The Penobscot Nation and the Penobscot River Basin

A Watershed Analysis & Management (WAM) Pilot Project

by the Penobscot Nation
Water Resources Program
Department of Natural Resources

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6 River Road, Indian Island, Maine

January 2001

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A Watershed Analysis and Management (WAM) Pilot Project

Part I. INTRODUCTION

The Penobscot Nation was one of four tribes nationwide to conduct a watershed analysis and management (WAM) pilot project. The project addresses water resource conditions in Penobscot River Basin and highlights key issues for tribal resources. This report presents information on four different aspects of the river basin and highlights connections between watershed functions, features, and values. Project maps are presented at the beginning of this report (MAPS Part II). Written summaries describe the tribal values that guide Penobscot Nation management goals for the Penobscot River (TRIBAL VALUES Part III), characterize water resource conditions (WATER RESOURCE CONDITIONS Part IV), describe the status of Atlantic salmon and other migratory fish species (MIGRATORY FISHERIES Part V), and provide an overview of the geological setting (GEOLOGICAL SETTING Part VI). The conclusion of the report integrates all of this information to highlight the issues of greatest management concern (SYNTHESIS BY SUB-BASIN Part VII).

Overview

From 1997 to 2000, the Penobscot Nation was one of four tribes nationwide to conduct a Watershed Analysis and Management (WAM) pilot project. The Penobscot Nation used this project to address tribal water resource issues in the Penobscot River Basin. The original WAM methodology was developed in the Pacific Northwest to help resolve complex watershed problems in that environment and has since been expanded for a wider range of applications.

The WAM approach is especially useful to tribes because it relies heavily on community and cultural values to determine watershed management priorities and shape management decisions. An interdisciplinary approach is used to identity connections between watershed functions and features. This approach fits well with traditional, holistic tribal views of the environment. The four participating tribes took part in an exercise to customize WAM procedures for broader use in watersheds nationwide. The Penobscot Reservation provided a unique setting for applying this ecosystems-based model. Prior applications in the Northwest dealt with the management of fisheries and forest resources within shared watersheds, and to our knowledge, the Penobscot application is the first time WAM has been used to examine point source discharges, non-point sources, and dams in an entire drainage basin.

Participants

Penobscot Nation Department of Natural Resources director John Banks and tribal Water Resources Program manager Dan Kusnierz provided guidance and general oversight for the WAM project. Specialists who formed the core of the WAM team included tribal water resources planner Tammis Coffin, Dan Kusnierz, tribal fisheries manager Clem Fay, consulting geologist Alice Kelley, and tribal G.I.S. specialists Jerry Barnes and Theresa Hoffman. Technical support was provided by the Steve Toth, Christy Parker, and Jim Currie of the Pacific Watershed Institute. Project funding and administrative oversight were provided by Martin Brossman of the EPA Office of Water. The tribal water resources laboratory manager Rhonda Daigle and technicians Jan Paul and Jason Mitchell contributed the water quality data and provided important observations from the field. Tammis Coffin coordinated the overall project and compiled the final report.

Penobscot Basin and the Penobscot Nation

The only pure water in the river is the tears shed by our ancestors.

– Butch Phillips

The Penobscot River basin is nearly 5.5 million acres in size and covers almost one third of the state of Maine. The highest place within the drainage is the one-mile high Katahdin – a sacred mountain to the Penobscot people. Basin headwaters reach east and west 115 miles, nearly touching the borders with Quebec and New Brunswick. Its five sub-basins are drained by five large rivers - the Mattawamkeag, Piscataquis, Passadumkeag, and the East and West Branches of the Penobscot River. Their waters unite to flow into Penobscot Bay in the mid-coast region. The Penobscot people take their name from the river and the river takes its name from the people. For centuries, this riverine tribe has maintained year-round residence and the seat of tribal government in a part of the river known for its "descending rocks."

The reservation today is composed of the many small islands, the river bed, and the surrounding waters of the Penobscot River, beginning at the descending rocks 40 miles from the sea and extending north for hundreds of miles. Indian Island remains the principal residence for tribal members.

The tribe has treaty reserved fishing rights in the Penobscot River. Tribal resource protection efforts extend beyond reservation boundaries to protect important migratory fish resources including Atlantic salmon. Additional Tribal Trust and Fee lands are spread throughout the river basin and total about 123,000 acres. Though tribal lands now make up a small part of the basin, many streams and lakes within the river basin retain their Penobscot names.

Water Resource Concerns

The Penobscot River forms a large part of the cultural identity of the Penobscot people and the tribe has sacred traditions that are tied to the river. The Penobscot Nation is seriously concerned about bioaccumulative toxics in the aquatic ecosystem, inadequate fish passage, and the cumulative impacts of point sources, dams, and non-point sources. Five pulp and paper mills discharge to the Penobscot River. Two are Kraft mills that use chlorine-containing compounds in the bleaching process, creating chlorinated organic by-products such as dioxin. There are discharges from a chlor-alkali plant and a textile mill, and municipalities discharge treated wastewaters within and downstream of the reservation.

> *Our goal is to have no dioxin in the river or any other contaminants.*
>
> Priscilla Attean

All tribal waters are posted with some form of fish consumption advisories, for dioxin, PCBs, mercury, or all three. River flows are highly manipulated, with over a hundred dams operating in the basin. Major hydro-electric projects affect fish passage, water quality and fish habitat. Three stretches of river are designated as Class C waters, with water quality issues that include toxics, dissolved oxygen levels, warming of the water, and episodic algae blooms. In addition, there are many non-point sources of pollution that have yet to be evaluated.

Project Goals

The goal of the Penobscot Nation WAM was to address cumulative impacts to the watershed that are caused by the combination of point sources, non-point sources, and dams, using a comprehensive, ecosystems approach. Additional goals were to use the WAM planning process to enhance ongoing water resources management activities, develop tribal G.I.S. mapping capabilities, and identify tribal beneficial uses in order to develop tribal water quality standards. Ongoing water quality assessment and management projects that Penobscot Nation was involved in while conducting the WAM project, included: developing review comments for point source, hydro, and proposed pipeline projects; developing a non-point source assessment and management plan for the tribal Trust lands; monitoring water quality for conventional parameters, toxics, and continuous temperature; monitoring fisheries resources; developing a tribal air quality program; characterizing and evaluating sediment quality; developing tribal fish consumption advisories; investigating the cause of algae blooms in the river; conducting educational and community outreach; holding focus groups on tribal beneficial uses of water resources; collaborating with the health department to understand and monitor the health effects of consuming contaminated fish; preparing a Unified Watershed Assessment to establish restoration priorities for the sub-drainages within the Penobscot River Basin; and researching the impact of dam operations on the uptake of mercury into the food chain.

Tribal Values

Tribal interviews, surveys, oral histories, and testimony underscore the strong cultural and spiritual connections between the Penobscot people and the Penobscot River. Tribal concerns about water quality are extensive. There is strong support for upholding the integrity of the aquatic ecosystem, maintaining cultural and spiritual practices on the river, and guarding aesthetic values. There is also a commitment to guarding tribal uses of the river for foods and medicines, drinking water, swimming and boating. Consensus is divided about continuing the tribe's use of the river for discharge of treated wastewaters, or perhaps pursuing hydropower development in the future. Identification of the tribe's documented cultural values and beneficial uses as part of this project has established the basis for drafting the tribe's narrative water quality criteria.

> *Being on the water in a healthy sense would feel a lot better than fearing splashing water off your paddle onto your hands or onto your face.*
>
> \- Barry Dana

Water Resource Conditions

Having monitored the Penobscot River for over a decade, the tribal Water Resources Program welcomed the opportunity to organize, interpret, and map water resources data and identify gaps in current research. Tribal monitoring efforts evaluate compliance of industrial discharges and hydro-electric facilities with water quality regulations and gain information for use in permit review and re-licensing. Dissolved oxygen levels, temperature, pH, nutrients, and foam are a few of the many variables that are sampled. Monitoring is being undertaken to support legislative upgrades to water quality classifications and assess whether tribal resources are protected by existing regulations. Contaminant levels in aquatic species are also analyzed.

As part of the WAM project, we combined approximately 200 U.S.G.S. quadrangles of the Penobscot River Basin, mapped tribal water quality monitoring sites and modified and improved existing federal and state maps of dams, discharges, and water quality classifications. We found that documentation of existing water quality conditions varies by category and much research is still in progress. Some research findings were available on episodic algae blooms and levels of toxics in plant and animal tissues, but research was still in progress on thermal discharges. There is little research on synergistic effects, non-point sources, foam, and issues surrounding negative perceptions of water quality.

Migratory Fisheries

The Penobscot Nation Fisheries Program is very active in the management and restoration of the fisheries resources of the Penobscot River. Of greatest interest is the continued restoration of the migratory fish species through improvements to the fish passages, and improvements to fish habitat through restoration of free-flowing character, better flow regulation and improved water quality. For the WAM project, we summarized the status of five migratory fish species of special management interest to the tribe: Atlantic salmon, American shad, alewife, blueback herring, and American eel, and prepared maps of fish restoration zones, range, and potential production habitat. We evaluated each dam in terms of its fish passage.

Geological Setting

This report combines bedrock and surficial geologic map interpretation with geomorphological analysis of topographic maps to produce an integrated reconnaissance level study that will be helpful for the future investigation of physical conditions and processes that may affect fisheries habitat, influence contaminant transport, and have a bearing on sediment transport and water quality. The results of this work are presented in a literature review and a series of maps that show the bedrock and surficial geology of Penobscot River banks and the channel geomorphology.

Results

The Penobscot Nation WAM project provided a means to clearly define tribal values that will establish a foundation for future water quality standards and shape future water resource management efforts. Much needed base maps of the Penobscot River basin were developed and data was compiled on water resource and fisheries conditions. Geological information was obtained that may have a useful bearing on future water resource and fisheries management efforts. This documentation of threats and conditions that affect tribal water resources will help to pave the way for a larger interagency effort to examine cumulative impacts. Maps and data layers can now be expanded to integrate information about additional features of the Penobscot River basin, such as topography, point sources of air pollution, surficial geology and soils, and non-point source threats.

THE PENOBSCOT NATION
AND THE PENOBSCOT RIVER BASIN

A Watershed Analysis and Management (WAM) Pilot Project

Part II

PROJECT MAPS

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    - A. Confinement
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    - C. Glaciofluvial Deposits
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    - G. Till

Map 1

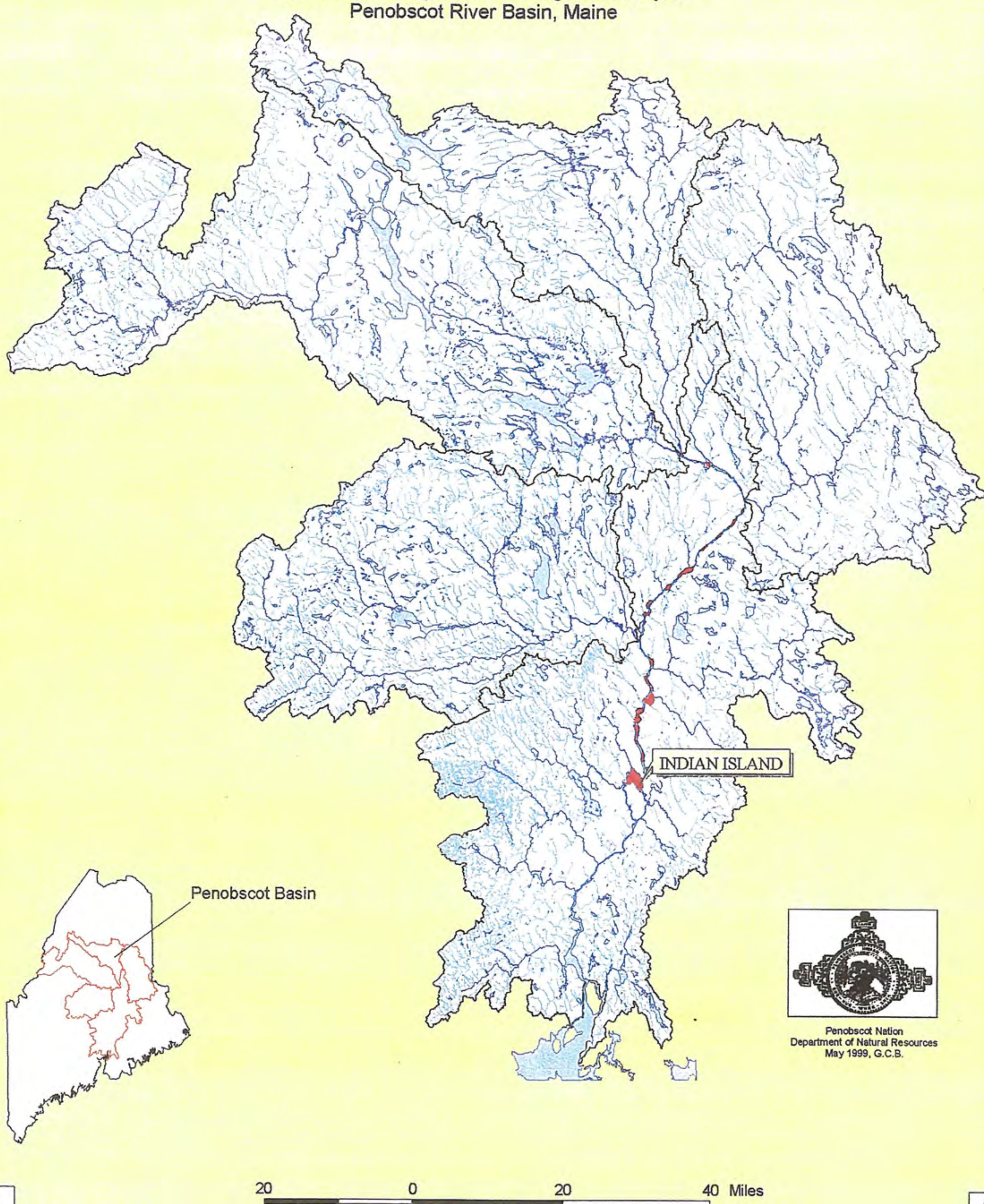
Penobscot River Basin Hydrology

Penobscot River Basin has a total drainage are of over 8,500 square miles and is centrally located within the borders of Maine. The basin extends north and south for about 150 miles and spans east and west about 120 miles. On the basis of drainage and average discharge (16,434 cubic feet per second), it is the largest river in the state. The Penobscot Basin is bounded to the north by the St. John River drainage, to the east by the watershed of the St. Croix River, to the west by the Kennebec Basin, and drains into Penobscot Bay, the Atlantic Ocean to the south. The river has six major tributaries: the East and West Branches of the Penobscot River, the Mattawamkeag River, the Passadumkeag River, the Piscataquis River, and Kenduskeag Stream. Surface waters within the Basin include 1,224 lakes and 188 named rivers and streams which total 7,127 river miles. Many of these waterways retain their Penobscot names.

