Maine Interagency Stream Connectivity Work Group
2009-2010 (Year One) Summary and Recommendations

July 2010

A Joint Report of the

Maine Coastal Program, Maine State Planning Office
Bureau of Sea Run Fisheries and Habitat, Maine Department of Marine Resources

River herring crowd a tributary of the Eastern River in Dresden during their annual spawning migration.

Acknowledgements

Thanks are extended to the Maine Interagency Stream Connectivity Work Group, whose diligent efforts are described in this report. A full list of Work Group participants is provided at the end of the document.

This report is dedicated to Melissa Laser, whose tireless work to restore Maine's rivers lives as an exemplar for all restoration practitioners.

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EXECUTIVE SUMMARY

Centuries of environmental degradation have impaired the chemical, physical, and biological linkages within and among Maine's estuaries, streams, lakes, and other aquatic systems. A notable source of this impairment is the loss of in-stream, or longitudinal connectivity. Frequently resulting from the construction of dams and road crossings over streams, impaired connectivity limits access to habitat that is critical to the survival of Atlantic salmon, alewife, native brook trout, freshwater mussels and other species requiring unimpeded movements during all or some of their life cycle. Along with ecological impacts, impaired connectivity also has considerable economic and social costs, including the loss of income and jobs historically supported by thriving commercial and recreational fisheries, some of which presently languish in a moribund condition or no loner exist. Likewise, the suppressing effects of impaired connectivity on population growth of at-risk riverine species has led to increasingly restrictive, costly and complex environmental regulatory processes developed to protect these species from further harm. Finally, for the same reasons that road-stream crossings often impair ecological connectivity, the inability of these structures to adequately accommodate the range of demonstrated stream flows presents an ongoing risk of damage to infrastructure and harm to public well-being that will be exacerbated if wetter weather and more severe storms become the norm, as climate change research suggests. Recognition that the consequences of impaired aquatic connectivity extend beyond fish populations has been slow to register outside of restoration disciplines. But with only partial success to show for over a half century of diligent restoration effort, it is clear that the limited capacity to fully engage in re-establishing connectivity over that period has hindered efforts.

Convened in 2009 at the behest of Governor Baldacci, the Maine Interagency Stream Connectivity Work Group represents the latest of several attempts in this decade to grapple with the challenge of restoring Maine's aquatic habitats. After one year of focused study, this assemblage of state, federal and non-government organizations concluded that progress toward recovery of our aquatic systems will be severely hindered without a highly coordinated restoration strategy having complimentary programmatic, regulatory, and funding elements. The full list of Work Group recommendations follows below. Each recommendation is designed to maximize returns on previous and future restoration investments in Maine (note that long-term funding needs in the recommendations are not inflation-adjusted).

The largest investment proposed in the recommendations (#3 below), makes an attempt to dramatically increase and maintain a high rate of projects that correct road-stream crossings that are severe barriers to connectivity. The cost of correcting the highest priority barriers to connectivity is sobering, and private, municipal, and State capacity to meet this challenge is currently insufficient. Yet without implementing this element of a larger strategy, the millions of dollars annually expended on restoration are unlikely to reverse trends of compromised environmental conditions or benefit at-risk species that have exhibited little response to less comprehensive restorative actions. The cost of this recommendation could be supported by a "green jobs", transportation, or environmental bond. Implemented over the coming decades, a program of this scale would require considerable materials and services to support project

management, design, and construction at sites located across the state. Consequently, the sustained economic benefit associated with this work could be noteworthy. Also beneficial, correction of barriers to standards that accommodate present flows could reduce risk of infrastructure damage and harm to the public by addressing crossings predisposed to failure. These designs could also incorporate climate change considerations, such as the likelihood of increased flows over the next decades.

Recommendations of the Maine Stream Connectivity Work Group

1. Facilitate leadership and capacity for restoration of aquatic connectivity in Maine by establishing a centralized restoration program.

