August
2010 DRAFT

Atlantic Salmon Recovery Framework

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

Atlantic Salmon Recovery Framework

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Background and Justification

The life history of an anadromous species poses challenges for management requiring action in freshwater, adjacent riparian habitat, estuaries and marine waters near and offshore. Joint responsibility for the species between two federal agencies adds additional layers of complexity. Added to this has been a strained and, at times, litigious relationship with the State and affected industries. It is for all of these reasons that enhanced coordination, deliberate and advance planning, and monitoring is essential to the future of this species.

The State of Maine, U.S. Fish and Wildlife Service (USFWS) and NOAA's National Marine Fisheries Service (NMFS) have a long history of working together for the conservation and recovery of Atlantic salmon. In the early 1990s, the three entities worked together on a pre-listing recovery plan for the species and initiated the river-specific stocking program. The Gulf of Maine Distinct Population Segment of Atlantic salmon was listed under the Endangered Species Act (ESA) in 2000, and this listing was expanded in 2009 to include a broader geographic range within the State of Maine.

In 2004, the Services published a draft recovery plan for the species and finalized that plan in 2005. The National Research Council also undertook a review of Atlantic Salmon in Maine and recommended that recovery planning for the species adopt a systematic, structured approach to making management decisions, focused on understanding critical uncertainties and on developing strategies that address key sources of ecological risk. In 2004 and 2005, the agencies collaborated to develop joint priorities with the goal of providing an internal and external focus to agency efforts on behalf of Atlantic salmon. The three focus areas were as follows: (1) investigate possible causes and magnitude of early marine survival; (2) operate and evaluate conservation hatchery programs for the DPS and Penobscot River; and (3) Habitat (including physical habitat, water quality and quantity and biological communities). The joint priority document is attached (Attachment One).

Also in 2005, the agencies also began to collaborate to obtain an independent review of the role of the hatchery program in recovery. Both in drafting and in implementing the recovery plan, observations were made that the list of activities was too long and unfocused and that there was a lack of integration across tasks and a need for a more structured prioritization process.

The hatchery peer review conducted by Sustainable Ecosystems Institute confirmed many of the experiences of those working within the salmon program. Key recommendations of their review are as follows:

- The current recovery program lacks a clear conceptual framework. Such a framework should include the basis for understanding the species, system and is the foundation for setting clear goals and for management decisions.
- Increased integration of key elements of the recovery program (i.e. monitoring, assessment, hatchery production schedules, and research) is absolutely essential to the recovery of Atlantic salmon.

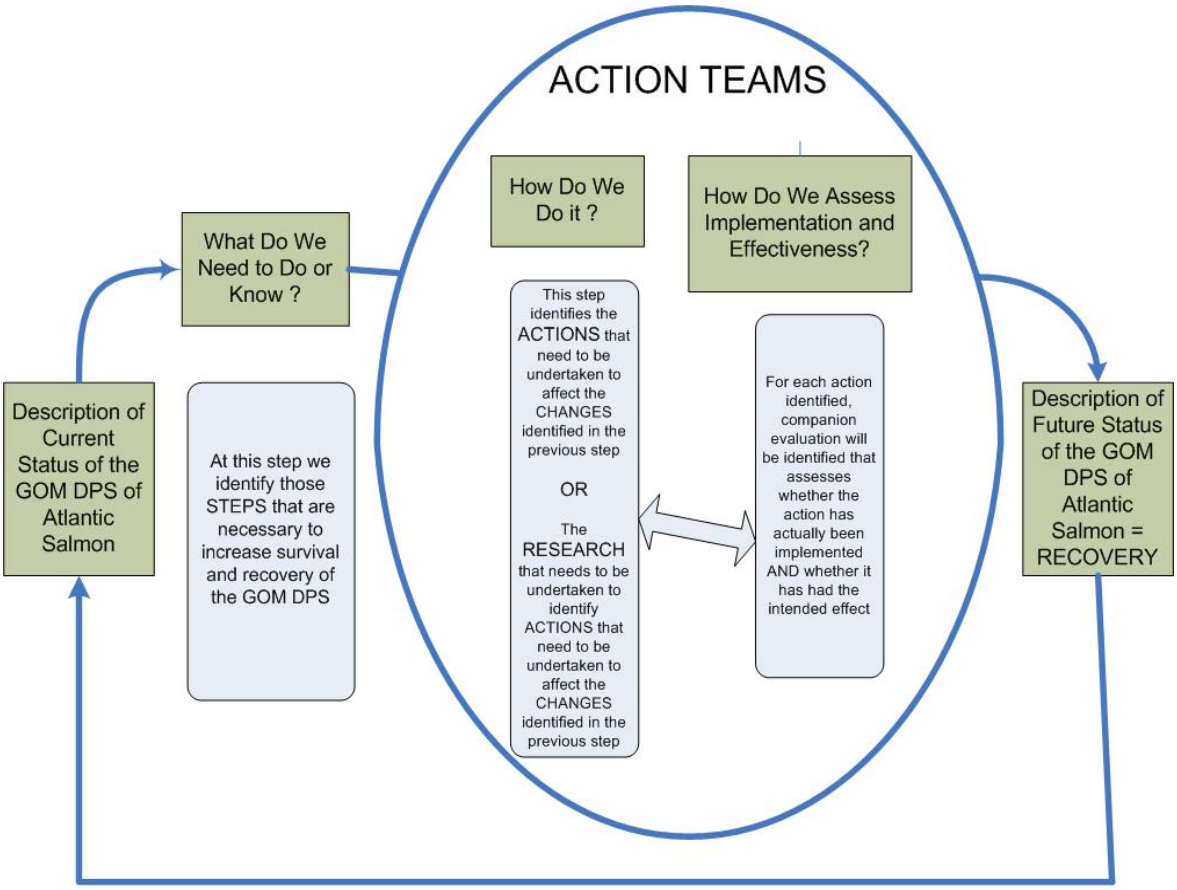
- Recovery goals should be the main driver in management decisions. Hatcheries are one of the tools of recovery and their use should be set by recovery goals. Hatchery supplementation should follow, not drive, recovery planning.
- Assessments and scientific advice should be formally reported out each year to provide informed management decisions based upon best available science. Periodically, this assessment should receive review by outside experts.

Having two independent third parties reaffirm these program shortcomings provided the impetus the agencies needed to reexamine the Atlantic salmon conservation and recovery program. During the winter of 2006/2007, NMFS began developing a conceptual Atlantic salmon recovery framework that was driven by the biological goals and needs of the species. That draft framework was shared with the USFWS and the State of Maine. While there were no fundamental objections to the end product, there was a desire for the three agencies to work more collaboratively to develop a recovery framework using structured decision making.

In May 2007, staff at NMFS and the Maine Atlantic Salmon Commission made a joint presentation to the Signatories[1] at the Maine Technical Advisory Committee meeting. The development of a new Atlantic salmon recovery framework and governance structure was proposed. The framework was intended to have clear goals and objectives, identify key limiting factors, and include adaptive management actions and associated assessment to address limiting factors. The goal for the governance structure was to minimize layers of review to improve efficiency.

The following simplified structure of the framework was presented to the signatories in May 2007.

[1] The Signatories are the Regional leadership of the 3 agencies: The NMFS Regional Administrator, USFWS Regional Director and MDMR Commissioner.



The following benefits of a clear salmon recovery framework were identified:

- Single plan for the 3 resource agencies to implement
- Clear identification of priority actions and research (and by default those not included in the framework are of lower priority)
- Increased transparency to other federal agencies, state agencies, academics and local organizations who want to assist in salmon recovery
- increased accountability of the 3 resource agencies
- increased understanding and ownership for those working within the salmon recovery program as the role each person plays as well as how it relates to the actions and programs of others is clearly articulated
- Is based on an adaptive management framework with integration of management and research and provides constant feedback with the ability to adapt as necessary

The following goals were established for the new governance structure:

- Simple and action oriented
- Minimize layers between those taking actions and monitoring response and those in decision-making positions within the agencies
- Establishes a single process for highlighting issues and resolving differences to reduce delays in decisions
- Action Teams
    - Members chosen for expertise (managers and researchers)

- Each team will function as an adaptive management team first identifying a hypothesis and a plan to address that hypothesis, then implementing and assessing the specific action.

The Signatories approved the conceptual plan presented and charged staff within the three agencies to further develop the recovery framework and the new governance structure.

Development of the Framework and new Governance

Through the summer and early fall of 2007, the agencies worked together to define goals and objectives and explore different approaches for developing the salmon recovery framework and to redefine the governance structure. USFWS and Maine Department of Marine Resources (MDMR) staff attended training at the National Conservation Training Center during which they became more familiar with tools to assist in decision making. Following this training, they advocated for a more structured approach to the development process. It was recognized that additional expertise may assist the agencies in tackling this effort, and in the fall of 2007, the services of Robin Gregory from Value Scope Research and Decision Research and Graham Long of Compass Resource Management were obtained. Nearly monthly meetings were held through the rest of 2007 to define and advance the planning process.

During the winter of 2007/2008 through the spring of 2009, agency staff collaborated to define overall biological objectives, agree on categories of actions (action teams) that could be implemented to achieve the objectives, establish a common set of criteria or descriptors for each action, and ultimately to establish goals for different portfolios of actions that would emphasize different areas of the salmon program. Through this process, we were forced to examine our existing baseline programs and explicitly assign resources to those activities and score them against the same criteria used for new initiatives.

During the early phases, we struggled with activities defined as non-discretionary, due diligence, mandatory or status quo. Some argued that these activities needed to be funded off the top and that we should only be discussing allocation of the balance, truly discretionary funds. However, it became clear that the decision as to whether an activity was discretionary was subjective, and it was also clear that there were not sufficient resources to fully fund those activities the group considered non-discretionary. Therefore, there was no balance of discretionary funds to allocate, but instead a deficit needed to fund non-discretionary activities. With this realization, the group decided that the most equitable way to proceed was to have all actions compared against each other.

The group also debated as to how to address assessment and research needs and funding. When the baseline exercise was conducted, it was determined that approximately 22% of the combined agency resources were being dedicated to assessment and research activities. Given that one of the goals of the new framework was to better integrate assessment into activities and to ensure that any

action undertaken was done in an adaptive manner, the agencies decided to integrate assessment activities and costs into the other action teams. The only assessment to be kept separate (task and costs) were those that focused on adult census or were independent of any particular project or activity. It was recognized that there could be some inefficiencies initially by incorporating assessment costs into each individual activity. However, once a suite of actions, or portfolio, was developed then a core group of assessment/research biologists would work with the action teams to develop a coordinated assessment plan that avoided duplication and sought out efficiencies.

Finally, the group also struggled with education and outreach activities. Like assessment, it was thought that education and outreach activities should not be isolated into a group separate from the other actions but instead should be integrated into the recovery actions. It was also acknowledged that there are a great number and diversity of outreach and education needs – those that directly support the framework by making others aware of the activities being undertaken by the agencies; those that are intended to change the behavior of an individual or industry to minimize impacts on salmon and their habitat; or to encourage collaboration by other agencies, academia, conservation organizations or other interested parties.

The new Atlantic Salmon Recovery Framework

The new Atlantic salmon recovery framework is built on a foundation of an agreement on the biological needs of the species, identification of objectives or a shared goal, and actions to achieve that goal.

Statement of the Problem

Biological Problem: The Gulf of Maine Distinct Population Segment of Atlantic salmon is listed under the Endangered Species Act and is at critically low levels. There is a strong public desire and legal mandate to recover this species which will result in benefits to the ecosystem and to the general public. Efforts to date have not successfully recovered the species. Given limited resources and competing priorities, there is a need to ensure that state and federal resource agencies coordinate closely to agree on a collective strategy to identify and implement the highest priority management actions and scientific studies that have the greatest potential to further our recovery objectives.

Governance Problem: The MDMR, USFWS and NMFS share responsibility for Atlantic salmon. The Passamaquoddy Tribe and the Penobscot Nation also have certain management and regulatory responsibilities regarding sustenance fishing within their respective tribal reservations. This provides benefits for the additional expertise and resources brought to bear on the species, which is particularly important given the significant obstacles that exist to achieve recovery. However, differences in legal authorities, agency procedures and protocols, and expertise have lead to confusion, delays in decision making and disagreements. There is a need for a clearer governance structure with well articulated roles and

responsibilities as well as a pre-agreed procedure and timeline for making decisions in order to avoid such problems in the future.

Objectives

The MDMR, USFWS and the NMFS agree that the fundamental objective of our efforts on behalf of Atlantic salmon is to achieve recovery of the species. We considered recovery, the desired end state, to have two fundamental components: abundance and distribution. We considered genetic diversity and ecosystem function not to be separate independent outcomes, but to be means to accomplish the desired increase in abundance and distribution. However, as is explained below, at various points during the development of the framework we considered genetic diversity and ecosystem function to be separate objectives. In the end, we determined that they were supporting objectives that were necessary to achieve the overall objectives of distribution and abundance.

Abundance: A recovered Atlantic salmon species will be at a higher abundance level than that currently existing in the U.S. Numbers of fish alone, however, do not describe a recovered Atlantic salmon species. In order to achieve recovery for the Atlantic salmon population, it is necessary to demonstrate that the majority of fish are of wild origin. While there may still be some hatchery program in operation, the wild component of the population must be self-sustaining and independent of a hatchery program, if one is still operating for other purposes. These essential characteristics are descriptive of a population that has stabilized at a robust level which provides confidence in the ability of that population to contend with natural variability.

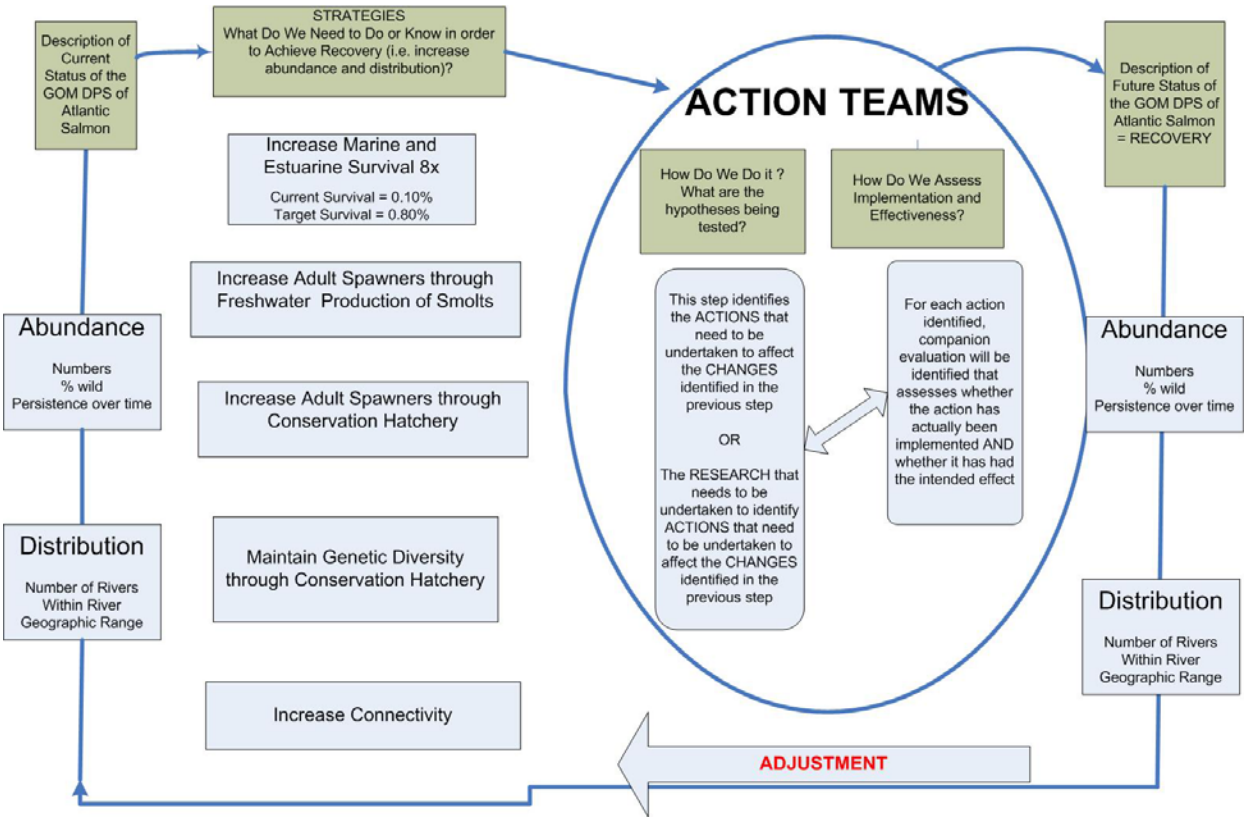
Distribution: While sufficient numbers of wild-origin fish are essential to recovery, it is equally critical that these fish be distributed across a wide geographic area and in a diversity of habitats. Any population that is well distributed across a wide geographic area necessarily has lower risks of extirpation due to environmental variability; thus, distribution essentially spreads risk and provides security. If Atlantic salmon are present in more places, then the potential for a specific threat or catastrophic event to affect the species is minimized. Thus, this objective seeks to increase distribution of Atlantic salmon both within rivers as well as across rivers across the full geographic range of the Gulf of Maine DPS as described in the final listing rule (74 FR 29344).

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, however, without having functioning ecosystems. The purpose of the Endangered Species Act is to recover the ecosystems upon which listed species depend. The ESA, therefore, recognizes that one cannot achieve recovery of depleted species without having recovered the abiotic and biotic components of the system as well as the interactions of the components. We are still accumulating information on the relative contributions of elements in a functioning ecosystem that can sustain the Atlantic salmon populations in Maine. 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.

In addition, sustainable, persistent populations of Atlantic salmon spread over a wide and diverse geographical range will not be achieved unless the species is sufficiently diverse. Diversity includes, but is not limited to genetic diversity, diversity in life history characteristics including age distribution and run timing, and diversity in morphological features. Sufficient diversity levels provide a mechanism for species to respond to and withstand natural variability and catastrophic events. Species lacking sufficient diversity levels are prone to extinction.

In summary, the agreed goal is to recover Atlantic salmon, and we describe and define a recovered species as one with significantly increased abundance of wild Atlantic salmon persisting over time and distributed over a wide geographic range. Inherent in achieving recovery is establishing functioning ecosystems and preserving genetic, life history, and morphological diversity.



The Strategies

There are a wide range of alternative strategies that can be implemented to achieve the fundamental objectives of increasing abundance (productivity) and distribution. We have identified the following 5 strategies for achieving these objectives:

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

Short Term (Preventing Extinction) versus Long Term Recovery Strategies

In our discussions, it became apparent that individuals placed differing levels of importance on efforts in the near term necessary to prevent extinction and investments in longer term actions necessary to achieve recovery. There was complete agreement that an Atlantic salmon recovery program needed to have both elements. It was also agreed that one could not define "short" term versus "long" term as the appropriate investment strategy would not be driven by predefined time limits, but on progress being made toward the biological objectives.

