

IDENTIFIED RESEARCH NEEDS FOR THE PENOBSCOT RIVER

from the Penobscot Science Forum (October 2004) and other research stakeholders

Introduction

The Penobscot River Restoration Project proposes to remove the two lowermost dams on the mainstem Penobscot River and improve fish passage and energy generation at the remaining dams. The dam removals will open up over 500 miles of habitat to sea-run fisheries and other wildlife, improve water quality, and restore connections between the marine and freshwater parts of the watershed. The restoration will also create opportunities for economic development, community outreach, and education in watershed communities. And finally, restoring the Penobscot River is important to the culture, history, livelihood, and integrity of the Penobscot Nation.

The Penobscot River restoration has been recognized as an opportunity for research since the project was announced in 2003. Participants in the October 2004 Penobscot River Science Forum identified the need for a research coordinating body (or "clearinghouse"). Participants and sponsors then convened an organizational meeting to begin the process of creating a steering committee to establish the framework for coordinating science and research on the river (held in December 2005). Also since the forum, various researchers and agencies have met to discuss Penobscot research and monitoring. Small-scale research projects on the river are already underway.

This draft document combines the research recommendations derived from the Science Forum and other Penobscot-related science and research meetings in the last year with information from a separate project, the Penobscot River Synthesis (<http://www.pearl.maine.edu/windows/penobscot>), which has been identifying past and current research activities related to the Penobscot River. After reviewing the notes from the Science Forum and subsequent meetings and discussions, there emerged three levels of research and/or monitoring needs related to the restoration:

- Level I. Data needed to satisfy permitting requirements.
- Level II. Research to evaluate the outcomes of the restoration.
- Level III. Research to further our understanding of large river ecosystems.

In Part 1 of this document, research questions are organized based on these levels. Where possible, information derived from the Synthesis on current and proposed research that addresses these needs has been integrated. Part 2 describes organizational and logistical details of coordinating research. Footnotes identify the Science Forum breakout session or other origin of the recommendation.

NOTE: This is a working document. These research recommendations have not been prioritized or officially endorsed by the Penobscot River Restoration Trust or the Mitchell Center. This list is merely an organized presentation of known research needs to date to inform discussions of the Penobscot River Science Steering Committee. Additional research questions will be added as they are identified or developed.

Part 1. Identified Research Needs

I. Data needed to satisfy permitting requirements.

The regulatory and permitting process will outline a minimum level of data and monitoring required for the Penobscot River Restoration Trust (PRRT) to obtain all the necessary permits to remove the dams.

The PRRT will, to the extent appropriate, provide information about permit needs and data requirements, if known. This information should help foster effective research coordination and collaboration.¹

II. Research to evaluate the outcomes of the restoration project.

Research and monitoring on pre- and post-dam removal baseline conditions, including flora, fauna, water quality, hydrology, geomorphology, chemical and nutrient processes, etc. will inform an evaluation of the effectiveness of the restoration project. This information may build upon information collected as part of permitting and will contribute to the larger, more complex research questions of Level III. It is also possible that some of the questions listed below will be addressed in concert with dam removal permitting.

- Baseline fish population and ecology data from the lower river zone where direct physical changes in habitat would occur and from connected lake systems.^{2,3}
Sturgeon habitat in the lower Penobscot is the subject of current research by Stephen Fernandes and Mike Kinnison at the University of Maine. Fish assemblages were assessed by Midwest Biodiversity Institute/Kleinschmidt for EPA in 2003-2004.
- Efficiency of fish passage, stress effects of passage, trapping, and sorting.⁴
- A characterization of diadromous fisheries after dam removal, including:
 - Develop a predictive model of recolonization. Assess the models and statistics that have been used for current projections of species restoration numbers and any alternative models or methods that may exist, as well as availability of models for species that have not yet been addressed.^{2,5}
 - The geographic scope of potential recolonization of diadromous species.^{2,4}
 - Stock assessments of diadromous fish populations in Gulf of Maine, Penobscot Bay, and tributaries below the dams.³
 - Stock assessment, commercial fishery documentation, fishway design, standardized sampling and/or tagging program for American eel.^{4,6}
 - Locations of the natural barriers to upstream fish migration.^{2,4}
USFWS recently completed culvert and barrier studies in the Piscataquis and Kenduskeag watersheds.