   Needs: Staffing and a modest operational budget to coordinate and implement a statewide strategy and individual projects at the watershed scale. Initial staffing requirements include a Restoration Coordinator and three Restoration Specialists (1 Ecologist/Project Leader; 2 Engineers) for a total cost of $320,000/year.

2. Develop and implement State regulatory criteria that compliment statewide restoration efforts.

   Needs: Support revision of DEP Permit by Rule language for new and replacement stream crossings that will accommodate physical and biological processes necessary for re-establishing and sustaining healthy aquatic ecosystems.

3. Create a bond-supported grant program to assist with the cost of correcting public and private road-stream crossings that represent the highest priority barriers to connectivity.

   Needs: $5 million/year initially, increased as capacity grows to administer the barrier correction grant program.

4. Develop and maintain a statewide barrier database and mapping system providing geographic and physical attributes of individual dams, road-stream crossings representing barriers, and other structural barriers to connectivity. Engage private landowners in the development process to ensure concerns over data accessibility are addressed.

   Needs: $30,000/year to support a part-time, barrier database/web mapping manager.

5. Inventory barriers to connectivity throughout the highest priority sections of Maine's watersheds.

   Needs: $150,000/year over the next 10 years to support field crews necessary to survey approximately 9,000 stream crossings in historical diadromous fish range in Maine and additional crossings outside of that range.

6. Develop, test, and implement a software application intended to prioritize actions necessary for correcting barriers to connectivity across the state.

   Needs: $100,000 to support development of this tool over the next two years.

7. Explore options for streamlined regulatory approaches that will compliment restoration efforts by facilitating increases in the efficiency, number, and rate of successful barrier-removal projects completed.

   Needs: Develop a certification or consultation process facilitating expedited federal review of projects that meet minimum "best practices" criteria and will clearly benefit efforts to restore populations or habitats of at-risk species.

8. Develop an incentive strategy for responsible dam ownership that compliments the goals of dam safety, restoration, and renewable energy production.

   Needs: Develop or more fully use existing legislative, regulatory and funding mechanisms to support a strategy facilitating dam safety, ecologically appropriate flow regimes, removal of dams in collaboration with willing owners, and accommodation of effective fish passage where dam removal is not currently feasible.

9. Clearly articulate the costs of impaired aquatic connectivity to policymakers and the public.

   Needs: Develop a case statement demonstrating the costs of statewide aquatic restoration and species recovery actions to date, and to what extent those costs are perpetuated by ongoing societal choices that impede attainment of restoration goals or ecosystem recovery. Demonstrate the benefits to public safety, property, commerce and long-term maintenance costs when adequately designed stream crossings are used in lieu of "cheaper" alternatives.

I. Introduction

Background on Aquatic Connectivity in Maine

Aquatic Connectivity refers to the chemical, physical, and biological linkages within and among different types of aquatic systems (e.g. estuaries, streams, lakes) and the upland environments with which they interact. When the integrity of these linkages is significantly impaired or broken, ecological functioning is likewise impacted. Despite notable successes resulting from decades of restoration effort, impaired connectivity within and between aquatic systems and their surrounding landscapes continues to hinder recovery of these systems. Loss of aquatic connectivity has many origins, but is most readily observed where structural barriers such as dams and road crossings physically restrict or block the flow of water, sediment, nutrients, and the movements of migratory and resident fish and wildlife. Other significant impairments to aquatic connectivity in Maine result from stream channel straightening, loss of riparian forest communities, stream acidification, and pollution of various kinds. A principal concern is that impaired connectivity hinders the migration, reproductive potential and ultimately, recovery and survival of diadromous species whose migratory habits require uninhibited access to marine and freshwater habitats alike. To various extent, these species, which include Atlantic salmon, American shad, and the "river herring" (alewife and blueback herring), formerly provided considerable economic, cultural and ecological benefit to this region. Today, impaired connectivity continues to suppress populations of these once key species, most of which persist at abundances sufficiently low to be considered extirpated or functionally irrelevant in large portions (or all) of their historic range in Maine. The highly prized eastern brook trout and other freshwater aquatic organisms, including salamanders and reptiles, also require unimpeded access to a variety of habitats to complete their life cycles. The conservation of these species is also hindered by habitat degradation that inhibits or prevents normal movements within and among aquatic systems.