Note the location of Indian Island, positioned in the downstream portion of Penobscot River Basin. This is the primary residence and the seat of tribal government for the Penobscot Nation. There are many additional islands within the reservation that extend further upstream within the River Basin.

Penobscot Basin Hydrology

Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine



Map 2

Penobscot Watersheds (Sub-Basins)

The Penobscot River Basin can be subdivided into five large watersheds or sub-basins, drained by the West Branch of the Penobscot River, the East Branch of the Penobscot River, the Mattawamkeag River, the Piscataquis River, and the Passadumkeag River.

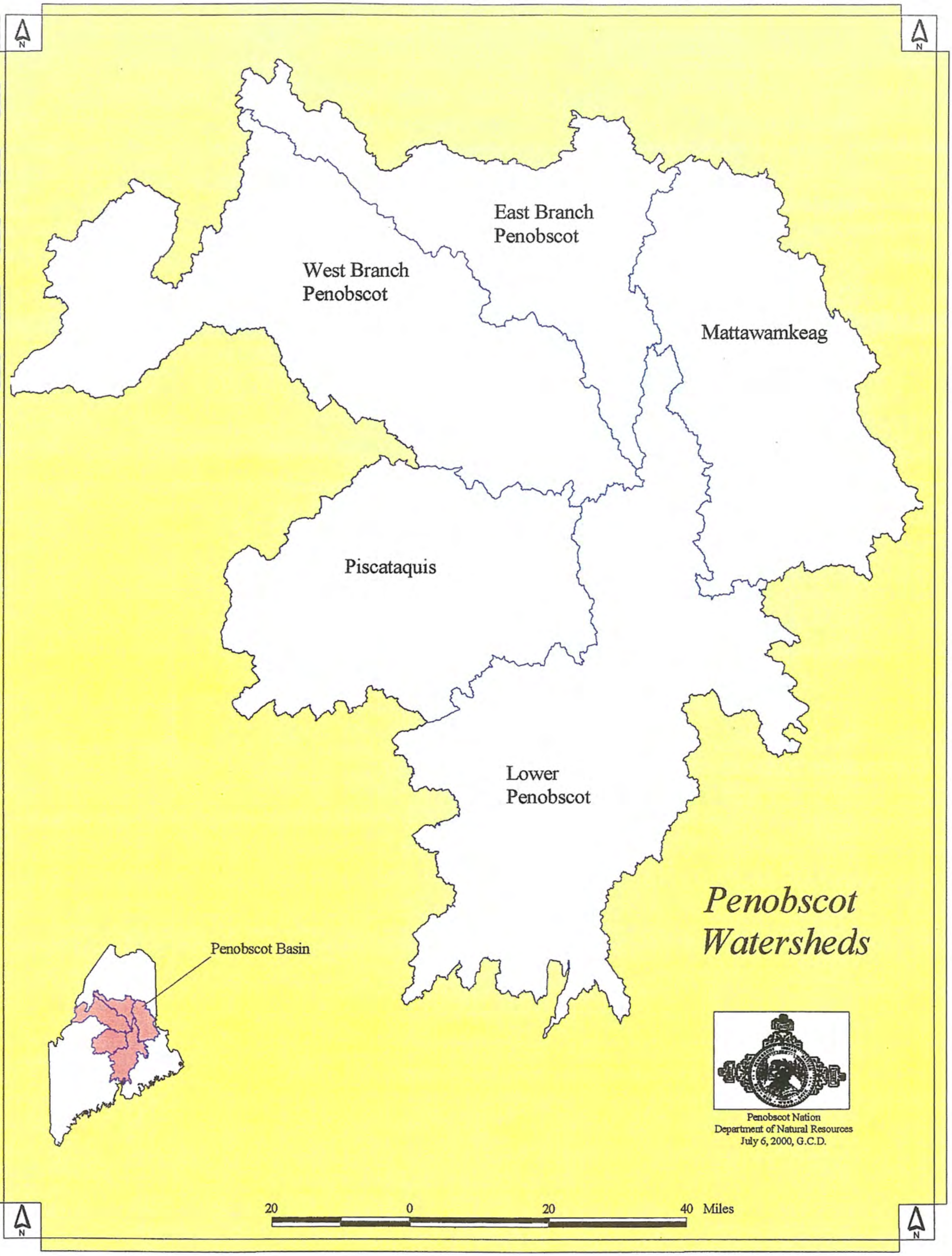
West Branch - The vast West Branch drainage occupies 25% of the land area in the river basin and contains the largest privately owned hydroelectric complex in the country. The Penobscot name for the West Branch is *Kettetegwewick*, meaning "the main branch." This is the canoe route to Katahdin, the highest mountain in Maine, and the tribe's most sacred place. The West Branch drainage is heavily manipulated for hydropower generation and receives wastewater from two pulp and paper mills and two municipalities.

East Branch - The remote East Branch occupies 13% of the land area in the river basin and is extremely important to the restoration of self-sustaining populations of Atlantic salmon to the Penobscot River drainage. The Penobscot name is *Wassategwewick*, indicating its importance for fishing. Lake Matagamon, at the headwaters, is home to a tribal trust land valued for its fishing and hunting.

Mattawamkeag - The Mattawamkeag is named for the gravel bar that marks the river's confluence with the Penobscot River. This drainage occupies 17% of the land area in the river basin and is characterized by a low relief, numerous bogs and wetlands, and slow run-off.

Piscataquis – The Piscataquis occupies 17% of the land area in the river basin. This "little branch stream" was an extremely important Penobscot travel route and contains significant Atlantic salmon spawning habitat. The Piscataquis River is affected by discharges from two large municipal treatment plants, a textile mill, non-point source pollution from agricultural and forestry operations, and at least six dams.

Lower Penobscot - The lower Penobscot bears the rocky drops (now dammed) that were the basis for the name of the river and the tribe. The majority of Penobscot tribal members live along this stretch of the river. The lower Penobscot drainage contains 28% of the land area in the river basin, and receives the water quality problems that wash downstream from the rest of the river basin. Two kraft mills discharge here and as a result there are fish consumption advisories for dioxins, furans, and PCBs.


East Branch
Penobscot
West Branch
Penobscot
Mattawamkeag
Piscataquis
Lower
Penobscot
Penobscot
Watersheds
Penobscot Basin
Penobscot Nation
Department of Natural Resources
July 6, 2000, G.C.D.
20
0
20
40
Miles

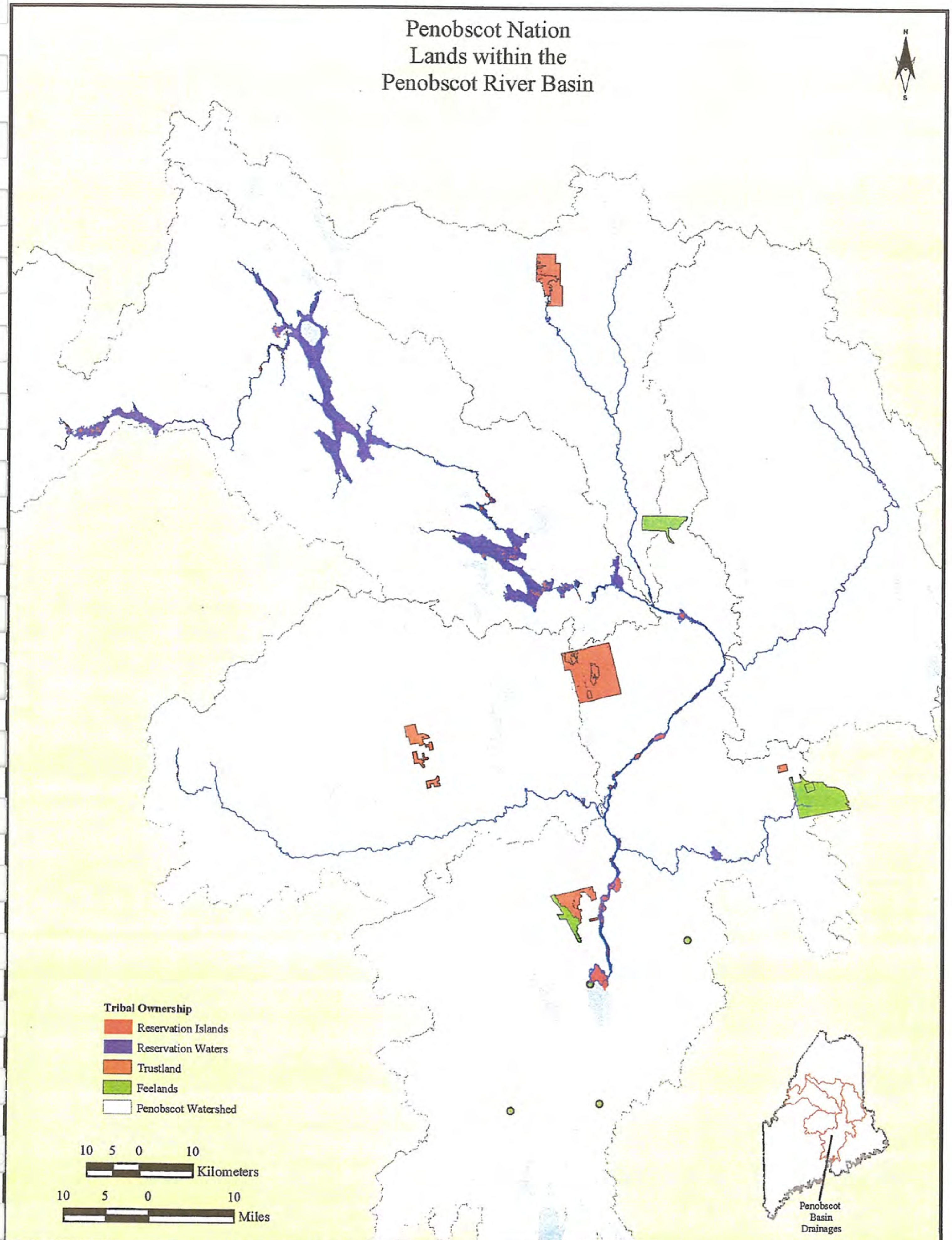
Map 3

Penobscot Nation Lands in Penobscot Basin

The Penobscot Nation Reservation, shown in red, is composed of the many small islands, the river bed, and the surrounding waters of the Penobscot River, starting at Indian Island and extending north. The Penobscot River and islands represent a portion of the ancestral home of the Penobscot people with uninterrupted occupation by the tribe for thousands of years. Important burial and ceremonial sites are located upon these islands, which are generally forested and low-lying, with extensive floodplains and forested wetlands. Traditional activities take place on and around the islands, including hunting, fishing, trapping, gathering, boating, camping, sweat lodges, and ceremonies. The floodplains support an annual household and commercial harvest of fiddlehead ferns.

Penobscot Nation Tribal Trust lands, shown in orange, add up to approximately 41,000 acres within the Penobscot River basin. These five separate parcels of land are located in Argyle, Lee, Mattamiscontis, Williamsburg, and Matagamon. The trust lands are used for fishing and hunting, and other sustenance and cultural activities such as basket making and fiddleheading. Hiking, boating, and swimming also take place at Trust Land mountains, rivers, and lakes. Portions of the trust lands are managed for timber, pulpwood, and household firewood. Other areas are zoned for wildlife management, or as set-asides for spiritual and ceremonial purposes. Seasonal occupation of camps is the norm, and access is by unpaved roads. There is an additional trust land at Alder Stream that is located outside of the Penobscot River Basin.

