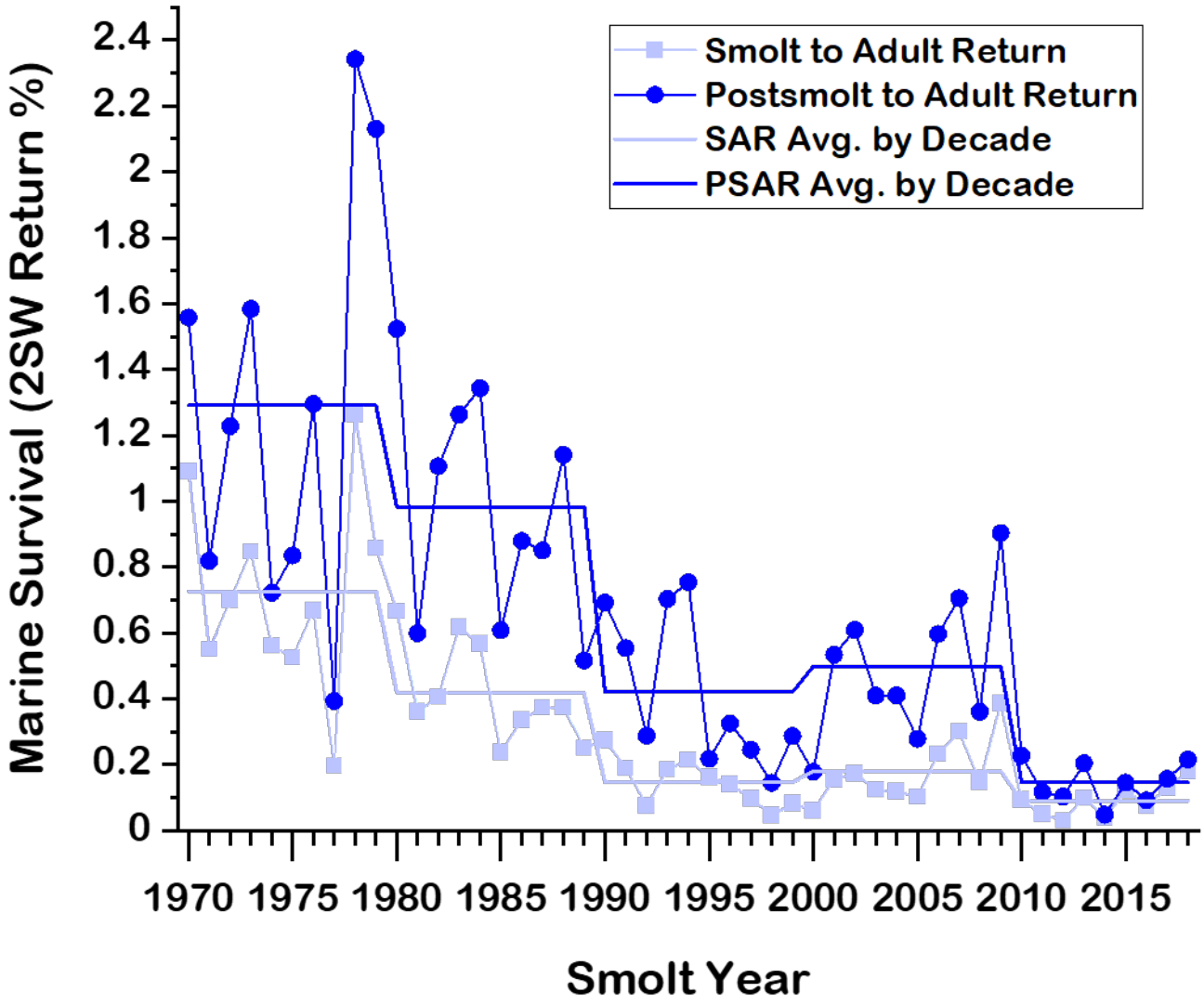


*Figure 6-1. Marine survival of Two Sea Winter (2SW) Atlantic salmon returns for 1970 to 2018 smolt stocking cohorts to the Penobscot River as indexed by Smolt to Adult Returns (SAR) and the preferred Post Smolt to Adult Returns that removed freshwater and estuary mortality (Stevens et al. 2019). Lines indicate average by decade.*