The Maine Interagency Stream Connectivity Work Group

Some of the first efforts to address impaired aquatic connectivity in Maine can be dated to the early 19th Century, when vigorous opposition to blocked fish passage at a number of dam sites nevertheless failed to prevent a more environmentally-considerate approach to harnessing our rivers and streams for water powered industry. In the past few decades, notable projects led by government and non-government organizations alike have dramatically improved degraded conditions in portions of some Maine watersheds. However, the scope and complexity of the problem exceed our present capacity to implement corrective action that would support major recovery of aquatic systems at a statewide scale. Clearly, a problem that was centuries in the making and continues today is not likely to be rapidly reversed, but there is also recognition among restoration practitioners that as time passes, actions to support ecosystem recovery will become more costly and the likelihood of success, less assured.

In the past decade, at least three efforts by key state, federal and non-government organizations were initiated to identify and evaluate approaches for increasing the pace and success of statewide river restoration efforts. These included the Maine River Restoration Task Force (2004), the Maine Stream Barrier Inventory, Prioritization, and Mitigation Project (2007), and an effort in 2008 aimed at improved coordination necessary for salmon recovery and re-establishing fish passage in Maine. Each of these groups identified major, ongoing hindrances to the restoration of Maine's rivers and streams and the fish and wildlife populations they support. Notable among them were a lack of: 1) standardized methods and data to describe the scope of statewide connectivity impairment, 2) ecologically-based decision making tools for prioritizing corrective action, 3) coordination among organizations engaged in restoration, and 4) capacity to address these needs. Four years after the first of these groups delivered their comprehensive list of recommendations to the Land and Water Resources Council in 2004, little progress had yet been made toward addressing longstanding, statewide restoration challenges. While some state programs are heavily engaged and successful in distinct aspects of restoration (e.g. Maine Department of Marine Resources Bureau of Sea Run Fisheries), the lack of a comprehensive state program to address the full suite of relevant connectivity issues prompted the US Fish and Wildlife Service Gulf of Maine Program (USFWS), National Oceanographic and Atmospheric Administration - Restoration (NOAA), Natural Resources Conservation Service (NRCS), American Rivers, and The Nature Conservancy – Maine (TNC) to request that the State form a river restoration team and create a state coordinator position to lead the effort. It should be noted that the Maine State Planning Office (SPO) houses a "Habitat Restoration Coordinator". However, major tasking of this position, which is funded mainly through a three-year NOAA Grant, is currently split between administering a restoration grant program for the Gulf of Maine region (50%) and working to build capacity for restoration within Maine (50%).

In response to the latest request for a coordinated restoration program in Maine, the Governor expressed continued support for the informal, collaborative process of river restoration in Maine and directed SPO and DMR to initiate another iteration of an ad hoc State of Maine river restoration group or committee. The governor also left open the option of reconsidering development of a more formal, state river restoration effort should it be deemed advisable by this latest group. A work group comprised of agency (state and federal) and NGO participants with technical and planning expertise was then convened in April 2009 to initiate the coordination process among state agencies NGOs and federal partners and met four additional times by Mid-March 2010. Participating Work Group Members included staff from State agencies including DMR, Department of Transportation (MDOT), Inland Fisheries and Wildlife (IFW), Department of Conservation (DOC), Department of Environmental Protection (DEP), the Maine Office of GIS, and SPO. Federal agencies were represented by staff of NOAA Restoration, NOAA Fisheries, USFWS, and NRCS. NGO representatives included American Rivers, Atlantic Salmon Federation, The Nature Conservancy (TNC), Maine Rivers, Project SHARE, and Trout Unlimited.