Maine Atlantic Salmon Commission conducted site-specific upstream-downstream fish passage efficiency studies in the 1980s and more recently has studied upstream movements and success rates for PIT-tagged adult salmon (w/USGS).

ASC also coordinates trap counts at Veazie and Weldon dams; routine monitoring of juvenile populations and redd counts. Historical fisheries populations have been reviewed by NOAA-Fisheries (M. Hachey) and by D. Trefts for the Trust. NOAA-Fisheries (J. Kocik, T. Sheehan) and the Cooperative Fish and Wildlife Research Unit (J. Zydlewski, C. Holbrook) have been studying migration of Atlantic salmon smolts and adults.

- A comprehensive fisheries management plan that looks at the entire community of diadromous and freshwater species in an ecosystem context. Such a plan should include monitoring. The Kennebec River Resource Management Plan, Susquehanna River, Russian River, Connecticut River are possible models.⁷ *At the Fisheries Agency meeting, the Maine Atlantic Salmon Commission offered to take the lead on this issue.*⁷
- What are the passage capabilities and movement dynamics of potential non-native species?^{2,7} For example, would northern pike or largemouth bass be able to use the Howland bypass to access the Piscataquis?² Would removal of lower river dams allow exotics potentially present in that zone of the watershed, such as black crappie and largemouth bass, to expand quicker and further than if the dams remained with conventional fish passages?² What are the implications of existing northern pike in Pushaw Lake?⁷
- What are the current socioeconomic aspects of existing fisheries (commercial, recreational, tribal sustenance) and how will the dam removal affect these aspects, particularly in the Gulf of Maine?²
- Comprehensive high resolution bathymetry³ and sediment characterization of the lower river.^{3,8} *Some of this work near the impoundments has been done under contract to PRRT (J. Reardon). For the bay, data are available from Musselwatch (NOAA) and DEP/DMR harbor monitorin. PIN surveyed sediment in river north of Indian Island in 1995 (w/ J. Kelley), 1999 (w/USGS), and 2001 (w/EPA).*
- Water quality characterization.^{3,8} *DEP surface water ambient toxics and dioxin monitoring program, PIN water quality monitoring, Mitchell Center samples sites on the Penobscot River above and below the dams. USGS is also conducting a pilot study to evaluate the potential for river water toxicity to increase following dam removal.*
- Salt wedge dynamics.³ *Maine Maritime Academy and NOAA annually evaluate spring salinity, temperature, and turbidity in the estuary during spring migration.*
- Baseline (presence/absence, seasonality, abundance, distribution, food habits, reproduction, contaminant levels) of other wildlife (besides fisheries of concern).⁸
- Habitat survey and characterization of dam sites and impoundments including submergent vegetation, riparian zone vegetation, substrate mapping, wetlands,

invertebrate inventory and insect hatch monitoring, mussel mapping, threatened and endangered species inventory and habitat use (including wintering Barrow's goldeneye and wood turtles).⁸ Some of this may be included in permitting. *DEP benthic macroinvertebrate sampling is conducted on a rotating basis every five years; the Penobscot is scheduled for 2006.*

- Develop models to predict wetland changes after dam removals. Ground-truth NWI maps and digital wetland data, assess wetland functions and values, including use by fish and wildlife populations.⁸
DEP wetland biomonitoring is scheduled for 2006.
- Baseline data on piscivorous birds (eagles, osprey, cormorants, mergansers, goldeneyes, great blue herons, kingfishers) and otter, mink, and marine mammals.⁸
- Details of the watershed's nutrient parameters and TMDL development.^{5,7}
DEP periphyton monitoring in Penobscot tributaries, algae data from PIN. DEP is scheduled to establish a TMDL by 2008. Field work in 2006 will investigate nutrient and DO issues from Millinocket to the estuary.

