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Atlantic Salmon Recovery Framework: Implementation Plan

National Marine Fisheries Service
Maine Department of Marine Resources
U.S. Fish and Wildlife Service
Penobscot Indian Nation

Atlantic Salmon Recovery Framework Implementation Plan

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Introduction

This implementation plan is part of the Atlantic Salmon Recovery Framework. In this document you will find information on the objectives, strategies, and actions of each of the Action Teams (i.e. Stock Assessment, SAAT; Marine and Estuary, MEAT; Connectivity, CAT; Genetic Diversity, GDAT; Conservation Hatchery, CHAT; and Freshwater, FWAT). The Framework's guiding document provides information on the Governance structure, objectives, short- and long-term recovery strategies, action teams, portfolio selection process, and monitoring implementation.

The actions within this plan balance the need to prevent extinction, identify causes and remedies for poor survival, and increase wild production. The actions presented resulted from a review of actions currently being implemented (status quo) by The State of Maine, U.S. Fish and Wildlife Service (USFWS), and NOAA's National Marine Fisheries Service (NMFS), and additional actions to benefit Atlantic salmon recovery. There were many worthy actions considered in this process that were not included in this implementation plan. The actions selected represent the path forward for the Framework and do not preclude others from implementing actions that are consistent with Atlantic salmon recovery. Please review the Framework's guiding document for information on how the criteria used to evaluate actions, allocate funding among strategies, and how to submit proposals to implement actions not included in the plan.

The intent of this plan is to identify specific actions to be implemented, the lead agency, the timeline, and the criteria that will be used to evaluate an actions success. Annual reporting is required to verify planned activities have been implemented. Additional monitoring and reporting will be necessary to evaluate the success of each action and propose adaptive management changes.

Summary of the Biological Objectives

The goal is to significantly increased abundance of wild Atlantic salmon persisting over time and distributed over a wide geographic range. Inherent in these objectives is the preservation of genetic, life history, and morphological diversity and improved ecosystem function.

Abundance: A recovered Atlantic salmon species will be at a higher abundance level than that currently existing in the U.S., the majority of which are wild origin, and the wild population must be self-sustaining and independent of a hatchery supplementation.

Distribution: A recovered Atlantic salmon species will be distributed across a wide geographic area and in a diversity of habitats. Thus, this objective seeks to increase distribution of Atlantic salmon both within rivers as well as among rivers across the full geographic range of the Gulf of Maine Distinct

Population Segment (GOM DPS) as described in the final listing rule (74 FR 29344). Any population that is well distributed across a wide geographic area has lower risks of extirpation due to environmental variability; thus, distribution essentially spreads risk and provides security.

Ecosystem Function and Diversity: As indicated above, a recovered Atlantic salmon species is one with abundance and distribution significantly increased from the current state. These two objectives cannot be achieved without having functioning ecosystems. We believe that species interactions, abiotic variability (such as climate, topography, and hydrology), patterns of past and present land use, natural disturbance, and succession dynamics are important. These factors influence habitat complexity, habitat connectivity, nutrient cycling, biological community diversity, and temperature regimes critical to the successful completion of Atlantic salmon's life history.

Summary of Framework Strategies

Five strategies were implemented to achieve the fundamental objectives of increasing abundance (productivity) and distribution.

Strategy A: Increase Marine and Estuarine Survival
Strategy B: Increase Connectivity
Strategy C: Maintain Genetic Diversity through the Conservation Hatchery
Strategy D: Increase Adult Spawners through the Conservation Hatchery
Strategy E: Increase Adult Spawners through the Freshwater Production of Smolts

An action team was formed for each of the five strategies identified above. Each Action Team was charged with developing a list of actions to achieve the biological objectives. In addition, a stock assessment team was formed to track the biological status of Atlantic salmon in the Gulf of Maine DPS.

Stock Assessment Action Team

Within the Atlantic salmon framework stock assessment has two tiers: 1) Assessing the status and trends of the stocks that comprise the GOM DPS, and 2) Assessing specific actions. Both tiers are essential for an adaptive process. The first tier (status and trends) pertains to collecting data and generating metrics to determine the abundance and distribution of GOM DPS salmon. The second tier requires detecting changes in the population resulting from an action at a smaller scale (e.g. habitat restoration on a tributary to one of the DPS rivers).

The role of the Stock Assessment Action Team is primarily in the first tier, which requires quantitative metrics to evaluate progress toward the fundamental objectives of recovery; increasing the abundance and distribution of Atlantic salmon. The adult census criteria in the critical habitat designation will also be in the Recovery Plan. These were used as the starting point for developing quantitative metrics based on adult censuses and identifying the data needed to calculate them. The stock assessment metrics proposed by the other Action Teams were considered and metrics integrating assessment data from multiple life stages (e.g. marine survival) were developed. The resulting metrics and data required are in Table 1.

Most of the necessary data are collected annually and compiled to produce the Maine portion of the US Atlantic Salmon Assessment Committee (USASAC) report. Some of the metrics are similar to those already generated annually, and the team is developing any new assessment analyses needed (e.g. methods to probabilistically assign wild returns to fry stocking and natural reproduction). We envision calculating and reporting these metrics as part of the annual USASAC meeting and including them in the report to the U.S. section to NASCO. As appropriate, we will request the metrics be critically reviewed by Atlantic salmon experts outside of the GOM DPS (i.e. USASAC and the ICES Working Group of North Atlantic salmon).

When requested, the Stock Assessment Team will advise the action teams on specific assessment questions related to methods, or design and analyses. The actions in Portfolio 7 are an annotated list that does not include specific assessment proposals with sampling locations, methods, design and analyses. Thus, it is not practical to determine if an action assessment will provide data useful in assessing overall status and trends, or if the data and metrics developed for status and trends could contribute to evaluating the action. In developing the actions for Portfolio 7, the Action Teams were responsible for ensuring that appropriate assessment would be part of the action. We have developed a white paper on assessment methods that documents ongoing assessments and provides basic information on sample size that can be used as a guide in assessing specific actions. Further, with the Action Team chairs assistance, we will maintain an updated metadata (e.g. principal investigator, location(s), focus life stage) list of ongoing assessments to facilitate collaborative data collecting and integrated analyses

among action teams, field biologists, and researchers. This will also provide the Assessment Team the opportunity to suggest how combining locations or assessments might provide data for multiple actions and where status and trend assessment data might be useful for assessing an action.

Table 1. Stock Assessment Action Team's preliminary assessment criteria and descriptions.

Preliminary Stock Status Recovery Assessment Criteria	**Comments**	**Metric**	**ID#**	**Action Team**	**Data**	**Database**	**Status**
Counts (1) The wild **adult spawner population of each salmon habitat recovery unit (SHRU) must be 500 or greater** in an effort to maintain sufficient genetic variability within the population for long-term persistence. This is to be determined or estimated through adults observed at trapping facilities or redd counts;	Lower Limit - 500 wild adult returns with documented positive population growth (benchmark of threatened status). Recovery target ~ 2,000 wild adult salmon per SHRU to utilize critical habitat. Third tier targets to be determined based on Conservation Spawning Escapement for ICES	Adult Returns Index **ARI** (total from trap counts and redd based estimates)	1	SAAT	DMR Trap Count: Dennys, Narraguagus, Penobscot, Kennebec, Androscoggin	DMR-BSRFH adult trap archive and USASAC_Salmon archive	Avail
			2	SAAT	DMR Redd: 8 small coastal river systems (partial coverage)	DMR-BSRFH redds archive	Avail
			3	SAAT	DMR and NOAA - Age Structure and Origin Analysis	pro-rate above for un-aged fish	Avail
			4	SAAT	NOAA- ReddsModel (Kocik @Risk Model)	Redd-based adult estimates	Avail
		% Conservation Spawning Escapement (**CSE**) by SHRU	5	SAAT	ARI and FWS SHRU Habitat Model (Abbot, Wright, Sweka 2010)	National Hydrography Dataset (NHD) for unsurveyed stream reaches	Revise 2011

Preliminary Stock Status Recovery Assessment Criteria	Comments	Metric	ID#	Action Team	Data	Database	Status
(2) The GOM DPS must demonstrate **self-sustaining persistence where each SHRU has less than a 50 percent probability of falling below 500 wild adult spawners in the next 15 years** based on PVA projections described above.	500 wild adult returns per SHRU; documentation of wild returns necessitates determining or estimating the potential naturally spawned component	P(<500) < 0.50 (From DennisPVA)	7	SAAT	same data as (1) partitioned for wild versus hatchery stocked components	Salmon Population AnalyZer (SPAZ) model partitioned by SHRU	Revise 2011
	Percentage of returns and escapement that are of smolt, parr, or naturally-reared origin in Trap Catches	% Trap Catch Origin	8	CHAT	NOAA-FWS-DMR Marking Programs & Associated prorating and scale analysis	DMR-BSRFH adult trap archive and USASAC_Salmon archive	Avail
	Partition Naturally-Reared fish into Fry and Wild-Spawned components - eventually this will need to be done by looking at origin of parents	Wild:Fry Stocked Ratio	9	CHAT	FWS- estimating wild returning salmon numbers (Sweka worksheet) Highlight need for NG genetics to verify ratios	DMR-BSRFH adult trap archive, USASAC_Salmon archive, DMR-BSRFH redds archive	Revise 2011
(3) The entire GOM DPS must demonstrate **consistent positive population growth for at least two generations (10 years).** Ten years of pre-decision data that reflects positive population trends provides some	In the short-term a composite replacement rate calculation can provide a metric for overall trends. Other metrics to examine the population growth are spawner/recruit metrics but ultimately must measure contributions of naturally-spawned and reared fish across generations.	Replacement Rate and 5 Year Geometric Mean of Replacement Rate > 1.0	11	SAAT	from Adult Returns Index - Age Structured? (Don't think we need to account for age structure given what we say in the cell below)	DMR-BSRFH adult trap archive and USASAC_Salmon archive	Revise 2011

Preliminary Stock Status Recovery Assessment Criteria	Comments	Metric	ID#	Action Team	Data	Database	Status
assurance that recent population increases are not happenstance but more likely a reflection of sustainable positive population growth;							
(4) A recovered GOM DPS must represent the natural population (i.e., adult **returns must originate from natural reproduction that has occurred in the wild**); hatchery product cannot be counted towards recovery because a population reliant upon hatchery product for sustainability is indicative of a population that continues to be at risk;	Generally agree with this criterion, but we still have the problem of differentiating natural returns that are from fry stocking or natural reproduction. As long as there is any hatchery input, returns will never be 100% natural. Criterion should also include some % of adult returns that are of natural origin (say 90%???)	Combination of the % of natural returns that are of wild origin. 10 year natural geometric mean replacement rate > 1.0.	13	SAAT	Percent natural returns obtained from adult trap data. Redd estimates pro-rated from this percentage. Replacement rate calculated as the number of natural returns in year t divided by the number of natural returns in year t-5. Natural returns estimated from Wild:Fry Stocked Ratio Model.	DMR-BSRFH adult trap archive and USASAC_Salmon archive	Revise 2011

Preliminary Stock Status Recovery Assessment Criteria	Comments	Metric	ID#	Action Team	Data	Database	Status
(5) Address additional threats to the GOM DPS.	Progress in sub-elements of the threats should be tracked through a stage-specific monitoring and assessment program and ultimately with a life history model that integrates major mortality factors by stages/environments	Spawning Area Saturation Index	15	FWAT	DMR - redds per stream km in each SHRU; distribution, etc.	DMR-BSRFH redds archive	New 2011
		Large Parr Production Index	16	FWAT	DMR-FWS Develop sampling scheme to examine by SHRU, densities and fry/other stocked distribution and redd-based wild spawned distribution (use buffers)	DMR-BSRFH electrofishing archive and USASAC juvenile abundance	Revise 2012
		Smolt Production Index	17	FWAT	NOAA-DMR Index developed from smolt trapping operations on the Narraguagus, Sheepscot, and maybe Penobscot (?) Populations	NOAA - smolt database archive	Avail
		Overwinter Survival Estimate	18	FWAT	uses 16 and 17		New 2011
		Dam Passage	19	CAT	review performance standards related to efficiency and overall survival-		Revise 2012

Preliminary Stock Status Recovery Assessment Criteria	Comments	Metric	ID#	Action Team	Data	Database	Status
					benchmarks anticipated in 2011 from desktop analysis for Penobscot River		
		Telemetry-Based Coastal Survival Rate	20		NOAA Estuary and Gulf of Maine Telemetry Assessments		Avail
		Marine Survival: Hatchery Smolts	21	CHAT and SAAT	Penobscot, Narraguagus - data on marked smolt group numbers and subsequent returns	DMR-BSRFH adult trap archive and USASAC_Salmon archive	Avail
		Marine Survival: Naturally-Reared Smolts	22	FWAT and SAAT	naturally reared smolt estimates from Narraguagus River and Sheepscot (starting in 2011) rivers with wild returns (trap or redds).	DMR-BSRFH adult trap archive, USASAC_Salmon archive, and DMR-BSRFH redds archive	Avail

Marine and Estuary Action Team

Strategy

Increase marine and estuary survival by increased understanding of these ecosystems and the location and timing of constraints to the marine productivity of salmon

Strategy Objective

To document factors limiting marine and estuarine survival of Atlantic salmon to facilitate informed ecosystem management of these stocks.