The Work Group meetings identified restoration opportunities and challenges and also educated the participants on strategies, techniques and mechanisms characteristic of successful restoration efforts elsewhere. Early in the process, the Work Group concluded that a broad

suite of connectivity issues (e.g. in-stream, between system [such as estuary-stream, stream-stream, stream-floodplain, stream-pond], aquatic-upland, physical and chemical characteristics, and fish *and* wildlife) warrant attention and that the relevant spatial scale of the group's work is the entire state. There Work Group agreed on the broad scope of issues requiring attention with an immediate need to restore longitudinal, in-stream connectivity, which is most often impaired by road crossings, dams and other structural/physical habitat alterations that restrict or block hydraulic flow, movements of aquatic organisms, and other physical and biological processes.

Summaries of the workgroup meetings are provided below:

10 April 2009: *American Rivers' "Rivers Restoration Program*"
Brian Graber provided an overview of the RRP in the northeast, after which much discussion followed, including identification of strengths of the various state dam removal and river restoration programs , including those supported by Vermont, New Hampshire, Massachusetts, Pennsylvania, and Connecticut.

17 June 2009: *Preliminary Assessment of Barrier Databases*
Vickie Schmidt (MDEP) and other participants discussed barrier and hydrographic data available from MDIFW, MFS, and MDOT and possibilities for future coordination.

23 September 2009: *Pennsylvania Dam Removal Program*
Scott Carney, Chief of the Division of Habitat Management (Pennsylvania Fish and Boat Commission), provided several presentations while touring Maine. Highlights of Scott's presentation on Pennsylvania's highly successful dam removal efforts (e.g. 35 dams removed in 2007) are available in a separate document.

17 November 2009: *Maine Dam Laws*
Dana Murch, Hydropower Specialist (MDEP) provided a review of Maine's dam data and laws. Dana discussed how Maine's dam inventory is outdated, incomplete and lacks a registry. He also noted that there are few legal mechanisms to compel maintenance or fish passage at most privately owned dams.

16 March 2010: *Increasing permitting efficiency: scenarios, triggers and frontloading*
Representatives from MDEP, NOAA and USFWS provided background on their roles in permitting restoration projects. Discussion at this meeting suggested that, especially where restoration is planned at sites within designated Atlantic salmon waters, a more efficient permitting approach that facilitates an increased rate of restoration (for salmon recovery) is warranted.

II. Milestones and Products for Year One

Products of notable milestones, which were identified to increase coordination among relevant agencies and organizations, follow below.

1. Identify overlap among the missions of participant organizations, challenges to coordination, and opportunities for enhanced restoration of connectivity.

   During the first meeting, the group developed a questionnaire to identify commonalities and also impediments to improved coordination and enhanced statewide restoration efforts. Several common themes that were apparent in the returned questionnaires are provided below:

   - An effective statewide restoration initiative will require centralized leadership providing consistency and coordination expertise.
   - Leadership will be most effective if mandated as an official state program. Funding is necessary to support statewide planning, regulatory improvements, and educational needs, especially if restoration is to occur in the most efficient manner.
   - Feasibility, design and implementation phases of "on the ground" restoration projects across the state require a considerable infusion of funding.
   - In many cases, (especially for thousands of road crossings that are barriers) a prioritization of needs across the state will provide the most ecologically meaningful use of limited funding and staff time.
   - There is a need to identify the economic and ecological costs and benefits associated with using different transportation infrastructure designs over short and longer-term time scales. For instance, the consequences of different designs on flows *and* passage of aquatic organisms should be clarified.
   - Outreach and demonstration projects are required to educate others about the value of connectivity, efficiencies gained by coordination, and available assistance in terms of expertise and funding.
   - Regulatory updates are required to reflect and support the most current ecological management goals of relevant agencies, including adaptation to climate change.
   - Success creates momentum for more success, so increasing demonstrable, "on the ground" results is important to enhancing future progress.
   - There are existing tools and methodologies to enhance statewide restoration efforts that can be adopted or adapted to Maine's needs.
   - This effort was initiated to enhance coordination among state agencies, but the group should add other organizations as needed to provide technical expertise.