We also discussed that a particular action might contribute less, equally, or more to decreasing the probability of extinction than to facilitating recovery. In general, it was thought that as population size became stable and began to increase, then proportionally greater resources would be dedicated to recovery. Because the risk of extinction would be significantly lower at that point, less emphasis would need to be placed on preventing extinction. It is not possible to place a specific timeframe on the shift of resources and emphasis from preventing extinction to facilitating recovery. It is recognized that the plan now needs to have a significant component dedicated to preventing extinction, but that our goal of recovery will not be achieved unless we dedicate resources also to address the impediments to recovery.

The Action Teams and Actions

An Action Team was formed for each of the five strategies identified above. Each Action Team was charged with developing a list of actions that could be implemented to achieve the biological objectives. Teams were asked to rank ongoing and proposed new actions using the same standard set of criteria. The number and scope of actions proposed by each individual action team was limited by a total dollar amount (expressed as a % of the combined salmon budget). Once each individual team created their list of actions, they worked across and among teams to eliminate any duplicative actions and seek opportunities for maximizing benefits through linked actions.

There is overlap among the strategies/Action Teams and this is expected. The strategies/Action Teams are intended to work cooperatively and collaboratively to further salmon recovery and therefore connections between and among them are

encouraged. The complex life history of Atlantic salmon requires a complex management regime where attention is focused in freshwater, estuaries and marine environments. Factors that affect salmon in freshwater may not manifest themselves until outmigration or during marine migration and vice versa. A comprehensive strategy for recovery of Atlantic salmon must address all portions of its life cycle and acknowledge the connections between the different habitats. While the overall strategy is comprehensive and holistic, for ease of management and implementation, we have broken the program up into manageable pieces. Integration across the pieces is critical.

Monitoring Implementation and Progress towards Recovery

There are multiple types of monitoring that are critical to the success of the Salmon Recovery Framework. Basic monitoring and reporting is required to verify that the planned activities have been implemented. More critical reporting on each action is necessary to verify whether the desired effect was achieved and to determine whether to continue with implementation as planned or modify future actions. Overall, species and ecosystem monitoring is also required to track progress toward achieving the objectives identified in the Framework (increased abundance (e.g., productivity), and increased distribution. Inherent in these objectives is the maintenance of genetic diversity and improved ecosystem function. It is important to realize that individual actions may be implemented and achieve their desired outcome without a detectable improvement in either of the two overall objectives. Also, there may be detected improvements in the two biological objectives, and we may or may not be able to link any of all of those to particular actions we have undertaken. The actions, of course, are designed and intended to improve those biological objectives and move us toward recovery, but the cause and effect relationship to individual or suites of actions is not always obvious or demonstrable.

The overall Framework is adaptive, in that the information collected from individual actions as well as monitoring of the objectives will be examined annually to determine whether to maintain the plan as is or if changes are indicated. The current salmon management program has had success in preventing further declines, but progress toward recovery has been limited. To achieve recovery, more experimental and innovative projects, which are less predictable than the status quo, are needed. Such projects must be implemented with full monitoring and evaluation to determine their contribution to recovery and allow decisions about their role in future recovery efforts.

Governance

Goal: Recovery of the Gulf of Maine DPS as defined in the final listing rule (74 FR 29344).

Objectives: The objective is to significantly increase the abundance of wild Atlantic salmon persisting over time distributed over a wide geographic range. Inherent in achieving recovery is the establishment of properly functioning ecosystems and the preservation of genetic and life history diversity.

Statement of the Problems:

Biological Problem: The Gulf of Maine Distinct Population Segment of Atlantic salmon is listed as endangered under the Endangered Species Act.

Governance Problem: The MDMR, USFWS and NMFS share responsibility for Atlantic salmon. The Passamaquoddy Tribe and the Penobscot National also have certain management and regulatory responsibilities regarding sustenance fishing within their respective tribal reservations. This provides benefits for the additional expertise and resources brought to bear on recovery efforts. However, differences in legal authorities, agency procedures, agency protocols, and expertise have lead to confusion, delays in decision making, and disagreements. The Hatchery Review (SEI 2007) highlighted these difficulties and recommended that the agencies develop a new governance structure with clear roles and responsibilities and a pre-agreed procedure/timeline for making decisions to avoid duplicating past problems.

Purpose:

The purpose of the revised Governance Structure is to: 1) ensure that recovery of the Gulf of Maine DPS as defined in the final listing rule is achieved in accordance with the framework[2]; 2) ensure that the best available science is being integrated into the framework ; 3) ensure that resources are made available to implement those actions or measures agreed to in any given cycle; 4) serve as dispute resolution and continuity of operations throughout the operational year; 5) ensure horizontal and vertical communication amongst the agencies and the various organization levels within the agencies; and (6) ensure that the trust responsibilities of the federal fisheries agencies to federally recognized tribes are appropriately exercised.

Proposal for a revised Governance Structure:

The Atlantic Salmon Recovery Program governance structure entails three basic levels; a policy level, an operational management level, and the implementation level. These will be referred to as the Policy Board (Signatories), the Management Board, and Action Teams respectively.

[2] Framework refers to the collection group of approved research and management actions developed by Action Teams which are integrated to form a coordinated plan for Atlantic salmon recovery.

Policy Board

Purpose: (1) Set broad policy direction
(2) Annually reaffirm priorities
(3) Commit resources for implementation

Members: NMFS RA
USFWS RD
MDMR Commissioner

Management Board

Purpose: (1) Set recovery priorities
(2) Develop decision making framework
(3) Provide detailed direction
(4) Commit resources in a transparent manner

Members: NMFS ARA for Protected Resources
USFWS ARD for Fisheries
MDMR Chief, Bureau of Sea Run Fisheries & Habitat
Tribal Representative

Action Teams

Purpose: (1) Develop and receive approval for list of actions
(2) Develop 5 year implementation plan
(3) Oversee, implement and monitor actions
(4) Coordinate across action teams to increase efficiency
(5) Identify and resolve areas of policy or scientific disagreement
(6) Receive and review proposals

Members: Each Team will be composed of 3-5 individuals from the agencies, they may bring in additional expertise as needed

Marine and Estuarine Action Team
Connectivity Action Team
Genetic Diversity Action Team
Conservation Hatchery Action Team
Freshwater Action Team
Education and Outreach Action Team

The Policy Board

The Policy Board is comprised of what has been known up until now as the Signatories. Membership includes the Regional Administrator of NMFS, the Regional Director of the US FWS, and the Commissioner of MDMR for the State of Maine. The Policy Board should meet at least once a year to; 1) set broad policy direction for the program, 2) affirm the priorities of the program on an annual basis, and 3) commit resources necessary to implement the agencies portions of the program in any given year. These meetings would also be attended by the Management Board and Action Team Chairs and at least one meeting every five years would be held in conjunction with the independent review meetings described below.

Management Board

The responsibilities of the Management Board include the following: formulating recovery priorities for Atlantic salmon; developing a decision making framework that will foster consistency in both short and long range planning for recovery actions; and providing more detailed direction for Action Teams so as to commit resources in a transparent and defensible manner.

Composition: The Management Board will consist of representatives from each of the three key agencies charged with the protection and recovery of Atlantic salmon (The U.S. Fish and Wildlife Service, NOAA's National Marine Fisheries Service and the Maine Department of Marine Resources Bureau of Sea-run Fish and Habitat) and a tribal representative. Each of the three agencies will contribute one member at the Assistant Regional Administrator, Assistant Regional Director, and the Bureau Chief level in MDMR.

Workshops: The Management Board will organize two, two day workshops annually to ensure that the Atlantic salmon recovery program is consistent with the established framework. The winter meeting (Jan-March) will evaluate the past year's activities against stated priorities and the framework while establishing the priorities and work plans for the coming year. The summer meeting (July-Sept) will provide progress reports and identify new information and any implementation issues. The intent of the workshops is to establish opportunities for communication across Action Teams; to evaluate if ongoing actions are meeting their stated objective; and determine if overall progress is being made toward recovery. The workshops will also allow for the identification and discussion of new and emerging issues or threats not included in the framework. The goal will be to answer the questions of whether the appropriate efforts are being undertaken in an effective manner and achieving the desired results.

The first day of the winter workshop will be a research forum where members of the recovery action teams and independent researchers present their findings/ ongoing work. The second day will be devoted to reviewing the framework's action plan in light of findings presented the previous day. The principles of adaptive management will be directly applied given that there may be a decision to remove, add or alter actions depending on results and new research presented. It is

expected that the Management Board and all relevant agency staff working on Atlantic salmon recovery tasks will attend the workshops.

Independent Review: The Management Board will also organize an independent review of the science behind the framework and associated management oversight at appropriate intervals. It is anticipated that the first review will take place after the first full five year cycle of framework implementation. The review will be conducted by a group of independent experts from outside of the Atlantic Salmon Recovery Program. The purpose of the review is to ensure that the framework and associated governance structure function as a true adaptive management model such that recovery implementation adjusts with changing scientific information and knowledge gained through implementation activities.

Interaction between Management Board and Action Teams: The Management Board will meet twice a year with the Chairs of the Action Teams at the workshops mentioned above. In addition, the Management Board will meet separately as needed throughout the year. The purpose of these meetings will be to assess progress of implementation and to establish priorities in anticipation of the Policy Board meeting and the annual recovery workshop. During these meetings, Action Team Chairs will submit individual action work plans and an assessment of all the work plans against the framework will be conducted to identify the highest ranking actions for implementation. Monitoring of progress towards achieving the stated biological objectives will also be presented at the workshops, with an annual report prepared for the winter workshop.

The Management Board will review and approve the Action Plans submitted by each Action Team and monitor progress through the workshops. The overall salmon framework will provide the roadmap for recovery and assist in the identification and prioritization of recovery activities. The Management Board will identify issues that cross multiple teams and ensure appropriate communication and coordination. The Management Board will also resolve any and all disagreements and if resolution cannot be reached, those issues will be elevated to the Policy Board in a timely manner. When issues are elevated, position papers will be provided presenting the various views for consideration. The ultimate decision from the Policy Board will be communicated back through the Management Board to the appropriate Action Team in a timely manner. Disagreements will be resolved prior to the next meeting.

Management Board Chair: The Chair of the Management Board will rotate among the three agencies annually. The Chair will be responsible for scheduling and making arrangements for the workshops, other meetings and conference calls among the Management Board and the Action Team(s) as appropriate and necessary. The Chair will also be responsible for documenting the work of the Management Board and the Action Teams over the course of that year, including preparation of meeting agendas and notes, supplemental meeting material and meeting minutes from all Management Board meetings, and communicating all decisions of the Management Board to the Action Teams. The Chair will also be responsible for coordinating the Policy Board meeting(s), including preparing an agenda and meeting notes.

The Management Board will enlist staff to assist as necessary in liaising with the various Action Teams and with integrating the products of the Action Teams into a comprehensive implementation and feedback plan. Staff will also assist in summarizing the products from the Action Teams to illustrate progress with implementing the framework. Staff support will also be enlisted to support Policy Board meetings, recovery workshops, and the independent review process.

Action Teams

Overview: Action Teams consist of a group of scientists and managers charged with developing work plans within a particular focus area to address critical information gaps and threats to Atlantic salmon in order to move Atlantic salmon towards recovery.

Composition: Action teams are composed of a mix of federal and state agency representatives with specific expertise in either the science or management of Atlantic salmon for that particular area. Each Action Team will be chaired by an employee of NMFS, USFWS or the MDMR. The Chairs will be selected by the Management Board and will be held accountable to their agency and the Management Board. There is no set term limit for Action Team Chairs, for some action teams, it makes sense for an individual in a set position to serve as Chair. An example of that would be the Conservation Hatchery Action Team which should logically be chaired by the USFWS Hatchery Manager. For others, most notably the Marine Action Team, there are a very limited number of individuals working on actions in that area. Therefore, the Management Board will replace and rotate chairs as needed and appropriate.

Each Action Team will consist of 3-5 individuals from the agencies and may bring in experts from outside the agencies to provide technical information to the team as needed. These outside experts can be from academia, NGO community, or from a particular industry such as farming or silviculture. However, these experts may only be brought in to provide technical, scientific or feasibility types of information to the group to assist in formulating work plans.

Action Team Point of Contact

The Action Team Chairs will select a Point of Contact who will serve as a single point of contact between the Management Board and the Action Team Chairs. While it is anticipated that the Management Board (through its Chair) can easily communicate with all of the Action Team Chairs, the Action Team POC provides a single point of contact for the Management Board Chair for coordination and communication.

Initial Charge: The Action Teams initially were charged with developing a list of actions under their area of responsibility for furthering conservation and recovery. They identified the resources required to implement that action, at a minimum and generous level, and characterized each action using a common set of criteria (e.g. duration of effect, geographic scope, biological value). Using descriptions of portfolios provided by the Management Board, the Action Teams then selected and

combined actions into different packages. The Action Team Chairs and Management Board met together to evaluate those different packages of actions, or portfolios, and built a new portfolio that in their view maximized the contribution to recovery.

Once agreement is reached on the preferred portfolio of actions, then each Action Team Chair will be charged with developing a 5 year implementation plan that provides additional detail on each action proposed. The teams will be provided with the relevant suggestions and comments from the hatchery review to consider and address. Where appropriate, the projects/actions should be outlined as adaptive management experiments with a clearly stated hypothesis and associated monitoring. The Action Team 5-Year Implementation Plan will, for each action, identify the responsible entity, state the goal of the action with a connection to the biological recovery objectives, describe the work to be undertaken, include a schedule, identify deliverables, and include a description of the evaluation means. An annual schedule with resource requirements and deliverables will also be included for each action. A template for the 5-Year Implementation Plan will be developed.

As stated previously, the Action Team Chairs will work with the Stock Assessment Group and the Education and Outreach Team to incorporate their input into their Action Plans. Once approved, these Action Plans become the operational plan for implementation of the framework and will serve as the basis for future reporting and for evaluation of progress.

When each Action Team identifies assessment/evaluation needs, they will contact the Stock Assessment Group to fully develop the assessment plan. The Stock Assessment Group will be responsible for compiling a five year assessment plan for the Atlantic Salmon Recovery Framework that integrates the needs identified by the various Action Teams and supplements those with any additional data collection needs necessary to track the biological status of the species. In turn, the Stock Assessment Group will annually ensure that Action Teams have access to data that will allow each Action Team to evaluate the effectiveness of their Action Plan.

Likewise, the Education and Outreach Team will receive the needs identified by each Action Team and coordinate with each Action Team, as appropriate, to define needed messages, products and deliverables. The Education and Outreach Team will integrate the identified needs into an overall Education and Outreach Action Plan. They will also be responsible for receiving and integrating information on implementation of education and outreach activities and will provide this data back to the appropriate Action Teams on an annual basis.

Implementation: Once the Action Team's plan is approved, their focus will shift to implementation. The Action Team will provide a written report to the Management Board for the two workshops that will occur annually. These written reports, which as much as possible should be excerpted from or contribute to other reports (e.g., USASAC, NOAA Cooperative Agreement semi-annual reports, theses, grants) will describe all actions undertaken, including assessment results while also reporting

on the effectiveness of the action in meeting the stated objectives. The Action Teams must continually evaluate both research and recovery actions against the framework and newly emerging science to assist in formulating subsequent work plans.

As noted previously, the two workshops that will occur each year provide opportunities for interaction between the Management Board and Action Teams as well as input from the public. It is anticipated that the Action Team Chairs will meet more frequently throughout the year, including some smaller meetings between two or more Action Teams with actions with greater overlap and interaction. These informal meetings are anticipated to be scheduled on an as needed basis at the discretion of the Action Team Chairs.

Action Teams are primarily responsible for driving implementation of the Framework. Action Team Chairs have authority and responsibility to oversee, facilitate, and coordinate implementing the Framework actions. Additional review or approval of those actions by the Management or Policy Boards is not necessary or appropriate. As noted above, the Action Team Chairs will provide semi-annual updates to the Management Board on implementation progress and are expected to identify any delays or unexpected obstacles to being able to complete the activity in within the specified time and resources provided. On urgent issues, the Action Team Chair may need to highlight or elevate issues outside of the semi-annual reporting period. Action Team Chairs are expected to seek review and approval by the Management Board on any issue where there is disagreement among the Action Team members and are expected to keep the Management Board advised of any policy or publicly controversial issues. Early notification on these issues can provide an opportunity for resolution or at least engagement before the issue gets further escalated.

Review of Proposals and Preparation of Solicitations

As noted previously, the Salmon Recovery Framework was developed to determine the best possible use of existing funds and resources. It can be equally used to establish priorities for new funding, should such funding become available in the future. If such funds are made available, depending on the focus of those funds, one or more Action Teams may be requested to identify priority actions and/or solicitation packages for those funds.

Proposals for new actions (research or management) may be generated internally within the agencies or submitted from external partners and collaborators. If a proposal is generated within one of the agencies and implementation would require significant change in resource allocation such that a previously planned action would be delayed or replaced, the proposal for that action will be first submitted to the relevant action team. The Action Team will review that agency proposal for consistency with the framework and will make a recommendation to the Management Board as to whether that action should or should not be implemented. If they recommend that it be implemented, they will also recommend what action(s) need to be eliminated to free up the necessary resources to implement the new action. Before submitting the recommendation to the Management Board

to replace an ongoing action with a new action, they will also obtain a technical review of the new proposal from the Stock Assessment Group, if the group was not consulted as the project was developed.

Proposals for new actions (research or management) that are generated externally may be submitted to the agencies for review and approval (in the case of proposals requesting fish or ESA authorization). The process for internal proposals that would not require a significant change in resources, and therefore not change any previously approved actions, is the same as the process for externally generated proposals. Those submitting proposals may be seeking any one or more of the following: (1) Technical Review; (2) Review for Consistency with the Salmon Recovery Framework; (3) Access to fish; (4) Access to Research Platforms or Space in the Hatchery; (5) Dedication of agency staff or resources for implementation; and/or (6) ESA permits to authorize take of salmon as a result of research activities. Any proposal submitted should first go to the appropriate subject matter Action Team for review for consistency with the Framework. If the proposal requires fish, the subject matter Action Team will remain the lead for review, but will provide a copy to the Conservation Hatchery Action Team and seek their input as to the availability of the requested fish and the impact of providing those fish (decrease on production, if any). When it completes its review for consistency with the Framework, the lead Action Team will then submit the proposal to the Stock Assessment Group for a technical review, if their team had concerns with the study design or analysis. If the lead Action Team reaches consensus on its review of the proposal and agree that it either is or is not (1) consistent with the Framework; (2) technically solid; and (3) any impact on agency resources (space, staff time, fish, other supplies or equipment) is minimal and does not negatively impact completion of other Framework tasks, then they will notify the Management Board of the proposal and preliminary determination and provide two weeks for review and comment. The single decision from the Management Board will be communicated by the Management Board Chair. If no response is received by the two week deadline, the decision of the Action Team Chair will be considered approved by the Management Board. At the end of the two week period, the Action Team Chair will communicate that finding directly to the individual or entity that submitted the proposal and the USFWS for proposals requiring ESA permits and copy the Management Board on that determination. The above review process will be used for applications submitted to the USFWS for ESA section 10 scientific research permits.