Strategy metrics

- Monitor marine survival of hatchery smolts in Penobscot Bay SHRU and decrease uncertainty in estimates
- Monitor marine survival of naturally-reared smolts in Downeast and Merrymeeting Bay SHRU and decrease uncertainty in estimates
- Monitor estuarine and coastal marine survival and identify location and time of mortality events at a population scale using telemetry and pelagic monitoring techniques in Penobscot Bay SHRU
- Increase understanding of Atlantic salmon transition ecology in estuaries, and coastal migrations in US waters and distant waters through active research and cooperatives through partners including universities, marine research institutes, ICES and NASCO resulting in peer-reviewed products

Description

It is recognized that a significant increase (8x) in marine survival is needed in order to achieve stabilization and move towards recovery of the GOM DPS of Atlantic salmon. Increases in marine survival are needed in order to increase the number of adult returns, percentage of the adult returns that are of wild origin, achieve self-sustaining populations, maintain genetic diversity, and maintain or increase the geographic distribution of salmon within the GOM DPS.

NOAA Fisheries has the lead for the majority of activities within the scope of the Marine and Estuary Action Team. These activities are primarily research in nature at this point as the team seeks to understand the marine migration of Atlantic salmon and, ideally, identify the factors that may be contributing to the current low survival. Stock assessment work is also a core activity and provides information to domestic and international Atlantic salmon managers. Current estuary and marine monitoring efforts provide spatial and temporal ecology information that is used for project management (work windows) and habitat conservation – project sighting. Monitoring of distant water fisheries and development of proportional stock allocation models

protects all US and GOM DPS Atlantic salmon populations through monitoring bycatch and changes in marine distribution that may put endangered stocks at risk. With this increased knowledge, we intend to implement management actions with the goal of increasing survival of post smolts and ultimately increasing adult returns.

The MEAT continues a strategic approach to investigating transition, coastal and distant waters marine ecology of salmon with an integrated approach that uses multiple techniques in varied environments. Overall marine survival is assessed and studied through active smolt marking programs and enumeration of emigrating smolts and monitoring of adult returns. Integrated work with the CAT is partitioning transition mortality due to dams from baseline migration mortality in free-flowing rivers and estuaries. Estuary survival and losses at different habitat reaches through estuary and coastal waters to smolt entry in Gulf of Maine is monitored with telemetry tags (ultrasonic and radio). Gulf of Maine movements and environmental conditions are monitored through partnerships with Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) and physical oceanographers and direct sampling of surface waters through post-smolt trawling. West Greenland fisheries are monitored closely to understand catch rates and continent and region of origin to protect GOM Atlantic salmon. Preliminary studies of migrations around Greenland are conducted through satellite tagging of adult salmon. To date, most efforts have been single species (Atlantic salmon) and fish focused. The new strategic framework approach focuses on Atlantic salmon and their estuarine and marine ecosystems (biological and physical) and is building partnerships with experts in related fields to leverage resources and uncover common trends in Northwest Atlantic productivity of pelagic fishes. The framework approach seeks to understand both the role of salmon in a broader context and the impacts of changing parameters within their marine habitat and interspecies interactions that can enhance recovery efforts.

The focus of the marine and estuary action team is monitoring and understanding the controlling factors in the estuarine and marine ecology of Gulf of Maine Atlantic salmon and the changes in their marine habitat. More specifically, there are four broad categories of actions highlighted as urgently needed to conserve and protect salmon and their habitat:

1. Protection and enhancement of salmon in estuary and marine habitats and conservation of these habitats and ecosystem services
2. Active participation in international and coastal Atlantic salmon management activities and assessments.
3. Estuarine and Coastal Salmon Ecology and Ecosystems - actively participate in and lead estuarine and coastal waters research efforts in US territorial waters
4. Ocean Salmon Ecology and Ecosystems - actively participate and lead research efforts in partnership with international organizations in Northwest Atlantic distant waters

Table 2. Marine and Estuary Actions Team's action, descriptions, and implementation schedule.

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
MEAT1	Continue to condition permits for activities within the estuaries, bays, and Gulf of Maine so as to minimize potential effects on Atlantic salmon migration	Annual summary of permit actions and target timetables	NOAA	1	80,000	Ongoing	None
MEAT2	Continue to enhance protection of estuarine and marine areas where necessary through expanded enforcement and modifications to the Natural Resource Protection Act, Forest Practices Act, LURC Zoning standards, Municipal Shoreland Zoning, and Marine Spatial Planning	Participate in domestic management processes	NOAA	0.1	8,000	Ongoing	None
MEAT3	Continued participation in International Council for Exploration of the Sea Working Group on North Atlantic Salmon (ICES WGNAS)	Development of USA Report and scientific participation	NOAA	0.1	14,000	Ongoing	None
MEAT4	Continued participation in North Atlantic Salmon Conservation Organization (NASCO)	Participate in international management processes	NOAA	1	120,000	Ongoing	None
MEAT5	Continued participation in NASCO's International Atlantic Salmon Research Board (IASRB)	Participate and represent US interests	NOAA	0.1	8,000	Ongoing	None
MEAT6	Support the development of amendments for the continuation of and amendments to the NEFMC FMP for Atlantic salmon prohibiting possession and any directed or	Revise and keep current Atlantic Salmon FMP	NOAA	0.1	8,000	As Needed	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	incidental commercial fishery in federal waters						
MEAT7	Continue to build large scale tracking infrastructure in estuaries, bays, and Gulf of Maine and partner internationally in Integrated Ocean Observing Systems and Ocean Tracking Network through initiation and support of tracking studies	Annual report demonstrating expanded networks and monitoring innovations.	NOAA	0.5	140,000	Ongoing	None
MEAT8	Support bioenergetic modeling/analysis of marine salmon to evaluate the importance of predator and prey fields and ocean circulation on Atlantic salmon growth and survival in the Gulf of Maine	Final report 2013 and interim products to describe coastal foodweb status	NOAA	0.1	83,000	2011-2013	None
MEAT9	Initiate and support adaptive management studies based on Nearshore survival workshops recommendations to synthesize information and improve our understanding of factors affecting the estuarine and nearshore mortality of Atlantic salmon.	Final Report 2011 and integrate advice into MEAT programs	NOAA	0.1	83,000	Planning Initiated	None
MEAT10	Examine interactions of salmon with predators and parasites -continue to monitor the occurrence of marine mammal scars on returning adults to the adult trap in the Penobscot River	Annual quantitative estimates of injury in Penobscot	NOAA/DMR	0.1	8,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
MEAT11	Initiate smolt telemetry, hydroacoustic, and survey projects to further investigate survival and ecology in estuary and coastal waters.	Annual report with quantitative estimates of survival and narrowed i.d. of mortality location	NOAA	0.25	55,000	2012-2014	None
MEAT12	Penobscot Estuarine Fish Community and Ecosystem Survey - evaluate whether alosids reduce predation risks to smolts	Annual updates and analyses of optimally effective methods	NOAA	0.2	76,000	2010-2012 Phases I & II	None
MEAT13	Continued participation and oversight of NASCO's West Greenland sampling	Annual update report to ICES/NASCO	NOAA	0.64	101,200	Ongoing	None
MEAT14	Continued participation and oversight of SALSEA Greenland transition to next International Atlantic Salmon Research Board Phase	Annual US update report to ICES/NASCO	NOAA	0.15	122,000	2010-2011 Phase I & 2012-2015 Phase II	None
MEAT15	Continue to archive and data mine historical high seas tag recaptures	Historic summary paper 2012 and annual database update	NOAA	0.25	26,000	Ongoing	None
MEAT16	Comprehensive evaluation of existing marine related data for correlations at USA, North America, and North Atlantic scales to better characterize impact of oceanographic changes on Atlantic salmon survival in the Northwest Atlantic	Final report 2013 and interim products to describe impacts of these dynamics on marine survival and towards forecasting models.	NOAA	0.75	66,000	2011-2013	None

Connectivity Action Team

Strategy

Enhanced connectivity between the ocean and freshwater habitats important for salmon recovery

Strategy Objectives

- Provide full access [1] to 30,000 habitat units with a habitat quality score[2] of 2 or 3 in the Merrymeeting Bay SHRU;
- Provide full access[1] to 30,000 habitat units with a habitat quality score[2] of 2 or 3 in the Penobscot Bay SHRU;
- Provide full access[1] to 30,000 habitat units with a habitat quality score[2] of 2 or 3 in the Downeast SHRU.

1. In order for habitat to be considered fully accessible, it must be in an area where:
    a. There are no anthropogenic barriers (dam, culvert, etc.) downstream (to the Gulf of Maine), OR
    b. Anthropogenic barriers have the following characteristics:
        i. Cumulative downstream fish passage efficiencies of all barriers are 95% or greater unless site-specific demographic studies demonstrate other targets are sufficient to allow for recovery, AND
        ii. Cumulative upstream fish passage efficiencies of all barriers are 95% or greater unless site-specific demographic studies demonstrate other targets are sufficient to allow for recovery.
2. Habitat quality scores are derived from NMFS (2009) figure 1.6.1 and summarized in tables 2.3b, 3.3b, and 4.3b.

Strategy Metrics

- Number of fully accessible habitat units in Merrymeeting Bay SHRU;
- Number of fully accessible habitat units in Penobscot Bay SHRU;
- Number of fully accessible habitat units in Downeast SHRU;

Description

Atlantic salmon require a diverse array of well-connected habitat types in order to complete their life cycle. Historically, the upstream extent of anadromy extended well into the mountainous headwaters of even the largest watersheds of Maine including the West Branch of the Penobscot River, the Carrabasset River in the Kennebec drainage and the Swift River in the Androscoggin basin as well as all the smaller coastal rivers. Today, the upstream migrations are substantially limited by dams and road crossings.

Unfortunately, many of the most productive areas for spawning and rearing are not well connected - either completely or partially inaccessible because of mainstem hydroelectric dams, smaller non-FERC licensed dams, and road crossings.