2. Identify provisional objectives and where feasible, initiate action

   Based on early discussions, the Work Group identified a provisional set of goals/objectives to guide subsequent efforts. Progress toward achieving each of these objectives is described below:

Administrative/Programmatic Objectives

- Develop and sustain a technical work group (representing relevant participant agencies and organizations) to guide statewide restoration progress.

  Progress: The Work Group, which includes several active committees, was established and continues.

- Acquire funding to support dedicated staff that will coordinate the group, implement its recommendations for improving statewide restoration of connectivity, and coordinate implementation of restoration projects.

  Progress: No funding for this objective acquired. Long-term restoration coordination and planning activities are not typically supported by the most prominent funding sources associated with restoration, such as NOAA Habitat Restoration Partnerships, which most often target "on-the-ground", physical habitat restoration work. Other sources of temporary funding have been investigated on an opportunistic basis, but there is little development capacity and also recognition that temporary funding sources are not a solution to an environmental challenge of this scope and magnitude.

Restoration Planning Objectives

- Develop a plan to dramatically increase the rate of projects planned, designed, permitted and implemented with an efficient system for monitoring multiple projects.

  Progress: Perhaps more of an overall goal, attaining this objective requires development and adoption of standardized restorative approaches, streamlined permitting, statewide barrier inventories (assessment), prioritization of project sites and effort, coordination among the many restorative entities, and financial capacity to support all of these activities. The group is investigating ways to support each of these elements as the other objectives in this list indicate.

- Initiate development of a statewide, georeferenced database providing attributes describing the ecological consequences of individual dams, culverts and other physical barriers to connectivity.

  Progress: The Data and Prioritization Committees have initiated development of a plan to house spatial data obtained from barrier inventories. It is envisioned that at least a portion of the data will be accessible via the internet in an interactive GIS.

- Streamline permitting and regulatory processes that hinder implementation of restoration projects.

Progress: Given the depressed population status of NOAA Special Concern species such as rainbow smelt, river herring and shad and also the federally endangered Atlantic salmon, there is a sense of urgency to restoration. However, uncertainties regarding regulatory requirements can hinder the efficiency of efforts to plan and implement restoration at distinct project sites. The workgroup is investigating development of streamlined regulatory/permitting processes that address the mandates of regulatory agencies while facilitating increases in the rate of restoration by qualified professionals.

- Develop measurable goals and benchmarks for measuring restoration success.

  Progress: The question of what amount (and rate) of restored connectivity is necessary to achieve goals for re-establishing a given level of ecosystem recovery has received relatively little critical attention. The workgroup has not convened an effort to wrestle with this issue but as prioritization efforts continue, it is likely to be addressed.

- Develop or adopt, and evaluate tools for prioritization of restorative action that is based on ecological objectives, project feasibility and opportunity.

  Progress: The workgroup's Prioritization Committee has convened several times to identify criteria that a prioritization tool should integrate. A workplan will be developed to identify key actions and resources necessary for delivery of the prioritization tool. The aim is for the tool to prioritize potential project sites based solely on ecological benefit. The group is also developing post-prioritization, or second tier, decision making criteria that correspond to feasibility. In concept, these feasibility attributes would be used by project planners to determine which high priority sites hold the greatest likelihood for success given current land ownership patterns, conflicts with other resource management policies, and other dynamic conditions that are difficult to anticipate or collect data for in a uniform manner for all barriers.

- Inform prioritizations with risk assessments for individual aquatic species that are sensitive to impaired connectivity.

  Progress: This objective is being addressed as part of the prioritization work described above.

Restoration Outreach and Assistance Objectives

- Develop and disseminate information that increases awareness of proper road-stream crossing design and construction methods among landowners, municipalities and other relevant parties.

Progress: Participants of several organizations/agencies contributing to this group are currently developing training for "shovel holders", (municipalities and private landowners relevant to road maintenance). They are also initiating efforts to develop a tool for estimating costs of different culvert sizing alternatives.