Tribal Fee Lands, shown in green, are spread throughout the river basin and total about 82,000 acres. There are additional fee lands located outside of the Penobscot River Basin. Most of these lands are managed for timber and pulpwood harvest by the Penobscot Nation Department of Natural Resources.



Penobscot Nation
Lands within the
Penobscot River Basin
N
S
Tribal Ownership
Reservation Islands
Reservation Waters
Trustland
Feelands
Penobscot Watershed
10 5 0 10
Kilometers
10 5 0 10
Miles
Penobscot
Basin
Drainages

Map 4

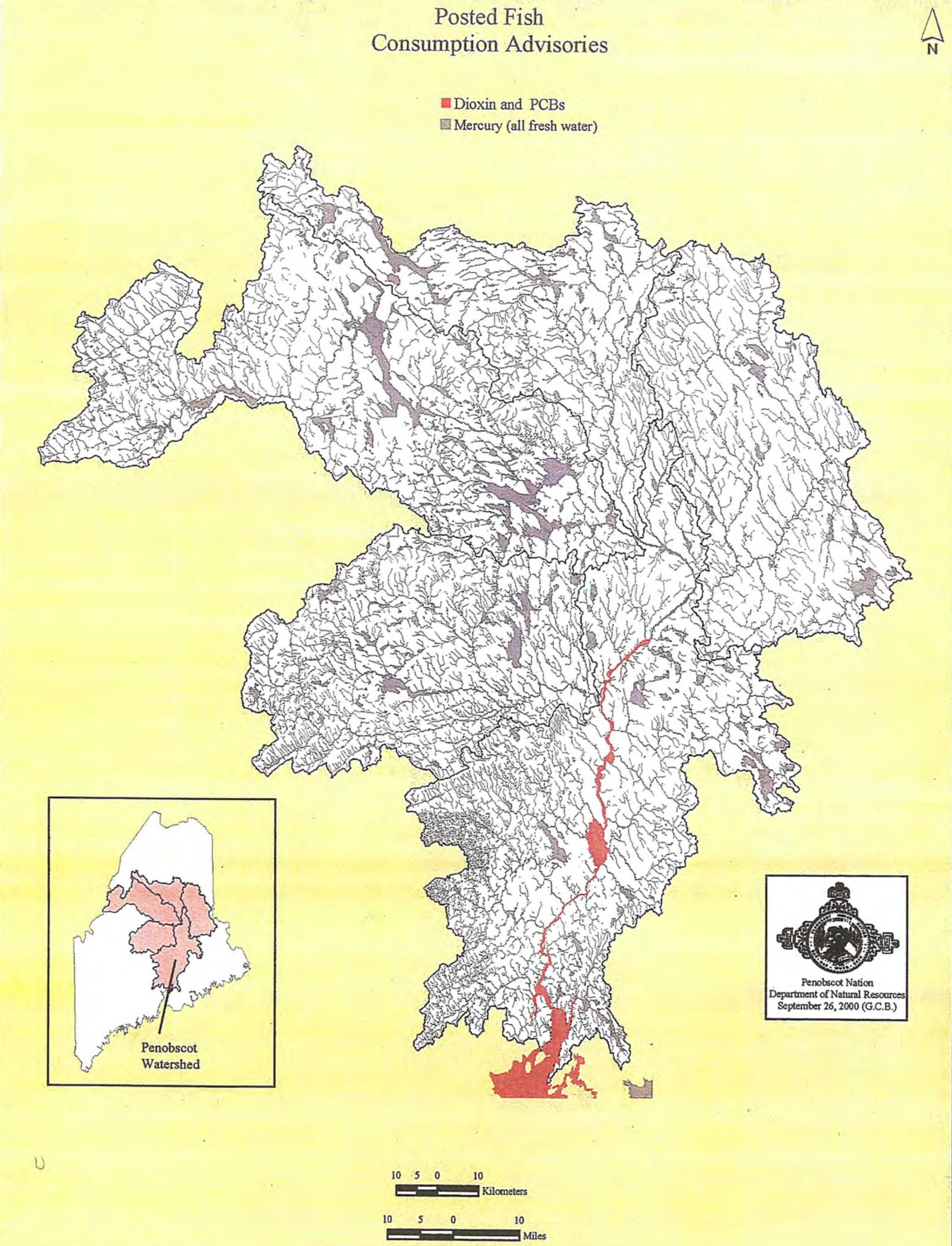
Posted Fish Consumption Advisories

All tribal waters are currently posted with some form of fish consumption advisories, for dioxin, PCBs, mercury, or all three. Mercury consumption advisories are in place for all Maine waters.

The lower 57 miles of the Penobscot River, including the Indian Island portion of the Reservation, are posted with an advisory for dioxin and co-planar PCBs, along with the Penobscot Estuary and Bay, where this advisory applies to lobster tomalley. Dioxin was first detected in Maine in 1984 as part of a national dioxin survey by the U.S. Environmental Protection Agency. By 1987 there was a health advisory in effect on the Penobscot River. A 1988 study of paper mills by EPA found levels of 32 ppq of dioxin associated with Lincoln Pulp and Paper discharges to the Penobscot River. From 1988 to the present, the Maine Dioxin Monitoring Program and the Penobscot Nation have been monitoring dioxin levels in fish tissues of the Penobscot River. State health advisories regarding dioxin in Penobscot River fish have been updated periodically and co-planar PCBs were added to the advisory in the late 1990s. An advisory for lobster tomalley in Penobscot Bay has also been in effect.

Tissues of smallmouth bass and white suckers analyzed for dioxin and co-planar PCBs in South Lincoln (approximately 4 miles downstream from Lincoln Pulp and Paper Company's bleached kraft mill) in Milford (34 miles downstream of the Lincoln draft mill), and in Veazie (7-8 miles below Ford James' bleached kraft mill in Old Town) were found to exceed the Fish Tissue Action Levels for human consumption in 1999.

Posted Fish Consumption Advisories



Map 5

Stream Water Quality Classifications

The state of Maine has established water quality standards for the waters of the Penobscot River Basin, ranging from AA, the highest protected level to C, the lowest. The Penobscot Nation is an active player in the state's periodic review of water quality for upgrades in classification. This map was developed by Maine DEP prior to 1997. Please see Appendix B for corrections and 1999 updates.

Class AA – Highest Classification. No discharges allowed. Suitable for drinking water after disinfection. Habitat characterized as free flowing and natural. Aquatic life, dissolved oxygen, and bacteria content as naturally occurs. Includes most waters of the East Branch sub-basin, and other streams known to have outstanding value for fish and wildlife.

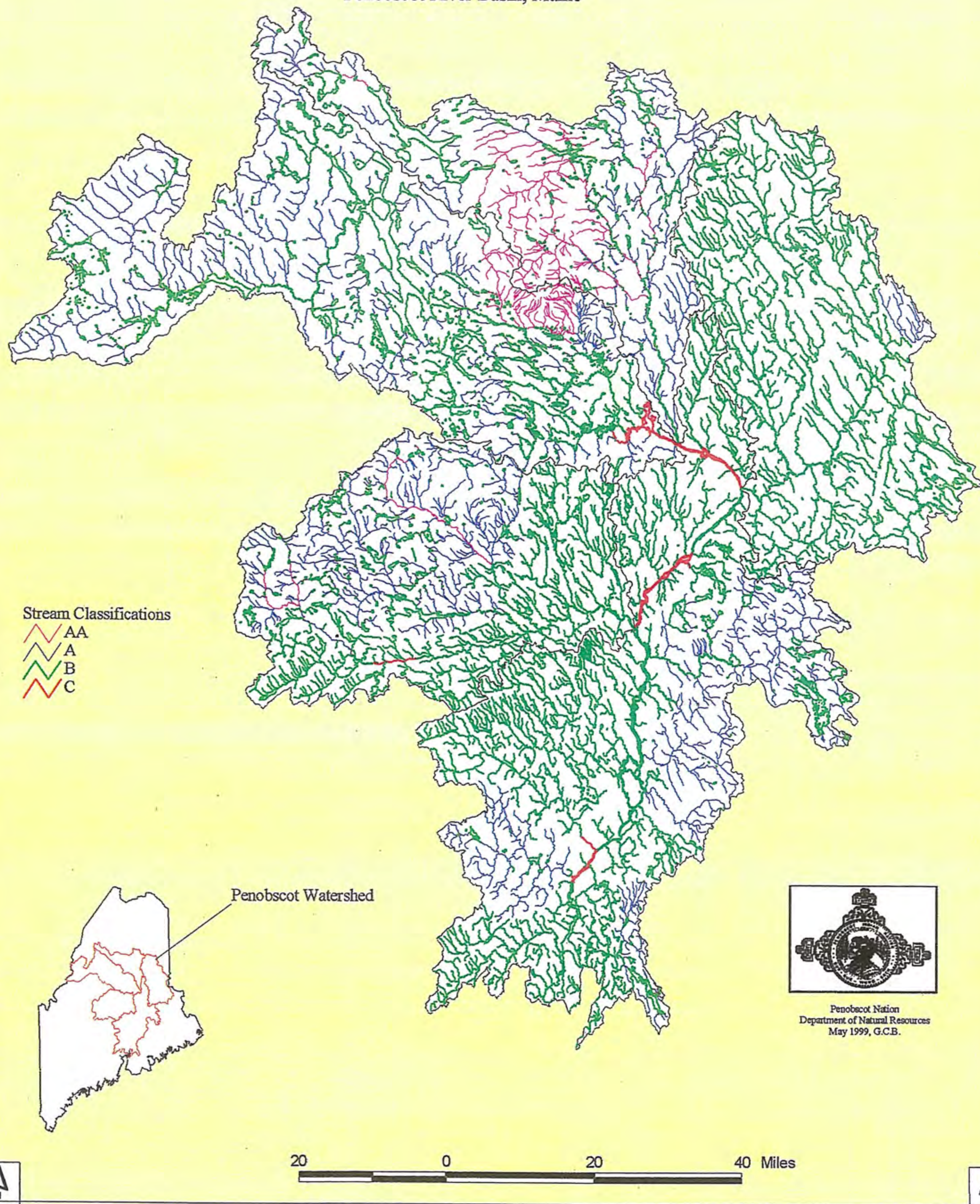
Class A – Second Highest Classification. Habitat characterized as natural. Discharges allowed only if no change to water quality. Dissolved oxygen no less than 7 parts per million or 75% of saturation, whichever is higher. Selected headwater streams have been granted this classification.

Class B – General Purpose Classification. Suitable for drinking water after treatment, fishing, recreation in and on the water, and habitat for fish and other aquatic life. Habitat characterized as unimpaired. Dams and treated discharges allowed. Dissolved oxygen standards same as Class A, but more stringent Oct 1 - May 14 to ensure spawning and egg incubation of indigenous fish. Discharges shall not cause adverse impact to aquatic life and should support indigenous species without detrimental changes in the biological community. May 15 - Sept 30, *E. coli* bacteria of human origin may not exceed a geometric mean of 64 per 100 ml or an instantaneous level of 427 per 100 ml. Includes most rivers and streams though some may meet Class A standards and merit an upgrade.

Class C – Commercial / Industrial Classification. Discharges may cause some changes to aquatic life, provided the receiving waters support indigenous species and maintain the structure and function of the resident biological community. The dissolved oxygen content of Class C water must be at least 5 parts per million or 60% of saturation, whichever is higher, except in identified salmonid spawning areas where water quality must ensure spawning, egg incubation, and survival of early life stages. Seasonal E. coli of human origin may not exceed a geometric mean of 142 per 100 ml or an instantaneous level of 949 per 100 ml. Three segments of the Penobscot River are currently class C: Dolby Pond Impoundment to the Mattawamkeag River, Lincoln Pulp and Paper to the West Enfield Dam, and within the City of Bangor. Two of these Class C segments lie in the Penobscot Nation Tribal Reservation.