A strategic approach to reconnecting the most important habitats is urgently needed. To date, most efforts have been opportunistic in nature. A strategic approach that seeks to re-connect the most productive areas in a timely fashion could substantially enhance recovery efforts.

A primary tenet of adaptive management is to evaluate efficacy of management actions using the scientific method. For connectivity restoration projects such as dam removals, funding, to date, has been insufficient to properly assess management actions taken. Hence, one primary focus of the connectivity action team is to emphasize the importance of monitoring in order to inform future management actions. With only 13% of the overall salmon budget, the connectivity action team will not be able to properly assess all restoration projects in the future. Therefore, the assessment strategy will be to select one large scale dam removal (Penobscot Project), one small scale dam removal (Sedgeunkedunk Stream), and one or more culvert replacement project (to be determined) and assess those to a level that clearly addresses a priori hypotheses dealing with salmon migration, fish community assessment, and abiotic conditions. Other assessments are urgently needed on other restoration projects; however, there are insufficient funds available to adequately address all the needs.

Further, at only 13% of the overall salmon budget, we anticipate some level of funding for planning, permitting and feasibility of restoration projects. However, there will be insufficient funds available to support significant amounts of on the ground restoration. Thus in order to conduct restoration activities, the salmon program must actively engage with other partners in order to support this most urgent need.

The focus of the connectivity action team is reconnecting headwater areas that are important for salmon spawning and rearing with the Gulf of Maine. More specifically, there are three categories of actions highlighted as urgently needed:

- Develop a list of barrier priorities for the GOM DPS and begin implementing connectivity restoration projects in a strategic fashion.
- Monitor and report on the effectiveness of connectivity restoration projects.
- Minimize the level of impact and provide incidental take authorization for existing fish passage barriers (such as dams) when appropriate.

Restoring connectivity serves to reduce a number of identified threats to the GOM DPS. Following is a list of threats that are reduced through increased connectivity. Although not exhaustive, the list of threats identified by Fay et

al. (2006) is reasonably thorough. Thus, the following list of threats is derived from appendix 8 in Fay et al. (2006):

- Altered habitat through altered thermal regimes
- Structurally simplified river channels resulting in altered habitat forming processes
- Altered habitat through altered hydrological regimes
- Dams - range curtailment
- Dams - inundating rearing and spawning habitat
- Dams - altered behavioral and physiological cues
- Dams - salmon passage inefficiency
- Dams - altering physical and chemical habitat to favor invasive species
- Dams - altering riverine fish communities and depleted diadromous fish communities
- Dams - alter native resident aquatic communities
- Roads and culverts diminishing passage
- Beaver dams diminishing passage and inundating habitat
- Predation by birds
- Predation and competition by non-native freshwater fish
- Effective population size (through direct mortality caused by upstream and downstream inefficiency)

Thus, restoring connectivity of habitat types concomitantly reduces a number of threats to salmon and therefore offers a cost effective recovery tool (sensu Roni et al. 2002).

Importantly, some of the actions highlighted for implementation do not directly increase the number of accessible habitat units. Several monitoring actions (actions 12-20) are designed to test underlying assumptions regarding the putative effects of dam removal and fish passage improvement. It is important to note, that no peer-reviewed publications make a clear link between dam removal and increased salmon production. Thus, the assumption must be rigorously evaluated in the context of adaptive management. Assessment of several of these individual actions will be a simple consideration of whether or not the action is conducted. This is described in the table below as follows: "Completion (yes/no) to be reported on annually."

Table 3. Connectivity Actions Team's action, descriptions, and implementation schedule.

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
CAT1	**Develop prioritization model to identify highest priority fish passage barriers for remediation** To date, passage barrier remediation efforts have been largely opportunistic. Recent demographic studies show that productivity of freshwater habitat is extremely variable with some watersheds producing many more juveniles per unit area than others. Thus, the goals of this effort are (1) to ensuring that the most productive areas are well connected to each other and to the Gulf of Maine and (2) to prioritize restoration projects based on their biological merits, rather than being selected as opportunities arise. This is not intended to diminish the importance of opportunistic restoration projects as the key to success of nearly any restoration project is collaboration with cooperative stakeholders.	CAT2; CAT3.	NOAA	0.1	8,000	Ongoing	Yes
CAT2	**Write prioritization guidelines to identify highest priority fish passage barriers for remediation** The prioritization model described above must provide a clear and transparent way of assessing the relative biological value of individual restoration opportunities. Thus, the objective of this action is a peer-reviewed manuscript describing the development and implementation of this model.	Completion (yes/no) to be reported on annually	NOAA	0.1	18,000	Ongoing	Yes
CAT3	**Perform fish passage barrier assessments**	Proportion of the	NOAA/	0.1	58,000	Ongoing	Yes

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	throughout the GOM DPS (see Abbot 2008) The prioritization model above requires accurate data regarding the amount of habitat in a watershed both above and below a given barrier as well as the accessibility of a given barrier as it exists without any restorative action. Thus, on the ground barrier surveys are required to measure barrier height and flow characteristics (depth, velocity, etc.) in order to assure that priorities are set using accurate information. To date, much of the Sheepscot, Penobscot, Narraguagus and Machias Rivers have been surveyed.	GOM DPS watersheds that are surveyed.	USFWS				
CAT4	**Provide funding for feasibility analyses for potential fish passage improvement projects** Once potential restoration projects are identified, comprehensive feasibility analyses (including alternatives analyses) are required in order to ensure that a given project has a reasonable likelihood of being completed. These feasibility analyses are typically led by local conservation groups with some technical assistance from consultants.	Number of Habitat units made available annually.	NOAA/ USFWS	0.1	33,000	Ongoing	Yes
CAT5	**Provide funding for engineering studies for potential fish passage improvement projects** Once the feasibility of a given restoration project has been analyzed and deemed appropriate to move forward, the project must be designed by a Professional Engineer (PE). While local conservation groups are often the driving force	Number of habitat units made available annually.	NOAA/ USFWS	0.1	33,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	behind any given project, they must typically hire the services of a PE for these aspects of project implementation.						
CAT6	**Provide funding for permitting for potential fish passage improvement projects** A variety of local, state, and federal regulations must be carefully considered during restoration project implementation. Among other things, this requires application to a variety of regulatory agencies for permits to conduct the project.	Number of habitat units made available annually.	NOAA/ USFWS	0.1	18,000	Ongoing	None
CAT7	**Remove dams according to the prioritization guidelines when feasible** Dam removals are among the most challenging restoration projects. The challenges are social, technical, and regulatory in nature. However, dam removal offers the highest likelihood of reconnecting large amounts of freshwater habitat required for salmon to successfully complete their life history. Dam removals will be accomplished through a variety of agency staff work and funding of external groups.	Number of habitat units made available annually.	NOAA/ USFWS	0.1	8,000	Ongoing	Yes
CAT8	**Remove culverts according to the prioritization guidelines when feasible** Culverts and other road crossings also block the migration of salmon and other migratory fish, particularly in headwater areas where culverts are ubiquitous across the landscape. The effects of known passage barriers can be somewhat ameliorated by culvert removal (often through road de-commissioning), culvert replacement (i.e., resizing to 1.2 bankfull width or greater),	Number of habitat units made available annually.	NOAA/ USFWS	0.1	8,000	Ongoing	Yes

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	or bridge construction.						
CAT9	**Install fishways according to the prioritization guidelines when feasible** In some instances, removal of fish passage barriers (particularly dams) is deemed to be unacceptable at a given site. However, traditional engineered fishways and nature-like fishways (rock ramps, nature-like bypasses, etc.) may be installed to partially ameliorate the effects of a given barrier.	Number of habitat units made available annually.	NOAA/ USFWS	0.1	8,000	Ongoing	Yes
CAT10	**Develop fish passage efficiency targets that do not "jeopardize the continued existence" of the GOM DPS** One of the primary factors leading to the listing of the GOM DPS as endangered is the presence and continued operation of mainstem hydro-electric dams. To date, there has not been a comprehensive demographic analysis of the effects of dams on the survival and recovery potential of the GOM DPS. In order for NMFS to provide take coverage to dam owners, it must first analyze the effects of any given dam on the survival and recovery potential to the GOM DPS as a whole. Thus, developing fish passage efficiency targets is a necessary a necessary first step toward providing incidental take coverage to dam owners.	Completion (yes/no) to be reported on annually	NOAA	2	170,000	Ongoing	Yes
CAT11	**Implement fish passage efficiency targets that do not "jeopardize the continued existence" of the GOM DPS through section 7 and/or section 10** Once fish passage efficiency targets are	CAT17; CAT18	NOAA	3	250,000	Ongoing	Yes

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	developed, NMFS must work with dam owners and other affected stakeholders to implement the targets in the event that they are not presently being met.						
CAT12	**Monumented cross-sectional surveys (per Collins et al. 2007)** Understanding the effectiveness of fish passage barrier removals requires systematic project monitoring and data reporting. Conducting monumented cross-sectional surveys is an important component of project monitoring as described by Collins et al. (2007) in the barrier removal monitoring guidance for the region.	Completion (yes/no) to be reported on annually	NOAA	0.05	4,000	Ongoing	None
CAT13	**Grain size distribution surveys (per Collins et al. 2007)** Understanding the effectiveness of fish passage barrier removals requires systematic project monitoring and data reporting. Conducting grain size distribution surveys is an important component of project monitoring as described by Collins et al. (2007) in the barrier removal monitoring guidance for the region.	Completion (yes/no) to be reported on annually	NOAA	0.05	4,000	Ongoing	None
CAT14	**Photo station surveys (per Collins et al. 2007)** Understanding the effectiveness of fish passage barrier removals requires systematic project monitoring and data reporting. Conducting photo station surveys is an important component of project monitoring as described by Collins et al. (2007) in the barrier removal monitoring guidance for the region.	Completion (yes/no) to be reported on annually	NOAA	0.05	4,000	Ongoing	None
CAT15	**Wetland and riparian plant community**	Completion	NOAA	0.05	4,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	surveys (per Collins et al. 2007) Understanding the effectiveness of fish passage barrier removals requires systematic project monitoring and data reporting. Conducting surveys of wetland and riparian plant communities is an important component of project monitoring as described by Collins et al. (2007) in the barrier removal monitoring guidance for the region.	(yes/no) to be reported on annually					
CAT16	**Fish community structure surveys (see NOAA 2008)** Understanding the effectiveness of fish passage barrier removals requires systematic project monitoring and data reporting. Monitoring the fish community structure before, during, and after project implementation will aid in evaluating if barrier removal leads to changes in resident or diadromous fish communities in terms of abundance, species richness and spatial distribution. This information will be invaluable for evaluating the success or failure barrier removal as a strategy toward restoring the ecosystem upon which salmon depend.	Completion (yes/no) to be reported on annually	NOAA	0.2	196,000	Ongoing	None
CAT17	**Juvenile salmon migration studies (see NOAA 2008)** Understanding the effectiveness of fish passage barrier removals requires systematic project monitoring and data reporting. The most direct way to measure success or failure of a given restoration project is to measure fish movement before and after project implementation.	Completion (yes/no) to be reported on annually	NOAA	0.2	106,000	Ongoing	None
CAT18	**Adult salmon migration studies (see NOAA**	Completion	NOAA/	0.2	26,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	2008) Understanding the effectiveness of fish passage barrier removals requires systematic project monitoring and data reporting. Understanding the effectiveness of fish passage barrier removals requires systematic project monitoring and data reporting. The most direct way to measure success or failure of a given restoration project is to measure fish movement before and after project implementation.	(yes/no) to be reported on annually	Maine DMR				
CAT19	**Water quality surveys (per Collins et al. 2007)** Understanding the effectiveness of fish passage barrier removals requires systematic project monitoring and data reporting. Conducting surveys of water quality is an important component of project monitoring as described by Collins et al. (2007) in the barrier removal monitoring guidance for the region.	Completion (yes/no) to be reported on annually	NOAA	0.05	4,000	Ongoing	None
CAT20	**Benthic macroinvertebrate surveys (per Collins et al. 2007)** Understanding the effectiveness of fish passage barrier removals requires systematic project monitoring and data reporting. Benthic macroinvertebrate surveys are an important component of project monitoring as described by Collins et al. (2007) in the barrier removal monitoring guidance for the region.	Completion (yes/no) to be reported on annually	NOAA	0.05	4,000	Ongoing	None
CAT21	**Enumeration of salmon spawning habitat made available as a result of the restoration** In order to evaluate progress toward achieving	Number of habitat units to b e reported on Annually	NOAA	0.05	4,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	the strategy level objectives (30,000 habitat units), progress toward the objective must be measured and reported annually. Measurements toward the objective will be made using GIS habitat models including the amount of habitat made available as a result of restoration projects annually.						
CAT22	**Enumeration of salmon rearing habitat made available as a result of the restoration** In order to evaluate progress toward achieving the strategy level objectives (30,000 habitat units), progress toward the objective must be measured and reported annually. Measurements toward the objective will be made using GIS habitat models including the amount of habitat made available as a result of restoration projects annually.	Number of habitat units to b e reported on annually	NOAA	0.05	4,000	Ongoing	None

Genetic Diversity Action Team

Strategy

Maintain the genetic diversity of Atlantic salmon populations in over time

Strategy Metric

Estimates of genetic diversity (e.g., allelic variation, heterozygosity) based on comparable suites of molecular markers will be assessed and monitored over time.