It is important to note that the 5-year implementation plans will identify and describe the planned actions to be undertaken by the three agencies (or funded by them and carried out by another entity) over the full 5-year period. These actions will be approved when the 5-year implementation plans are approved. The above described process, therefore, is designed for actions and activities that are not included in the 5 year implementation plan. It is also the intention that there will be an annual call for proposals so that the review can occur in a planned and organized manner. This is important, particularly, where applicants may be requesting access to fish and the total requests need to be evaluated and compared to ensure the best possible use of the fish.

Public involvement

No recovery effort can be successful without a transparent process for the public to learn, participate, and be given the opportunity to contribute. There will be time available at the semi-annual meetings for a public session. The opportunity for questions and suggestions for input into any given years' activities will be incorporated into the meeting process; however, the Management Board does reserve the capability to meet in closed session for any unspecified reason. Likewise, the annual Policy Board meeting will have a public session, although it may also meet in closed sessions as necessary.

A database of contact information of interested parties will be maintained and be utilized to distribute all relevant notices, information and meeting announcements. Additionally, a web site will be established to provide public access to the framework, work plans, solicitations and any relevant documents. Also, specific data reports and information that is developed as a result this effort should also be made available.

Relationship of the Atlantic Salmon Recovery Framework to the ESA Atlantic Salmon Recovery Plan

The ESA requires that a Recovery Plan be developed for the GOM DPS of Atlantic salmon. As the lead agency for completing the ESA recovery plan, the USFWS intends that the Atlantic salmon recovery framework will form the foundation of the ESA recovery plan. The framework identifies the highest priority management actions and scientific studies having the greatest potential to further the recovery objectives for MDMR, NMFS and USFWS. Building on the framework, the ESA Recovery Plan will include additional necessary elements, such as measurable recovery criteria, estimated recovery timeframes, estimated cost of recovery, and involvement of stakeholders.

Proposed Calendar for Completion of the Atlantic Salmon Recovery Framework and 5 Year Action Plans (2010-2014)

July 2009

- ATC and MB select preferred portfolio and develop plan (and timing) for transition from ongoing activities to the preferred portfolio

August 2009

- Joint agency staff meeting to provide update on framework development and proposed preferred portfolio

September 2009 – December 2010

- Selected stakeholder meetings to provide updates on framework development and outline next steps
- Action Team Chairs meet to coordinate actions in the preferred portfolio, remove any duplication and seek opportunities for collaboration. In addition the Action Team Chairs will identify assessment needed for their actions and work with the Assessment Group.
- Assessment Group works with Action Teams to identify assessment needs and also develops assessment needs to track progress toward the framework's biological objectives.
- 5-Year Implementation Plans developed by each Action Team, Stock Assessment Group, and Education and Outreach Team
- Management Board works with Action Teams to specifically compare the status quo with the preferred portfolio and develop transition plan
- Website developed
- Process for public involvement and semi-annual workshops finalized
- Atlantic Salmon Recovery Framework for 2010-2015 is compiled as a complete document

January 2011

- First winter workshop held with Policy Board, Management Board, Action Teams, Stock Assessment Group and members of the public
- 5-Year Framework Implementation begins
- Management Board reviews and approves Action Team 5-Year Plans, Stock Assessment Group 5 year Plan and Education and Outreach 5 Year Plan

Proposed Annual Calendar

January – March

- Winter Recovery Meeting of the Policy Board, Management Board, and Action Team Chairs
- Open to the Public
- Written and verbal reports provided by each Action Team on previous years implementation activities
- Report on population status and progress toward biological objectives
- Review and agree plan for the coming year of implementation
- Annual Report on Framework Implementation prepared
- Annual Call for Proposals (due June 1, response no later than August 31)

July – September

- Mid-year meeting held
- Action Team Chairs highlight any obstacles to meeting end of year targets
- Any new findings or information is presented and discussed

The Action Team Chairs and Management Board will hold periodic meetings as needed to resolve issues, when appropriate joint meetings will be held.

Portfolio Alternatives and Selection of the Preferred Portfolio

As an initial step, USFWS, NOAA Fisheries and Maine DMR conducted an inventory of the existing Atlantic salmon program. Only those funds directed towards Atlantic salmon management and research activities consistently on an annual basis were part of this inventory. In addition to these base salmon program funds, each agency has expended additional funds on Atlantic salmon activities, but those sources are not consistently dedicated to Atlantic salmon so these were not included in the base salmon program budget. For example, in recent years NOAA has dedicated significant funds to barrier removals through the ARRA and Open Rivers funding. Combined funding from the three agencies is approximately $7.5 million annually.

Agency staff then brainstormed additional actions and research that could be undertaken to further Atlantic salmon recovery. This resulted in a much longer list of possible activities. Each action, whether ongoing or new, was evaluated against a common set of criteria. This criteria included the following: number of SHRUs affected; number of HUCs affected; endurance of benefits; benefit timeframe; initiation timescale; confidence in benefits; and possible risks/benefits to other species. A biological benefit index was calculated which considered the life stage affected.

Ongoing actions were placed into the following six categories: (1) marine survival; (2) estuary/coastal survival; (3) genetic diversity; (4) increase adults through conservation hatchery; (5) increase adults through freshwater smolt production; and (6) population assessment. In the status quo alternative, population assessment actions and resources were separated into one category. For alternative options we moved stock assessment actions into the other five categories. The reason for this decision was that one of the main goals of the Salmon Recovery Framework was to make it adaptive in nature and to ensure that all actions implemented were assessed. To emphasize this point and to maximize the potential for this Framework goal to be achieved, we moved the assessment into the other five categories where it would be directly linked to each action.

In developing the Salmon Recovery Framework, we wanted to challenge the existing program with the goal of selecting the combination of actions that maximized the potential to achieve our collective recovery goals. In order to explore alternative recovery strategies that would emphasize different areas, we reallocated existing resources to the five categories above and then identified actions that would be undertaken with those funds. We then were able to compare the various suite of actions or portfolios to see their relative performance towards the recovery goals.

The table below shows the six portfolios examined. The six portfolios are presented as the columns in the table. The six categories of actions are contained in the rows. The first alternative examined, as indicated above, is

the status quo. In the status quo, the combined resources of the three agencies are allocated as follows: (1) marine survival 10%; estuary/coastal survival 6%; (3) genetic diversity 5%; (4) increasing adults through the conservation hatchery 32%; (5) increasing adults through freshwater smolt production 25%; and (6) population assessment 22%. The first portfolio focuses on marine survival and therefore the amount of resources dedicated to marine survival is increased from 10% in the status quo to 40% in this portfolio. Similarly for the other portfolios, resources are shifted to one or more focus area and the other focus areas decrease in emphasis. With the changes in the resource allocations across the suite of portfolios, we added or subtracted actions. As a result, we were able to examine six different combinations of actions and consider what these different salmon recovery programs would look like and consider their relative ability to recover Atlantic salmon.

The portfolios examined are as follows:

	Status Quo	Marine Focus	Estuarine & Hatchery Focus	Freshwater & Hatchery Focus	Freshwater Connectivity & Diadromous	Marine & Freshwater Focus
Marine Survival	10%	40%	5%	5%	5%	30%
Estuary/Coastal Survival	6%	4%	20%	3%	16%	25%
Genetic Diversity	5%	5%	8%	10%	5%	4%
Increase adults through Conservation Hatchery	32%	32%	50%	50%	32%	20%
Increase adults through freshwater smolt production	25%	17%	15%	30%	40%	19%
Population Assessment	22%	2%	2%	2%	2%	2%

Once these six alternative portfolios were developed, we examined them all and through those discussions we developed a new alternative that had took some of the best actions from the six portfolios we examined. This became Preferred Portfolio 7. The allocation of resources in Preferred Portfolio 7 is quite similar to the Status Quo, however the actions being implemented using the funding changed between the two Portfolios. In addition to this new Portfolio 7, we also examined 3 additional Portfolios which considered how new additional funding would be expended. The first of these additional funding scenarios considered an additional permanent allocation of $5 million; the second considered the one time addition of $10 million; and the

third considered the permanent addition of $10 million. In looking at those Portfolios below it is important to realize that the funding allocations in these columns only apply to the new funds and not the base funds. In other words, if we were to receive an additional $5 million, we would recommend allocating 30% of that new allocation ($1.5M) to marine survival. This new $1.5M would be in addition to the 10% of the base program allocation (10% of $7.5 million = $750K).

The additional Portfolios examined are as follows:

	Status Quo	Preferred Portfolio 7	Extra $5M permanent	Extra $10M – one time	Extra $10M permanent
Marine	10%	10%	30%	20%	30%
Estuary/Coastal	6%	16%	30%	60%	30%
Genetic Diversity	5%	7%	10%	5%	10%
Conservation Hatchery	32%	40%	15%	0%	15%
Freshwater	25%	25%	15%	15%	15%
Population Assessment	22%	2%	0%	0%	0%

The Action Teams then began working on refining the Preferred Portfolio and it became obvious that there was a great deal of overlap among some of the teams and some actions did not fit cleanly into one category or action team. Connectivity activities were the most problematic as they could fall under the estuary/coastal or the freshwater action team. In recognition of the importance of connectivity in achieving our recovery objectives, we decided that it warranted an action team of its own. The reformatted teams and associated allocations are presented in the table below.

	Preferred Portfolio	Approximate Funding Level
Increase Marine-Estuary Survival	12%	$900,000
Enhance Connectivity between Ocean and Freshwater Habitats	13%	$975,000
Maintain Genetic Diversity through Conservation Hatchery	8%	$600,000
Increase Adult Spawners through Conservation Hatchery	45%	$3,375,000
Increase Adult Spawners through Freshwater Production of Smolts	20%	$1,500,000
Population Monitoring Assessment	2%	$150,000

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 Group 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 the attached spreadsheet. (which could be a table.)

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 Gulf of Maine 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.

ID#	Recovery Criteria from Critical Habitat Designation	Comments	Metric	id	Action Team	Data	Database	Status
1	(1) The wild **adult spawner population of each 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 stautus). 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	SA AT	DMR Trap Count: Dennys, Narraguagus, Penobscot, Kennebec, Androscoggin	AdultTrap.mdb and USASAC_SalmonYYYY	Avail
2				2	SA AT	DMR Redd Counts: 8 small coastal river systems (partial coverage)	DMR-BSRFH ReddsArchive ver 2009.mdb	Avail
3				3	SA AT	DMR and NOAA - Age Structure and Origin Analysis	pro-rate above for un-aged fish	Avail
4				4	SA AT	NOAA- ReddsModel (Kocik @Risk Model)	Redd-BasedAdultEstimates2010ver2010-03-16.xlsx	Avail
5			% Conservation Spawning Escapement (**CSE**) by SHRU	5	SA AT	ARI and FWS SHRU Habitat Model (Abbot, Wright, Sweka 2010)	For NHD stream reach - for unsurveyed	Revise 2011
6				6				
7	(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 neccesitates determining or estimating the potential naturally spawned component	P(<500) < 0.50 (From DennisPVA)	7	SA AT	same data as (1) partitioned for wild versus hatchery stocked components	John S will work with Tim to get SPAZ model and start work to partition by SHRU	Revise 2011
8		Percentage of returns and escapement that are of smolt, parr, or naturally-reared origin in Trap Catches	% Trap Catch Origin	8	CH AT	NOAA-FWS-DMR Marking Programs & Associated Prortion and Scale Analysis	AdultTrap.mdb; USASAC_SalmonYYYY.mdb;	Avail
9		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	CH AT	FWS- estimating wild retruning salmon numbers (Sweka worksheet) Highlight need for NG genetics to verify ratios	AdultTrap.mdb; USASAC_SalmonYYYY.mdb; DMR-BSRFH ReddsArchive ver 2009.mdb	Revise 2011
10				10				
11	(3) The entire GOM DPS must demonstrate **consistent positive population growth for at least two generations (10 years)** before the decision to delist is made. Ten years of pre-decision data that reflects positive population trends provides some assurance that recent population increases are not happenstance but more likely a reflection of sustainable positive population growth;	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 accross generations.	Replacement Rate and 5 Year Geometric Mean of Replacement Rate > 1.0	11	SA AT	from Adult Returns Index - Age Structured? (Don't think we need to account for age structure given what we say in the cell below)	AdultTrap.mdb and USASAC_SalmonYYYY.mdb	Revise 2011
12				12				
13	(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	SA AT	% natural returns obtained from adult trap data. Redd estimates pro-rated from this %. 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.	AdultTrap.mdb and USASAC_SalmonYYYY.mdb	Revise 2011
14				14				
15	(5) In order to delist the GOM DPS**, the threats identified at the time of listing must be addressed** through regulatory or any other means.	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	FW AT	DMR - redds per stream km in each SHRU; distribution, etc.	DMR-BSRFH ReddsArchive ver 2009.mdb	New 2011
16			Large Parr Production Index	16	FW AT	DMR-FWS Develop sampling scheme to examine by SHRU, densities and fry/other stocked distribution and redd-based wild spawned distribution (use buffers)	ME electrofishing database (I forget the actual name) and USASAC_JuveAbundanceYYYY.mdb	Revise 2012
17			Smolt Production Index	17	FW AT	NOAA-DMR Index developed from smolt trapping operations on the Narraguagus, Sheepscot, and maybe Penobscot (?) Populations	NOAA - Smolt database	Avail
18			Overwinter Survival Estimate	18	FW AT	uses 16 and 17		New 2011
19			Dam Passage	19	C AT	review perfomance standards related to efficiency and overall survival- benchmarks anticipated in 2011 from desktop analysis for Penobscot River		Revise 2012
20			Telemetry-Based Coastal Survival Rate	20		NOAA Estuary and Gulf of Maine Telemetry Assessments		Avail
21			Marine Survival: Hatchery Smolts	21	CH AT and SA AT	Penobscot, Narraguagus - data on marked smolt group numbers and subsequent returns	AdultTrap.mdb; USASAC_SalmonYYYY.mdb	Avail
22			Marine Survival: Naturally-Reared Smolts	22	FW AT and SA At	naturally reared smolt estimates from Narraguagus River and Sheepscot (strating in 2011) rivers with wild returns (trap or redds).	AdultTrap.mdb; USASAC_SalmonYYYY.mdb; DMR-BSRFH ReddsArchive ver 2009.mdb	Avail
23				23				

Marine and Estuarine Action Team

Introduction

Strategy:

Increase marine and estuarine survival of Atlantic salmon

Strategy metric:

Increased understanding of the factors limiting marine and estuarine survival of Atlantic salmon and the implementation of adaptive management actions to increase survival in these environments when appropriate

Under status quo management, the Marine and Estuarine Action Team (MEAT) expended approximately 10% of the Atlantic salmon inter-agency funding focused on the Gulf of Maine Distinct Population Segment recovery program. Actions under these resources could be characterized into three general categories: Domestic and International Assessment and Management, Research Scoping, and Active Marine Research. Domestic and International Assessment and Management Actions were focused on providing continued to support to the New England Fishery Management Council's Fishery Management Plan for Atlantic salmon as well as continued USA participation in the ICES Working Group on North Atlantic Salmon's and North Atlantic Salmon Conservation Organization's (NASCO) related efforts. Actions were also dedicated to continuing to condition permits for activities within estuaries to minimize potential effects on migration of juveniles and adults and to enhance protection of estuarine riparian areas through enforcement and modifications to the various natural resource acts and zoning standards available. Research Scoping related actions focused on the continued participation in the NOAA Fisheries Service-Sea Grant Nearshore Workshop. Active Marine Research related actions were related to continued support for large scale tracking at both domestic and international levels, continued support in NASCO's Salmon at Sea (SALSEA) marine research program including the US lead effort of SALSEA Greenland. These actions were primarily carried out by NOAA Fisheries Service staff and funds.

Under the new preferred portfolio (PP7), the MEAT would expend approximately 12% of Atlantic salmon inter-agency funding. Many of the actions undertaken under the Status Quo funding scenario will continue as these actions are still perceived to provide benefits to the recovery program and also may involve legal mandates or domestic and international commitments that can not be terminated. However, a few of these past commitments have come to fruition and their uncommitted budgetary resources are being combined with the slight increase in funding provided under PP7 to allow for the initiation of a number of priority projects. These priority projects will be focused within the Active Research category and will aim to further our understanding of marine phase Atlantic salmon and their

role in this ecosystem. Efforts will involve initiating a comprehensive evaluation of existing marine related data for correlations with trends in salmon population abundance at USA, North America, and North Atlantic scales, developing a marine salmon bioenergetic model to evaluate cost/benefits of future scenarios of ocean conditions, forage fish dynamics, predator dynamics and evaluating whether river herring populations reduce predation risks to emigrating smolts. Additionally, new smolt radio tagging projects should be initiated to further identify zones of high mortality with the goal of developing adaptive management activities to combat these phenomena. Finally, new adaptive management studies to synthesize information and improve our understanding of factors affecting the estuarine and nearshore mortality of Atlantic salmon will be pursued based on the recommendations from the Nearshore Workshop. Collectively these efforts will provide researchers and managers a greater understanding of marine phase Atlantic salmon, a greater understanding of their role in this environment and greater understanding of the causes of the poor survival currently depressing the species.