Penobscot Basin Water Quality
Maine DEP Stream Classifications

Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine



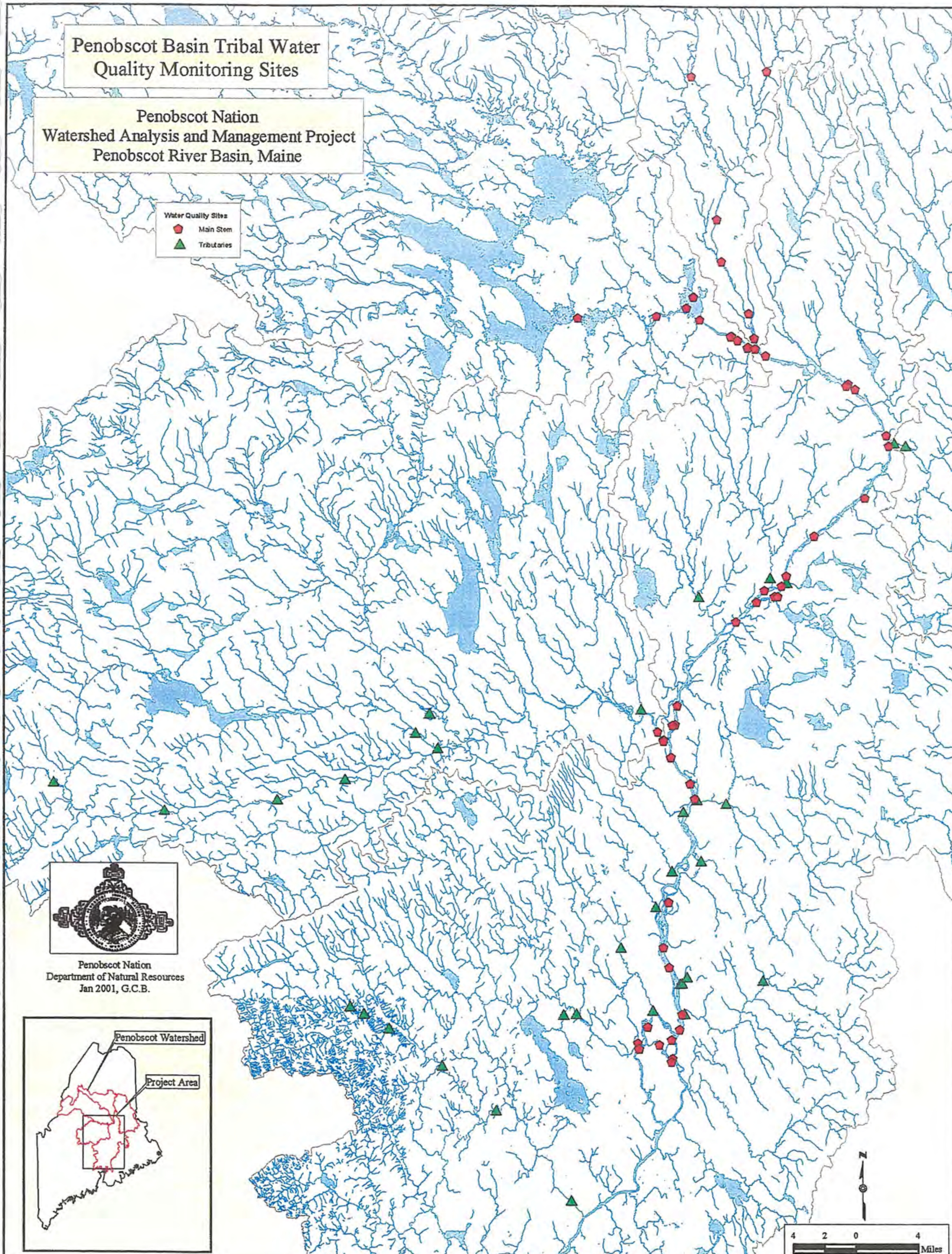
Map 6

Tribal Water Quality Monitoring Sites

Penobscot Nation water quality monitoring efforts evaluate compliance of industrial discharges and hydro-electric facilities with water quality regulations and gain information for use in permit review and re-licensing. Monitoring is also undertaken to support legislative upgrades to water quality classifications and assess whether tribal resources are protected by existing regulations. Contaminant levels in aquatic species are also analyzed.

The tribe's Water Resources Program conducts general ambient water quality sampling at more than 80 sites on the Penobscot River and more than 30 sites on tributaries. Parameters monitored include temperature, dissolved oxygen, biological oxygen demand (BOD), bacteria (*E. coli*), color, total suspended solids, turbidity, secchi disk, transparency, foam, and conductivity.

Other Penobscot Nation monitoring projects include algae and nutrient studies, biomonitoring using benthic macroinvertebrates, continuous temperature monitoring, G.I.S. mapping, toxics studies, and waste load allocation studies. Contaminants such as dioxins, furans, PCBs, heavy metals, chlorinated phenols, and AOX have been examined in fish, turtle, muskrat, fiddleheads, freshwater mussels, and sediments.


Penobscot Basin Tribal Water Quality Monitoring Sites
Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine
Water Quality Sites
Main Stem
Tributaries
Penobscot Nation
Department of Natural Resources
Jan 2001, G.C.B.
Penobscot Watershed
Project Area
N
4 2 0 4
Miles

Map 7

Dams

Black Symbols - Dams in Migratory Fish Restoration Zones
The dams identified with black symbols are major hydro-electric projects that lie within active migratory fish restoration zones. They have been ranked by restoration priority.

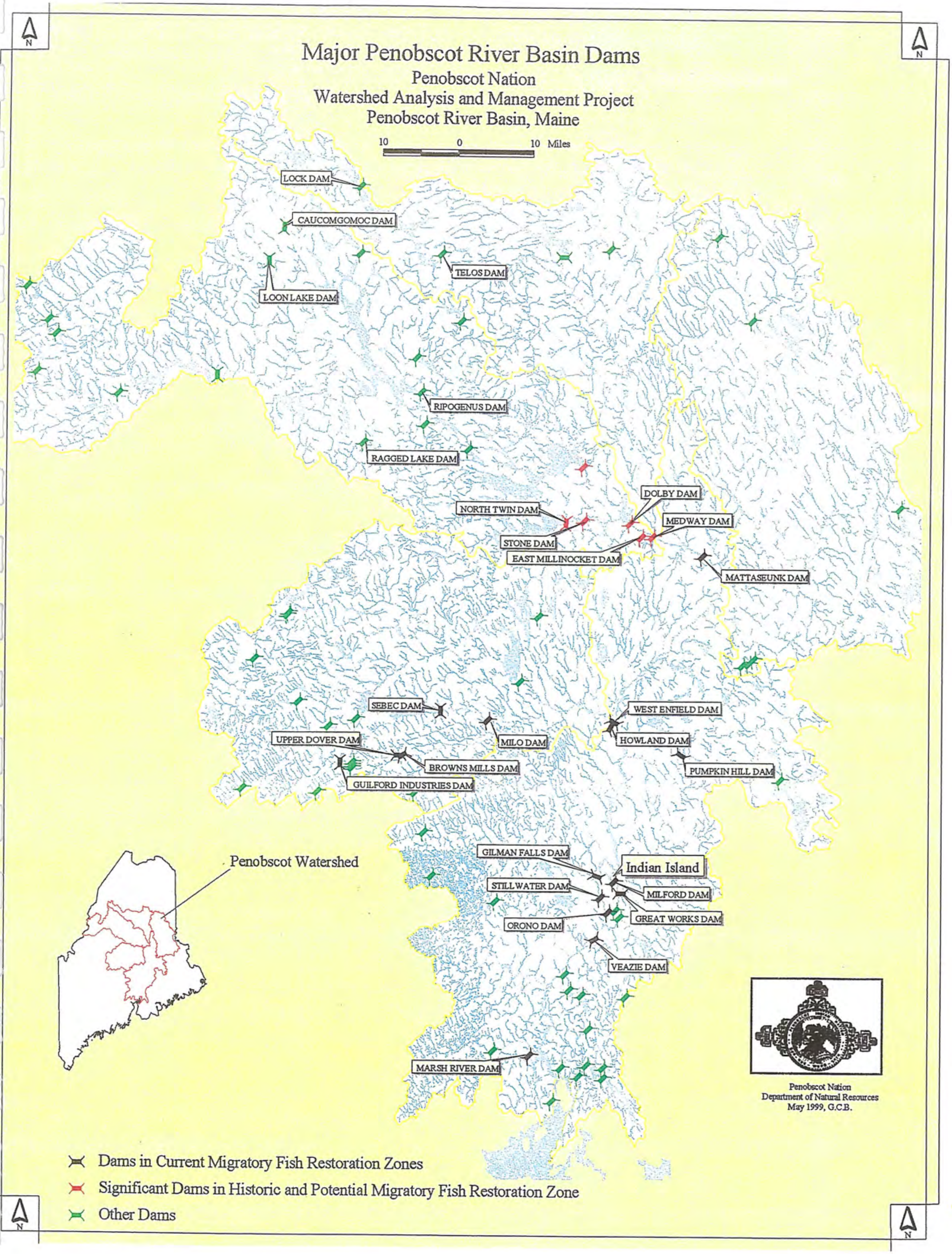
Class One Priority
The most significant obstacle for migratory fish species is the Veazie Dam which lies closest to the sea and contains the entire freshwater portion of the Penobscot River. All migratory fish in the Penobscot River Basin must pass Veazie Dam on their journey upstream and downstream. Improvements to this fish passage would make a dramatic difference for Atlantic salmon, shad, alewife, blueback herring, and eels. Removal of this dam would also allow substantial restoration of Atlantic sturgeon, short nosed sturgeon, Atlantic tomcod, rainbow smelt, and striped bass.

Class Two Priority
In addition to the Veazie Project, there are five additional large hydro-electric projects in the lower Penobscot basin that are highly significant for migratory fish restoration: Great Works, Milford, Howland, West Enfield, and Mattaseunk. Improvements to fish passage at these dams would make a significant difference for the restoration of Atlantic salmon, shad, alewife, blueback herring, and eels.

Class Three Priority
Dams on major tributaries or side channels of the Penobscot River within active fish migratory zones are third level priorities in the basin. The three dams along the Piscataquis (Brown's Mills, Upper Dover, and Guilford) are among the most important of these. They affect passage of Atlantic Salmon to high quality spawning grounds upstream. In addition, three dams located on the Stillwater River, a side channel of the lower Penobscot in Orono and Old Town, have no fishways. However, fish may bypass those dams by remaining in the mainstem Penobscot River.

Red Symbols - Significant Dams, Potential Fish Restoration Zone
In a class by themselves are the major hydro-electric dams on the West Branch, where no fishways are in place and none are presently planned. Prior to dam construction, several of the migratory species used this sub-basin.

Green Symbols - Other Dams
Other dams among the 116 licensed dams in the Basin include those used for local power generation or water-level control.


Major Penobscot River Basin Dams
Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine
10 0 10 Miles
LOCK DAM
CAUCOMGOMOC DAM
TELOS DAM
LOON LAKE DAM
RIPOGENUS DAM
RAGGED LAKE DAM
DOLBY DAM
NORTH TWIN DAM
MEDWAY DAM
STONE DAM
EAST MILLINOCKET DAM
MATTASEUNK DAM
SEBEC DAM
WEST ENFIELD DAM
UPPER DOVER DAM
MILO DAM
HOWLAND DAM
BROWNS MILLS DAM
PUMPKIN HILL DAM
GUILFORD INDUSTRIES DAM
GILMAN FALLS DAM
Indian Island
STILLWATER DAM
MILFORD DAM
GREAT WORKS DAM
ORONO DAM
VEAZIE DAM
MARSH RIVER DAM
Penobscot Watershed
Penobscot Nation
Department of Natural Resources
May 1999, G.C.B.
Dams in Current Migratory Fish Restoration Zones
Significant Dams in Historic and Potential Migratory Fish Restoration Zone
Other Dams
N