Description

Maintenance of genetic diversity and the preservation of the genetic structure present in Atlantic salmon is a critical component to the restoration and recovery of Atlantic salmon in Maine. The Genetic Diversity Action Team (GDAT) has identified a variety of actions important to include as part of the broader management efforts for Atlantic salmon in Maine. Actions identified by the GDAT relate to three primary focus areas: monitoring genetic diversity, evaluating hatchery practices and products, and monitoring to detect aquaculture Atlantic salmon. Actions identified are consistent with the Broodstock Management Plan, and expand to include additional research needs, monitoring of weirs for aquaculture-origin salmon, and to monitor the effectiveness of the Aquaculture Biological Opinion.

In total, 27 actions have been identified by the GDAT to be implemented and assessed for Atlantic salmon recovery and restoration in Maine. As a result of incorporating additional actions and collating to the suite of actions implemented by the GDAT, an increase in the allocation of available resourcing from 5% under past management structure to 8% of available resourcing (FTEs=6.15, $696,500).

Many of the GDAT actions identified are specified in the Broodstock Management Plan (Bartron et al. 2006). Therefore, most actions are currently undertaken to maintain genetic diversity within the Atlantic salmon program and reduce risks associated with captive breeding programs and are critical to the recovery process. Actions identified by the GDAT provide additional monitoring and evaluation of hatchery management practices, including improving abilities to evaluate performance (survival) of hatchery products in the wild. Actions added will increase evaluations of fitness and performance which will help determine how hatchery production is contributing to restoration activities. For example, genetic parentage analysis is be used to assess the composition of hatchery versus natural origin individuals within adult and parr broodstock collections. Other actions added to the GDAT collate all monitoring activities of aquaculture permits, genetic screening of broodstock for stray aquaculture-origin individuals, and operating weirs on the Dennys River, or in emergency situations in response to an escape event.

The strategy used to assess the overall outcome of the actions identified by the GDAT is the maintenance of genetic diversity over time. The metrics used to measure the effectiveness of the strategy are estimates of genetic diversity, including allelic variability (i.e. number of alleles per locus, allelic diversity), and heterozygosity. These estimates are obtained through the use of a comparable suite of molecular markers that are consistently used to monitor diversity over time. Loss of genetic diversity could be due to inbreeding, small population sizes, or artificial selection. Assessment and reporting schedules for most of the GDAT actions are specified as part of the Broodstock Management Plan (Bartron et al. 2006), or are part of the Aquaculture Biological Opinion. Although many actions are identified to be initiated in 2011, many are already part of Atlantic salmon restoration and recovery activities. Because the actions identified by the GDAT provide information and strategies to manage against loss of genetic diversity, implementation of these actions should help to maintain genetic diversity of Atlantic salmon populations in Maine over time.

The GDAT works closely with the other action teams to evaluate and implement management practices that are consistent with maintenance of genetic diversity. Although the GDAT focuses evaluation efforts at the hatchery facilities, genetic methods can be utilized to evaluate of hatchery products in the wild, monitor contribution of natural reproduction by hatchery and wild Atlantic salmon, and as a marking tool to evaluate management practices and habitat utilization.

Literature Cited

Bartron, M.L., D. Buckley, T.L. King, T. King, M. Kinnison, G. Mackey, and T. Sheehan. 2006. Captive Broodstock Management Plan for Atlantic salmon at Craig Brook National Fish Hatchery. Report to Maine Technical Advisory Committee.

Table 4. Genetic Diversity Action Team's action, descriptions, and implementation schedule.

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
Genetic monitoring							
GDAT1	**Use genetic methods to annually characterize parr and sea-run adults (fundamental action)** This action must be accomplished to allow many of the other actions listed to be carried out because it provides the genetic data necessary for further analyses.	Follow procedures outlined in Broodstock Management Plan	USFWS	2.0	197,500	Ongoing	None
GDAT2	**Monitor broodstocks for evidence of genetic diseases or deleterious genetic traits** Evaluate broodstock (parr and adult) for expression of traits, such as reduced fecundity, poor survival of fertilized eggs, or increased proportion of deformities in offspring. Expression of these traits could indicate negative effects of inbreeding, or the increased expression of rare traits.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	9,000	Ongoing	None
GDAT3	**Genetically assess consequences of alternate stocking strategies for multiple life history stages** Use genetic tools and techniques to evaluate alternate stocking strategies, such as stocking pre-spawn adults or alternate life stages. Genetic tools can be used to evaluate if reproduction by pre-spawn adults is successful through genetic analysis of potential offspring and parentage assignment, or by stocking unique family batches of different life stages for mark and	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	9,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	recapture purposes.						
GDAT4	**Prioritize current genetic data analysis needs with respect to current and long-term management goals** Given limited funding, annual assessment of priorities for genetic analysis is important to determine that annual monitoring needs are completed and to prioritize additional needs based on needed application of genetic methods for monitoring, assessment, or evaluation of ongoing studies or programs.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	4,000	Ongoing	None
GDAT5	**Evaluate if certain program components are missing (gap analysis) in regards to genetic goals of the program.** Examine existing data and the ability for that data to provide information to overall genetic assessment needs of the program to determine if additional areas of focus are needed. This assessment can include review of literature to identify new tools, techniques, or analyses that if applied to the Maine Atlantic salmon program could provide additional insight into the restoration program.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	6,500	Ongoing	None
GDAT6	**Monitor estimates of genetic diversity of the wild or naturally reproducing Atlantic salmon (for currently defined hatchery program / DPS and Penobscot)** Monitor estimates of genetic diversity of the wild or naturally reproducing Atlantic salmon for the currently defined hatchery program.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.1	13,000	Ongoing	None
GDAT7	**Use genetic determination of parentage**	Follow procedures	USFWS		2,500	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	to identify percentage of families recovered from stocking events, and monitor yearly to evaluate broodstock collection practices. Use genetic determination of parentage to identify percentage of hatchery families recovered during broodstock collection efforts. These analyses will be monitored yearly to evaluate broodstock collection practices of the representation for hatchery genetics.	outlined in Broodstock Management Plan					
GDAT8	I**mprove management of data resulting from production, stocking, and genetic evaluation to facilitate program assessment and monitoring** This includes database management and development, annual updating and evaluations.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	6,500	Ongoing	None
GDAT9	**Continually monitor critical trait variation (quantitative, morphometric, other physical trait) to assess risks of inadvertent selection.** Continually monitor critical trait variation (quantitative, morphometric, other physical trait) to assess risks of inadvertent selection.	Follow procedures outlined in Broodstock Management Plan	USFWS		5,000	Ongoing	None
GDAT10	**Use 2-phased criteria to assess if spawning optimization program effectively reduces potential for inbreeding.** Use 2-phased criteria to assess if spawning optimization program effectively reduces potential for inbreeding identified in the Broodstock Management Plan.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	9,000	Ongoing	None
GDAT11	**Use 3-phased criteria (relatedness,**	Follow procedures	USFWS	0.05	9,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	inbreeding, and limited population size) to determine if spawning populations within or between capture years is needed. Use 3-phased criteria (relatedness, inbreeding, and limited population size) to determine if spawning populations within or between capture years is needed as identified in the Broodstock Management Plan.	outlined in Broodstock Management Plan					
Evaluation of hatchery practices and product							
GDAT12	**Optimize practices to reduce risks of inadvertent selection that might reduce fitness in the wild** Use genetic monitoring data to evaluate if hatchery practices (including spawning, stocking, or rearing) are resulting in artificial selection. This would be observed by increased rates of decreased allelic diversity.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	9,000	Ongoing	None
GDAT13	**Utilize broodstock database to track spawning history for all salmon held for broodstock purposes and implement spawning protocols described in the Broodstock Management Plan** Continue to implement the spawning protocols identified in the Broodstock management plan, specifically to continue the use of the Access-database developed at CBNFH to track, monitor, and document all spawning activities at CBNFH.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	9,000	Ongoing	None
GDAT14	**Implement stocking practices that broadly distribute genetic groups (families) throughout the stocking sites**	Follow procedures outlined in Broodstock	USFWS		2,500	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	Work with hatchery staff and biologists to ensure that individual families are batched into larger groups so that when stocked, each site is stocked with representatives from as many families as possible. Broadly distributing the genetic diversity of each broodstock throughout its drainage will increase the likelihood of maintaining genetic diversity over time.	Management Plan					
GDAT15	**Implement pedigree lines if demographic, family recovery, aquaculture escape event, or other parameter limits the potential collection of a broodstock year class** Pedigree lines involve the retention at the hatchery of individuals from each family created within a broodstock for a given spawn year. Parr from the same spawn year are still captured from the wild, and the family information is obtained genetically from both the "captive" parr and "domestic" parr to assess individual family representation for the future broodstock. Pedigree lines will continue to be implemented based if a specific broodstock meets the implementation criteria.	Genetic diversity within each broodstock will be monitored to determine if pedigree lines should be continued	USFWS	0.1	23,000	Ongoing	None
GDAT16	**Maintain and enhance as applicable the genetic viability of river-specific broodstocks for supplementation according to the Broodstock Management Plan** Implement the practices as identified	Follow procedures outlined in Broodstock Management Plan	USFWS	0.1	10,500	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	Broodstock Management Plan to maintain genetic diversity for each broodstock, including incorporation of parr that are not assigned to hatchery broodstocks as long as those individuals had passed screening requirements.						
GDAT17	**Link hatchery production parameters (i.e.. Changes in fecundity, broodstock reproducing, etc.) to genetic characteristics of the broodstocks to assist in monitoring of fitness.** Link hatchery production parameters (i.e.. Changes in fecundity, broodstock reproducing, etc.) to genetic characteristics of the broodstocks to assist in monitoring of fitness	Follow procedures outlined in Broodstock Management Plan	USFWS	0.1	10,500	Ongoing	None
GDAT18	**Implement collection practices that obtain representative genetic variation (i.e. majority of artificial and wild spawned families), including widespread field collection-Juveniles for DPS parr collections for current parr program** Implement recommendations identified in the Broodstock Management Plan and work with broodstock collectors to ensure that broodstock collection practices obtain representative genetic variation from each population. This would include collecting the majority of artificial and wild spawned families, and would include widespread field collection for the parr collection programs.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	9,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	Funding is provided for developing guidelines and recommendations, and working with staff to make sure these guidelines are understood and implemented.						
GDAT19	**Evaluate the genetic implications of collecting adult fish for captive propagation versus wild reproduction.** Evaluate the genetic implications of collecting adult fish for captive propagation versus potential offspring of wild reproduction in the parr collections, for allowing for increased natural escapement.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	9,000	Ongoing	None
GDAT20	**Evaluate and optimize grading practices to reduce genetic selection (initial emphasis on grading for smolt production)** Use genetic tools and techniques to evaluate grading practices to determine if these practices are reducing the genetic variability being stocked at different life stages. This action can also help to determine if there is a genetic basis (using parentage analysis) to differences in growth rates.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.05	9,000	Ongoing	None
GDAT21	**Implement collection practices that obtain representative genetic variation (i.e. majority of artificial and wild spawned families), including widespread field collection-Adults for collection of adult returns to the Penobscot for broodstock** This action focuses on collection of adults returns to the Penobscot for broodstock.	Follow procedures outlined in Broodstock Management Plan	USFWS	0	5,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	Funding is provided for developing guidelines and recommendations, and working with staff to make sure these guidelines are understood and implemented.						
GDAT22	**Experimental genetic analyses and projects for increased hatchery evaluation** Develop and complete additional genetic analyses and provide genetic analysis to support projects for evaluate hatchery production of Atlantic salmon.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.75	95,000	Ongoing	None
GDAT23	**Consider options to evaluate, improve, and enhance the hatchery product and broodstock management practices in experimental environments outside of hatchery production requirements** Use existing data to consider options to evaluate, improve, and enhance the hatchery product and broodstock management practices in experimental environments outside of hatchery production requirements. This action would provide for genetic analysis to support studies that require genetic analysis to identify individuals stocked as part of experimental studies.	Follow procedures outlined in Broodstock Management Plan	USFWS	0.5	70,000	Ongoing	None
Monitoring of aquaculture							
GDAT24	**Screen incoming parr and adults for aquaculture escapees.** Use the genetic screening practices identified in the Broodstock Management Plan to screen incoming parr and adults for aquaculture	Follow procedures outlined in Broodstock Management Plan	USFWS	0.1	13,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	escapees. This work is completed annually by the FWS Conservation Genetics Lab for both parr and adult collections, and results are provided to CBNFH prior to spawning.						
GDAT25	**Monitor effectiveness of Aquaculture Biological Opinion (including site inspections, audits, etc)** Monitor effectiveness of Aquaculture Biological Opinion (including site inspections, audits, etc). This action provides for funding to cover staff that provide permit review and implementation as required by the Aquaculture Biological Opinion.	Ensure that permits, inspections, and audits are proceeding according to schedule.	USFWS/ NOAA	0.8	64,000	Ongoing	None
GDAT26	**Prevent aquaculture adults from entering rivers with existing trapping facilities and using emergency methods when large escapes occur and trapping is possible** Prevent aquaculture adults from entering rivers with existing trapping facilities and using emergency methods when large escapes occur and trapping is possible. This funding would provide for additional staff and supplies needed to coordinate and monitor when needed large aquaculture escape events. Generally the funding needed to support these efforts is low (hence listed at minimum resourcing).	If escape occurs, assess number of aquaculture origin individual in rivers	Maine DMR	0.25	25,000	Ongoing	Yes
GDAT27	**Operate the Denny's weir for the preemptive purpose of excluding aquaculture Atlantic salmon.** Given the	Assessment of number of adults that were able to	Maine DMR	0.75	62,000	Ongoing	Yes