Preferred Portfolio 7 Marine and Estuarine Actions

Action	Minimum Resourcing (FTE)	Effective Resourcing Cost ($k)
continued participation in ICES Working Group on North Atlantic Salmon (ICES WGNAS)	0.10	14,000
continued participation in North Atlantic Salmon Conservation Organization (NASCO)	1.00	120,000
continued participation in NASCO's International Atlantic Salmon Research Board (IASRB)	0.10	8,000
continued participation and oversight of NASCO's West Greenland sampling	0.64	101,200
continued participation and oversight of SALSEA Greenland	0.15	122,000
continue to build large scale tracking infrastructure at domestic and international level and participate in such a program through initiation of tracking studies	0.50	140,000
continue to archive and data mine historical high seas tag recaptures	0.25	26,000
continue to monitor the occurrence of marine mammal scars on returning adults to the adult trap in the Penobscot River	0.10	8,000
continue to support the development of amendments for the continuation of and amendments to the NEFMC FMP for Atlantic salmon prohibiting possession and any directed or incidental commercial fishery in federal waters	0.10	8,000
continue to condition permits for activities within the estuaries of DPS rivers so as to minimize potential effects on migration of juveniles and adults	1.00	80,000

Action	Minimum Resourcing (FTE)	Effective Resourcing Cost ($k)
continue to enhance protection of estuarine riparian areas where necessary through expanded enforcement and modifications to the Natural Resource Protection Act, Forest Practices Act, LURC Zoning standards, and/or Municipal Shoreland Zoning	0.10	8,000
initiate a comprehensive evaluation of existing marine related data for correlations with trends in salmon population abundance at USA, North America, and North Atlantic scales	0.75	66,000
initiate smolt radio tag project to further investigate when and where smolts are dying in the estuary	0.25	55,000
initiate a new study to evaluate whether river herring populations reduce predation risks to emigrating smolts	0.20	76,000
initiate a new study on bioenergetic modeling/analysis of marine salmon to evaluate cost/benefits of future scenarios of ocean conditions, forage fish dynamics, predator dynamics…	0.10	83,000
initiate 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.	0.10	83,000
	5.44	**998,200**

*Descriptions of **Marine and Estuarine Actions** in the Preferred Portfolio*

The table below provides additional clarification and description for each of the actions in the above table.

Continued Participation in ICES Working Group on North Atlantic Salmon (ICES WGNAS) Scientists from the NOAA-F Northeast Fishery Science Center and the State of Maine carry forward the U.S. Atlantic Salmon Assessment Committee data and analysis to the international arena by participating in the ICES Working Group on North Atlantic Salmon. These data are used to contribute to stock assessments and also to compare trends and observations across the full range of the species.
Continued Participation in North Atlantic Salmon Conservation Organization (NASCO) Scientists and managers from NOAA-F, USFWS, and the State of Maine participate in the North Atlantic Salmon Conservation Organization which is devoted to international cooperation to further the conservation of Atlantic salmon. The NOAA-F Northeast Regional Administrator is the federal U.S. Commissioner to NASCO and the head of the U.S. delegation. The Maine DMR Commissioner is a non federal Commissioner.
Continued Participation in NASCO's International Atlantic Salmon Research Board (IASRB) The Parties to NASCO recognized that marine survival is the limiting factor preventing recovery of Atlantic salmon stocks at both sides of the Atlantic Ocean. Marine surveys are expensive and logistically challenging and Parties recognized that there was a much greater potential to be able to conduct surveys if there was international cooperation. The NASCO Parties created the IASRB to coordinate and collaborate with the shared goal of improving our understanding of this critical life stage of Atlantic salmon.
Continued Participation and Oversight of NASCO's West Greenland Sampling The Parties to the West Greenland Commission of NASCO collaborate to conduct research on the salmon caught in Greenland as part of the internal use fishery. This sampling provides critical information on the genetic composition of the catch off Greenland, but provides other important information on the health and condition of salmon each year. Scientists from the NOAA-F' Northeast Fishery Science Center organize and coordinate this international sampling effort including assigning samplers and making all necessary arrangements for the collection and analysis of samples obtained.

Continued Participation and Oversight of SALSEA Greenland

The Parties to NASCO have agreed to collaborate on a two year focused effort to conduct surveys at sea in order to gain insights into the mystery of salmon at sea. Collaborative surveys were conducted on both sides of the Atlantic in 2008 and 2009. Salmon intercepted off Greenland as part of the internal use fishery provide another platform for investigation into salmon at sea. SALSEA West Greenland is a research program conducted in 2009 and 2010 to conduct full analysis of the fish captured off Greenland including a wide suite of fish health and physiology samples. This program was designed, implemented and monitored by scientists at the NOAA-F NEFSC.

Continue to Build Large Scale Tracking Infrastructure at Domestic and International Level and Participate in Such a Program through Initiation of Tracking Studies

New technology provides us with an opportunity to gain insights into the marine migration of Atlantic salmon. The NOAA-F will continue to work within the United States and collaboratively with Canada to maintain and expand the network of receivers that can be used to track the movement of Atlantic salmon and other species.

Continue to Archive and Data Mine Historical High Seas Tag Recaptures

It is recognized that recovery of Atlantic salmon within the U.S. and internationally depends on an improvement in marine survival. There is a tremendous emphasis, therefore, on gaining insights and understanding of the marine migration of salmon. Many researchers in many countries have data sets on tagging and tracking studies they have conducted over the years and the value of collecting, archiving and analyzing this data has recently been recognized. Scientists from NOAA-F have participated in ICES working groups to advance this issue and will continue to work with international scientists to make full utilization of data available in historical datasets.

Continue to Monitor the Occurrence of Marine Mammal Scars on Returning Adults to the Adult Trap in the Penobscot River

With declining Atlantic salmon populations and increasing marine mammal populations, there has been speculation that predation may be negatively impacting salmon stocks. It is very difficult to obtain data on marine mammal predation of Atlantic salmon stocks in the U.S. and adults returning to rivers serve as a source of data on the occurrence, frequency and any trend in marine mammal predation. Protocols to document injuries consistently have been developed and are implemented by Maine DMR staff at the Veazie Trap.

Continue to Support the Development of Amendments for the Continuation of and Amendments to the NEFMC FMP for Atlantic Salmon Prohibiting Possession and any Directed or Incidental Commercial Fishery in Federal Waters The fishery management plan (FMP) for Atlantic salmon is unique in that it was created for the purpose of prohibiting possession of Atlantic salmon and position the U.S. to participate in NASCO to negotiate quotas internationally that are protective of U.S. stocks. NOAA-F staff continue to coordinate with the New England Fishery Management Council as needed to assist with any modifications or amendments needed to the Atlantic salmon FMP.
Continue to Condition Permits for Activities within the Estuaries of DPS rivers so as to Minimize Potential Effects on Migration of Juveniles and Adults Federal agencies permitting, funding or carrying out work in estuaries must consult with the NOAA-F to determine if those activities are likely to affect the GOM DPS of Atlantic salmon and its designated critical habitat. NOAA-F reviews these proposals and seeks to work with applicants, project proponents and permitting agencies to avoid, minimize and mitigate impacts.
Continue to Enhance Protection of Estuarine Riparian Areas where necessary through Expanded Enforcement and Modifications to the Natural Resource Protection Act, Forest Practices Act, LURC Zoning standards, and/or Municipal Shoreland Zoning Where negative impacts to estuaries and/or estuarine riparian areas are documented, NOAA-F staff will work with enforcement and others as needed to identify the cause of the impact and seek corrective action. Where shortcomings are identified in existing regulations, guidelines, processes or practices, NOAA-F will work with the appropriate agencies and industries to make corrections to reduce the risk of reoccurrences.
Initiate a Comprehensive Evaluation of Existing Marine Related Data for Correlations with Trends in Salmon Population Abundance at USA, North America, and North Atlantic scales NOAA-F has or has access to extensive databases which document trends in marine survival for Atlantic salmon. In order to try and understand what might be driving trends in marine survival, NOAA-F will identify sources of data to look for environmental and/or biological correlates. By understanding species or conditions that correlate with Atlantic salmon marine survival may provide some insights into possible cause and effect relationships and ideally management actions that could be taken to attempt to positively influence marine survival.
Initiate Smolt Radio Tag Project to Further Investigate when and where Smolts are Dying in the Estuary NOAA-F is funding and providing technical support and guidance to projects that use radio tags to evaluate smolt passage at hydroelectric facilities. As these fish progress downstream, information can be gained on estuary behavior and areas of mortality by combining radio-tag data with NOAA estuary ultrasonic tracking data to allow both projects to gain more resolution and understanding of predation

Initiate a New Study to Evaluate Whether River Herring Populations Reduce Predation Risks to Emigrating Smolts It has been hypothesized that Atlantic salmon populations would benefit from improved river herring populations as river herring may provide an alternative food source for predators. However, baseline community data (fish, birds, and mammals) is the first step towards testing this hypothesis. NOAA-F will work with Maine DMR and others to initiate the Penobscot Estuary Community Study, a study that describe the relative abundance and seasonality of multiple living marine resources.
Initiate a New Study on Bioenergetic Modeling/Analysis of Marine Salmon to Evaluate Cost/Benefits of Future Scenarios of Ocean Conditions, Forage Fish Dynamics, Predator Dynamics. NOAA-F has initiated a CINAR agreement with Gulf of Maine Research Institute to examine the geospatial and temporal information on the near-shore Gulf of Maine, Fundian Channel and other features on the migration routes (present and historical) of salmon smolts to help refine the spatial extent of telemetry and trawl work toward answering specific hypotheses about alternative migration corridors at sea.
Initiate 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. NOAA-F and NOAA Sea Grant have hosted a series of workshops to compile and analyze existing information on migration of Atlantic salmon as they leave and return to Maine waters. The purpose of these workshops was to identify and prioritize management and research actions to improve our understanding of marine migration and, ideally, take actions with the goal of improving marine survival. The last workshop in this series is intended to provide a list of recommendations and NOAA-F intends to select actions from this list of implementation in an adaptive manner.

Marine and Estuarine 5 Year Implementation Plan

Description: It is recognized that a significant increase (8x) in estuarine and/or marine survival is needed in order to achieve stabilization and move towards recovery of the GOM DPS of Atlantic salmon. Increases in estuarine and 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 and 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 Estuarine Action Team. These activities are primarily research and assessment projects that seek to understand the estuarine and marine ecology and migration of Atlantic salmon. This work is focused on understanding the structure and function of these communities and working towards identifying the factors that may be contributing to the current low survival. With this increased knowledge, we intend to implement management actions with the goal of increasing survival of outmigrating smolts, post smolts and ultimately increasing adult returns.

CURRENT PLAN

Current Resource Allocation: 10%

Current Focus of Efforts:

- **Main areas of focus**
  - Domestic and International Assessment and Management
  - Research Scoping
  - Active Nearshore, and Marine Sampling and Research

- **Domestic and International Assessment and Management**
  - continued participation in ICES Working Group on North Atlantic Salmon (ICES WGNAS)
  - continued participation in North Atlantic Salmon Conservation Organization (NASCO)
  - continue to support the development of amendments for the continuation of and amendments to the NEFMC FMP for Atlantic salmon prohibiting possession and any directed or incidental commercial fishery in federal waters
  - continued participation in international effort to data mine historical high seas tag recaptures (ICES WKDUHSTI and WKSHINI)
  - continued participation and oversight of NASCO's West Greenland sampling

- **Research Scoping**
  - participate in the Nearshore Workshop/Symposium
  - continued participation in NASCO's International Atlantic Salmon Research Board

- **Active Estuarine and Marine Research**
  - continued support for building of large scale tracking infrastructure at domestic and international level and participation in such a program through initiation of tracking studies
  - continued support for stomach (diet) sampling and analysis at West Greenland
  - continued participation and support for SALSEA-Merge
  - participation and support for SALSEA (Salmon at Sea)-North America
  - develop, participation, oversight and support for SALSEA-West Greenland
  - continue analysis and manuscript development for datasets associated with 2001-2005 Postsmolt Trawl Survey
  - implement and develop Penobscot Estuary Community Survey

Preferred Portfolio 5-Year Plan

Resource Allocation under the Preferred Portfolio: 13%

Goals and Objectives for the Estuarine and Marine Action Team 2011 – 2014

- Increase understanding of estuarine and marine ecology and migration
  - How will this be accomplished?
    - Participation in SALSEA NA, WG and Merge
    - Participation in Int'l Salmon Summit
    - Completing Nearshore Symposiums
    - Support for Large Scale Tracking Infrastructure
    - NOAA Penobscot Estuary Community Survey Reports
    - Publish results in peer-reviewed literature
  - How will progress be demonstrated and measured?
    - Completion and documentation of the SALSEA NA and SALSEA WG projects
    - US Contributions to the Salmon Summit
    - Proceedings of the Salmon Summit
    - Development of Action Plan following Nearshore Symposiums
    - Refinement and expansion of broad scale Tracking Studies
    - Publish results in peer-reviewed literature

		2011	2012	2013	2014	2015
Domestic and International Assessment & Management						
	Participation in ICES WGNAS	**X**	**X**	**X**	**X**	**X**
	Participation in NASCO	**X**	**X**	**X**	**X**	**X**
	Participate in NASCO's International Atlantic Salmon Research Board	**X**	**X**	**X**	**X**	**X**
	Participation and oversight of NASCO's West Greenland Sampling	**X**	**X**	**X**	**X**	**X**
	Conduct analysis and document findings of SALSEA WG sampling in 2009 & 2010		**X**	**X**	**X**	**X**
	Seek opportunities to integrate SALSEA WG, MERGE and NA research findings		**X**	**X**	**X**	**X**
	Continue to archive and data mine historical high seas tag recaptures	**X**	**X**	**X**	**X**	**X**
	Continue to support the development of amendments to the NEFMC FMP for Atlantic salmon prohibiting possession and any directed or incidental commercial fishery in federal waters	**As needed**	**As needed**	**As needed**	**As needed**	**As needed**
	Continue to condition permits for activities within the estuaries of DPS rivers so as to minimize potential effects on migration of juveniles and adults	**X**	**X**	**X**	**X**	**X**
	Continue to enhance protection of estuarine riparian areas where necessary through expanded enforcement and modifications to the Natural Resource Protection Act, Forest Practices Act, LURC Zoning standards, and/or Municipal Shoreland Zoning	**X**	**X**	**X**	**X**	**X**
	Initiate a comprehensive evaluation of existing marine related data for correlations with trends in salmon population abundance at USA, North America and North Atlantic scales	**X**	**X**			
Research Scoping						
	Continued Participation in NOAA Fisheries Service-Sea Grant Nearshore Workshop	**X**				

		2011	2012	2013	2014	2015
Active Estuarine and Marine Sampling and Research						
	Continue to build large scale tracking infrastructure at domestic and international level and participate in such a program through initiation of tracking studies	**X**	**X**	**X**	**X**	**X**
	Continue to monitor the occurrence of marine mammal scars on returning adults to the adult trap in the Penobscot River	**X**	**X**	**X**	**X**	**X**
	Initiate smolt radio tag project to further investigate when and where smolts are dying in the estuary	**X**	**X**	**X**	**X**	**X**
	Initiate a new study to evaluate whether river herring populations reduce predation risks to emigrating smolts	**X**	**X**	**X**	**X**	**X**
	Initiate a new study on bioenergetic modeling/analysis of marine salmon to evaluate cost/benefits of future scenarios of ocean conditions, forage fish dynamics, predatory dynamics	**X**	**X**	**X**		
	Initiate adaptive management studies based on Nearshore survival workshop recommendations to synthesize information and improve our understanding of factors affecting the estuarine and nearshore mortality of Atlantic salmon.	**X**	**X**	**X**	**X**	**X**

Connectivity Action Team

Introduction

Strategy:

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

Strategy objectives:

- Provide unimpeded access[3] to 30,000 habitat units with a habitat quality score[4] of 2 or 3 in the Merrymeeting Bay SHRU;
- Provide unimpeded access[1] to 30,000 habitat units with a habitat quality score[2] of 2 or 3 in the Penobscot Bay SHRU;
- Provide unimpeded access[1] to 30,000 habitat units with a habitat quality score[2] of 2 or 3 in the Downeast SHRU;

Strategy metrics:

- Number of accessible[1] habitat units with a habitat quality score[2] of 2 or 3 in Merrymeeting Bay SHRU;
- Number of accessible[1] habitat units with a habitat quality score[2] of 2 or 3 in Penobscot Bay SHRU;
- Number of accessible[1] habitat units with a habitat quality score[2] of 2 or 3 in Downeast SHRU;

Under the status quo scenario, connectivity actions receive less than 10% of the inter-agency salmon budget. These actions are largely opportunistic in nature, relying upon willing land owners and motivated biologists piecing together funding from a variety of (often disparate) sources. While some monitoring of small scale fish passage projects does occur, little emphasis has been placed on understanding ecological connections to date.

Under the preferred alternative, connectivity actions would receive roughly 13% of the overall inter-agency salmon budget. The first and most important step toward renewing the salmon program's focus on connectivity is the completion of a barrier prioritization exercise that has recently been initiated. Funding would also be available for feasibility studies, engineering

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[3] In order for habitat to be considered 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:
    1. 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

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.

[4] Habitat Quality scores are derived from NMFS (2009) figure 1.6.1 and summarized in tables 2.3b, 3.3b, and 4.3b.

studies, and implementation of high priority projects. Over time, it is hoped that a greater proportion of the connectivity budget would go toward project implementation after priorities are established. The renewed focus on connectivity would also result in a greater emphasis on evaluating the ecological and demographic ramifications of barrier removal and fish passage improvement. Finally, greater emphasis is placed on working with owners of fish passage barriers to minimize the level of impact and provide incidental take authorization when appropriate.

Preferred Portfolio 7 Connectivity Actions

Action	FTEs	Effective Resourcing Cost ($k)
Perform fish passage barrier assessments throughout the GOM DPS (see Abbot 2008)	0.10	58,000
Develop prioritization model to identify highest priority fish passage barriers for remediation	0.10	8,000
Write prioritization guidelines to identify highest priority fish passage barriers for remediation	0.10	18,000
Remove dams according to the prioritization guidelines when feasible	0.10	8,000
Remove culverts according to the prioritization guidelines when feasible	0.10	8,000
Install fishways according to the prioritization guidelines when feasible	0.10	8,000
Provide funding for feasibility analyses for potential fish passage improvement projects	0.10	33,000
Provide funding for engineering studies for potential fish passage improvement projects	0.10	33,000
Provide funding for permitting for potential fish passage improvement projects	0.10	18,000
Provide funding for implementation of fish passage improvement projects	0.10	8,000
Develop fish passage efficiency targets that do not "jeopardize the continued existence" of the GOM DPS	2.00	170,000
Implement fish passage efficiency targets that do not "jeopardize the continued existence" of the GOM DPS through section 7 and/or section 10	3.00	250,000
Monumented cross-sectional surveys (per Collins et al. 2007)	0.05	4,000
Grain size distribution surveys (per Collins et al. 2007)	0.05	4,000
Water quality surveys (per Collins et al. 2007)	0.05	4,000
Photo station surveys (per Collins et al. 2007)	0.05	4,000
Wetland and riparian plant community surveys (per Collins et al. 2007)	0.05	4,000
Benthic macroinvertebrate surveys (per Collins et al. 2007)	0.05	4,000

Action	FTEs	Effective Resourcing Cost ($k)
Fish community structure surveys (see NOAA 2008)		196,000
Juvenile salmon migration studies (see NOAA 2008)		106,000
Adult salmon migration studies (see NOAA 2008)		26,000
Enumeration of salmon spawning habitat made available as a result of the restoration	0.05	4,000
Enumeration of salmon rearing habitat made available as a result of the restoration	0.05	4,000
	6.40	980,000

Connectivity Action Team – Action Descriptions

July 30, 2010

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.
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.
Perform fish passage barrier assessments 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.
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.
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 behind any given project, they must typically hire the services of a PE for these aspects of project implementation.
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.