Map 8

Point Source Discharges

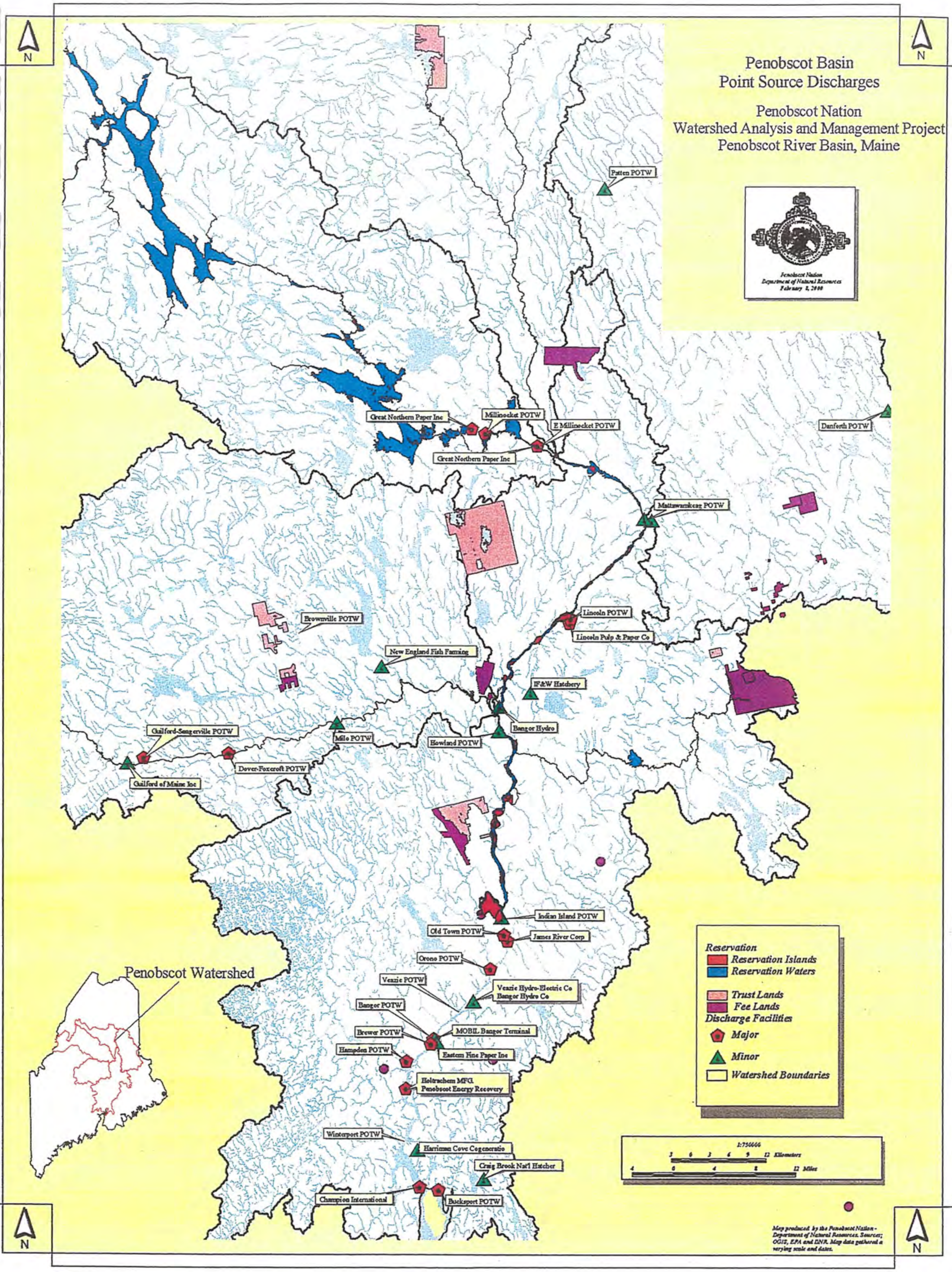
There are approximately 57 facilities with federal and state permits to discharge treated wastewater to the Penobscot River Basin. Major point sources, shown with red hexagons on the map, are licensed to discharge over one million gallons of wastewater a day, or have the potential to release toxic contaminants in toxic amounts. Seven major point sources discharge upstream of Indian Island, directly in the waters of the reservation. These include three paper mills, one owned by Lincoln Pulp and Paper, and two owned by Great Northern. The four other major point sources are the municipal treatment plants for the communities of Lincoln, Millinocket, Dover-Foxcroft and Guilford-Sangerville. The latter receives wastes from textile dying operations at Guilford Industries.

Downstream of Indian Island, there are nine additional major point sources, including a paper mill owned by Fort James (formerly James River), a paper mill owned by Champion International, a chlor-alkali plant owned by HoltraChem, a waste incinerator run by Penobscot Energy Recovery, and municipal treatment plants for the cities and communities of Old Town, Orono, Bangor, Brewer, Hampden, and Bucksport. The Brewer treatment plant receives wastes from Eastern Fine Paper, an additional paper-making operation.

The federal permits for these facilities are issued as part of the National Pollutant Discharge Elimination System (NPDES), administered by the U.S. Environmental Protection Agency.

Toxic substances in the discharges include dioxins, furans, chlorinated organics, mercury, and other metals. Other known point-source pollutants include nutrients, oxygen depleting substances, foam, color, odor, and cooling water. In addition to disrupting tribal cultural and sustenance ties to the river, point source pollutants accumulate in the food chain, deplete oxygen levels, warm the water, contribute to algae blooms, harm aesthetics, imbalance the aquatic ecosystem and increase the stress on migrating Atlantic salmon.

Discharges downstream of tribal waters are of interest to the tribe because of their potential impacts on the habitat, resting, and passage requirements of migratory fish that must pass through the lower reaches of the Penobscot River to reach reservation waters and spawning habitats upstream.



Penobscot Basin
Point Source Discharges
Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine
Penobscot Nation
Department of Natural Resources
Patten POTW
Danforth POTW
Great Northern Paper Inc
Millinocket POTW
E Millinocket POTW
Great Northern Paper Inc
Mattawamkeag POTW
Lincoln POTW
Lincoln Pulp & Paper Co
Brownville POTW
New England Fish Farming
IF&W Hatchery
Bangor Hydro
Howland POTW
Guilford-Sangerville POTW
Milo POTW
Dover-Foxcroft POTW
Guilford of Maine Inc
Indian Island POTW
Old Town POTW
James River Corp
Orono POTW
Veazie POTW
Veazie Hydro-Electric Co
Bangor Hydro Co
Bangor POTW
Brewer POTW
MOBIL Bangor Terminal
Eastern Fine Paper Inc
Hampden POTW
Holtrachem MFG.
Penobscot Energy Recovery
Winterport POTW
Harriman Cove Cogeneratio
Craig Brook Nat'l Hatcher
Champion International
Bucksport POTW
Penobscot Watershed
Reservation
Reservation Islands
Reservation Waters
Trust Lands
Fee Lands
Discharge Facilities
Major
Minor
Watershed Boundaries
Kilometers
Miles
Map produced by the Penobscot Nation - Department of Natural Resources. Sources; OGIS, EPA and DNR. Map data gathered a varying scale and dates.
N

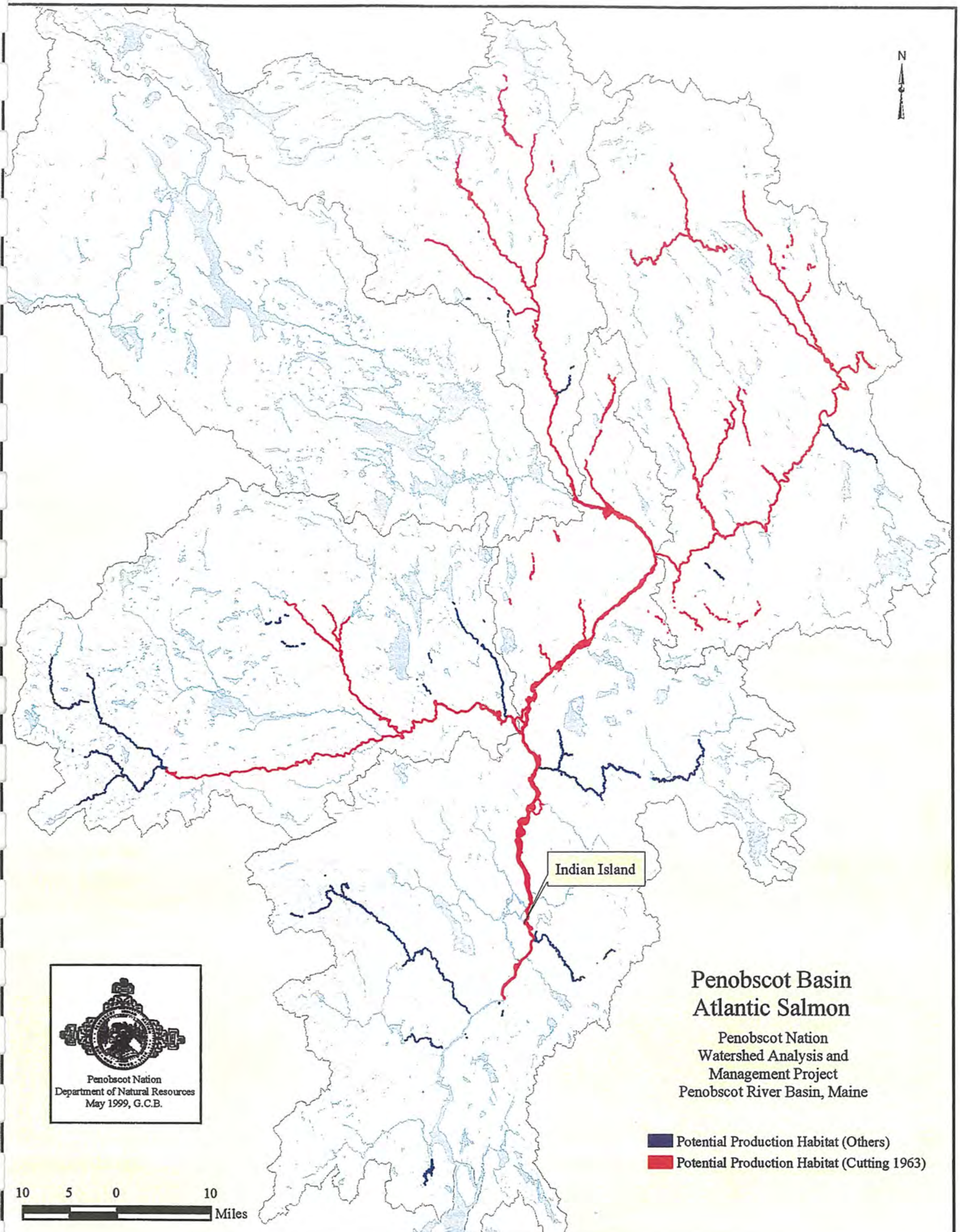
Map 9

Atlantic Salmon

This map shows where spawning or juvenile production habitat for Atlantic salmon has been identified. We relied heavily on Cutting (1963), and filled in gaps with work by others, including records from the Maine Atlantic Salmon Commission and observations of our Penobscot Nation Fisheries Manager. While there is some spawning and production potential in virtually all but the lowest gradient reaches of the drainage, the quality level varies widely. It is generally believed that the highest quality production habitat today is located in the East Branch sub-drainage (above Grindstone), the Piscataquis River (above Guilford) and the Pleasant River (a tributary to the Piscataquis at Milo), and the Mattawamkeag River sub-drainage (above Haynesville). In total, these reaches account for at least three quarters of the prime production habitat currently available for these species.

Unfortunately, upstream access to many of the prime production reaches remains problematic, due to the presence of numerous dams with inadequate fish passage. Salmon must currently pass at least four major dams, and possibly as many as seven, to reach any of these prime production areas. Compounding the problems facing salmon restoration efforts is the lack of effective downstream fish passage facilities at these dams, which cumulatively and substantially impact smolt survival during out-migration to the ocean. Finally, the presence of large number of native (e.g. cormorants) and introduced (e.g. smallmouth bass) predators, in combination with the enhanced predatory environments created by the hydropower impoundments and dams, represents yet another difficult obstacle to tribal and agency restoration efforts.

Cutting, Richard E. 1963. Penobscot River Salmon Restoration. Maine Atlantic Sea-Run Salmon Commission. Orono, Me. 161 pp.


N
Indian Island
Penobscot Nation
Department of Natural Resources
May 1999, G.C.B.
Penobscot Basin
Atlantic Salmon
Penobscot Nation
Watershed Analysis and
Management Project
Penobscot River Basin, Maine
Potential Production Habitat (Others)
Potential Production Habitat (Cutting 1963)
10 5 0 10
Miles

Map 10

American Shad

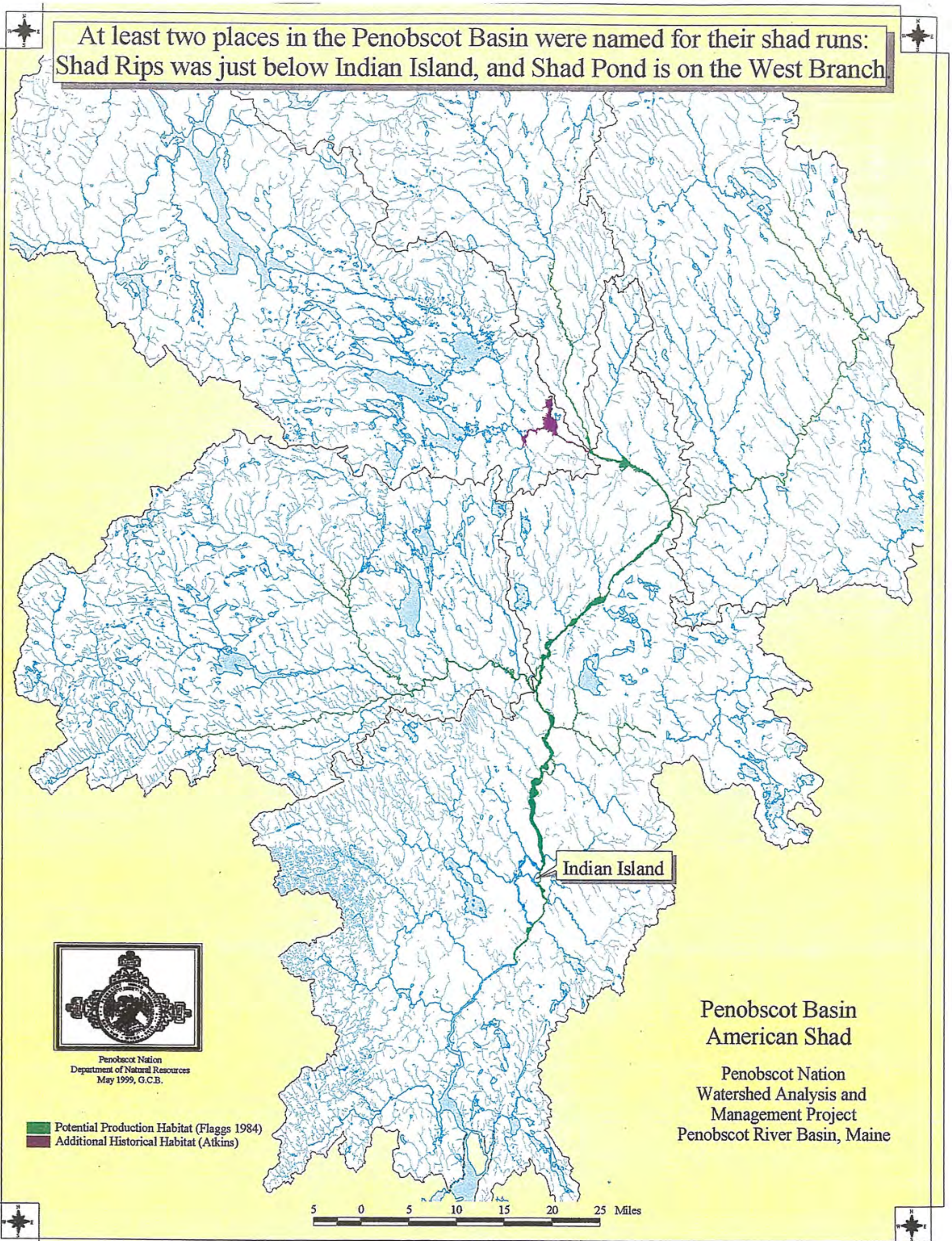
In the Penobscot River basin, the production potential for adult shad is estimated at 1.5 million, based on average production values from other similar rivers with sustained runs (Penobscot River American Shad Working Group, 2000; Flagg 1984). We have prepared a map indicating potential shad production habitat, based on existing sources.