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	proximity to the Dennys River to aquaculture operations, this action would provide funding to continue to operate the Denny's weir for the preemptive purpose of excluding aquaculture Atlantic salmon.	pass the weir when it was in place or prior to when the weir was put in place					

Conservation Hatchery Action Team

Strategy

Increase Adult Spawners through the Conservation Hatchery Program

Strategy Metric

Adult return per egg equivalent, reported by SHRU (salmon habitat recovery unit)

Description

The goal of the Conservation Hatchery Action Team (CHAT) is to increase adult spawners through the conservation hatchery program (CHP). Programs currently implemented include: fish health management (fish health inspections, screening, diagnostics and treatment, and surveillance), brood stock management (Penobscot River sea-run and domestic brood programs, and the captive brood program for the Sheepscot, Narraguagus, Pleasant, Machias, East Machias, and Dennys Rivers), and juvenile production (various life stage and stocking strategies for each population held in the CHP). These programs have been effective in preventing river specific populations from becoming extirpated, and have also maintained river specific effective population size, ensured healthy and disease free hatchery populations, maintained a sustainable source of parr for the captive brood program, and returned sufficient numbers of Penobscot River adults to sustain the sea-run brood program.

In the 5 year CHAT implementation plan, the CHP continues to provide these programs, as well as consolidate and streamline the in-stream hatchery product monitoring and assessment programs. An additional assessment project is added to provide for a quality measure of hatchery production. Better integration of the CHP and hatchery product assessment will improve project feedback and enhance adaptive management capacity. The CHAT proposes new projects that move production projects towards realizing greater natural spawning occurrence in the wild. Examples include ceasing fry stocking in the Dennys River and instead releasing pre-spawn captive adults into quality habitat; and reducing fry stocking on the Penobscot River and allowing more sea-run adults to spawn naturally. The CHAT also proposes a new smolt stocking and assessment project on the Penobscot River that includes river imprinting, direct estuary release, and seawater acclimatization, which has the potential to dramatically increase smolt to adult survival.

Table 5. Conservation Hatchery Action Team's action, descriptions, and implementation schedule.

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
Hatchery Operations							
CHAT1	**Conduct annual Fish Health Inspections** Lamar Fish Health Center completes health screening for representative samples of all fish hatchery populations prior to stocking to ensure hatchery products are healthy and disease free. Includes resources for staff time and supplies	Compliance with the Service Fish Health Policy; Annual fish health inspections completed to detect the presence of fish pathogens in captive reared stocks in federal fish hatcheries. Maine Atlantic Salmon Conservation Plan Conduct fish health sampling on Atlantic salmon fry parr and smolts	USFWS (Lamar)	0.10	16,000	Ongoing	Mention Website?
CHAT2	**Conducts surveillance of Infectious Salmon Anemia Virus in sea-run brood** All sea-run Penobscot brood brought to Craig Brook National Fish Hatchery (NFH) are screened for ISAV before being mixed with fish that have previously passed screening and found to be free of ISAV. Suspect fish are not used for hatchery brood and are removed from the hatchery population. This is a mitigation measure that decreases risk from the entire hatchery population to small sub-groups. Includes staff and operating costs for	Maine Atlantic Salmon Restoration and Management Plan,1983 Manage fish health and disease Fishery Mgt Plan for Atlantic Salmon: Incorporating an Environmental Assessment and Regulatory Impact Review Conduct varied research projects to	USFWS (CBNFH)	0.20	41,000	Ongoing	Mention Website?

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	Lamar Fish Health Center and Craig Brook NFH	gain additional information on the biology of salmon USFWS Fish Health Policy Develop more comprehensive, accurate, and sensitive diagnostic methods to detect regulated fish pathogens in cultured fish species including cold, cool, and warm water culture programs.					
CHAT3	**Fish health diagnostics** Lamar Fish Health Center provides real-time fish health diagnostic services for any hatchery population whenever hatchery staff is suspicious of potential disease issues. Includes resources for staff time and supplies	USFWS Fish Health Policy Develop more comprehensive, accurate, and sensitive diagnostic methods to detect regulated fish pathogens in cultured fish species including cold, cool, and warm water culture programs; Conduct diagnostic cases as needed on fish hatcheries and holding facilities. AFS Fish Health	USFWS (Lamar)	0.20	16,000	Ongoing	Mention Website?

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
		Bluebook					
CHAT4	**Provide therapeutic and prophylactic treatment recommendations for optimum fish health** Lamar Fish Health Center provides real-time expertise on the treatment and prevention of pathogenic and environmental fish health issues. Includes resources for staff time and supplies	U.S. food and drug Administration, USFWS AADAP Program; USFWS Fish Health Policy Develop hatchery management techniques and protocols	USFWS (Lamar)	0.10	16,000	Ongoing	Mention Website?
CHAT5	**Review and implement biosecurity plan** Hatchery staff coordinates with staff from Lamar Fish Tech Center and Fish Health Center to ensure biosecurity plan is up to date, effective, feasible, and implemented. Includes resources for staff time and supplies.	Follow procedures outlined in biosecurity plan.	USFWS (CBNFH, GLNFH)	0.10	16,000	Ongoing	Mention Website?
CHAT6	**Screen all gametic fluids taken during broodstock spawning** Lamar Fish Health Center screens sexual fluid from every fish spawned at the hatchery in order to identify and prevent the vertical transmission of disease between brood and progeny. Includes resources for staff time and supplies	USFWS Fish Health Policy; Annual fish health inspections completed to detect the presence of fish pathogens in captive reared stocks in federal fish hatcheries	USFWS (Lamar)	0.10	16,000	Ongoing	Mention Website?
CHAT7	**Screen all non-fry mortality for pathogens at Craig Brook NFH** Lamar Fish Health Center provides mortality screening services for all brood fish populations at Craig Brook NFH in an effort to identify and control any	USFWS Fish Health Policy Develop more comprehensive, accurate, and sensitive diagnostic methods to	USFWS (Lamar)	0.10	31,000	Ongoing	Mention Website?

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	undetected disease outbreaks before they escalate. Includes resources for staff time and supplies	detect regulated fish pathogens in cultured fish species including cold, cool, and warm water culture programs; Conduct diagnostic cases as needed on fish hatcheries and holding facilities. American Fisheries Society Fish Health Bluebook					
Hatchery Production							
CHAT8	**Maintain captive brood for Dennys** A captive brood population for the Dennys River is maintained at Craig Brook NFH for the purpose of providing a guaranteed egg source, maintaining effective population size, and preventing inbreeding depression. Captive brood are fish that spent at least 1.5 years in the wild from the feeding fry stage to the large parr stage, and can also include fish from natural spawning in the river. At any given time, either four or five brood year classes are in captivity at the hatchery. Includes staff and operating costs for parr collection and hatchery operations	Follow procedures outlined in Broodstock Management Plan. Annual report to U.S. Atlantic Salmon Assessment Committee	USFWS (CBNFH)	0.55	71,000	Ongoing	CBNFH Visitor Center
CHAT9	**Maintain captive brood for East Machias** A captive brood population for the East	Follow procedures outlined in Broodstock Management Plan.	USFWS (CBNFH)	0.55	71,000	Ongoing	CBNFH Visitor Center