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.
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 bankful width or greater), or bridge construction.
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.
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.
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 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.
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.
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.

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.
Wetland and riparian plant community 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.
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.
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.
Adult salmon migration studies (see NOAA 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.
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.
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.
Enumeration of salmon spawning 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.

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.

Connectivity Action Team – 5 Year Implementation Plan

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.

CURRENT PLAN

Current Resource Allocation: <10%

Current Focus of Efforts:

- **3 main areas of focus**
  - Barrier Surveys
  - Monitoring
  - Culvert removal and replacement

- **Barrier Surveys**
  - Continue surveys in the Penobscot, Kennebec, Machias, Narraguagus, and Sheepscot watersheds

- **Monitoring**
  - Monitoring and evaluation of the Penobscot River Restoration Project
  - Monitoring and evaluation of road crossing improvement projects in the Machias and Narraguagus watersheds
  - Monitoring and evaluation of small dam removals in the Sedgeunkedunk watershed

- **Culvert removal and replacement**
  - Improve fish passage in small streams at road crossings in the Machias and Narraguagus watersheds through culvert removal or replacement with bottomless arch culverts

Preferred Portfolio 5-Year Plan

Resource Allocation under the Preferred Portfolio: 13%

Preferred Portfolio Focus of Efforts:

Goals and Objectives for the Connectivity Action Team 2011 – 2014

- Enhanced connectivity between the ocean and freshwater habitats important for salmon recovery
  - How will this be accomplished?
    - Develop prioritization model to identify highest priority fish passage barriers for remediation
    - Remove highest priority impediments identified by prioritization model

        - Develop and implement fish passage efficiency targets that do not "jeopardize the continued existence" of the GOM DPS
        - Evaluate progress toward these goals through thorough monitoring and evaluation
    - How will progress be demonstrated and measured?
        - Completion and documentation of the barrier prioritization model
        - Begin removing passage barriers in accordance with the prioritization model
        - Publish findings from monitoring and evaluation efforts in the peer reviewed literature
        - Begin consultations with dam owners to develop and implement fish passage efficiency targets that do not "jeopardize the continued existence" of the GOM DPS
        - Assess and report the amount of habitat made available through connectivity-related projects

		2011	2012	2013	2014	2015
Develop prioritization model to identify highest priority fish passage barriers for remediation						
	Develop prioritization model to identify highest priority fish passage barriers for remediation	X	X	X	X	X
	Write prioritization guidelines to identify highest priority fish passage barriers for remediation	X				
	Perform fish passage barrier assessments throughout the GOM DPS (see Abbot 2008)	X	X	X	X	X
Remove highest priority impediments identified by prioritization model						
	Remove dams according to the prioritization guidelines when feasible				X	X
	Remove culverts according to the prioritization guidelines when feasible			X	X	X
	Install fishways according to the prioritization guidelines when feasible			X	X	X
	Provide funding for feasibility analyses for potential fish passage improvement projects		X	X	X	X
	Provide funding for engineering studies for potential fish passage improvement projects		X	X	X	X
	Provide funding for permitting for potential fish passage improvement projects		X	X	X	X
	Provide funding for implementation of fish passage improvement projects		X	X	X	X

		2011	2012	2013	2014	2015
Develop and implement fish passage efficiency targets that do not "jeopardize the continued existence" of the GOM DPS						
	Develop fish passage efficiency targets that do not "jeopardize the continued existence" of the GOM DPS	X	X	X	X	X
	Implement fish passage efficiency targets that do not "jeopardize the continued existence" of the GOM DPS through section 7 and/or section 10	X	X	X	X	X
Evaluate progress toward these goals through thorough monitoring and evaluation						
	Enumeration of salmon rearing habitat made available as a result of restoration activities	X	X	X	X	X
	Enumeration of salmon spawning habitat made available as a result of restoration activities	X	X	X	X	X
	Juvenile salmon migration studies (see NOAA 2008)	X	X	X	X	X
	Fish community structure surveys (see NOAA 2008)	X	X	X	X	X
	Wetland and riparian plant community surveys (per Collins et al. 2007)	X	X	X	X	X
	Photo station surveys (per Collins et al. 2007)	X	X	X	X	X
	Grain size distribution surveys (per Collins et al. 2007)	X	X	X	X	X
	Monumented cross-sectional surveys (per Collins et al. 2007)	X	X	X	X	X

Genetic Diversity Action Team

Introduction

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.

The Genetic Diversity Action Team (GDAT) has identified preferred genetic actions for revision of Atlantic salmon management activities in Maine. While some actions highlight general goals of the captive broodstock program (e.g., reducing artificial selection from hatchery practices), other actions are specific (e.g., implementation of pedigree lines). Many of the genetic actions identified link directly to actions specified in the Broodstock Management Plan, however, additional actions related to monitoring and evaluation of the regulations and permits related to the oversight of the Atlantic salmon aquaculture industry in Maine, and operations of weirs to reduce the potential spawning by aquaculture Atlantic salmon if a major escape event occurs.

Because many of the GDAT actions are directly related to the Broodstock Management Plan, almost all listed actions were considered due diligence: most actions are currently undertaken to maintain genetic diversity within the Atlantic salmon program and reduce risks associated with captive breeding programs. Consequently, these actions provide direct benefits to multiple life stages as the goal of maintaining genetic diversity requires successful reproduction of offspring which then are able to successfully reproduce. For example, actions to avoid spawning of related adults are directed to the freshwater adult stage, but because the action is being undertaken to avoid inbreeding, then egg, fry, parr, and smolts are directly impacted as inbreeding effects could be expressed in these alternate life stages.

Actions included in the status quo focused on application of genetic techniques to evaluate hatchery management. Actions identified in Portfolio 7 build upon these activities to provide additional monitoring and evaluation of hatchery management practices, including improving abilities to evaluate performance (survival) of hatchery products in the wild. Increased evaluations of fitness and performance will help determine how hatchery production is contributing to overall restoration activities.

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 if genetic diversity is being maintained over time are estimates of genetic diversity, such as alleleic variability (i.e. number of alleles per locus, alleleic 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. Because the actions identified by the GDAT provide information and strategies to manage against loss of genetic diversity, genetic diversity should not be appreciably be lost over time.

Preferred Portfolio 7 – Genetic Diversity Actions

Action	Minimum Resourcing (FTE)	Effective Resourcing Cost ($k)
Optimize practices to reduce risks of inadvertent selection that might reduce fitness in the wild	0.05	9,000
Utilize broodstock database to track spawning history for all salmon held for broodstock purposes and implement spawning protocols described in the Broodstock Management Plan	0.05	9,000
Implement stocking practices that broadly distribute genetic groups (families) throughout the stocking sites	-	2,500
Implement pedigree lines if demographic, family recovery, aquaculture escape event, or other parameter limits the potential collection of a broodstock year class	0.10	23,000
Maintain and enhance as applicable the genetic viability of river-specific broodstocks for supplementation according to the Broodstock Management Plan	0.10	10,500
Monitor broodstocks for evidence of genetic diseases or deleterious genetic traits	0.05	9,000
Genetically assess consequences of alternate stocking strategies for multiple life history stages	0.05	9,000
Prioritize current genetic data analysis needs with respect to current and long-term management goals	0.05	4,000
Evaluate if certain program components are missing (gap analysis) in regards to genetic goals of the program.	0.05	6,500
Evaluate and optimize grading practices to reduce genetic selection (initial emphasis on grading for smolt production)	0.05	9,000
Link hatchery production parameters (i.e.. Changes in fecundity, broodstock reproducing, etc.) to genetic characteristics of the broodstocks to assist in monitoring of fitness	0.10	10,500
Monitor estimates of genetic diversity of the wild or naturally reproducing Atlantic salmon (for currently defined hatchery program/DPS and Penobscot)	0.10	13,000
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	0.05	9,000
Use genetic determination of parentage to identify percentage of families recovered from stocking events, and monitor yearly to evaluate broodstock collection practices	-	2,500
Screen incoming parr and adults for aquaculture escapees	0.10	13,000
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	-	5,000

Action	Minimum Resourcing (FTE)	Effective Resourcing Cost ($k)
Improve management of data resulting from production, stocking, and genetic evaluation to facilitate program assessment and monitoring	0.05	6,500
Continually monitor critical trait variation (quantitative, morphometric, other physical trait) to assess risks of inadvertent selection	-	5,000
Fundamental: Use genetic methods to annually characterize parr and sea-run adults	2.00	197,500
Use 2-phased criteria to assess if spawning optimization program effectively reduces potential for inbreeding	0.05	9,000
Use 3-phased criteria (relatedness, inbreeding, and limited population size) to determine if spawning populations within or between capture years is needed	0.05	9,000
Evaluate the genetic implications of collecting adult fish for captive propagation versus wild reproduction	0.05	9,000
added: Experimental genetic analyses and projects for increased hatchery evaluation	0.75	95,000
added: Consider options to evaluate, improve, and enhance the hatchery product and broodstock management practices in experimental environments outside of hatchery production requirements		70,000
Monitor effectiveness of Aquaculture Biological Opinion (including site inspections, audits, etc)	0.80	64,000
Prevent aquaculture adults from entering rivers with existing trapping facilities and using emergency methods when large escapes occur and trapping is possible.	0.25	25,000
Operate the Denny's weir for the preemptive purpose of excluding aquaculture Atlantic salmon	0.75	62,000
	5.65	696,500
		9%

Action	**Description**
Evaluation of hatchery practices and product	
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 alleleic diversity.
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.
Implement stocking practices that broadly distribute genetic groups (families) throughout the stocking sites	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.
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.
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 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.
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

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. Funding is provided for developing guidelines and recommendations, and working with staff to make sure these guidelines are understood and implemented.
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 wild reproduction
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.
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	Implement collection practices that obtain representative genetic variation (i.e. majority of artificial and wild spawned families), including widespread field collection. This action focuses on collection of adults returns to the Penobscot for broodstock. Funding is provided for developing guidelines and recommendations, and working with staff to make sure these guidelines are understood and implemented.
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.
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.
Genetic monitoring	
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.
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 recapture purposes.

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.
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.
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.
Use genetic determination of parentage 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.
Improve management of data resulting from production, stocking, and genetic evaluation to facilitate program assessment and monitoring	Improve 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.
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.
Fundamental: Use genetic methods to annually characterize parr and sea-run adults	Use genetic methods to annually characterize parr and sea-run adults. This action provides for the DNA extraction and genotyping of all parr and adult broodstock received as part of the broodstock management process. This action provides the genetic information necessary for completing the rest of the actions listed.
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.
Use 3-phased criteria (relatedness, 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.

Monitoring for aquaculture	
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 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.
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.
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).
Operate the Denny's weir for the preemptive purpose of excluding aquaculture Atlantic salmon	Given the 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.

Genetic Diversity Action Team-5 Year Implementation Plan

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 of genetic diversity, evaluation of hatchery practices and products and monitoring for aquaculture introgression. 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.

The GDAT will work 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.

CURRENT PLAN

Current Resource Allocation: 5%

Current Focus of Efforts:

- 3 main areas of focus
    - Monitoring of genetic diversity
    - Evaluation of hatchery practices and products
    - Monitoring for aquaculture

- Monitoring of genetic diversity
    - Use genetic methods to annually characterize parr and sea-run adults
    - Monitor broodstocks for evidence of genetic diseases or deleterious genetic traits
    - Genetically assess consequences of alternate stocking strategies for multiple life history stages
    - Prioritize current genetic data analysis needs with respect to current and long-term management goals
    - Evaluate if certain program components are missing (gap analysis) in regards to genetic goals of the program.

    - Monitor estimates of genetic diversity of the wild or naturally reproducing Atlantic salmon (for currently defined hatchery program/DPS and Penobscot)
    - Use genetic determination of parentage to identify percentage of families recover from stocking events, and monitor yearly to evaluate broodstock collection practices
    - Improve management of data resulting from production, stocking, and genetic evaluation to facilitate program assessment and monitoring
    - Continually monitor critical trait variation (quantitative, morphometric, and other physical trait) to assess risks of inadvertent selection
    - Use 2-phased criteria to assess if spawning optimization program effectively reduces potential for inbreeding
    - Use 3-phased criteria (relatedness, inbreeding, and limited population size) to determine if spawning populations within or between capture years is needed
- Evaluation of hatchery practices and products
    - Optimize practices to reduce risks of inadvertent selection that might reduce fitness in the wild
    - Utilize broodstock database to track spawning history for all salmon held for broodstock purposes and implement spawning protocols described in the Broodstock Management Plan
    - Implement stocking practices that broadly distribute genetic groups (families) throughout the stocking sites
    - Implement pedigree lines if demographic, family recovery, aquaculture escape event, or other parameter limits the potential collection of a broodstock year class
    - Maintain and enhance as applicable the genetic viability of river-specific broodstocks for supplementation according to the Broodstock Management Plan
    - Link hatchery production parameters (i.e.. Changes in fecundity, broodstock reproducing, etc.) to genetic characteristics of the broodstocks to assist in monitoring of fitness
    - 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
    - Evaluate the genetic implications of collecting adult fish for captive propagation versus wild reproduction
    - Evaluate and optimize grading practices to reduce genetic selection (initial emphasis on grading for smolt production)
    - 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
    - Experimental genetic analyses and projects for increased hatchery evaluation

    - Consider options to evaluate, improve, and enhance the hatchery product and broodstock management practices in experimental environments outside of hatchery production requirements
- Monitoring for aquaculture
    - Screen incoming parr and adults for aquaculture escapees
    - Monitor effectiveness of Aquaculture Biological Opinion (including site inspections, audits, etc)
    - Prevent aquaculture adults from entering rivers with existing trapping facilities and using emergency methods when large escapes occur and trapping is possible
    - Operate the Denny's weir for the preemptive purpose of excluding aquaculture Atlantic salmon

Preferred Portfolio 5-Year Plan

Resource Allocation under the Preferred Portfolio: 8%

Additional actions identified for the Preferred Portfolio (*in addition to actions listed above under the current plan*):

- Monitoring of genetic diversity
    - Experimental genetic analyses and projects for increased hatchery evaluation
    - Consider options to evaluate, improve, and enhance the hatchery product and broodstock management practices in experimental environments outside of hatchery production requirements
- Evaluation of hatchery practices and products

- Monitoring for aquaculture
    - Monitor effectiveness of Aquaculture Biological Opinion (including site inspections, audits, etc)
    - Prevent aquaculture adults from entering rivers with existing trapping facilities and using emergency methods when large escapes occur and trapping is possible
    - Operate the Denny's weir for the preemptive purpose of excluding aquaculture Atlantic salmon

Goals and Objectives for the Genetic Diversity Action Team 2011-2014

- Maintain the genetic diversity of Atlantic salmon populations in over time
    - How will this be accomplished?
        - Implementation of the actions identified in the preferred portfolio for the Genetic Diversity Action Team
    - How will progress be demonstrated and measured?

- Monitoring of genetic diversity actions will be conducted and reported as described within the Broodstock Management Plan
- Monitoring for aquaculture actions will be conducted annually and reported according to the reporting guidelines developed by the Implementation Plan
- Evaluation of hatchery practices will be documented as part of the reporting for the Broodstock Management Plan
- Monitoring and evaluation of returning adult Atlantic salmon
- Monitoring and evaluation of natural reproduction by hatchery and wild Atlantic salmon

Genetic Diversity Action Team
5-Year Implementation Plan Time Yearly Action

Action	2011	2012	2013	2014	2015
Evaluation of hatchery practices and products					
Optimize practices to reduce risks of inadvertent selection that might reduce fitness in the wild	X	X	X	X	X
Utilize broodstock database to track spawning history for all salmon held for broodstock purposes and implement spawning protocols described in the Broodstock Management Plan	X	X	X	X	X
Implement stocking practices that broadly distribute genetic groups (families) throughout the stocking sites	X	X	X	X	X
Implement pedigree lines if demographic, family recovery, aquaculture escape event, or other parameter limits the potential collection of a broodstock year class	X	X	X	X	X
Maintain and enhance as applicable the genetic viability of river-specific broodstocks for supplementation according to the Broodstock Management Plan	X	X	X	X	X
Link hatchery production parameters (i.e.. Changes in fecundity, broodstock reproducing, etc.) to genetic characteristics of the broodstocks to assist in monitoring of fitness	X	X	X	X	X
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	X	X	X	X	X
Evaluate the genetic implications of collecting adult fish for captive propagation versus wild reproduction	X	X	X	X	X
Evaluate and optimize grading practices to reduce genetic selection (initial emphasis on grading for smolt production)	X	X	X	X	X
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	X	X	X	X	X
Experimental genetic analyses and projects for increased hatchery evaluation	X	X	X	X	X
Consider options to evaluate, improve, and enhance the hatchery product and broodstock management practices in experimental environments outside of hatchery production requirements	X	X	X	X	X

	2011	2012	2013	2014	2015
Monitoring of genetic diversity					
Monitor broodstocks for evidence of genetic diseases or deleterious genetic traits	X	X	X	X	X
Genetically assess consequences of alternate stocking strategies for multiple life history stages	X	X	X	X	X
Prioritize current genetic data analysis needs with respect to current and long-term management goals	X	X	X	X	X
Evaluate if certain program components are missing (gap analysis) in regards to genetic goals of the program.	X	X	X	X	X
Monitor estimates of genetic diversity of the wild or naturally reproducing Atlantic salmon (for currently defined hatchery program/DPS and Penobscot)	X	X	X	X	X
Use genetic determination of parentage to identify percentage of families recovered from stocking events, and monitor yearly to evaluate broodstock collection practices	X	X	X	X	X
Improve management of data resulting from production, stocking, and genetic evaluation to facilitate program assessment and monitoring	X	X	X	X	X
Continually monitor critical trait variation (quantitative, morphometric, other physical trait) to assess risks of inadvertent selection	X	X	X	X	X
Fundamental: Use genetic methods to annually characterize parr and sea-run adults	X	X	X	X	X
Use 2-phased criteria to assess if spawning optimization program effectively reduces potential for inbreeding	X	X	X	X	X
Use 3-phased criteria (relatedness, inbreeding, and limited population size) to determine if spawning populations within or between capture years is needed	X	X	X	X	X
Monitoring for aquaculture					
Screen incoming parr and adults for aquaculture escapees	X	X	X	X	X
Monitor effectiveness of Aquaculture Biological Opinion (including site inspections, audits, etc)	X	X	X	X	X
Prevent aquaculture adults from entering rivers with existing trapping facilities and using emergency methods when large escapes occur and trapping is possible.	X	X	X	X	X
Operate the Denny's weir for the preemptive purpose of excluding aquaculture Atlantic salmon	X	X	X	X	X

Conservation Hatchery Action Team

Introduction

Strategy:

Increase Adult Spawners through the Conservation Hatchery Program (CHP)

Strategy metric:

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

Under status quo management, the CHP expends approximately 32% of Atlantic salmon inter-agency funding focused on the Gulf of Maine Distinct Population Segment (DPS) recovery program. Programs implemented with this funding 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.