Historically, shad were very abundant in the Penobscot, and provided for a substantial commercial fishery. Prior to the construction of two major dams on the lower river in the 1830s, shad were documented to migrate as far upstream as Wassataquoik Stream on the East Branch, Monson Junction and Silver Lake on the Piscataquis River, Grand Falls on the Passadumkeag River, and Mattawamkeag Lake on the Mattawamkeag River. Their range also extended into the West Branch, at least to Shad Pond, prior to construction of dams in that sub-basin. Currently, the size of the shad population in the Penobscot is unknown, but is likely in the several thousand fish range at best, and is restricted to the short river segment below the first dam in Veazie.

Until recently, there have been no active shad restoration efforts in the Penobscot basin. However, pursuant to a 1995 Cooperative Planning Agreement between the Penobscot Nation, the State Departments of Marine Resources and Inland Fisheries and Wildlife, and the U. S. Fish and Wildlife Service, the "Penobscot River American Shad Working Group" prepared a Strategic Plan for the active restoration of shad. The signatories have approved this plan, and next steps include the preparation and implementation of an operational plan. Key components to active restoration include substantially improved fish passage at lower river dams, and a commitment of resources toward developing a hatchery stock for "seeding" upriver habitat reaches while fish passage improvements are underway.

Flagg, Lewis. 1984. Penobscot River Shad and Alewife Restoration Potential. Maine Dept. Marine Resources. 8 pp.

Penobscot River American Shad Working Group. 2000. A Strategic Plan to Restore American Shad (*Alosa sapidissima*) to the Penobscot River, Maine. 15 pp.


At least two places in the Penobscot Basin were named for their shad runs:
Shad Rips was just below Indian Island, and Shad Pond is on the West Branch.
Indian Island
Penobscot Nation
Department of Natural Resources
May 1999, G.C.B.
Potential Production Habitat (Flaggs 1984)
Additional Historical Habitat (Atkins)
Penobscot Basin
American Shad
Penobscot Nation
Watershed Analysis and
Management Project
Penobscot River Basin, Maine
5 0 5 10 15 20 25 Miles

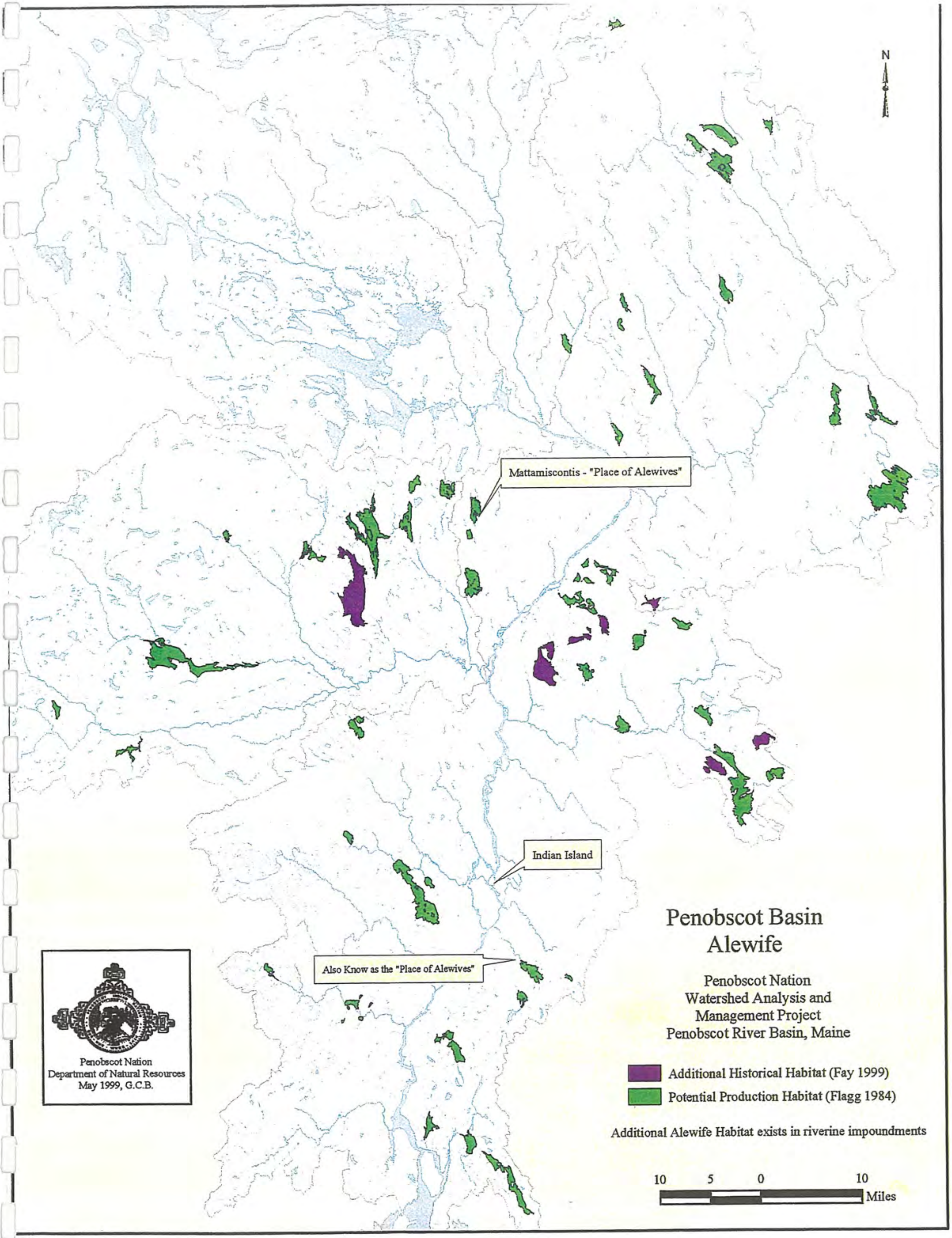
Map 11

Alewife and Blueback Herring

This map indicates the potential production habitat for alewife in the Penobscot River Basin. We relied heavily on Flagg (1984), and filled in gaps with work by others, including the observations of our Penobscot Nation Fisheries Manager. Currently, there are no active alewife or blueback herring restoration efforts on the Penobscot. However, populations seem to be rebuilding slowly on their own, based on the occasional appearance of adults and juveniles in recent years above the Milford or Howland dams, where for many years there have been none. Unfortunately, as with salmon and shad, fish passage limitations at lower river dams are known to be impeding the restoration. Improvements are needed at these facilities before populations in the Reservation above Milford Dam can be restored to the self-sustaining levels needed for subsistence or commercial use by the Penobscot Nation. Such improvements may result from the implementation of the American Shad Restoration Plan.

Externally, blueback herring are nearly indistinguishable from alewife. However, their spawning habitat preferences are more similar to those of shad. Thus, while we did not prepare a separate map for this species, generally speaking, the lowermost two thirds of the range map for shad is an adequate representation of blueback herring production habitat in the basin.

Flagg, Lewis, et al. 1984. Penobscot River Shad and Alewife Restoration Potential. Maine Department of Marine Resources.


N
Mattamiscontis - "Place of Alewives"
Indian Island
Also Know as the "Place of Alewives"
Penobscot Nation
Department of Natural Resources
May 1999, G.C.B.
Penobscot Basin
Alewife
Penobscot Nation
Watershed Analysis and
Management Project
Penobscot River Basin, Maine
Additional Historical Habitat (Fay 1999)
Potential Production Habitat (Flagg 1984)
Additional Alewife Habitat exists in riverine impoundments
10 5 0 10
Miles

Map 12

American Eel - Documented Upstream Range

The documented current upstream range of American eel in the Penobscot River basin is shown on this map and listed by sub-basin as follows. The information was taken from Flagg et al. (1996) and was compiled from Maine Department of Inland Fish and Wildlife lake fish population surveys, most of which are over 20 years old. This map should not be considered comprehensive in terms of current eel distribution in the drainage.

Kenduskeag Stream
Garland Pond

Passadumkeag River
Nicatous Lake and Number 3 Pond

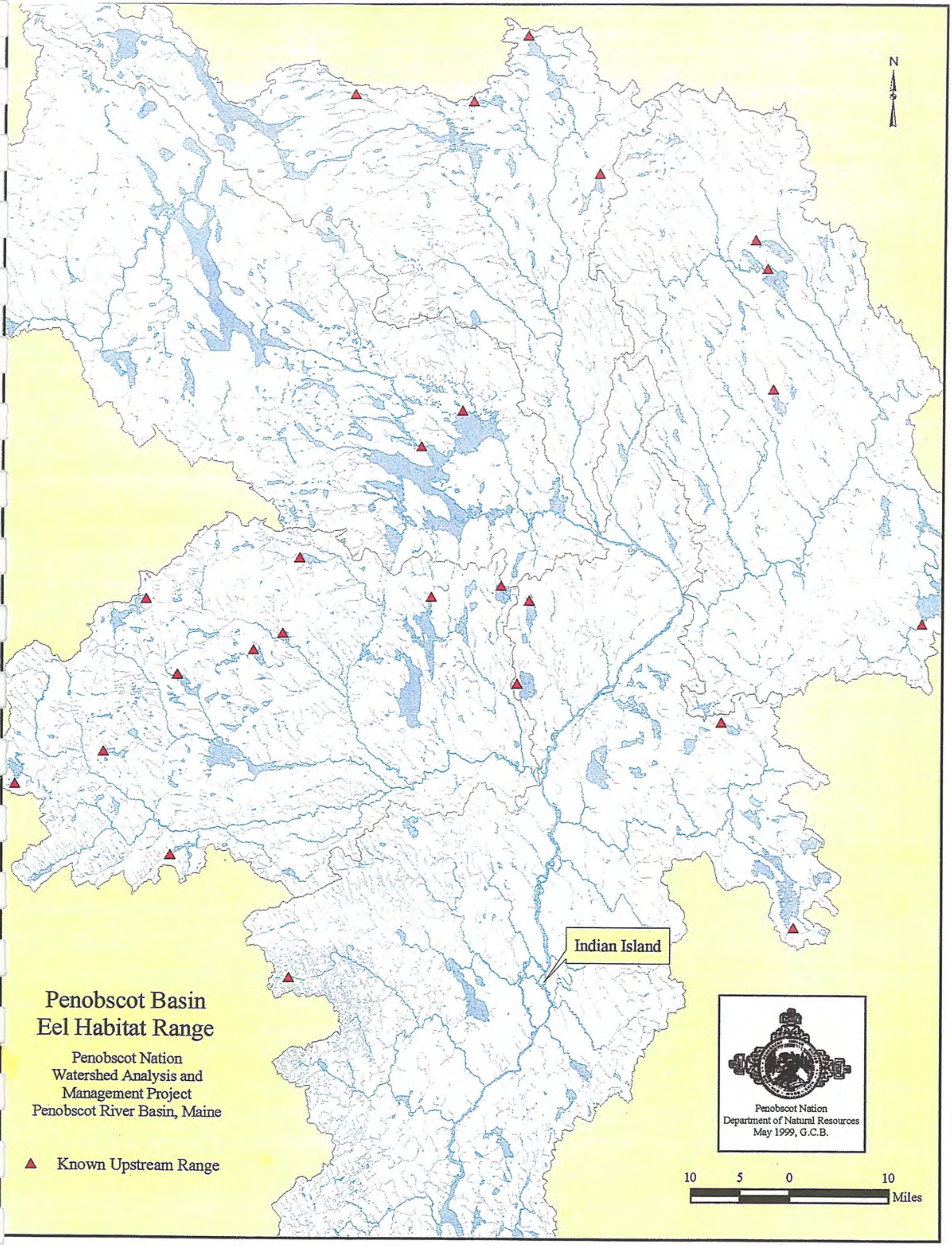
Piscataquis River
Bald Mountain and Harlow Ponds and Hebron Lake; Upper Wilson Pond and Lake Onawa (Sebec River); Silver Lake and Houston Pond (W Branch Pleasant); B Pond (E Branch Pleasant); Seboeis and East Branch Lakes (Seboeis River)

Mattawamkeag River
Mattawamkeag, Pleasant, Wytopitlock, Baskahegan Lakes

West Branch
Pemadumcook Chain of Lakes and Millinocket Lake

East Branch
3rd Matagamon, Scraggly, Grand Seboeis Lakes, Upper Shin Pond

Flagg, Lewis, et al. 1996. American Eel Species Management Plan. The Joint Department of Marine Resources and Department of Inland Fisheries and Wildlife Committee on American Eel Management for Maine.