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	Machias River is maintained at Craig Brook NFH for the purpose of providing a guaranteed egg source, maintaining effective population size, and preventing inbreeding depression. Captive brood are fish that spent at least 1.5 years in the wild from the feeding fry stage to the large parr stage, and can also include fish from natural spawning in the river. At any given time, either four or five brood year classes are in captivity at the hatchery. Includes staff and operating costs for parr collection and hatchery operations.	Annual report to U.S. Atlantic Salmon Assessment Committee					
CHAT10	**Maintain captive brood for Machias** A captive brood population for the Machias River is maintained at Craig Brook NFH for the purpose of providing a guaranteed egg source, maintaining effective population size, and preventing inbreeding depression. Captive brood are fish that spent at least 1.5 years in the wild from the feeding fry stage to the large parr stage, and can also include fish from natural spawning in the river. At any given time, either four or five brood year classes are in captivity at the hatchery. Includes staff and operating costs for parr collection and hatchery operations	Follow procedures outlined in Broodstock Management Plan. Annual report to U.S. Atlantic Salmon Assessment Committee	USFWS (CBNFH)	0.55	71,000	Ongoing	CBNFH Visitor Center
CHAT11	**Maintain captive brood for Narraguagus** A captive brood population for the Narraguagus River is maintained at Craig	Follow procedures outlined in Broodstock Management Plan. Annual report to U.S.	USFWS (CBNFH)	0.55	71,000	Ongoing	CBNFH Visitor Center

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	Brook NFH for the purpose of providing a guaranteed egg source, maintaining effective population size, and preventing inbreeding depression. Captive brood are fish that spent at least 1.5 years in the wild from the feeding fry stage to the large parr stage, and can also include fish from natural spawning in the river. At any given time, either four or five brood year classes are in captivity at the hatchery. Includes staff and operating costs for parr collection and hatchery operations	Atlantic Salmon Assessment Committee					
CHAT12	**Maintain captive brood for Pleasant** A captive brood population for the Pleasant River is maintained at Craig Brook NFH for the purpose of providing a guaranteed egg source, maintaining effective population size, and preventing inbreeding depression. Captive brood are fish that spent at least 1.5 years in the wild from the feeding fry stage to the large parr stage, and can also include fish from natural spawning in the river. At any given time, four or six brood year classes are in captivity at the hatchery. Includes staff and operating costs for parr collection and hatchery operations.	Follow procedures outlined in Broodstock Management Plan. Annual report to U.S. Atlantic Salmon Assessment Committee	USFWS (CBNFH)	0.55	71,000	Ongoing	CBNFH Visitor Center
CHAT13	**Maintain captive brood for Sheepscot** A captive brood population for the Sheepscot River is maintained at Craig Brook NFH for the purpose of providing a guaranteed egg source, maintaining	Follow procedures outlined in Broodstock Management Plan. Annual report to U.S. Atlantic Salmon	USFWS (CBNFH)	0.55	71,000	Ongoing	CBNFH Visitor Center

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	effective population size, and preventing inbreeding depression. Captive brood are fish that spent at least 1.5 years in the wild from the feeding fry stage to the large parr stage, and can also include fish from natural spawning in the river. At any given time, either four or five brood year classes are in captivity at the hatchery. Includes staff and operating costs for parr collection and hatchery operations	Assessment Committee					
CHAT14	**Maintain Penobscot domestic brood** A domestic brood population for the Penobscot River is maintained at Green Lake NFH for the purpose of serving as a backup population for the sea-run population. Domestic brood are fish that have never spent any time in the wild, and are sourced from the Penobscot River smolt program. At any given time, three to five year classes are being held at the hatchery	Follow procedures outlined in Broodstock Management Plan. Annual report to U.S. Atlantic Salmon Assessment Committee	USFWS (GLNFH)	0.10	18,000	Ongoing	Mention Website?
CHAT15	**Produce Penobscot F2 eggs as backup source** Approximately 1.3 million green Penobscot eggs are produced at Green Lake NFH from domestic brood fish each year as a backup to the sea-run Penobscot eggs produced at Craig Brook NFH. The program has had to use these products on several occasions to prevent production short falls	Follow procedures outlined in Broodstock Management Plan. Annual report to U.S. Atlantic Salmon Assessment Committee.	USFWS (GLNFH)	0.25	30,000	Ongoing	Mention Website?
CHAT16	**Stock adult spent broodstock into**	No assessment needed.	USFWS	0.20	26,000	Ongoing	Remind

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	river of origin All spent hatchery brood, with a few exceptions due to research projects, get released back into their river of origin. Includes staff and operational costs, and stocking	Occasional to trapping facilities	(CBNFH, GLNFH)				Public
CHAT17	**Stock eggs via Artificial redd in Kennebec (Sandy River)** Eyed eggs are taken from Green Lake NFH and planted in artificial redds in the Sandy River, a large tributary of the Kennebec River. The eggs are Penobscot River F2 produced from the backup domestic brood population, and can number up to approximately 800,000. This action is the 2nd highest priority conservation use for these eggs. This project is the primary stocking strategy for the Sandy River, and the goal is to produce juvenile that is in better synchrony with environmental conditions that is subjected to less domestication pressure than a comparable fry stocked product. Includes resources for staff and operations for stocking and assessment	Fry trapping and juvenile population assessments. Objective: meet or exceed survival and abundance of natural reproduction.	Maine DMR	0.20	26,000	Ongoing	
CHAT18	**Stock fry in Dennys** Craig Brook NFH produces approximately 400,000 fry for release into the Dennys River. Includes resources for hatchery staff and operations, and stocking	Assess through juvenile population estimates and adult returns. Objective: produce enough 1 and 2+ parr to support the broodstock program	USFWS (CBNFH)	0.80	81,000	2011-2012	CBNFH Visitor Center

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
CHAT19	**Stock fry in East Machias** Craig Brook NFH produces approximately 200,000 fry for release into the East Machias River. Includes resources for hatchery staff and operations, and stocking	Assess through juvenile population estimates and adult returns. Objective: produce enough 1 and 2+ parr to support the broodstock program	USFWS (CBNFH)	0.80	81,000	Ongoing	CBNFH Visitor Center
CHAT20	**Stock fry in Machias** Craig Brook NFH produces approximately 500,000 fry for release into the Machias River. Includes resources for hatchery staff and operations, and stocking.	Assess through juvenile population estimates and adult returns. Objective: produce enough 1 and 2+ parr to support the broodstock program	USFWS (CBNFH)	0.80	81,000	Ongoing	CBNFH Visitor Center
CHAT21	**Stock fry in Narraguagus** Craig Brook NFH produces approximately 500,000 fry for release into the Narraguagus River. Includes resources for hatchery staff and operations, and stocking	Assess through juvenile population estimates and adult returns. Objective: produce enough 1 and 2+ parr to support the broodstock program	USFWS (CBNFH)	0.80	81,000	Ongoing	CBNFH Visitor Center
CHAT22	**Stock fry in Penobscot (sea-run brood)** Penobscot sea-run brood are utilized as the preferred source of all Penobscot hatchery products. Sea-run brood are captured in the river and brought to Craig Brook NFH for holding until spawn. Includes staff and operational costs for operating the Veazie fish trap, transporting brood to hatchery, and hatchery operations such as existing fry	Assess through juvenile population estimates and adult returns. Objective: produce enough 1 and 2+ parr to support the broodstock program	USFWS (CBNFH)	2.25	230,000	2011-2012	Remind Public

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	stocking operation, which has produced anywhere from 1 to 1.75 million fry recent years.						
CHAT23	**Stock fry in Pleasant** Craig Brook NFH produces approximately 100,000 fry for release into the Pleasant River. Includes resources for hatchery staff and operations, and stocking	Assess through juvenile population estimates and adult returns. Objective: produce enough 1 and 2+ parr to support the broodstock program	USFWS (CBNFH)	0.80	81,000	Ongoing	CBNFH Visitor Center
CHAT24	**Stock fry in Sheepscot** Craig Brook NFH produces approximately 200,000 fry for release into the Sheepscot River. Includes resources for hatchery staff and operations, and stocking	Assess through juvenile population estimates and adult returns. Objective: produce enough 1 and 2+ parr to support the broodstock program	USFWS (CBNFH)	0.80	81,000	Ongoing	CBNFH Visitor Center
CHAT25	**Stock parr 350,000 0+ into the Penobscot** Green Lake NFH produces 350,000 advanced 0 year old graded parr for fall release into the Penobscot River. These fish are a by-product of the smolt program, but treated as a valuable bonus for the conservation stocking program. Includes resources for hatchery staff and operations, and stocking.	Assess through smolt trapping and adult returns/ escapement. Objective: increase adult returns to Veazie to exceed CSE	USFWS (GLNFH)	2.50	355,000	Ongoing	GLNFH
CHAT26	**Stock parr in Sheepscot** Craig Brook NFH produces 15,000 ambient 0 year old ungraded parr for release into the Sheepscot River. Includes resources for hatchery staff and operations, and	Assess through smolt trapping and adult returns/ escapement. Objective: increase adult escapement to	USFWS (CBNFH)	0.10	18,000	Ongoing	CBNFH Visitor Center

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	stocking.	exceed CSE					
CHAT27	**Stock smolts 50,000 1+ / 1+ parr into the Narraguagus** Green Lake NFH produces 50,000 advanced 1 year old ungraded smolt (a small component are parr and remain in river for an additional year) for release into the Narraguagus River. Includes resources for hatchery staff and operations, and stocking	Assess through smolt trapping and adult returns/ escapement. Objective: increase adult escapement to exceed CSE	USFWS (GLNFH)	0.25	45,000	2011-2012	GLNFH
CHAT28	**Stock smolts 50,000 1+ smolt / 1+ parr into the Pleasant** Green Lake NFH produces 50,000 advanced 1 year old ungraded smolt (a small component are parr and remain in river for an additional year) for release into the Pleasant River. Includes resources for hatchery staff and operations, and stocking.	Assess through smolt trapping and adult returns/ escapement. Objective: increase adult escapement to exceed CSE	USFWS (GLNFH)	0.25	45,000	2013-2015	GLNFH
CHAT29	**Stock smolts 550,000 1+ into the Penobscot** Green Lake NFH produces 550,000 advanced 1 year old graded smolt for release into the Penobscot River. Includes resources for hatchery staff and operations, and stocking	Assess through adult returns to Veazie trap. Objective: increase adult escapement to exceed CSE	USFWS (GLNFH)	4.00	635,000	Ongoing	GLNFH
CHAT30	**Stock 750K fry in Penobscot; balance of sea-run adult spawn naturally** Craig Brook NFH produces 750,000 fry for the Penobscot River, and allows the balance of sea-run brood not used for hatchery production to spawn naturally.	Assess through juvenile population estimates and adult returns to Veazie trap. Objective: increase adult escapement to exceed	USFWS (CBNFH)	1.50	195,000	2013-2015	CBNFH Visitor Center

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	The naturally spawning brood can either be allowed to swim the river, be trucked to suitable spawning habitat, brought to the hatchery and held to just before spawn and trucked to suitable spawning habitat, or any combination of the options. This action replaces the existing fry stocking operation, which has produced anywhere from 1 to 1.75 million fry recent years. Includes resources for hatchery staff and operations, as well as fry stocking costs. Adult translocation costs are covered within Current Program: release spent broodstock into river of origin	CSE					
CHAT31	**Stock gravid adults (no fry) in Dennys** Craig Brook NFH will stock gravid captive brood fish into suitable high quality spawning habitat in the Dennys River. This action replaces the traditional fry stocking program, and relies solely on natural spawning to sustain the Dennys population (captive and domestic backup brood populations will be in place at the hatchery during initial implementation). Includes resources for hatchery staff and operations, and stocking	Assess through extensive spawners, acoustic tracking, juvenile population estimates and abundance of 1 and 2+ parr and resulting sea-run adults. Objective: increase adult escapement to exceed CSE	USFWS (CBNFH)	0.80	81,000	2012-2015	
Assessment Actions							
CHAT32	**Mark significant number of smolt / parr releases** A representative sample of smolt and parr being produced at Green Lake NFH are	Assess return rates at trapping facilities. Enable managers to better determine origin	NOAA	1.00	130,000	Ongoing	