Under alternative portfolio of actions number 7 (the preferred portfolio, or PP), the CHP would expend approximately 45% of Atlantic salmon inter-agency funding. The large increase in PP from status quo reflects the inclusion of all monitoring and assessment projects related to hatchery products, stocking practices, and survival in the wild. Some of these projects, as implemented under status quo, were originally allocated funding within the Population Monitoring Assessment strategy, but are placed within the Conservation Hatchery Action Team (CHAT) in PP. The assessment projects are to be separated into life stage categories for tracking purposes, such as *in-stream fry and parr assessment* and *smolt migration / production assessment*. An additional assessment project not in existence in the status quo, *develop and implement in-hatchery product assessment*, 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. Additional existing costs that were not included in the status quo that further result in allocation increase include complete inter-agency funding of stocking juveniles, capturing future captive brood, and capturing and managing sea-run brood.

In PP, 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.

Preferred Portfolio 7 – Genetic Diversity Actions

Action	Minimum Resourcing (FTE)	Effective Resourcing Cost ($k)
Current Prog: review and implement biosecurity plan	0.10	16,000
Current Prog: Provide therapeutic and prophylactric treatment recommendations for optimum fish health	0.10	16,000
Current Prog: conduct USFWS annual Fish Health Inspections	0.10	16,000
Current Prog: fish health diagnostics	0.20	31,000
Current Prog: screen all non-fry mortality for pathogens at CB	0.10	16,000
Current Prog: screen all gametic fluids taken during broodstock spawning	0.10	16,000
Current Prog: produce PN F2 eggs as backup source	0.25	30,000
Current Prog: maintain captive brood for Machias	0.55	71,000
Current Prog: maintain captive brood for NG	0.55	71,000
Current Prog: maintain captive brood for Dennys	0.55	71,000
Current Prog: maintain captive brood for Sheepscot	0.55	71,000
Current Prog: maintain captive brood for East Machias	0.55	71,000
Current Prog: maintain captive brood for Pleasant	0.55	71,000
Current Prog: maintain PN domestic brood	0.10	18,000
Current Prog: conducts surveillance of Infectious Salmon Anemia Virus in sea-run brood	0.20	41,000
Current Prog: maintain use of PN sea-run brood	2.25	230,000
Current Prog: release spent broodstock into river of origin	0.20	26,000

Action	Minimum Resourcing (FTE)	Effective Resourcing Cost ($k)
Current Prog: 50,000 1+ smolt / 1+ parr into the NG	0.25	45,000
Current Prog: 550,000 1+ smolts into the PN	4.00	635,000
Current Prog: 350,000 0+ parr into the PN	2.50	355,000
Culture & Stocking: 50,000 1+ smolt / 1+ parr into the PL	0.25	45,000
Current Prog: stock 15K parr in Sheepscot	0.10	18,000
Culture & Stocking: stock 750K fry in PN; balance of searun adult spawn naturally	1.50	195,000
Current Prog: stock 500K fry in Machias	0.80	81,000
Current Prog: stock 500K fry in NG	0.80	81,000
Culture & Stocking: stock gravid adults (no fry) in Dennys	0.80	81,000
Current Prog: stock 200K fry in Sheepscot	0.80	81,000
Current Prog: stock 200K fry in East Machias	0.80	81,000
Current Prog: stock 200K fry in Pleasant	0.80	81,000
Tools & Assess: mark significant number of smolt / parr releases	1.00	130,000
Culture & Stocking: smolt release utilizing imprinting and seawater acclimation	0.20	41,000
Culture & Stocking: artificial redd / egg stocking in KE (Sandy R)	0.20	26,000
Tools & Assess: develop and implement in-hatchery product assessment program	0.50	90,000
Tools & Assess: in-stream fry and parr assessment program	2.50	275,000
Tools & Assess: smolt migration / production assessment program	1.50	160,000
	26.30	**3,383,000**

Conservation Hatchery Action Team – Action Descriptions

Current Program: 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, and implementable. Includes resources for staff time and supplies.
Current Program: 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.
Current Program: conduct USFWS 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.
Current Program: 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.
Current Program: 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 undetected disease outbreaks before they escalate. Includes resources for staff time and supplies.
Current Program: 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.
Current Program: 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 searun Penobscot eggs produced at Craig Brook NFH. The program has had to use these products on several occasions to prevent production short falls.

Current Program: 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.
Current Program: maintain captive brood for Narraguagus A captive brood population for the Narraguagus 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.
Current Program: 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.
Current Program: 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 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.

Current Program: maintain captive brood for East Machias A captive brood population for the East 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.
Current Program: 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.
Current Program: 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 searun 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.
Current Program: conducts surveillance of Infectious Salmon Anemia Virus in sea-run brood All searun Penobscot brood brought to Craig Brook 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 Lamar Fish Health Center and Craig Brook NFH.
Current Program: maintain use of Penobscot sea-run brood Penobscot searun brood are utilized as the preferred source of all Penobscot hatchery products. Searun 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.

Current Program: release spent broodstock into 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.
Current Program: 50,000 1+ smolt / 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.
Current Program: 550,000 1+ smolt 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.
Current Program: 350,000 0+ parr 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.
Culture & Stocking: 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. This action replaces the Merrimack River smolt production program at Green Lake NFH.
Current Program: stock 15K 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 stocking.
Culture & Stocking: stock 750K fry in Penobscot; balance of searun adult spawn naturally Craig Brook NFH produces 750,000 fry for the Penobscot River, and allows the balance of searun brood not used for hatchery production to spawn naturally. 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 Prog: release spent broodstock into river of origin.*

Current Program: stock 500K 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.
Current Program: stock 500K 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.
Culture & Stocking: 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.
Current Program: stock 200K 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.
Current Program: stock 200K 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.
Current Program: stock 200K fry in Pleasant Craig Brook NFH produces approximately 200,000 fry for release into the Pleasant River. Includes resources for hatchery staff and operations, and stocking.
Tools & Assess: mark significant number of smolt / parr releases A representative sample of smolt and parr being produced at Green Lake NFH are 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.

Culture & Stocking: 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. 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.
Culture & Stocking: artificial redd / egg stocking 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.
Tools & Assess: 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.
Tools & Assess: in-stream fry and parr assessment 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.

Tools & Assess: 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.

Conservation Hatchery Action Team – 5 Year Implementation Plan

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 this 5 year 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.

CURRENT PLAN

Current Resource Allocation: 32%

Current Focus of Efforts:

- **Fish Health**
  - Fish health inspections
  - Fish health diagnostics and treatment recommendation
  - Screen all gametic fluids
  - ISAV surveillance

- **Brood Stock Management**
  - Hold sea-run Penobscot adults and spawn
  - Culture, hold, and spawn captive brood from Sheepscot, Narraguagus, Pleasant, Machias, East Machias, and Dennys Rivers
  - Culture, hold, and spawn domestic Penobscot River brood

- **Juvenile Production**
  - Produce Penobscot, Narraguagus, and Pleasant River accelerated parr and smolt
  - Produce Sheepscot ambient parr
  - Produce Sheepscot, Narraguagus, Pleasant, Machias, East Machias, and Dennys River fry
  - Produce Penobscot River F2 eyed eggs

Preferred Portfolio 5-Year Plan

Resource Allocation under the Preferred Portfolio: 45%

Goals and Objectives for the Conservation Hatchery Action Team 2011 – 2014

- Increase Adult Spawners through the Conservation Hatchery Program
  - How will this be accomplished?
    - Continue focus on existing fish health, brood stock management, and juvenile production programs
    - Investigate and implement new smolt stocking strategies to increase smolt to adult survival
    - Investigate and implement production and stocking strategies that realize greater natural spawning occurrence in the wild
    - Develop and implement an in-hatchery product assessment program
  - How will progress be demonstrated and measured?
    - Overall strategy will be measured by long term tracking of adult returns per egg equivalent hatchery production

- Individual management actions will be assessed by tracking life stage specific survivals at fry, parr, smolt, and adult life stages

Action	2011	2012	2013	2014	2015
Current Program: review and implement biosecurity plan	X	X	X	X	X
Current Program: Provide therapeutic and prophylactic treatment recommendations for optimum fish health	X	X	X	X	X
Current Program: conduct USFWS annual Fish Health Inspections	X	X	X	X	X
Current Program: fish health diagnostics	X	X	X	X	X
Current Program: screen all non-fry mortality for pathogens at Craig Brook NFH	X	X	X	X	X
Current Program: screen all gametic fluids taken during broodstock spawning	X	X	X	X	X
Current Program: produce Penobscot F2 eggs as backup source	X	X	X	X	X
Current Program: maintain captive brood for Machias	X	X	X	X	X
Current Program: maintain captive brood for Narraguagus	X	X	X	X	X
Current Program: maintain captive brood for Dennys	X	X	X	X	X
Current Program: maintain captive brood for Sheepscot	X	X	X	X	X
Current Program: maintain captive brood for East Machias		X	X	X	X
Current Program: maintain captive brood for Pleasant	X	X	X	X	X
Current Program: maintain Penobscot domestic brood	X	X	X	X	X
Current Program: conducts surveillance of Infectious Salmon Anemia Virus in sea-run brood	X	X	X	X	X
Current Program: maintain use of Penobscot sea-run brood	X	X	X	X	X
Current Program: release spent broodstock into river of origin	X	X	X	X	X
Current Program: 50,000 1+ smolt / 1+ parr into the Narraguagus	X	X	X	X	X
Current Program: 550,000 1+ smolt into the Penobscot	X	X	X	X	X
Current Program: 350,000 0+ parr into the Penobscot	X	X	X	X	X
Culture & Stocking: 50,000 1+ smolt / 1+ parr into the Pleasant	X	X	X	X	X
Current Program: stock 15K parr in Sheepscot	X	X	X	X	X
Current Program: stock 1 million fry in Penobscot	X	X			
Culture & Stocking: stock 750K fry in Penobscot; balance of searun adult spawn naturally			X	X	X
Current Program: stock 500K fry in Machias	X	X	X	X	X
Current Program: stock 500K fry in Narraguagus	X	X	X	X	X
Current Program: stock 400K fry in Dennys	X	X	X		

Action	2011	2012	2013	2014	2015
Culture & Stocking: stock gravid adults (no fry) in Dennys				X	X
Current Program: stock 200K fry in Sheepscot	X	X	X	X	X
Current Program: stock 200K fry in East Machias	X	X	X	X	X
Current Program: stock 100K fry in Pleasant	X	X	X	X	X
Tools & Assess: mark significant number of smolt / parr releases	X	X	X	X	X
Culture & Stocking: smolt release utilizing imprinting and seawater acclimation	X	X	X	X	X
Culture & Stocking: artificial redd / egg stocking in Kennebec (Sandy River)	X	X	X	X	X
Tools & Assess: develop and implement in-hatchery product assessment program			X	X	X
Tools & Assess: in-stream fry and parr assessment program	X	X	X	X	X
Tools & Assess: smolt migration / production assessment program	X	X	X	X	X

Freshwater Action Team

Introduction

Strategy:

Increase adult spawners through the freshwater production of smolts

Strategy metrics:

1. Population estimates of smolt production at index rivers
2. Catch-per-unit-effort of large parr based on a stratified random sampling design
3. Distribution and abundance of redds
4. Counts of wild adult returns at index rivers

Under status quo management, the Freshwater Action Team (FWAT) expends approximately 25% of inter-agency funding focused on Maine Atlantic salmon recovery. Traditional programs implemented with this funding include large parr assessments, adult trap operations, smolt assessments, habitat surveys, water temperature monitoring, and connectivity issue. Within the last few years, efforts have also included research on habitat manipulations and marine derived nutrients. While the hatchery programs have been effective in preventing populations from extirpation, they have not resulted in an extensive amount of natural reproduction. In the absence of natural reproduction, much of the current freshwater work focuses on the assessment of hatchery products and stocking practices.

Under the alternative portfolio number seven, the FWAT would expend 20% of inter-agency funding. The decrease in funding reflects the exclusion of redd counting, large parr assessment, adult trap operations, the collection of sea-run brood, the collection of large parr for captive brood, and connectivity issues. Funding for those actions was reallocated under the new structure.

The focus of the FWAT has been concentrated on the objective of increasing adult spawners through the freshwater production of smolts. There are two overarching strategies to increasing smolt production; increase freshwater survival rates and increase natural spawning. The preferred portfolio focuses on improving habitat quality for spawning and rearing to maximize the production potential of returning adults. The suites of actions in portfolio seven address both abiotic and biotic factors that may limit freshwater production. Estimates of smolt production, naturally reared adult returns, redd counts, redd distribution, parr densities, and parr distribution will contribute to a weight-of-evidence needed to evaluate success.

Preferred Portfolio 7 Freshwater Actions

ACTIONS	FTEs	$
Investigate natural spawning performance of translocated adult salmon	0.25	80,000
Perform experimental habitat manipulations adding large wood to streams	1.25	140,000
Evaluate the ecological role and importance of diadromous fish (alewives, shad, smelt etc. etc.) contributions to the freshwater production of smolts.	0.50	40,000
Design and implement a state-wide juvenile salmon sampling plan based on statistical sampling with fully standardized methods	1.00	130,000
Evaluate smolt production on selected rivers (i.e. Narraguagus, Penobscot, and Sheepscot Rivers)	1.50	180,000
Monitor reaches for natural re-colonization	0.04	7,200
Increase escapement of adult salmon to the Penobscot River	0.24	19,200
Trap and Truck adult salmon from Lockwood Dam to the Sandy River drainage, Kennebec basin	0.25	30,583
Sample all Aquaculture suspects captured for disease	0.02	6,600
Identify causes and remedies for poor natural juvenile recruitment	0.05	8,000
Review existing stocking programs (various trout spp, bass spp, or any other species) and assess the potential impacts of these introductions on Atlantic salmon populations	0.16	12,800
Assess avian, fish, and mammal predation in freshwater-all life stages.	0.48	48,400
Assess the effectiveness of smallmouth bass removal and the feasibility of conducting the action on at various scales	0.07	5,280
Assess affect of water temperature on salmon production (consider different life stages, growth, mortality, behavior, predation, competition, etc.)	0.50	50,000
Prioritize and evaluate habitat restoration strategies based on system connectivity, habitat quality, and the expected benefit to Atlantic salmon	0.25	20,000
Conduct habitat qualification surveys to augment quantitative surveys (e.g. substrate quality, complexity etc.)	0.25	25,000
Map riparian zones and activities (e.g., harvest practices, ATVs, development etc.) that may impact Atlantic salmon (sedimentation, flow, etc.)	1.00	130,000
Retain large woody debris in streams and rivers to support salmon habitat quality and quantity.	0.10	8,000
Develop habitat based productivity estimates and identify key elements of productive salmon habitat and limiting factors	0.25	25,000
Conduct watershed (or basin-level) specific comprehensive productivity studies	1.00	130,000
Identify areas with salmon production potential that are currently unoccupied for possible restoration	0.25	30,000

ACTIONS	FTEs	$
Review existing water quality standards for salmon rivers to determine adequacy to meet the needs of Atlantic salmon	0.05	5,000
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	0.25	21,000
Support riparian zones best management practices for water quality and habitat	0.30	29,000
Identify areas for riparian forest improvement and pursue resources for improvements	0.05	29,000
Monitor water temperatures in selected salmon river systems	0.10	18,000
Evaluate the impacts of sedimentation and changes of stream channel geomorphology on habitat quality/quantity	0.50	40,000
Implement the State of Maine Penobscot Operational Plan	-	-
Develop a Section 10(a)(1)(B) habitat conservation plan for recreational fishing permitted by the State that may incidentally take Atlantic salmon	0.50	40,000
Develop a Section 10(a)(1)(B) habitat conservation plan for fisheries management activities (stocking, assessment etc.)	0.50	40,000
Prohibit (or continue prohibition of) all recreational fishing in select areas utilized by Atlantic salmon as holding areas to all fishing where Atlantic salmon may be taken as bycatch or poached	0.01	800
Continue to enforce commercial freshwater fisheries regulations/permits where the potential for incidental take of Atlantic salmon exists	0.01	800
Investigate recruitment from natural spawning relative to other enhancement strategies	0.16	28,800
Capture and captive-rear, in sea-cages, wild and/or naturally-reared Penobscot smolts for release as sexually mature adults in selected river reaches	0.25	30,000
Assess overwinter survival of juvenile salmon using best available data initially, and design and undertake further research as needed.	0.64	51,200
Perform experimental habitat manipulations to reduce sedimentation (i.e. embeddedness/armoring) and evaluate the effect on the biological function of streams.	0.75	65,000
Examine the role of connectivity between main stem and tributaries and habitat types (rapids, flat waters, runs, riffles, pools), on productivity	0.02	1,600
	13.50	1,526,263

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 a broad index of population abundance and distribution.

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. Maintaining trapping efforts and long-term sites to establish index sites as indicators of smolt production within each SHRU.

Monitor reaches for natural re-colonization

While the standardize assessment will focus on occupied habitat, this action will monitor a few unoccupied areas for natural re-colonization (areas with no active stock enhancement, but access) through juvenile assessments and redd surveys on an annual basis.

Increase escapement of adult salmon to the Penobscot River

Review options that would increase adult escapement to the Penobscot River to increase wild smolt production. 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. What is the best use of an Atlantic salmon adult return?

Trap and Truck adult salmon from Lockwood Dam to the Sandy River drainage, Kennebec basin

This is the current best management practice to increases the effective spawning population by transporting adults upstream and releasing them in the area where they were reared.

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.

Identify causes and remedies for poor natural juvenile recruitment

Natural recruitment is limited, in part, because the numbers of wild spawners are inadequate to foster robust juvenile populations. However, increased adult escapement alone will not remedy poor juvenile recruitment if the habitat is compromised and limiting. This action will review the current literature and agency reports to identify the most likely environmental factor that contribute to poor natural recruitment.

Investigate recruitment from natural spawning relative to other enhancement strategies

A better understanding of juvenile recruitment from natural spawning is needed to make informed management decision about restoration techniques and weight the benefits of our management options such as stocking fry, smolts, and wild spawning.

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 and large rivers. This monitoring network will compliment USGS gage sites.

Assess effect of water temperature on salmon populations-consider different life stages, growth, mortality, behavior, predation, competition, etc.

A literature review and synthesis of current data are needed to evaluate the interactions of water temperature, stream community, and juvenile production to aide in prioritize restoration efforts.

Conduct habitat qualification surveys to augment quantitative surveys (e.g. substrate quality, complexity etc.)