- Help landowners and municipalities comply with stream connectivity legislation by creating funding mechanisms to support cost-sharing and technical assistance for high priority culvert replacements.

  Progress: Currently, the Maine Natural Resources Protection Act requires road-stream crossings to accommodate fish passage. Yet recent barrier inventories, such as those in the Sheepscot, Presumpscot, and Lower Penobscot watersheds demonstrate that on average, about 40% of road-stream crossings represent "severe" barriers to connectivity. Extrapolated across the entire state, this trend indicates that without a considerable infusion of funding to reverse poorly designed crossings, thousands of barriers will continue to hinder connectivity restoration efforts. The magnitude of capital required to correct barriers is far greater than existing restoration funding sources currently can accommodate. One option for reversing this trend would be to develop a major transportation, green jobs, or environmental bond – the feasibility of this option is being investigated.

- Develop a web-based Maine Aquatic Restoration Clearinghouse that includes workgroup information, permitting guidance materials, restoration design guidance for shovel holders, and list of prominent funding opportunities for "on-the-ground" implementation of restoration projects including feasibility studies, construction design, and construction.

  Progress: None to date.

- Develop a network of participants in the workgroup to provide on-site assistance when needed for project implementation (survey, monitoring, on-site inspection, etc.)

  Progress: None to date.

- Draft a White Paper that demonstrates the ecological and social benefits of reestablishing connectivity.

  Progress: Several participants expended considerable time on a draft white paper. The document was intended to provide a detailed, but accessible discussion of the issues and challenges associated with restoration of stream connectivity and also comprise the basis for one or more issue briefs to be used as outreach materials.

Stalled progress on this objective is a consequence of the Work Group's limited capacity and shifting priorities.

III. Recommendations

The comprehensive exploration of restoration challenges and opportunities by the Work Group provided the basis for several key recommendations, several of which concur with the conclusions of previous restoration scoping efforts coordinated by the State.

1. Provide leadership and capacity for restoration of aquatic connectivity in Maine by establishing a centralized restoration program.

   Rationale: Participation of the many agencies and organizations involved in and supporting the present effort was integral to scoping and addressing the challenges of impaired connectivity in Maine. However, there is universal agreement that the present ad hoc, informal approach is insufficient to adequately address the scope and urgency of challenges related to impaired connectivity in Maine's waters. The purpose of a formal restoration program in Maine is to efficiently plan, coordinate and implement actions that will increase the pace and success of aquatic restoration statewide. Among the northeastern states, New Hampshire, Vermont, Massachusetts, Connecticut, New York, and Pennsylvania support stream restoration programs. Although they vary in capacity from rudimentary to highly developed, these programs offer a number of demonstrated benefits, some of which are described below:

   - increased implementation rates of actions to support at-risk species and systems
   - heightened efficiency in time and money spent on restoration
   - opportunities to better address the mandates of multiple agencies
   - greater consistency among agency policies and approaches for restoration
   - increased capacity for restoration through funding opportunities that favor requests from established, formalized programs

   Needs: Staffing and a modest operational budget to coordinate and implement a statewide strategy and individual projects at the watershed scale. Initial staffing requirements include a Restoration Coordinator and three Restoration Specialists (1 Ecologist/Project Leader; 2 Engineers) for a total cost of $320,000/year.

2. Develop and implement Maine regulatory criteria that compliment statewide restoration efforts.

   Rationale: Recent data from extensive field surveys in Maine demonstrate that road crossings over streams often fail to meet hydraulic requirements and rarely are designed to adequately pass aquatic organisms, transport nutrients and sediment, or facilitate connectivity between the stream channel and the floodplain. As a result, thousands of

sub-standard crossings impede or block fish passage, degrade aquatic habitat, and are unlikely to accommodate projected higher flows associated with climate change.

Needs: Support revision of DEP Permit by Rule language for new and replacement stream crossings that will accommodate physical and biological processes necessary for re-establishing and sustaining healthy aquatic ecosystems.

3. Create a bond-supported grant program to assist with the cost of correcting public and private road-stream crossings that represent the highest priority barriers to connectivity.