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	marked for positive identification as returning adults (both for production / stocking assessments and research projects). Currently, approximately 33% of the Penobscot smolt production receives a VIE mark, 100% of Narraguagus and Pleasant River smolt receive a VIE mark, and between 50 – 100% of Penobscot parr receive a fin clip. This action maintains current marking levels. Includes resources for tagging staff, materials, and operations	of salmon and make decisions on areas of focus.					
CHAT33	**Smolt migration / production assessment program** This action aims to enumerate smolt emigration from freshwater rearing habitats. This information is used to assess freshwater habitat productivity, hatchery product survival from fry through smolt, and provides the basic information needed to calculate smolt to adult survival. The primary method is trapping with rotary screw traps. Includes resources for staff and operations	Determine abundance and origin of out migrating smolts. Objective: to gain a population estimate on out migrating smolts.	Maine DMR	1.50	160,000	Ongoing	
CHAT34	**Smolt release utilizing imprinting and seawater acclimation** Green Lake NFH transports and ponds approximately 30,000 VIE marked Penobscot smolt to the West Enfield Dam smolt ponds for river water imprinting, then transports and stocks these imprinted smolt directly into the estuary.	Assess the seaward movement pattern of imprinted smolt group relative to smolts stocked using standard practices. (45 imprinted smolts and 255 natural and	USFWS (GLNFH)	0.20	41,000	Ongoing	

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	This action continues this stocking and assessment project and adds short-term net-pen holding in the estuary to acclimate the smolt to seawater conditions. The project aims at increasing smolt to adult survival, and assesses which treatment produces the highest survivals; conventional in-river smolt stocking, direct estuary release of imprinted smolt, or seawater acclimated imprinted smolt. Includes resources for hatchery staff and operations, stocking, and assessment	hatchery reared smolts tagged with acoustic transmitters) 100 acoustic receivers throughout the lower Penobscot River will track movement patterns. Assess the return rate of adults from imprinted smolts relative to smolts stocked through standard stocking practices. Objective: to increase SAR (smolt-to-adult return rate).					
CHAT35	**Develop and implement in-hatchery product assessment program** This action aims to develop and implement a hatchery product assessment program that quantifies and assesses the quality of hatchery products prior to release into the wild. The focus will be on describing and developing metrics for physiological, morphological, and behavioral hatchery product traits, so that they can be clearly defined and more successfully manipulated to a condition that maximizes juvenile survival in the wild. Includes resources for staff and operations	To be determined	USFWS	0.50	90,000	2013-2015	
CHAT36	**In-stream fry and parr assessment**	Stock assessment work	USFWS/	2.50	275,000	Ongoing	

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	program This action is the primary monitoring and assessment program for the conservation hatchery stocking program, providing freshwater life stage monitoring so as to assess hatchery product success to specific benchmarks in the wild. This action also covers substantial wild (progeny of natural spawning) production monitoring, since these fish are captured while sampling for hatchery products, although it is often impossible to distinguish the wild from hatchery products at these life stages. The objective of this action is to explicitly tie specific monitoring tasks to hatchery stocking practices, to assess the success of the different strategies of the program. Includes resources for staff and operations	done through electrofishing estimates and smolt trapping. Allows for evaluation of management actions.	Maine DMR				

Freshwater Action Team

Strategy

Increase adult spawners through the freshwater production of smolts

Strategy Objectives

- Increase our understanding of factors that limit juvenile Atlantic salmon survival
- Develop a process and infrastructure to identify and implement habitat restoration projects
- Protect and conserve productive Atlantic salmon Habitat

Strategy Metrics

- Population estimates of smolt production at index rivers
- Catch-per-unit-effort of large parr based on a stratified random sampling design
- Distribution and abundance of redds (Stock Assessment action)
- Counts of wild adult returns at index rivers (Stock Assessment action)

Description

The Freshwater Action Team is charged with increasing adult spawners through the freshwater production of smolts. By increase the freshwater production of smolts you will increase in adult returns, assuming marine survival remains constant and that juvenile densities do not exceed a threshold where density dependence effects decrease survival. Thus, creating a positive feedback loop. The Freshwater Action Team is also working to increase the distribution of Atlantic salmon and restore ecosystem function. To accomplish the Framework's objectives, the Freshwater Action Team is working to reduce the treats to Atlantic salmon through habitat restoration. The actions of the Freshwater Action Team in conjunction with the actions of the Connectivity Action Team have the potential to increase wild juvenile Atlantic salmon production.

The primary objective is to increase juvenile survival. Current freshwater survival is estimated to be 3.5%. The goal is to increase freshwater survival to 6%. This can be accomplished be reducing the treats to Atlantic salmon survival and maximizing the production potential of each returning adult Atlantic salmon. By increasing survival, you are establishing a population that is more resilient to short-term disturbance. In the short term, wild juvenile production can also be increase by reducing the brood stock (parr and sea-run adults) that are diverted to the conservation hatchery. Reducing brood stock requires an evaluation of hatchery practices and understanding the best use of an adult return. The later method does not address threats to long-term sustainability.

The work of the Freshwater Action Team will be conducted in a manner that will maximize the benefit of each action for the propose of increasing juvenile smolt production. To increase freshwater survival, the portfolio is designed to address freshwater treats, excluding connectivity, to Atlantic salmon. The prioritized list of threats are 1) reducing the present or threatened destruction, modification, or curtailment of habitat or range; 2) reduce other factors affecting Atlantic salmon; 3) reduce predation, 4) reduce overutilization; and 5) reduce the inadequacy of existing regulations.

Maine Department of Marine Resources is the lead Agency for the majority of activities within the scope of the Freshwater Action Team. The actions balance the need to identify and restore degrade habitat, evaluate restoration techniques, and protect areas that currently produce Atlantic salmon. Included in the portfolio (Table 5.1) are several actions that are designed to address habitat degradation and habitat protection. Those actions will classify and identify Atlantic salmon spawning and rearing habitat, identify habitats that are under performing, evaluate the causes and remedies of under performing habitat, and prioritize restoration efforts. The suite of actions related to habitat restoration is designed to increasing the quality and quantity of Atlantic salmon habitat, increase freshwater survival of Atlantic salmon, and ultimately increase wild production. Other actions evaluate restoration techniques and evaluate methods to populate or supplement locations with Atlantic salmon. Additional actions focus on maximizing protection for Atlantic salmon through policy and education. The success of the suit of actions will be evaluated by monitoring smolt production, numbers of naturally reared adult returns, redd counts and distribution, and parr densities and distribution.

The Freshwater Action Team will work closely with the Connectivity and Conservation Hatchery Action Teams. Prioritizations of habitat restoration projects will need to be integrated with the restoration actions of the Connectivity Action Team and vise versa. In order to increase or establish Atlantic salmon smolt production, hatchery supplementation may be need to seed newly accessible or restored habitat.

Table 6. Freshwater Action Team's action descriptions and implementation schedule.

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
Monitoring and assessment							
FWAT1	**Design and implement a state-wide juvenile salmon sampling plan based on statistical sampling with fully standardized methods** Implement a standardized juvenile assessment sampling scheme across the State to provide large parr trend information at the drainage, SHRU, and State scales. The goal is to maximize the use of information collected from individual action assessments and minimize additional sampling needed to have enough power to detect changes in long-term trend dataset. The assessment will rely primarily on Catch-Per-Unit-Effort (CPUE) electrofishing protocol for stream resident juveniles. An approach integrating CPUE with the few long term salmon population assessment sites allows sampling more sites in sub-drainages and provides an index of relative population abundance and distribution that can be related to juvenile Atlantic salmon density.	Review of sampling design and data quality (variance) of the Parr Production Index %CV ≤ 35	Maine DMR	1.50	170,000	Ongoing	Web page that reports juvenile trends
FWAT2	**Evaluate smolt production on selected rivers (i.e. Narraguagus, Penobscot, and Sheepscot Rivers)** Emigrating smolt estimates provide a measures of smolt production that links parr production to adult returns and redd counts.	Calculated smolt estimates and evaluate smolt production in association	Maine DMR	2.00	210,000	Ongoing	Web page that reports smolt data.

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	The goal is to conduct smolt trapping at one long-term sites within each SHRU to establish an index of smolt production.	with large parr production					
FWAT3	**Monitor reaches for natural re-colonization** While the standardize assessment will focus on occupied habitat, this action will monitor a unoccupied areas for natural re-colonization (areas with no active stock enhancement, but accessible by Atlantic salmon) through juvenile assessments and redd surveys on an annual basis with a goal of documenting changes in distribution of Atlantic salmon.	Contrast tends in natural re-colonization to adult Atlantic salmon abundance, distribution, and changes in connectivity	Maine DMR	0.05	5,000	Ongoing	None
FWAT4	**Monitor water temperatures in selected salmon river systems** Develop and implement a systematic water temperature monitoring network that will provide an index of surface water temperatures in each SHRU from headwater streams to coastal rivers. This monitoring network will compliment USGS gage sites.	Data will be used by manages when evaluating juvenile production and juvenile production potential	Maine DMR	0.10	10,400	Ongoing	None
Habitat restoration and preservation							
FWAT5	**Develop habitat based productivity estimates and identify key elements of productive salmon habitat and limiting factors** Watersheds differ in fish communities, benthic communities, geomorphology (thus	Data used as inputs for the Atlantic salmon production model	Maine DMR	1.00	110,000	2012-2015	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	interspersion and complexity of salmon habitat), hydrologic regime, thermal regime, underlying aquifers and bedrock, land use patterns, flow regimes, and water chemistry. These factors and others (e.g. stream depth and width, N:P ratio, alkalinity, conductivity, temperature, pH) affect habitat suitability for Atlantic salmon. The utility of these factors as predictors of juvenile habitat suitability needs to be assessed. The goal of this action is develop a data set to related juvenile abundance to habitat parameters that can be used as inputs to develop a predictive model. Development of such relationships is dependant on the use of wild and hatchery stocks.						
FWAT6	**Develop a GIS model to predict Atlantic salmon production, based on abiotic and biotic parameters** In smaller watersheds, salmon habitat typically has been mapped and identified by foot or boat survey or on-the-water surveys. This approach is not practical for the many watersheds in Maine. The development of GIS model(s) to predict the location and amount of productive juvenile Atlantic salmon habitat will provide value information (with estimates of precision) at lower cost than habitat surveys of entire watersheds. The model will allow managers to focus restoration efforts in productive Atlantic salmon habitat.	Completion of the model is used to develop a model to predict habitat suitability for Juvenile Atlantic salmon	USFWS/ Maine DMR	1.00	115,000	2012-2015	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
FWAT7	**Conduct surveys to validate GIS Atlantic salmon production model (e.g. substrate quality, complexity etc.)** The GIS model(s) to predict productive juvenile Atlantic salmon habitat will need to be validated. Field surveys should focus on surveying a diversity of stream types (size, gradient, geographic location) and included observation on large wood, connectivity, embeddedness, and substrate type.	Model successfully predicts Atlantic salmon production	Maine DMR/ USFWS	0.50	43,000	2014-2015	None
FWAT8	**Map riparian zones and activities (e.g., harvest practices, ATVs, development etc.) that may impact Atlantic salmon (sedimentation, flow, etc.)** Mapping riparian zones and the associated land use in conjunction with habitat models and empirical data will be used identify areas for restoration.	Completed map of riparian zones that can inform restoration prioritization	Maine DMR	0.50	80,000	2012-2013	None
FWAT9	**Identify areas for riparian forest improvement and pursue resources for improvements** In conjunction with habitat surveys and modeling efforts, areas for riparian habitat improvements will be identified. Riparian zones benefit fish habitat by providing overhead cover and shade, woody debris, organic matter (leaf little inputs provides food sources for invertebrates and fish), invertebrates, and can improve water quality.	Map of riparian areas that could be targeted for restoration and number of grant applications filed	Maine DMR	0.10	13,000	2013-2014	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	Resources for the riparian zone restorations will be pursued through grant writing and the help of our NGO partners.						
FWAT10	**Support riparian zones management practices for water quality and habitat** Riparian processes are closely linked to habitat complexity and water quality and are an element of lateral and vertical connectivity. Based on the land use history and forest growth models, riparian forests need to be restored and protected. State and Federal Agencies will work with the Maine Forest Service and conservation organizations to implement this strategy. For example, managing the Dennys and Machias river corridors, which were purchased by the State of Maine to protect salmon habitat. The goal of this action is to conserve and protect riparian zones.	Number of consultation and acres of riparian zones in conservation	Maine DMR	0.10	9,000	Ongoing	Land owner outreach and education
FWAT11	**Prioritize and evaluate habitat restoration strategies based on system connectivity, habitat quality, and the expected Atlantic salmon production and pursue resources for improvements** Habitat restorations should be prioritized based on the expected benefits to Atlantic salmon populations, accessibility (current and future) by Adult Atlantic salmon, and the degree and type of degradation. By contrasting current and predicted juvenile Atlantic salmon	The development of a list	Maine DMR	0.50	60,000	2014-2015	