N
Indian Island
Penobscot Basin
Eel Habitat Range
Penobscot Nation
Watershed Analysis and
Management Project
Penobscot River Basin, Maine
Known Upstream Range
Penobscot Nation
Department of Natural Resources
May 1999, G.C.B.
10 5 0 10
Miles

Map 13

Bedrock Geology

In this bedrock geologic map of the Penobscot River Basin, we have simplified the state's geologic map (Osberg et al., 1985) by grouping the bedrock units into four groups: granite, metasedimentary, other intrusive (mostly diorite), and volcanic.

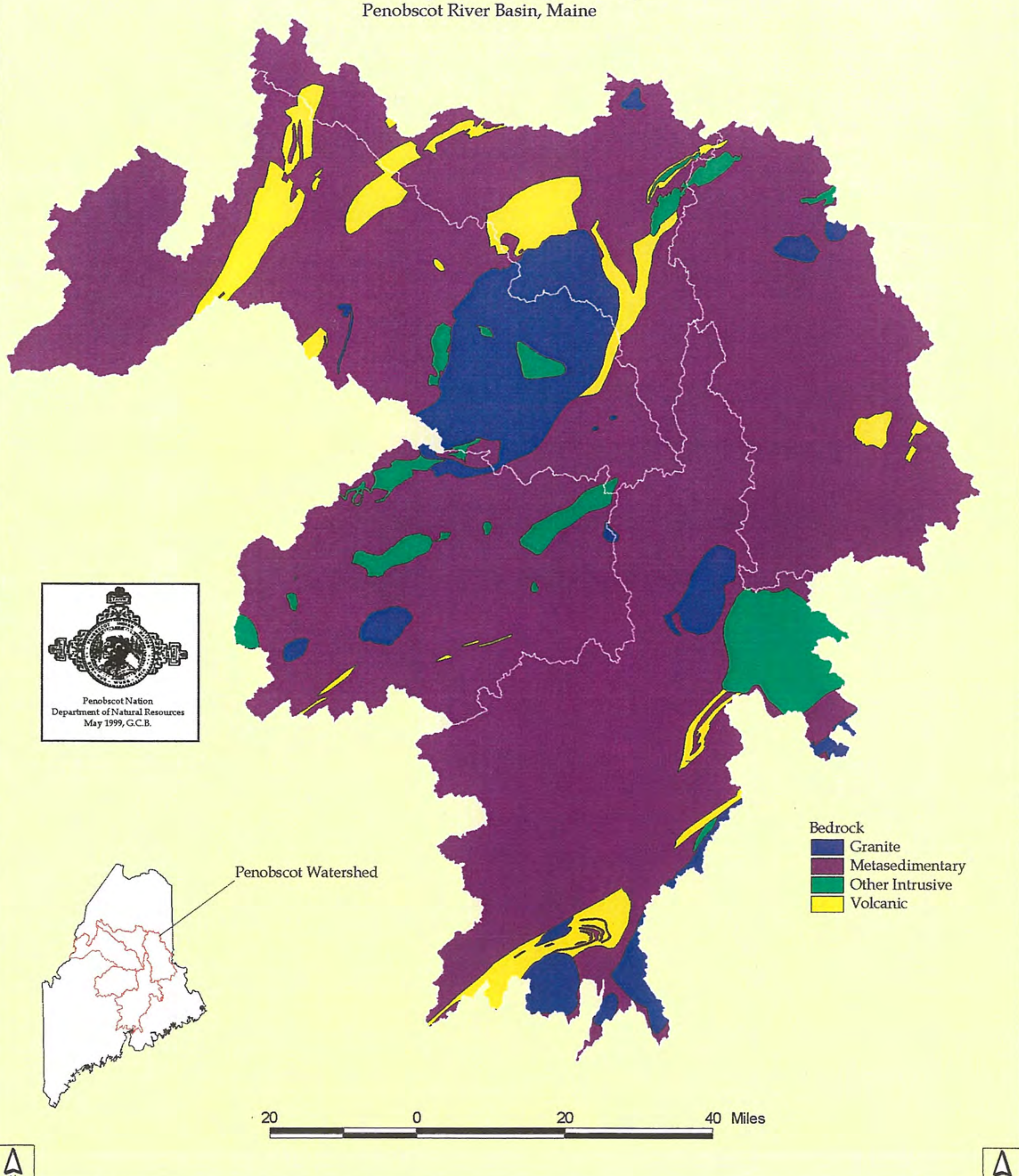
A general awareness of the bedrock type is useful in watershed characterization. It can assist water quality specialists in predicting which waters are likely to be better buffered from acidification. Granitic bedrock is known to be more closely linked with acidification, whereas limestones have the reverse effect. The metamorphized limestones, sandstones, and mudstones that form the majority of the basin may cause these waters to be better buffered than those waters underlain with granite.

Knowledge of bedrock type is useful for understanding the general lay of the land. Granite tends to be associated with the more mountainous parts of the drainage, such as the Katahdin range, because it is more resistant to erosion. More easily eroded metasedimentary units underlie the broad valleys of the lower river basin.

Osberg, Philip, Hussey, Arthur M., II, and Boone, Gary, M., 1985, Bedrock Geologic Map of Maine, Maine Geological Survey, Augusta, Maine.

Penobscot Basin
Bedrock Geologic Map
Penobscot Watershed

Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine



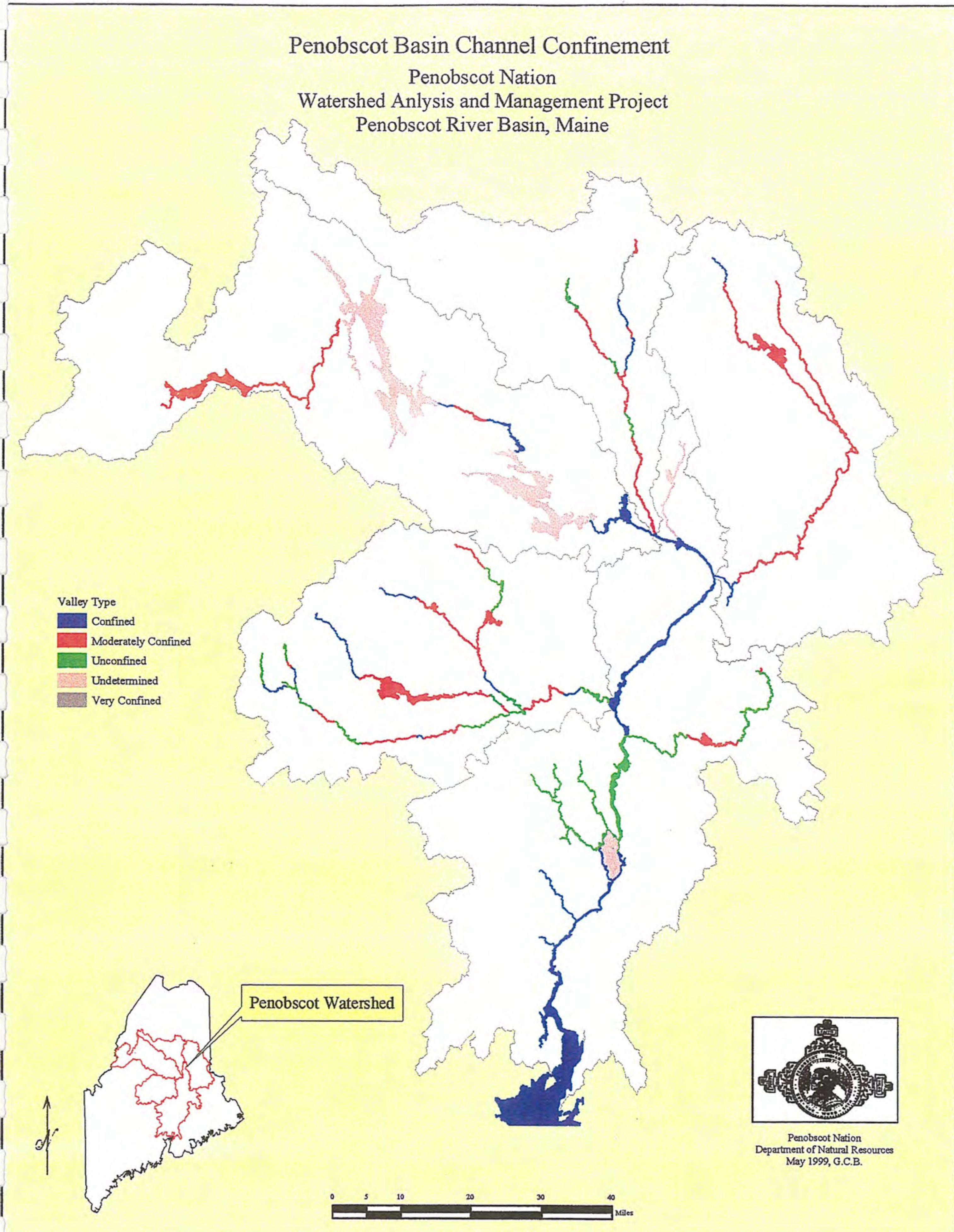
Map 14-A

Channel Geomorphology: Confinement

Early work divided the main stem of the Penobscot River valley into four distinct geomorphic units (Kelley, et al., 1988): mountainous upland, island and bar, rapids and terrace, and tidally influenced. The current study has produced a much finer division of the Penobscot and its major tributaries based on a variety of geomorphic factors, including presence of rapids, steepness of river banks, and sinuosity of the river course. The map showing channel confinement on the next page indicates the width of the river valley, as very confined, confined, moderately confined, unconfined, or undetermined. This determination was based on an examination of topographic maps and surficial geology maps (Thompson and Borns, 1985).

Kelley, Alice R., Kelley, J.T., Belknap, D.F., Sanger, D., 1988, Quaternary Stratigraphy and Geomorphology of the Lower Penobscot Valley, Geological

Thompson, W.B. and Borns, H.W., Jr., 1985, Surficial Geology Map of Maine, Maine Geological Survey, Augusta, Maine 1:500,000.