   Rationale: Recent barrier inventories have demonstrated that about 44% of over 4,000 road-stream crossings surveyed in Maine represented severe barriers to connectivity. Multiplying that percentage (44%) by the total number of road-stream crossings in historic range of diadromous fish in Maine (23,664) provides a rough estimate of the total severe barriers to connectivity in that geographic area: 10,412 severe barriers. These do not include barriers outside of the range of diadromous fish. Because many site-specific factors influence the cost of each individual barrier correction, no average cost/per corrected barrier has been developed that inspires particular confidence. However, based on several assumptions, a very rough estimate can at least characterize the magnitude of cost required to correct at least a percentage of severe barriers. At an estimated average of $51,000 per site (very likely a low estimate, see below), the total cost of correcting only the highest priority 33% of severe barriers in diadromous fish range would approach $175 million. Current capacity to administer and implement a program of this scale may restrict the amount of work accomplished each year. As a result, a decadal-scale effort may be necessary to fully achieve the goals of such a program, especially when considering the addition of severe barriers outside the historic range of diadromous fish.

   The $51,000 cost/site was based on NRCS estimates for the cost of a culvert replacement in Washington Co., Maine requiring a 48’ L x 5’ H x 12’ W structure. For incorporated municipalities where heavily travelled, tarred roads predominate, and for crossings over coastal marsh systems, this cost estimate can grossly underestimate actual need. It is suggested that more refined estimates for anticipated road-stream crossing replacements be incorporated into these recommendations as they become available.

   Without a considerable infusion of funding to assist with corrections to these barriers, the persistence, magnitude and statewide scale of this problem will continue to limit the degree of restoration attainable for Maine’s waters and the populations of aquatic organisms that they support. Upgrades to crossings could be made to accommodate climate change-induced increases in flows or at least improve performance under present flow conditions, which would lessen the risk of costly and potentially dangerous road failures. At the very least, the unhindered passage of aquatic organisms should be a principle goal.

Needs: $5 million/year initially, increased as capacity to administer the barrier correction grant program grows.

4. Develop and maintain a statewide barrier database and mapping system providing geographic and physical attributes of individual dams, road-stream crossings representing barriers, and other structural barriers to connectivity. Engage private landowners in the development process to ensure concerns over data accessibility are addressed.

   Rationale: There is universal agreement that development and maintenance of a centralized database describing the geographic scope and physical condition of structural barriers to connectivity is fundamental to informing restoration planning in Maine. The Data and Prioritization Committees of the present Work Group have initiated development of a plan to house barrier inventory data. The intent is to make much of the data accessible to restoration practitioners via the internet in an interactive mapping system. To function properly, the inventory database and mapping system will require GIS manager support for operation, maintenance, system updating as barriers are removed, and liaising with restoration practitioners.

   Needs: $30,000/year for a part time database/web-mapping manager.

5. Inventory barriers to connectivity throughout the highest priority sections of Maine's watersheds.

   Rationale: Watershed-specific barrier data are the essential foundation on which to base an efficient and defensible prioritization of action. Data will be housed in the statewide database (in #2, above). The current model is for local groups, in cooperation with agency partners and guidance, to obtain these data by conducting inventories.

   Needs: $150,000/year over the next 10 years to support field crews necessary to survey approximately 9,000 stream crossings in historical diadromous fish range in Maine and additional crossings outside of that range.

6. Develop, test, and implement a software application intended to prioritize actions necessary for correcting barriers across the state.

   Rationale: A standardized barrier prioritization tool is required to promote the efficiency and rate of successful aquatic ecosystem recovery statewide. The Connectivity Work Group is engaged in creating a workplan and criteria for development of a prioritization tool.

   Needs: $100,000 to support development and delivery of this tool.

7. Explore options for streamlined regulatory approaches that will compliment restoration efforts by facilitating increases in the efficiency, number, and rate of successful barrier-removal projects completed.