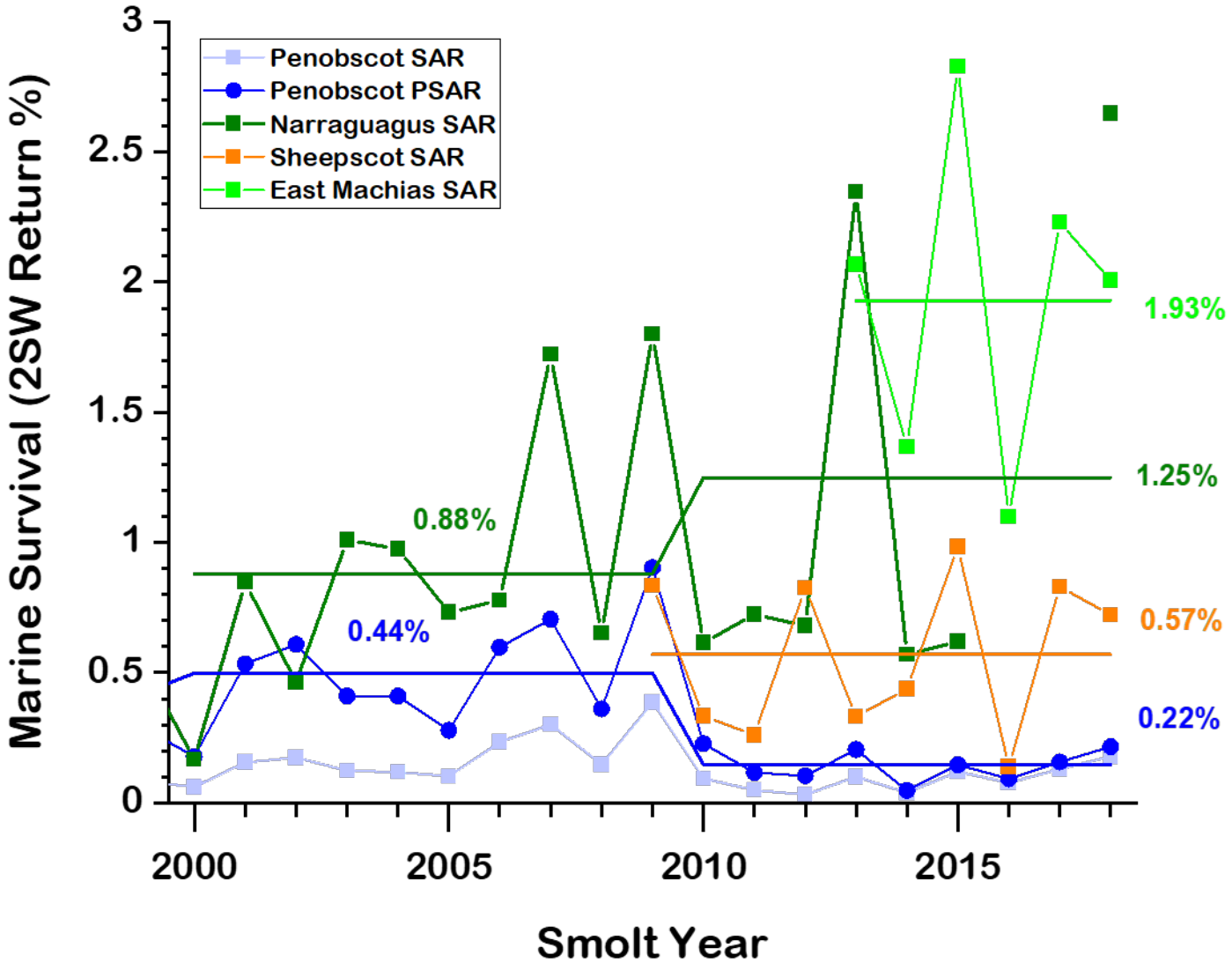


*Figure 6-2. Marine survival of Two Sea Winter (2SW) Atlantic salmon returns since the 2000 smolt cohorts for the Penobscot, Narraguagus, Sheepscot, and East Machias Rivers as indexed by Smolt to Adult Returns (SAR) for all rivers and the Post Smolt to Adult Returns that removed freshwater and estuary mortality for the Penobscot (Stevens et al. 2019). Lines indicate average by decade or available time series in case of East Machias.*

# Attachment 1

**FERC STANDING COMMITTEE**
**2021 Activities**

*Role of Committee*

- Review research and monitoring studies at FERC hydro projects.
- Make recommendations to improve Atlantic salmon survival, abundance, and distribution at FERC hydro projects.
- We also discuss other diadromous fish species including herring, shad, and American eels.

*Responsibilities*

- Provide input and coordination concerning priorities for the use of hatchery origin and wild Atlantic salmon for research and monitoring purposes at FERC hydro projects.
- Review and provide technical input concerning the methods, results, data analysis, and conclusions of newly issued research and monitoring study reports concerning FERC hydro projects in the GOM DPS.
- To help guide the development of opportunities to improve the survival, abundance, and distribution of Atlantic salmon at various FERC hydro projects based upon the results of research and monitoring.

*Ways of Working*

- The Group typically meets once a month as necessary to review draft study reports.
- Chair distributes newly issued research and monitoring study reports prior to meetings for review and discussion
- After meeting, the Chair distributes notes for review and comment.
- Consists of members from State and Federal Resource Agencies, PIN, and University Researchers

In 2021, the group held ~five meetings. Activities included:

- We reviewed the following draft fish passage study reports:
    - West Enfield Project Draft Upstream Passage Evaluation of Adult River Herring Report
    - West Enfield Project Draft Downstream Adult River Herring Survival Study Report
    - West Enfield Draft Condition Assessment of Fish Passage through Upstream Fishway Report

    - West Enfield Draft Downstream American Eel Study Report
    - West Enfield Draft Acoustic Study Report
    - West Enfield Draft Downstream Passage Alternatives Study Report
    - Medway Project Draft Downstream American eel downstream passage report.
- UMO Presented:
    - Updates on Penobscot River Passage and Predation Studies

- Other
    - Multiple updates on FERC relicenings in Penobscot, Kennebec and Union Rivers
    - Multiple updates on fish passage studies in these watersheds
    - Penobscot Net Pen Project