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 Atlantic salmon habitat will provide more information faster (with estimates of precision) at lower cost than surveys of the entire watershed. Model outputs will be verified with existing data. 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.

Conduct watershed (or basin-level) specific comprehensive productivity studies.

This action will provide additional data for the development of a habitat productivity model and data for model validation.

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 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 ability of these factors to predict juvenile habitat suitability and provide management with information to make decisions needs to be assessed.

Identify areas with salmon production potential that are currently unoccupied for possible restoration

One of the objectives of the Framework is to increase the distribution of salmon. This action will provide manages with information on potential areas to focus restoration efforts on that are not currently being managed for Atlantic salmon. Information from this action should be evaluated in conjunction with the barrier prioritization list to identify the best possible areas to restore.

Evaluate the impacts of sedimentation and changes of stream channel geomorphology on habitat 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 is important to identify and prioritize habitat restoration efforts.

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.

Prioritize and evaluate habitat restoration strategies based on system connectivity, habitat quality, and the expected benefit to Atlantic salmon

Habitat restorations should be prioritized based on the expected benefits to Atlantic salmon populations and access(current and future).

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.

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. Resources for the riparian zone restoration restorations will be pursued through grant writing and the help of our NGO partners.

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). Encouraging stakeholders to not remove LWD from streams (protect and conserve the resource) is easier and more cost effective than restoring removed wood.

Perform experimental habitat manipulations adding large wood to streams

Large woody debris (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 stands, topography, and land uses and 2) supporting a study currently underway to test the effectiveness of adding LWD to salmon habitat.

Perform experimental habitat manipulations to reduce sedimentation (i.e. embeddedness/armoring) and evaluate the effect on the biological function of streams.

Embeddedness is often associated with poor juvenile Atlantic salmon rearing habitat. This actions will experimentally evaluate population level effects of reducing embeddedness.

Examine the role of connectivity among main stem and tributaries and habitat types (rapids, flat waters, runs, riffles, pools), on productivity

Improving freshwater survival is dependent on the restoration of ecosystem functions like flow regimes, thermal regimes, and sediment transport. This action will evaluate the benefits of connectivity between main stem and tributary habitat on juvenile Atlantic salmon production by studying how and when Atlantic salmon utilize tributary habitat.

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? This action will evaluate sources of Atlantic salmon predation and their impacts on juvenile and smolt production.

Assess the effectiveness of smallmouth bass removal and the feasibility of conducting the action on at various scales

Evaluate the interactions of smallmouth bass and juvenile Atlantic salmon, evaluate the benefits of removing bass from salmon habitat and the feasibility of conducting such removals at various scales (i.e. reach, drainage, sub basin).

Evaluate the ecological role and importance of diadromous fish (alewives, shad, smelt etc.) contributions to the freshwater production of smolts.

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.

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.

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 wild and/or naturally-reared smolts in sea-cages to adults and releasing them in selected river reaches to spawn. The outcome has the potential to increase adult escapement and increase spawning effectiveness.

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.

Review existing water quality standards for salmon rivers to determine adequacy 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.

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.

Implement the State of Maine Penobscot Operational Plan

This action is included to facilitate the implementation of the State's Penobscot River Operational Plan and any research proposals as a result of that Plan not explicitly stated as actions under the Freshwater Portfolio.

Develop a Section 10(a)(1)(B) habitat conservation plan for recreational fishing permitted by the State that may incidentally take Atlantic salmon

A habitat conservation plan is required as part of an incidentally take permit application to authorize recreational fishing that may impact protected Atlantic salmon.

Develop a Section 10(a)(1)(B) habitat conservation plan for fisheries management activities (stocking, assessment etc.)

A habitat conservation plan is required as part of an incidentally take permit application to authorize fisheries management activities that may impact protected Atlantic salmon.

Review existing stocking programs (various trout spp, bass spp, or any other species) and assess the potential impacts 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.

Prohibit (or continue prohibition of) all recreational fishing in select areas utilized by Atlantic salmon as holding areas to all fishing where Atlantic salmon may be taken as bycatch or poached

This action represents the time that Atlantic salmon Biologists spend reviewing State recreational fishing regulations for species other than Atlantic salmon and the postings of fishing closures that protect Atlantic salmon.

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.

Description: The Freshwater Action Team is charged with increasing adult spawners through the freshwater production of smolts. The premise is that by increase freshwater production of smolts you will see an increase in adult returns holding marine survival constant. By increasing adult spawning you should increase the abundance of Atlantic salmon. The Freshwater Action Team must also work to increase the distribution and diversity of Atlantic salmon and ecosystem function. To accomplish the Framework's objectives, the Freshwater Action Team is working to reduce the treats to Atlantic salmon through habitat restoration. By increasing habitat complexity you increase the production potential and resiliency or the population.

There are two strategies that will increase freshwater production. The first strategy is to increase the numbers of Atlantic salmon spawning in the wild. This can be accomplished by reducing the numbers of returning adult Atlantic salmon that are used for brood stock or stocking adults. Reducing sea-run brood stock requires an evaluation of the best use of an adult return and some compromise between the Conservation Hatchery Action, Genetic Diversity Action Team, and The Freshwater Action Team. The method is focused on increasing juvenile production in the short term and does not address threats to long-term sustainability. The second strategy is to increase juvenile survival. By increasing survival you are establishing a population that is more resilient to short-term disturbance. Current freshwater survival is estimated to be 3.5%. The goal is to increase freshwater survival to 6%.

Included in our portfolio are several action that will classify Atlantic salmon spawning and rearing habitat, identify habitat deficiencies, evaluate restoration techniques, prioritize restoration efforts, and identify the best way to populate previously unoccupied habitat. All of the research activities will help to answer relevant question that will guide restoration management.
There are actions that increase the protection for Atlantic salmon through policy such as, developing Habitat Conservation Plans for the State, reviewing water quality parameters, and maintaining directed fishery closures. In addition there are several assessment actions that help us to evaluate our overall progress. Assessment of smolt production, naturally reared adult returns, redd counts and distribution, parr densities and parr distribution will provide weight-of-evidence to gauge our success.

This plan is designed to provide direction and focus to our freshwater restoration efforts. It is understood that all restoration efforts in freshwater should be conducted in a manner that will maximize the benefit of each project. The work of the Freshwater Action Team will be in integrated with the actions of other teams, in particular the Connectivity Team.

CURRENT PLAN

Current Resource Allocation: 25%

Current Focus of Efforts:

- **2 main areas of focus**
  - Management
  - Research

- **Salmon Management**
  - Assessing smolt production
  - Managing hatchery product distribution
  - Adult & parr broodstock collection
  - Assessing natural production
  - Assessing hatchery product in freshwater
  - Habitat survey focused on substrate type
  - Water temperature monitoring
  - Redd counts

- **Research**
  - Ambient parr stocking and assessment
  - Captive reared adult stocking and assessment
  - Egg planting and assessment
  - Adult pre-spawn translocation stocking and assessment
  - Large woody debris additions and assessment

Preferred Portfolio 5-Year Plan

Resource Allocation under the Preferred Portfolio: 20%

Goals and Objectives for Freshwater 2011 – 2015

- Increase adult spawners through the freshwater production of smolts
  - How will this be accomplished?
    - Increase the number (or proportion) of Atlantic salmon spawning in the wild
    - Increase freshwater survival of Atlantic salmon to 6%
  - How will Atlantic salmon abundance and survival be increased?
    - Habitat evaluation and restoration
      - Evaluate current status of salmon habitat including water quality, substrate, habitat complexity, productivity, and community composition
      - Identify data gaps and gather information
      - Model and map habitat quality
      - Prioritize restoration activities
      - Implement restoration projects
    - Research activities to inform management actions
      - Atlantic salmon response to increased habitat complexity
      - Atlantic salmon response to marine derived nutrients

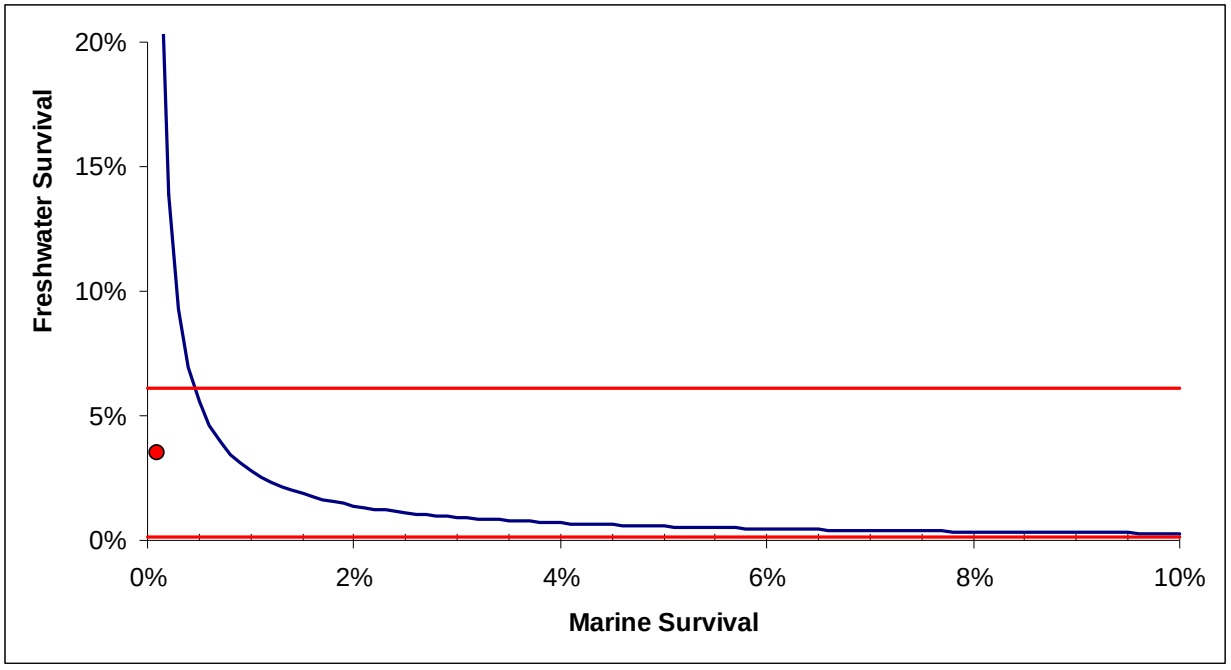
        - Investigate wild spawning by hatchery origin adult returns
        - Sea-cage rearing of wild smolts to adult and their spawning
        - Evaluate the importance of small tributaries to juvenile production
        - Evaluate patterns of overwinter survival
    - Atlantic salmon Juvenile Assessments and Monitoring
        - Long-term juvenile monitoring
        - Index of smolt production
        - Index and distribution of wild spawning (redd counts)

Action	2011	2012	2013	2014	2015
Design and implement a state-wide juvenile salmon sampling plan based on statistical sampling with fully standardized methods	X	X	X	X	X
Evaluate smolt production on selected rivers (i.e. Narraguagus, Penobscot, and Sheepscot Rivers)	X	X	X	X	X
Monitor reaches for natural re-colonization	X	X	X	X	X
Increase escapement of adult salmon to the Penobscot River	X	X	X	X	X
Trap and Truck adult salmon from Lockwood Dam to the Sandy River drainage, Kennebec basin	X	X	X	X	X
Sample all Aquaculture suspects captured for disease	X	X	X	X	X
Identify causes and remedies for poor natural juvenile recruitment	X	X	X		
Investigate recruitment from natural spawning relative to other enhancement strategies	X	X	X		
Monitor water temperatures in selected salmon river systems	X	X	X	X	X
Assess affect of water temperature on salmon production (consider different life stages, growth, mortality, behavior, predation, competition, etc.)	X	X	X		
Conduct habitat qualification surveys to augment quantitative surveys (e.g. substrate quality, complexity etc.)	X	X	X	X	X
Conduct watershed (or basin-level) specific comprehensive productivity studies.		X	X	X	X
Develop habitat based productivity estimates and identify key elements of productive salmon habitat and limiting factors	X	X	X	X	X
Identify areas with salmon production potential that are currently unoccupied for possible restoration	X	X	X	X	X
Evaluate the impacts of sedimentation and changes in stream channel geomorphology on habitat quality and quantity	X	X	X	X	X
Map riparian zones and activities (e.g., harvest practices, ATVs, development etc.) that may impact Atlantic salmon (sedimentation, flow, etc.)	X	X	X	X	X

Action	2011	2012	2013	2014	2015
Prioritize and evaluate habitat restoration strategies based on system connectivity, habitat quality, and the expected benefit to Atlantic salmon	X	X	X	X	X
Support riparian zones best management practices for water quality and habitat	X	X	X	X	X
Identify areas for riparian forest improvement and pursue resources for improvements	X	X	X	X	X
Retain large woody debris in streams and rivers to support salmon habitat quality and quantity	X	X	X	X	X
Perform experimental habitat manipulations adding large wood to streams	X	X	X	X	X
Perform experimental habitat manipulations to reduce sedimentation (i.e. embeddedness/armoring) and evaluate the effect on the biological function of streams	X	X	X	X	X
Examine the role of connectivity between main stem and tributaries and habitat types (rapids, flat waters, runs, riffles, pools), on productivity	X	X	X	X	X
Assess avian, fish, and mammal predation in freshwater-all life stages	X	X	X		
Assess the effectiveness of smallmouth bass removal and the feasibility of conducting the action on at various scales	X	X			
Evaluate the ecological role and importance of diadromous fish (alewives, shad, smelt etc. etc.) contributions to the freshwater production of smolts	X	X	X	X	X
Investigate natural spawning performance of translocated adult salmon	X	X	X		
Capture and captive-rear, in sea-cages, wild and/or naturally-reared Penobscot smolts for release as sexually mature adults in selected river reaches	X	X	X	X	X
Assess overwinter survival of juvenile salmon using best available data initially, and design and undertake further research as needed	X	X	X		
Review existing water quality standards for salmon rivers to determine adequacy to meet the needs of Atlantic salmon	X	X			

Action	2011	2012	2013	2014	2015
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	X	X	X	X	X
Implement the State of Maine Penobscot Operational Plan	X	X	X	X	X
Develop a Section 10(a)(1)(B) habitat conservation plan for recreational fishing permitted by the State that may incidentally take Atlantic salmon	X	X			
Develop a Section 10(a)(1)(B) habitat conservation plan for fisheries management activities (stocking, assessment etc.)	X	X			
Review existing stocking programs (various trout spp, bass spp, or any other species) and assess the potential impacts of these introductions on Atlantic salmon populations	X	X	X	X	X
Prohibit (or continue prohibition of) all recreational fishing in select areas utilized by Atlantic salmon as holding areas to all fishing where Atlantic salmon may be taken as bycatch or poached	X	X	X	X	X
Continue to enforce commercial freshwater fisheries regulations/permits where the potential for incidental take of Atlantic salmon exists	X	X	X	X	X

Appendix 1: Current Freshwater and Marine Survivals relative to Targets



The red dot in the above graph is an approximation of recent freshwater survival (3.5%) and marine survival (0.1%) regimes. The top red line is the expected freshwater survival from a healthy population with suitable habitat conditions. The blue line represents the possible combinations of marine and freshwater survival that will result in replacement. If a population fell precisely on the blue line, it would be replacing itself; that is, each female would theoretically produce two adult offspring, one male and one female. Combinations of freshwater and marine survival that place the red dot above the blue replacement line result in population growth.

The above graph illustrates that significant increases in freshwater and marine survival are needed in order to result in population increases. It is also clear that, while likely harder to achieve, incremental increases in marine survival have a much greater potential to result in population growth than comparable increases in freshwater survival.

Appendix 2: Joint Priorities - 2005

The information below represents the agreed upon joint priorities of the Maine Atlantic Salmon Commission, NOAA Fisheries Service, and the US Fish and Wildlife Service. We recognize that recovery efforts cannot be completed without reaching beyond current agency bounds. We must look to the commonalities of other agencies and NGO's to accomplish many of the tasks listed. As requests for research and programmatic changes come forward they will be need to fit within this new focus area to receive any consideration of funding or staff resources.

Investigate Potential Causes and Magnitude of Early Marine Survival
Monitoring and assessing early marine survival is a core responsibility of the National Marine Fisheries Service. Ongoing activities include documenting and describing the distribution of post smolts. Efforts are being expanded to monitor the coastal environment more broadly including reviewing and analyzing data sets on environmental variables, food availability, and changes in ecosystem structure and dynamics. Accomplishing this requires cooperation and collaboration with other personnel within NOAA and with state, federal and international resource agencies and academia, as well as non-traditional parties such as NGO's and the commercial industry. Future program areas include testing hypothesis that fish, bird or marine mammal predation reduces survival of smolts leaving rivers and passing through estuaries.

Operate and Evaluate Conservation Hatchery Programs for DPS and Penobscot River
Operating federal fish rearing facilities needed for recovery of the DPS and Penobscot are part of the core responsibilities of FWS. A broodstock management plan will be completed by the end of the 2005 calendar year. Annual stocking plans will also be available by January 2006 that include explanations and justifications for each life stage stocking approach/methodology, identify stocking locations, and describe assessments. An independent review of hatchery goals and objectives, production practices, the use of river specific facilities and demographic effects of stocking for the DPS and the Penobscot River will be conducted. Existing data will be used to review hatchery practices. The primary goal is to develop adaptive management approaches to hatchery production and stocking.

Habitat
Activities associated with habitat assessment, protection, restoration and enhancement were the most diffuse across the agencies as well as conservation organizations, and private individuals. Greater technical assistance is needed to guide habitat efforts, coordination to ensure priority habitat issues are addressed, and evaluation of habitat restoration and enhancement projects.

Physical Habitat: Greater attention will be focused on improving our understanding of how current physical habitat characteristics (hydrology, substrate, embeddedness and permeability) affect salmon production. We will work with USGS to (a) determine the sediment budget of streams and rivers; (b) assess the impacts of large-scale landscape change on watershed processes; and (c) determine "natural" channel of streams prior to historic alterations.

The primary agencies will continue to work with the recovery team and other agencies (e.g. NRCS) to seek opportunities to reconnect habitat through the removal of barriers and improved passage. This includes getting involved early in DOT and Maine Forest Service planning processes to prioritize critical crossings for bottomless arches. Finally, a working group/team will be created to facilitate adaptive habitat management experiment(s) addressing one or more of the following: (a) experimentally manipulate embeddedness levels; (b) adding large woody debris to streams; and/or (c) restore a stream to a natural channel.

Water Quality and Quantity: Identifying water quality issues that have the potential to cause over-winter mortality is a high priority and EPA's expertise and involvement will be sought. The TAC habitat working group and Recovery Team habitat working group will be asked to determine effective/efficient methods to increase productivity and manipulate river productivity. A commitment by USGS to maintain stream gages at points along the rivers within the DPS is a recovery priority.