   Rationale: Without development of a streamlined regulatory approach that recognizes the contributions of restored connectivity, recovery of at-risk species is hindered. Professionally executed restoration projects benefitting species such as the Endangered Atlantic salmon are and should be perceived as critical to species and ecosystem recovery. Cooperative development of standardized restoration guidelines or "best practices" can be crafted to emphasize the joint goals and concerns of those representing both the regulatory oversight and project-management elements of species recovery and habitat restoration efforts. Given the pre-existing abundance of road-stream crossings that represent barriers, the recent expansion of salmon waters requiring federal oversight, and the lack of regulatory capacity to adequately oversee corrective actions conducted at individual sights, a refined oversight approach would likely benefit all parties involved. Streamlined approaches have the potential benefit of facilitating reallocation of regulatory staff time to projects representing the greatest threat to at-risk species, such as road infrastructure projects performed by people other than trained/experienced restoration practitioners. To that end, development of standardized training, a certification process, or performance criteria for restoration practitioners might aide development of this new approach.

   Needs: Convene relevant agencies to modify regulatory approaches in ways that recognize mounting constraints on oversight capacity and the contributions to species recovery represented by projects that re-establish connectivity.

8. Develop an incentive strategy for responsible dam ownership that compliments the goals of dam safety, restoration, and renewable energy production.

   Rationale: It has been estimated that there are over 1,000 dams in Maine, not including remnant structures associated with historical logging activity. Dams consistently represent the most challenging of barriers to connectivity to improve or correct, either through the addition of fish passage structures or removal. Most dams in Maine no longer support their intended uses, and many are in disrepair, yet they continue to hinder recovery of at-risk species and impede or prevent physical and biological processes necessary for healthy ecosystem function. For the relatively few dams with fish passage structures, inadequate rates of passage efficiency can undermine recovery efforts on which millions of dollars have been spent each year, for decades. An incentive-based program to promote effective fish passage at dams that are infeasible to remove would significantly compliment other ongoing restoration efforts. Likewise, periodic and systematic attempts to identify owners who are willing to relinquish their dams would allow development of a candidate pool from which removals representing the greatest ecological priority and feasibility could be targeted.

Needs: Develop or more fully use existing legislative, regulatory and funding mechanisms to support a strategy facilitating dam safety, ecologically appropriate flow regimes, removal of dams in collaboration with willing owners, and accommodation of effective fish passage where dam removal is not currently feasible.

9. Clearly articulate to policymakers and the public the costs and benefits of using different approaches to addressing barriers to connectivity.

   Rationale: Failing to correct existing barriers to connectivity and prevent new ones has both ecological and economic consequences. Inadequate road-stream crossings and dams increase the risk of road failure, which can cause damage to property, harm to the public, and impacts to commerce associated with closed roads. These structures also cause losses of culturally and economically significant commercial and sport fisheries, consumptive and non-consumptive recreational tourism, and linked service industries. Declines in native species and ecosystem function that result from impaired connectivity are often followed by expansions of government bureaucracy, regulatory restrictions and recovery efforts. These costs are rarely mentioned, despite the considerable capacity required to support such programs (e.g. approximately $7 million is directed to Atlantic salmon recovery efforts in Maine each year, which is nevertheless inadequate to meet the urgency of need for that endangered species). Without additional investments coupled with adoption of new approaches for addressing the negative influence of dams and inadequate road-stream crossings, the cost required to achieve successful restoration will certainly mount over the next decades.

   Needs: Describe the costs of statewide restoration and species recovery actions to date, and to what extent the need for these programs is perpetuated by ongoing societal choices that impede attainment of restoration goals or ecosystem recovery. Identify the ways that inadequate stream crossings lead to economic impacts, such as road failures (that put public welfare, property, and commerce at risk), lost fisheries and tourism opportunities, and higher long-term costs associated with “cheaper” alternatives for constructing crossings.

Suggested Readings

Recent Publications Related to Restoration of Connectivity in Maine

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Committee letter code: D = Data, M = Mission, P = Prioritization, W=White Paper; bold font indicates subcommittee chair