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	production and actual Atlantic production a						
Management and research actions							
FWAT12	**Increase escapement of adult salmon to the Penobscot River** The goal of this action is to increase adult escapement Penobscot River to increase wild smolt production. The first step is to review options that would increase adult escapement. One way to increase spawning escapement would be to reduce the numbers of adult Atlantic salmon taken as broodstock to Craig Brook National Fish Hatchery. Embedded with in this action is an evaluation of which returning adult Atlantic salmon are most beneficial to restoration versus hatchery propagation. For example, survival of offspring from smolt origin adult returns that were stocked low in the drainage may be compromised because they are less likely to spawn in quality salmon habitat. What is the best use of an Atlantic salmon adult return, given its origin?	Increasing % of wild origin trap catch	Maine DMR/ USFWS	0.25	20,000	Ongoing	Web page that reports annual escapement similar to Maine DMR's adult trap catches web page and a link to the Brood stock Management Plan
FWAT13	**Trap and truck adult salmon from Lockwood Dam to the Sandy River drainage, Kennebec basin** This is the current management practice to increases the effective spawning population in the Sandy River by transporting adults upstream and releasing them in the area were	A positive association between the number of female Atlantic salmon transported	Maine DMR	0.25	30,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	they were reared. Upstream passage at the Lockwood Dam does not exist.	upstream and redd counts and juvenile CPUE is expected					
FWAT14	**Sample all Aquaculture suspects captured for disease** Monitoring captured salmon aquaculture escapees for disease when the opportunity presents itself will alert biologist to potential disease issues. The goal of this action is to monitor the potential disease threats to wild Atlantic salmon imposed by aquaculture escapees.	Review of pathogen reports and management SOPs as necessary	USFWS/ Maine DMR	0.02	6,600	Ongoing	None
FWAT15	**Investigate recruitment from natural spawning and various hatchery stocking strategies as tools to repopulate vacant habitat with Atlantic salmon to facilitate future adult returns** A better understanding of juvenile recruitment from adult returns (fitness) from various stocking strategies, such as, egg planting, in-stream incubation, and stocking pre-spawn captive adults, in addition to the traditional hatchery products like fry, parr and smolts, is needed to make informed management decision about the best techniques to reestablish wild population populations.	Comparison of fry and large parr recruitment	Maine DMR	0.25	30,000	2012-2015	Volunteer opportunity
FWAT16	**Evaluate the impacts of sedimentation and changes to stream channel geomorphology on habitat**	Data was used to inform habitat	Maine DMR	0.50	40,000	2012-2015	Outreach on non-point sources of

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	quality/quantity Stream channel degradation, including sedimentation and embeddedness, decreases habitat suitability and reduces carrying capacity. Understanding how varying degrees of streambed degradations affect juvenile Atlantic salmon and identifying appropriate e restoration techniques is important to identify and prioritize habitat restoration efforts.	modeling efforts					sedimentation
FWAT17	**Retain large woody debris in streams and rivers to support salmon habitat quality and quantity.** Educate stakeholder on the ecological benefits of maintaining large woody debris (LWD) in stream corridors. Encouraging stakeholders to maintain LWD in streams. The goal is to conserve and protect the resource to avoid costly restoration efforts in the future.	Number of river kilometers where land owners have made a committed to maintain LWD inputs	Maine DMR	0.10	10,000	Ongoing	Land owner outreach and education
FWAT18	**Implement habitat manipulations adding large wood to streams** Large woody debris (LWD) provides cover, shelter, and helps to maintain the shape of the channel. LWD is at extremely low levels in main coastal Maine rivers and the status of LWD in the Penobscot SHRU and other inland rivers have not been fully evaluated. This action will develop the linkages among LWD, channel geomorphology, and Atlantic salmon populations based on 1) LWD surveys across reaches with different stream sizes, forest	Number of river kilometers treated and juvenile Atlantic salmon response	Maine DMR	1.25	140,000	2012-2015	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	stands, topography, and land uses and 2) supporting a study currently underway to test the effectiveness of adding LWD to salmon habitat. Increasing LWD in streams will benefit Atlantic salmon by increasing habitat heterogeneity.						
FWAT19	**Perform experimental habitat manipulations to reduce sedimentation (i.e. embeddedness/armoring) and evaluate the effect on the biological function of streams.** Sedimentation is associated with poor juvenile Atlantic salmon rearing habitat. Sedimentation degrades spawning habitat and alters aquatic source for juvenile fish. This actions will experimentally evaluate population level effects of reducing embeddedness.	Number of river kilometers treated and juvenile Atlantic salmon response	Maine DMR	0.75	65,000	2012-2015	None
FWAT20	**Assess avian, fish, and mammal predation in freshwater-all life stages.** What are the effects of predation on juvenile, smolt, and adult Atlantic salmon in freshwater and how can predation be reduced. This action will evaluate sources of Atlantic salmon predation and their impacts on juvenile and smolt production.	Report on Atlantic salmon predation issues that leads to a reduction in salmon predation	Maine DMR	0.50	50,000	2012-2015	Outreach on non-native species introductions
FWAT21	**Evaluate the ecological role and importance of diadromous fish (alewives, shad, smelt etc.) contributions to the freshwater production of smolts.**	Report on nutrient additions	NOAA	0.50	40,000	2011-2015	Possible opportunity for outreach on sea-run

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	Does an increase in marine derived nutrients result in greater freshwater production of smolts? Currently, NOAA is funding a University of Maine study to address this question. Information learned from this study is important to future restorations efforts.						Outreach on alewife restorations
FWAT22	**Investigate natural spawning performance of translocated adult salmon** Escapement to headwater spawning habitat is compromised by upstream passage deficiencies and other factors (e.g. imprinting) and smolt migration is compromised by downstream passage deficiencies as well. This action seeks to identify the utility of stocking smolts low in a drainage and transport the adult returns in to quality spawning habitat by evaluating their reproductive success. DMR has implemented a study to evaluate the effectiveness of natural spawning by hatchery origin adult returns translocated into novel habitat.	Transporting Atlantic salmon into novel habitat increased juvenile production in the targeted habitat relative to other strategies (e.g. stocking smolts or fry)	Maine DMR	0.20	26,000	2011-2013	None
FWAT23	**Capture and captive-rear, in sea-cages, wild and/or naturally-reared Penobscot smolts for release as sexually mature adults in selected river reaches** This research action will investigate a strategy for maximizing adult production by rearing naturally-reared smolts in sea-cages to maturity and releasing them in selected reaches to spawn. The outcome has the potential to increase adult escapement and increase spawning effectiveness.	Increased adult escapement, juvenile production, and "return" rates relative to treatment controls.	Maine DMR	0.25	30,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
FWAT24	**Assess overwinter survival of juvenile salmon using best available data initially, and design and undertake further research as needed** Information on overwinter survival is sparse for Maine rivers. To complete life history models of Atlantic salmon, estimates of overwinter survival are needed. The current information on overwinter survival is based on autumn juvenile electrofishing data and spring smolt trapping data on the Narraguagus River and a study on Shorey Brook. Overwinter survival data are needed for additional drainages.	Report on overwinter survival in Maine	Maine DMR	0.50	52,000	Ongoing	None
FWAT25	**Support and implement studies that provide manages with information on abundance, distribution, and habitat utilization of Atlantic salmon** Knowing where, when, and how Atlantic salmon utilization habitat at various life stages is valuable information for assessing habitat restoration conservation needs. This action is intended to provide support to research projects that track and monitor Atlantic salmon movements with priority given to return sea-run adult salmon. This action will proved information on Atlantic salmon distribution.	Increased knowledge of Atlantic salmon distribution and habitat utilization that can be incorporated with passage and juvenile production data	Maine DMR	0.25	50,000	Ongoing	None
Policy and permitting							
FWAT26	**Review existing water quality standards for salmon rivers to determine adequacy**	Report on the adequacy of	Maine DMR	0.05	5,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	to meet the needs of Atlantic salmon A review of existing water quality standards for salmon waters is needed to ensure that current regulations protect salmon and their habitat. Maine's Water Classification Act, 1986 (38 MRSA, Section 464) adopted narrative aquatic life standards for water classification. Aquatic life criteria were established by Maine's DEP Biomonitoring Program which uses aquatic macroinvertebrate, aquatic plant, and algal communities as indicators of water and habitat quality.	water quality standards in Maine to protect Atlantic salmon					
FWAT27	**Ensure that water withdrawal permit requirements protect stream flows required for the recovery and conservation of Atlantic salmon. Enforce all appropriate permits for water withdrawals** This action represents the time that Atlantic salmon Biologists spend reviewing water withdrawal permits and policies.	Report on the adequacy of water withdrawal permits in Maine to protect Atlantic salmon	Maine DMR	0.20	17,000	Ongoing	None
FWAT28	**Evaluation of permit requests associated with incidentally take of Atlantic salmon** This action represents the time that Atlantic salmon Biologists spend reviewing and participating in consultations for permits.	Number of permit requests reviewed	USFWS	1.00	88,000	Ongoing	None
FWAT29	**Review existing stocking programs (various trout spp, bass spp, or any other species) and assess the potential impacts**	Identification of stocking programs that	Maine DMR	0.20	17,000	Ongoing	None

Action Number	Action Name and Description	Evaluation of Action	Lead Agency	FTE	Cost	Timeline	Outreach
	of these introductions on Atlantic salmon populations What are the impacts of various stocking programs on sea-run Atlantic salmon production and where are conflicts likely to occur? Maine Department of Marine Resources will meet periodically with Maine Inland Fish and Wildlife to discuss and evaluate stocking programs.	have the potential to reduce Atlantic salmon survival.					
FWAT30	**Minimize bycatch of Atlantic salmon through closure of adult Atlantic salmon holding areas to fishing and angler education** This action represents the time that Atlantic salmon Biologists spend reviewing State recreational fishing regulations and the postings of fishing closures to protect Atlantic salmon.	Areas closed and/or posted	Maine DMR	0.05	4,000	Ongoing	Outreach and education regarding the benefits of closures and fishing restrictions
FWAT31	**Continue to enforce commercial freshwater fisheries regulations/permits where the potential for incidental take of Atlantic salmon exists** This action represents the time that Atlantic salmon Biologists spend reviewing commercial freshwater fishing regulations for species other than Atlantic salmon.	Reducing Atlantic salmon bycatch	NOAA	0.05	4,000	Ongoing	Outreach and education regarding the benefits of closures and fishing restrictions