Biological Communities. Restoration of diadromous species assemblages that co-evolved with salmon is a priority so that they can serve as predator buffers and improve nutrient exchange. Working with IFW to promote aggressive management practices against populations of exotic fish species in salmon rivers is also necessary. The new TAC habitat working group will be requested to identify what is known about optimal habitat conditions (physical habitat, water quality, food) that can serve as background for the design of experiment(s) to create and evaluate optimal habitat. The new TAC habitat working group will also be asked to facilitate adaptive management experiment(s) that manipulates predators and evaluates the effect of this on salmon.

Appendix 3: Action Team Members

MEAT		CAT		GDAT	
AT Chair	Tim Sheehan	**AT Chair**	Rory Saunders	**AT Chair**	Meredith Bartron
AT members		**AT members**	Jed Wright	**AT members**	Denise Buckley
			Antonio Bentivoglio		Paul Christman
			Dan Kircheis	**Ad hoc**	Mike Kinnison

CHAT		FWAT		Outreach	
AT Chair	Paul Santavy	**AT Chair**	Oliver Cox	**AT Chair**	E. Peter Steenstra
AT members	Anitra Fimenich	**AT members**	Scott Craig	**AT members**	Don Sprangers
	J. Bill Fletcher		Dan Kircheis		Jacob Van de Sande
	Christine Lipsky		Colby Bruchs		Katrina Mueller
	Ernie Atkinson				Josh Platt
Ad hoc	Joe Zydlewski				

Stock Assessment Group	
Members	John Kocik
	Joan Trial
	John Sweka

Appendix 4: White Paper on Atlantic Salmon Stock Assessment

White Paper on Atlantic Salmon Stock Assessment

August 16, 2010 Draft

Stock Assessment Action Team (SA AT)
John Kocik, John Sweka, and Joan Trial

Background

A stock assessment provides decision makers with much of the information necessary to make reasoned choices (Cooper 2006). At minimum, a quantitative stock assessment requires monitoring abundance (How big is the stock? Is it growing in size or shrinking?), and biological characteristics of the stock (e.g. age, growth, natural mortality, sexual maturity and reproduction; the geographical boundaries of the population and the stock; critical environmental factors affecting the stock; feeding habits; and habitat preferences). These primary sources of data feed into mathematical models that represent the demographics of the managed fish stock (Legault 2005, Robertson 2005, Fay et al. 2006).

The purpose of this document is to describe what Atlantic salmon stock assessment work is currently being conducted, and provide guidance on the minimum amount of assessment effort needed to detect trends in Atlantic salmon populations.

Scales of Assessment

There are two general categories of assessment activities: (1) assessment for evaluating overall stock status and (2) assessment for targeted studies. Both these categories can be done at multiple scales (sub-watershed to range-wide). The first type of assessment measures abundance and vital rates of the population (e.g. survival) and changes in abundance and vital rates in response to changes in management programs or natural population variance over time. Examples include annual estimates of total parr and smolt abundance on the Narraguagus River and estimates of parr to smolt survival. Other examples are evaluating a large scale changes in stocking methods such as on the Sheepscot River where age 0+ parr were stocked in the lower mainstem of the river in response to poor survival of fry in this area, and point stocking rather than typical dispersal stocking of fry on the Dennys River.

The second type of assessment usually evaluates smaller scale experiments that have implications for larger scale programmatic management. Examples include evaluation of hatchery versus streamside incubated fry in the West Branch Sheepscot River, effects of different fry stocking densities on survival to parr stages, and determining the dispersal of

fry from point stocked locations. However, work on the Penobscot River to assess stocking locations with over 100,000 smolts stocked illustrates that an adaptive management experiment can be done at a larger scale as well.

Regional and International Stock Assessment

Atlantic salmon population assessment data from Maine are integrated into regional and international assessments. At the annual meeting of the US Atlantic Salmon Assessment Committee (USASAC) NOAA Fisheries Service, US Fish and Wildlife Service, Maine Department of Marine Resources, and other New England fisheries agencies compile data to determine the status of US stocks. The USASAC attendees also addresses terms of references from North Atlantic Salmon Conservation Organization (NASCO) to the International Council for the Exploration of the Sea (ICES) Working Group on North Atlantic Salmon (WGNAS) and from the US delegates to NASCO. Data from the USASAC meeting are carried to ICES WGNAS where they contribute to formulating the scientific advice to NASCO, which manages high seas and foreign water Atlantic salmon fisheries. The core assessments carried to ICES are: annual USA returns and spawners, estimates of marine survival (requires estimates of smolt and adult returns over time on individual rivers), biological characteristics of juvenile and adult salmon (e.g. size at age, age at smolt emigration, age at maturity, fecundity), and trends in juvenile population abundance.

Description of Assessment Activities up to 2010

Adult Returns and Spawning Activity

Trapping facilities to intercept, count, and collect biological data from migrating adult Atlantic salmon are operated on the Narraguagus, Dennys, and Penobscot rivers. The Cherryfield fishway trap, located at a low head ice control dam on the Narraguagus River, was built in 1991, and has been operated from early May through mid-November each year. Weirs with fish traps were built on the Pleasant and Dennys rivers in 1999. Pleasant River weir operations were discontinued in 2005. The Dennys weir was redesigned, deployed for a portion of 2005, and full season operations were reinitiated in 2006. The Veazie fishway trap on the Penobscot River has been operated since 1978. Atlantic salmon are also captured and enumerated at fishway traps on the Kennebec, Sebasticook, Saco, St. Croix, East Branch Penobscot, Union, and Androscoggin rivers. Length, river and sea age, sex, and origin (hatchery, wild, and aquaculture) are determined for fish handled at the traps.

Redd counts are made on the small coastal rivers within the geographic range of the GOM DPS, and on selected habitat segments in other drainages. Redd counts are an index of adult salmon abundance and distribution at spawning time, and can be related to known spawning escapement to provide sub-reach level estimates of egg deposition within a basin. Relating redd counts to trap counts allows us to calibrate redd counts as a

stock assessment tool for rivers without salmon trapping facilities. Currently, a regression model is used to estimate returns to small coastal rivers within the geographic range of GOM DPS from redd survey count data only. The regression model was developed using concurrent annual data on returns and redds in from one to three rivers (Narraguagus, Dennys, Pleasant). The model is updated every 5 years, requiring at a minimum data from two rivers each year for the period.

Juvenile Populations

Parr Production. There are sites distributed across all salmon rivers that have been used to track annual populations of parr in Maine. The number of years that parr abundance data have been collected varies by watershed (10-digit HUC). Beginning in 1991, a Basinwide Geographic and Ecologic Stratification Technique (BGEST) was developed to estimate Atlantic salmon parr populations on the Narraguagus River. This resulted in an increase in sites with population abundance data for juvenile Atlantic salmon in the drainage. Electrofishing based on BGEST has also been conducted in the Dennys and Sheepscot rivers for a limited number of years. A Catch Per Unit Effort (CPUE) electrofishing protocol and sampling scheme has been integrated with the index sites. This approach allows sampling more sites in drainages and provides a broad index of population abundance and distribution. Salmon size (length and weight) and age are determined for a portion of the juvenile salmon captured. Although much effort is expended each year in electrofishing for parr abundance indices, the actual percentage of available habitat sampled annually within a watershed is between 0.01 and 7.25%.

Smolt Production. Rotary screw smolt traps are operated from late April through early June to capture smolts as they migrate into marine waters. Since 1997, mark-recapture estimates of smolt abundance and migration timing data have been obtained for the Narraguagus River. Population estimates are derived on the Narraguagus River using a stratified mark-recapture design. The recapture marking strata consist of alternating marks every four days throughout the trapping season to identify mark groups. Estimates based on marking and moving smolts upstream of traps have been calculated for the Upper Piscataquis River in Abbot (2009 & 20010), the Sheepscot River at Head-of Tide (2001), and in the upper portion of the Narraguagus River (2005 to 2010). Smolt traps have been operated on the Pleasant River, a Penobscot basin tributary from 2003 to 2010. In addition, migration timing data and smolt abundance indices have been collected on the Penobscot below Veazie, Dennys, Sheepscot, and Pleasant (Washington County) rivers for a range of years. The age and size of emigrating smolts are determined for a portion of the smolts captured.

Minimum Data Collection Guidance

The effort needed to detect a population trend depends upon the life stage considered, variance of the index of abundance, the number of years monitored, and the rate of change per unit time to be detected.

Adult Abundance

Adult assessment rivers should be of varying sizes and be distributed along the coast (in all three SHRU). Monitoring for adult abundance also requires data on two types of rivers: 1) being stocked with demographically significant numbers of Atlantic salmon juveniles (likely to produce returning adults), and 2) for which no river specific hatchery stocks were developed (Table 1). There are two methods collecting data on adult abundance, intercepting and counting adults at traps, and counting redds. Traps provide a census of the population and for rivers without traps, redd counts are an index of adult abundance. Redd surveys should target 80% or more of the mapped spawning habitat. Multiple counts within river reaches are encouraged, but the count made after cessation of spawning is the only one used to estimate adult returns using a regression model developed using concurrent annual data on returns and redds in one to three rivers (Narraguagus, Dennys, and Pleasant). Based on recent data collecting, three rivers with concurrent trap and redd counts annual are needed to ensure that data from at least of two rivers are available.

Parr Abundance

Minimum sample size requirements to detect increasing trends in large parr abundance were estimated for 10-digit HUC regions using historic electrofishing data, density estimates, and power analysis methods outlined in Gerrodette (1987).

Gerrodette (1987) described linear trend in abundance as:
$A_i = A_1[1 + r(i-1)]$ where A_i = the abundance in year i and r is the rate of change per year.

The number of samples needed per year to estimate a trend in parr density can be estimated by the equation:

$$r^2 n(n-1)(n+1) \geq 12CV^2\left(z_{\alpha/2} + z_{\beta}\right)^2 \cdot \left\{1 + r(n-1)\left[1 + \frac{r}{6}(2n-1)\right]\right\}$$

where n = the number of time intervals (years) monitored; CV = the coefficient of variation on a single estimate of abundance (i.e. density or CPUE); $z_{\alpha/2}$ and z_{β} = the values of the standardized random normal variable such that the area under one tail of the probability density function beyond $z_{\alpha/2}$ and z_{β} is $\alpha/2$ and β, respectively; α = probability of a Type 1 error; β is the probability of a Type 2 error; and $1 - \beta$ = power. The above equation assumes that CV is proportional to $1/\sqrt{A_i}$ and sampling is conducted under a simple random sampling design.

By knowing four out of the five parameters, the fifth can be solved for. The computer program TRENDS (version 3.0) was used to estimate the CV required to detect a positive trend in mean density and catch-per-unit-effort (CPUE) over a 10 year period for rates of change of r = 0.05 to 0.50 by 0.05 for each 10 digit HUC in the electrofishing data. The number of samples (m) needed in each 10 digit HUC was estimated as

$m = \left(\frac{CV}{CV_1} \right)^2$ where CV_1 was as the mean yearly coefficient of variation of parr density for each 10 digit HUC between 1991 and 2007.

As the rate of change increases, the required sample sizes decrease (Figure 1). On average, 15 and 17 sites need to be sampled annually using mean density and CPUE, respectively, to have an 80% chance of detecting an increasing trend with a 0.10 rate of change per year over a 10 year period. The number of samples required in each watershed to detect such a trend showed substantial variability because of differences in among site variation within these watersheds (i.e. greater among site variation requires more samples). This variability is due to differences in spatial coverage within a 10-digit HUC and the number of years sampling occurred within a 10-digit HUC. If we only consider those HUCs with 5 or more years of data, and those that had good spatial coverage, required sample sizes decrease to 9 and 10 sites per year for mean density and CPUE, respectively, for the same 0.10 rate of change per year.

The dilemma in recommending appropriate sample sizes is deciding what rate of change is biologically meaningful and over what time period. Parr densities show great fluctuation from year to year due to natural hydrological variation, therefore the annual rate of change, or overall rate change, must be large enough to differentiate a true population trend from natural variation. Also, we must consider available resources for sampling.

We recommend a minimum of 5 – 10 sites be sampled annually within a HUC of interest using either multiple pass removal estimates of mean density or mean CPUE methodologies. This amount of sampling effort will provide 80% power in detecting an increasing trend in the index of abundance for annual rates of change between 0.1 and 0.2. Although the ability to detect smaller changes is desirable, the amount of sampling required to detect such changes greatly increases at annual rates of increase less than 0.1 and may not be feasible with limited sampling resources. Annual rates of change of 0.1 to 0.2 correspond to approximately a doubling or tripling of the index of abundance in a 10 year period. Because of the natural annual variation in parr abundance, anything less than a true doubling of abundance may be of little to no significance in overall population growth rates of Atlantic salmon.

Slightly more samples would be required if CPUE were to be used as an index of parr abundance compared to mean density. However, obtaining an estimate of CPUE for a given site requires less time than obtaining an estimate of density because CPUE estimates do not require placement of block nets or multiple electrofishing passes. Thus, CPUE methodology may be more desirable for a fixed total amount of sampling effort (or person-hours) available. Mean density does, however, have more biological meaning (# / 100 m^2).

Smolt Abundance

Estimates of smolt abundance integrate overall freshwater productivity for multiple years of freshwater rearing for the two, and sometimes three emigrating cohorts. In addition to enumerating naturally-reared smolts, smolt monitoring can provide information on rearing origin of smolts if marking programs are in place. A minimal monitoring program provides estimates or indices of abundance. A more comprehensive smolt monitoring program provides a better understanding of smolt growth, age structure, and freshwater and ocean survival. These data may also help researchers differentiate between mortality occurring in riverine habitats and mortality occurring in estuarine and open ocean habitats. The ability to detect smolt production trends or compare temporal or geographic changes in management strategy in or among a watershed depends on the variance associated with annual estimates or average daily catches. Smolt population estimates generated from the aforementioned mark-recapture design are relatively precise estimates compared to mean parr density estimates. On the Narraguagus River the average CV for the smolt estimate is 0.1238, which allows for an 80% chance of detecting an increasing trend of 0.04 rate of change per year over a 10 year period (power calculations of Gerrodette 1987).

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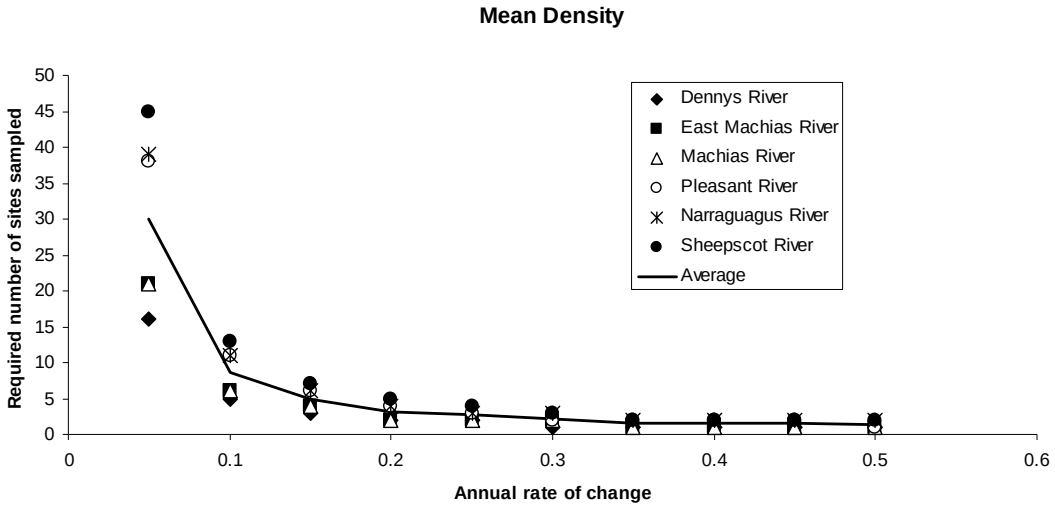
Table 1: Maine rivers where adult assessment has been conducted, noting if the rivers are within the geographic range of the GOM DPS, have recently been stocked with juveniles sufficient to produce adult returns, and the methods of assessment.

River	GOM DPS	Demographic Stocking (2005-2006)	Adult Assessment
Saco	N	Yes (Penob F2)	Trap
Kennebec	Y	Maybe	Trap
Sebasticook	Y	No	Trap
Androscoggin	Y	No	Trap
Sheepscot	Y	Yes	Redd Survey
Ducktrap	Y	NONE	Redd Survey
Cove Brook	Y	NONE	Redd Survey
Penobscot	Y	Yes	Trap
Union	Y	No	Trap
Narraguagus	Y	Yes	Trap & Redd Survey
Pleasant	Y	Yes	Redd Survey
Machias	Y	Yes	Redd Survey
East Machias	Y	Yes	Redd Survey
Dennys	Y	Yes	Trap & Redd Survey
St. Croix	N	No	Trap (NGO)
Aroostook	N	Yes	Trap (NGO)



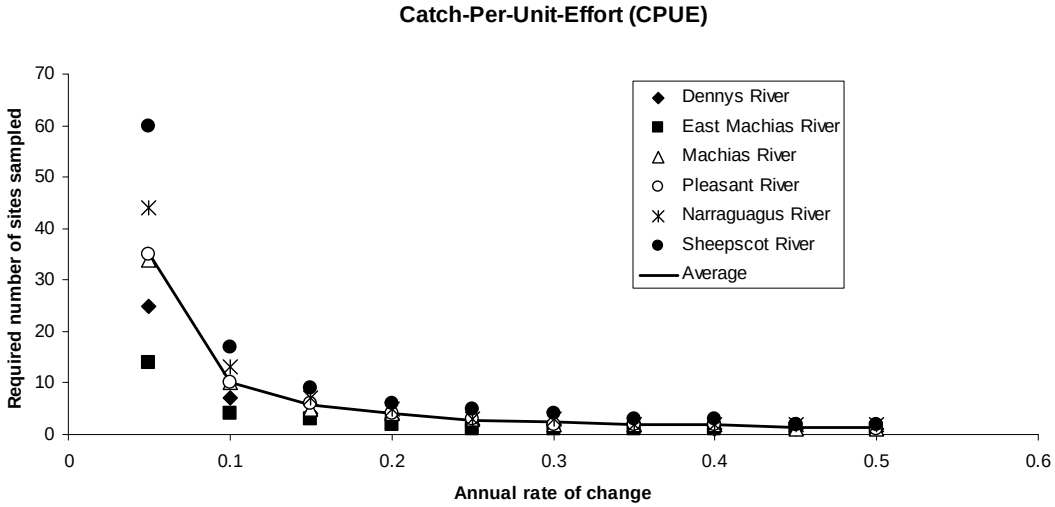


Figure 1: Sample sizes needed to detect a given annual rate of change in indices of parr abundance. The rivers on the graphs are those that have had ≥ 5 years of sampling with good spatial coverage.