III. Research to further our understanding of large river ecosystems.

A major environmental change such as dam removal on a large river like the Penobscot provides an opportunity to address basic ecological questions. This type of research would benefit from academic institutions working in partnership with state and federal agencies and the Penobscot Nation. This research will build on, and may be a part of, the permitting data and baseline pre-removal studies.

- What kind of changes will result from the re-establishment of historic nutrient cycling processes between marine and freshwater environments, and how will established fish populations be affected?^{2,5} Track changes in nitrogen and carbon cycles.^{1,5,7} *Maine Cooperative Fish & Wildlife Research Unit (C. Loftin) is currently working on two pilot projects, one using dendrochronology and stable isotopes to determine the distribution of marine-derived nutrients in the Penobscot River basin, and the second looking at the response of Northeast U.S. freshwater ecosystems to restoration of marine-derived nutrients delivered by anadromous fish.*
- What are the predator-prey and competition issues between freshwater stages of alewives and larval/young-of-the-year smallmouth bass, particularly in lake ecosystems² and in the middle part of the watershed?⁷ What are the competition and predation issues with sea and river herring?³
*K. Wilson and T. Willis of USM are completing an alewife-bass interaction study on the St. Croix that may be a good model for the Penobscot.*⁷

- What are the current and projected trends in nonpoint source pollution, riparian use and management, and general development in the watershed?¹
L. Lewis, Bates College, Valuing Environmental Changes for Decision Making: Dam Removal and Restoration on the Penobscot and Kennebec River. Also USFS Forests on the Edge: Housing Development on America's Private Forests. This project seeks to improve understanding of the processes and thresholds associated with increases in housing density in private forests and likely effects on the contributions of those forests to timber, wildlife, and water resources. The first report displays and describes housing density projections on private forests, by watershed, across the conterminous United States. The Lower Penobscot Watershed was projected to experience the greatest increase in housing density on over 300,000 acres of private forest, more than any other watershed in the study. The project leaders are continuing work in the lower Penobscot watershed.

- How will the potential changes in sediment and nutrient transport as a result of dam removal and/or watershed development change the vegetation and sedimentation patterns in the Penobscot estuary? How will potential changes in sediment and contaminant transport affect biota in the estuary?⁸
K. Merritt and A. Amirbahman at UMaine are investigating mercury in water and sediment south of Orrington related to releases from the former Holtrachem facility.

Part 2. Research Coordination

It is widely agreed that research should be coordinated, collaborative, comprehensive, and transparent. The results of the Science Forum suggest that coordination could be led by the University of Maine in cooperation with other entities and institutions. Universities and colleges including the University of Maine were identified as being independent and accessible institutions with the resources (including faculty expertise) and infrastructure required for a such a large research program.^{1,9} Also, universities can offer resources across a much broader range of issues such as historical, cultural, and socio-economic aspects, many of which will be integral to the successful implementation and monitoring of the progress of the restoration.⁸ And finally, universities can offer opportunities for K-12, undergraduate, and graduate education related to the Penobscot river.¹ State agencies have expressed that collaboration with universities is critical to getting many research needs addressed in a timely manner, due to continuing shortages of staff, equipment, and funding resources amongst the agencies.⁸ USGS, the Mitchell Center and the UM Freshwater Group were identified as possible homes for a coordinating research "institute" or lead person, with the understanding that the responsibility should not be simply added on to an existing staff or faculty member.^{1,5,8} Ayers Island was also suggested as a possible field research station.⁵

A watershed management plan

The need for a "master document," "white paper," or "watershed management plan," has been expressed repeatedly, in order to most efficiently pursue collaborative research without overlapping efforts and targeting funding sources as separate pieces of a comprehensive whole.^{1,5,7,8} The document might allow individual researchers to address/pick particular issues to use for grant proposals.⁸ An interagency management plan would allow the public to comment on and provide feedback and advice on the proposed plan.^{1,5}

Data and information sharing

Research programs can benefit from a comprehensive plan for managing, storing, and sharing data and communicating information among researchers as well as to the interested public. The following recommendations have been made regarding data and communication.

- Collect all baseline data into one centralized database accessible to all researchers.^{1,5} *At the organizing committee meeting on December 1, it was agreed that PEARL (<http://www.pearl.maine.edu>) already hosts existing Penobscot data and is the appropriate location for future datasets.*
- A necessary shared data set would include the hydrodynamics of the bay, temperature/salinity/discharge, and habitat areas. GIS layers would include geographic divisions of USGS, NOAA, DMR jurisdictions and be available in Excel and GIS maps.^{3,5}
- Data could be coordinated with NOAA/GoMOOS (add more buoys?).⁵ *GoMOOS buoy F is located in Penobscot Bay near Rockland. As part of the GoMOOS program, and with another NASA program, the station monitors chlorophyll, solar radiation, ocean color, and particle scattering. A Bigelow Laboratory project has placed sensors in the Penobscot River that monitor particulate and dissolved matter entering the bay, accompanied by chemical analyses of samples collected around the watershed.*
- Reopen USGS gauging stations^{5,7} and make data available as usual on USGS page but also on PEARL.
- Provide a comprehensive list (and coordination?) of funding opportunities.⁸
- Provide a summary of the background information presented at the Science Forum as well as the results of all the breakout discussions.⁸
- Maintain a web page with contact information of the steering committee, a bulletin board of research initiatives, and a research database.¹⁰

- Hold an annual conference that brings together researchers from the Penobscot River project (and/or from river projects across the country).^{1,5,7}
- Develop a lecture series for the public.¹ *The Mitchell Center's spring seminar series is focused on current Penobscot River research.*
- Research results and the implications of scientific findings should be clearly communicated to stakeholders.¹

Education and outreach

While the scope of research coordination is yet to be determined, whatever entity is charged with the task is likely to be involved in education and outreach, especially if coordination is based at an academic institution. The Penobscot River restoration could provide the focus for field-based undergraduate and graduate courses and new K-12 curricula on river restoration and ecology.¹

Some of the monitoring described above in Level II research recommendations could be accomplished through local communities, watershed councils, schools or citizen monitoring groups, facilitated by university extension and in partnership with Maine DEP and County Soil and Water Conservation Districts. The Kenduskeag Stream watershed in the Penobscot Basin has established an “evolving” model for such initiatives, which includes at least two schools, the Penobscot County S&WCD, the DEP (via Stream-Team Program), the PIN, and several other collaborating/oversight resource agencies.^{1,5,8} Reinvigorating the Penobscot Riverkeepers program was also suggested.¹

It should be noted that future outreach and education efforts should overlap, but not compete with, the outreach of the Penobscot River Restoration Trust, the Penobscot Nation, and others. The main goal of research-related outreach should be to communicate research results and scientific knowledge to stakeholders and the public.

¹ Forum, Second breakout, Group 4 (S. Stockwell)

² Forum, First breakout, Fisheries (C. Fay)

³ Forum, First breakout, Gulf of Maine (A. Goode)

⁴ Forum, First breakout, Fish Passage

⁵ Forum, Second breakout, Group 1

⁶ 2005 Review of the ASMFC Fishery Management Plan for American eel

⁷ Fisheries Agency meeting, October 2005 (G. Wippelhauser)

⁸ Forum, First breakout, Nongame species

⁹ Forum, Second breakout, Group 3 (C. Fay)

¹⁰ Forum, Second breakout, Group 2 (A. Calhoun)

The notes from the first breakout sessions are included as Appendix A in a separate document.

Compiled by Catherine Schmitt, Senator George J. Mitchell Center for Environmental & Watershed Research/Maine Sea Grant, February 3, 2006.