Penobscot Basin Channel Confinement
Penobscot Nation
Watershed Anlysis and Management Project
Penobscot River Basin, Maine
Valley Type
Confined
Moderately Confined
Unconfined
Undetermined
Very Confined
Penobscot Watershed
Penobscot Nation
Department of Natural Resources
May 1999, G.C.B.
0 5 10 20 30 40
Miles

Map 14-B

Channel Geomorphology: Surficial Units

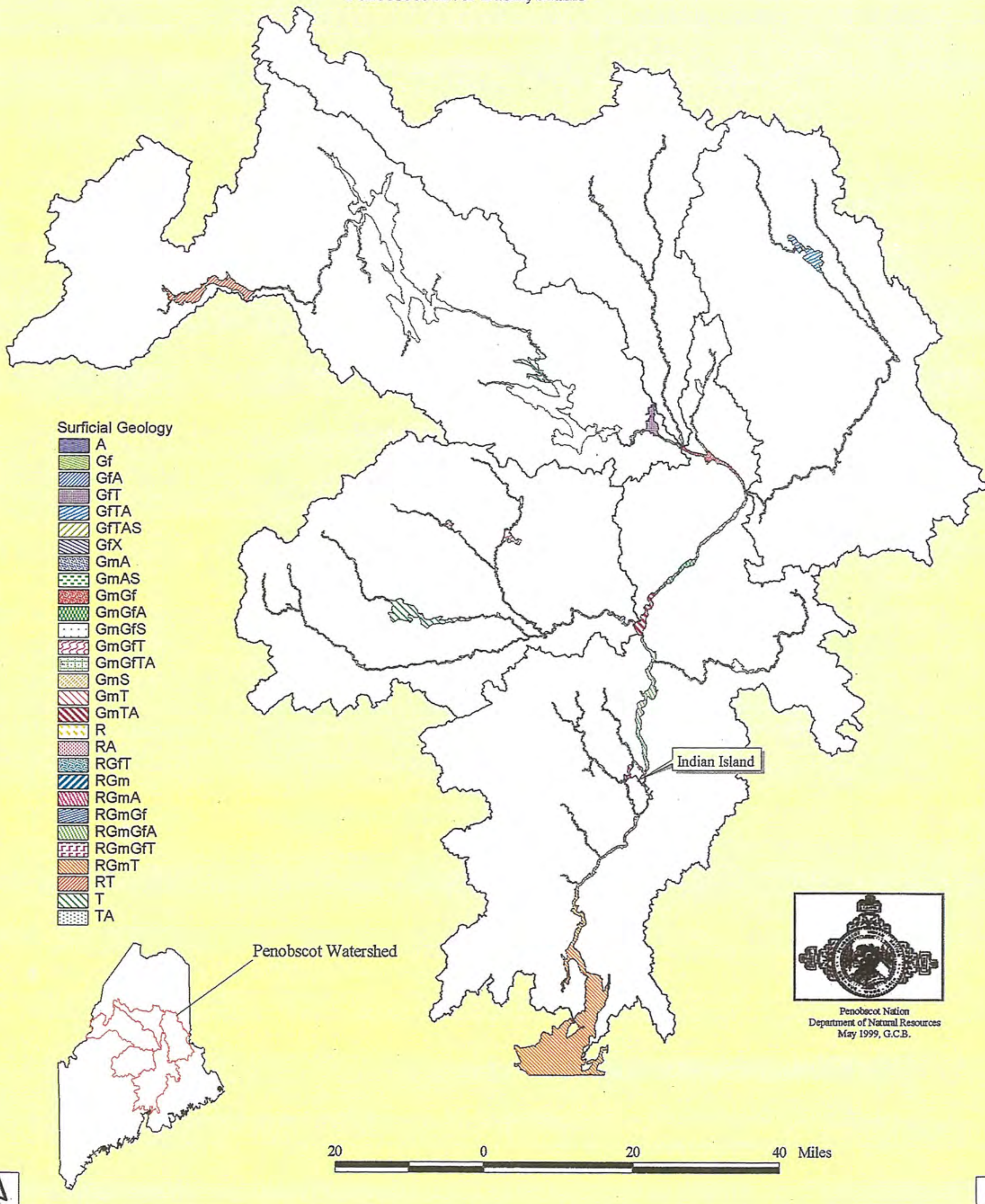
The next map indicates the surficial geologic units of the major rivers and streams of the Penobscot River Basin. It was prepared using a surficial geologic map of Maine (Thompson and Borns, 1985) and the knowledge of Alice Kelley and Penobscot Nation staff. The 29 units in the map key indicate different combinations of substrates along the riverbanks.

The letter "A" designates deposits of Stream Alluvium. The letters "Gf" designate deposits of Glaciofluvial Deposits such as eskers and outwashes. The letter "T" designates deposits of Till. The letters "Gm" designate Glaciomarine Deposits, the blue-gray clay that was deposited post-glacially when Penobscot River Basin lay under the sea. The letter "R" designates an outcrop of bedrock. This map is meant to be used in combination with the maps that follow.

The tidal portion of the Penobscot River is labeled "RGmT." This indicates that the banks of the estuary are predominantly rock ledge (R), glaciomarine clays (Gm), and till (T). The Penobscot River where it surrounds Indian Island and Orson Island is "RGmA." The river banks here continue to be composed of solid rock and clay, but deposits of stream alluvium (A), or waterborne sediments are more prevalent here than deposits of till. Continuing upstream the river for 20 miles, the river banks are characterized similarly, as "RgmGfA," with the addition of glaciofluvial deposits (Gf).

Penobscot Basin Channel Geomorphology

Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine



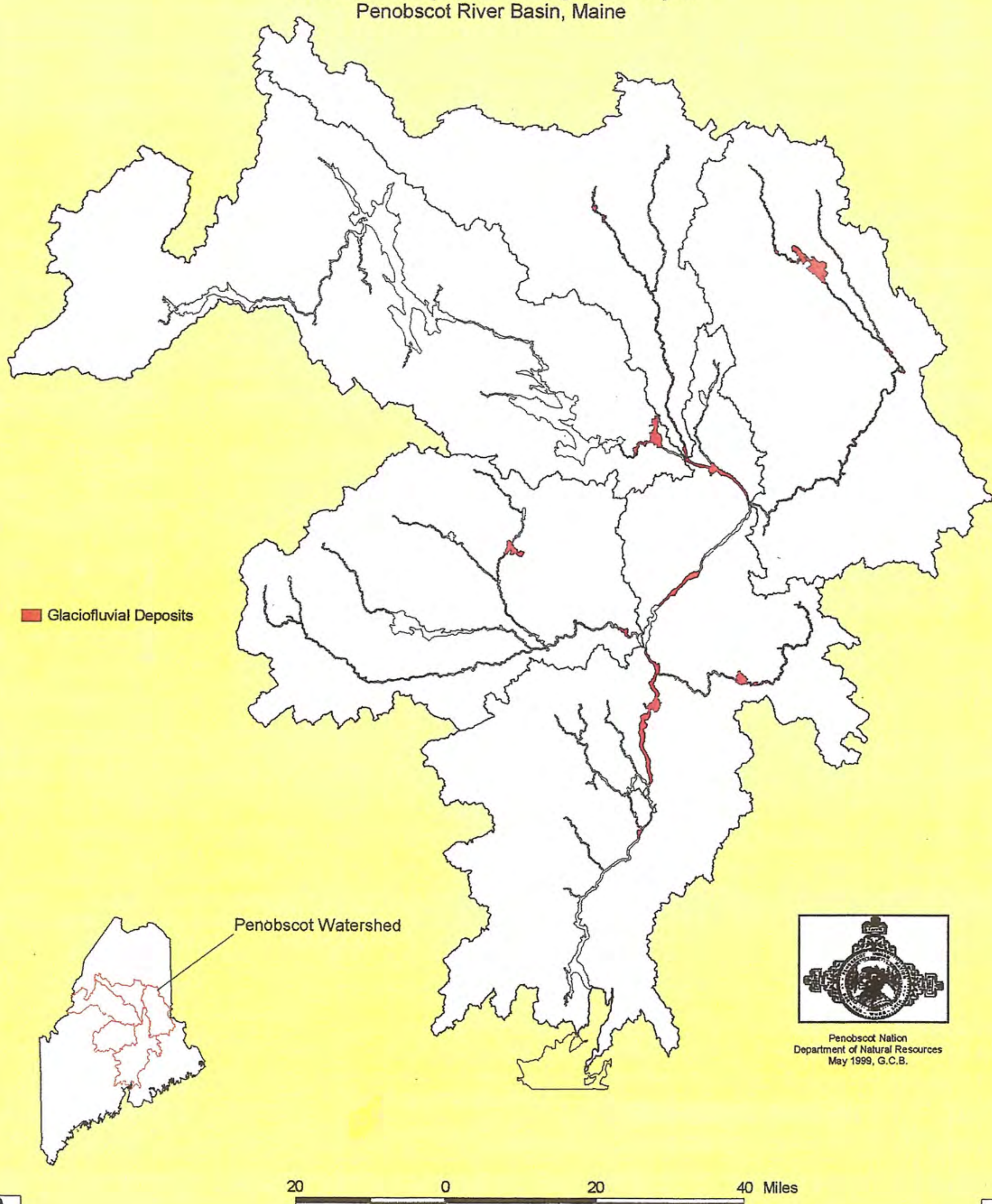
Map 14-C

Channel Geomorphology: Glaciofluvial Deposits

Glaciofluvial deposits consist mainly of sand and gravel. They include eskers, non-marine outwash plains, deltas, and fans. Eskers are ridges deposited by meltwater streams flowing in tunnels within or beneath the glacial ice sheet. Many eskers intersect river channels in the lower Penobscot and the Piscataquis drainage, or run parallel to them. They are significant in terms of fisheries management and tribal drinking water. These sand and gravel deposits represent ground waters flowing close to the surface; thus, they are important aquifers. Eskers intersecting the river channel provide an inflow of cool water and create warm weather refugia for salmonids during the summer when river temperatures rise. Eskers along the banks of the Stillwater River side-channel of the Penobscot are tapped for drinking water used by Penobscot Nation at Indian Island and the municipalities of Old Town and Orono. The quality of these drinking water supplies has the potential to be affected by water quality conditions in the river, as there is generally a close interface between alluvial aquifers and their adjacent surface waters.

Penobscot Basin Channel Geomorphology

Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine



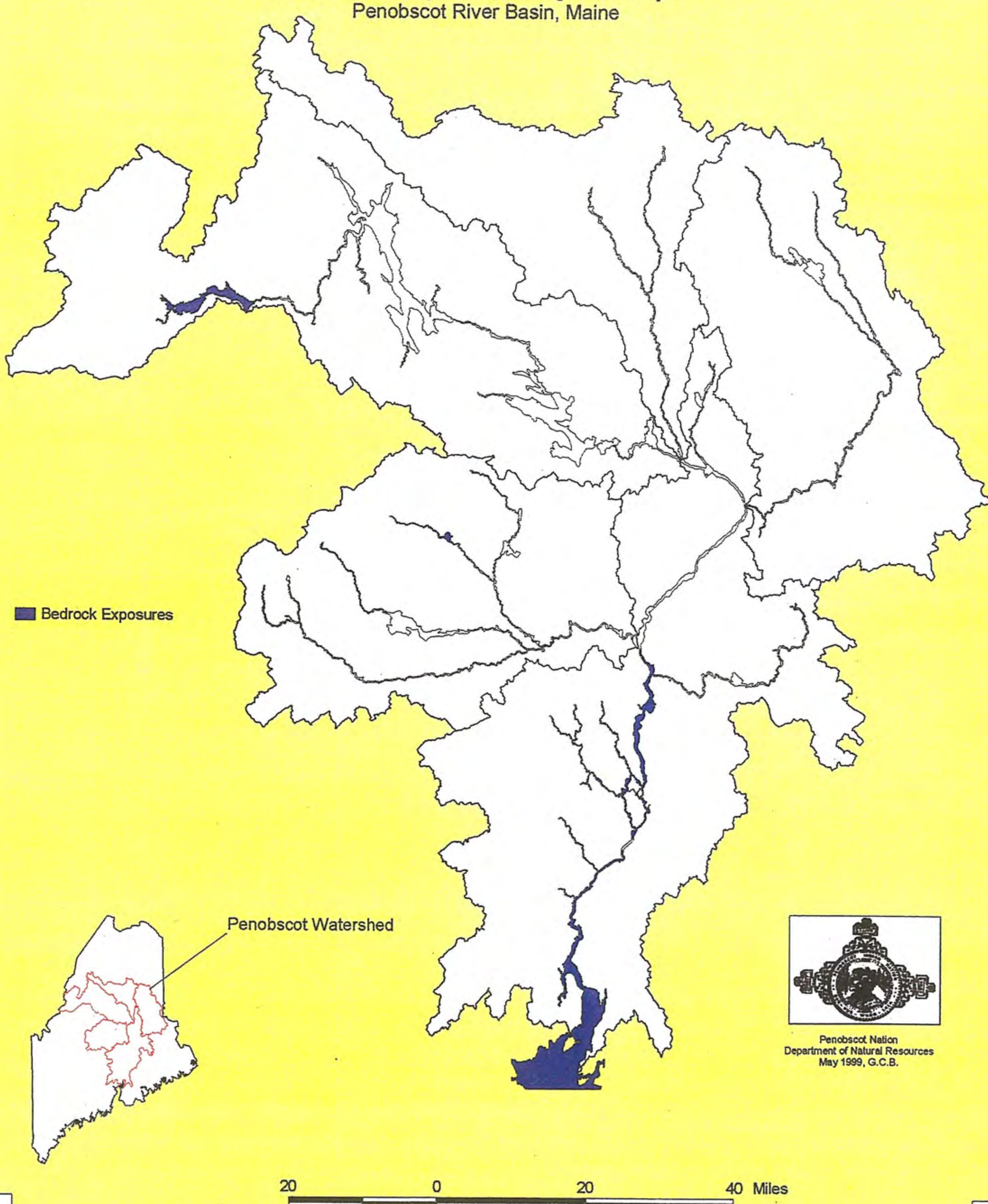
Map 14-D

Channel Geomorphology: Bedrock Exposures

This map shows where bedrock is exposed along the shores of some of the larger river channels within the Penobscot River Basin, or where the bedrock has only a thin cover of soil and vegetation. Nearly all of the major river channels within the lower Penobscot River Basin are characterized by the presence of exposed bedrock along their banks. Rocky shores characterize the tidal estuary and bay and some of the basin's headwaters. The word Penobscot is translated to mean, "at the place of the descending rocks" or "rocky place." Bedrock ledges often signify the presence of waterfalls, rapids, or modern-day dams.

Penobscot Basin Channel Geomorphology

Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine



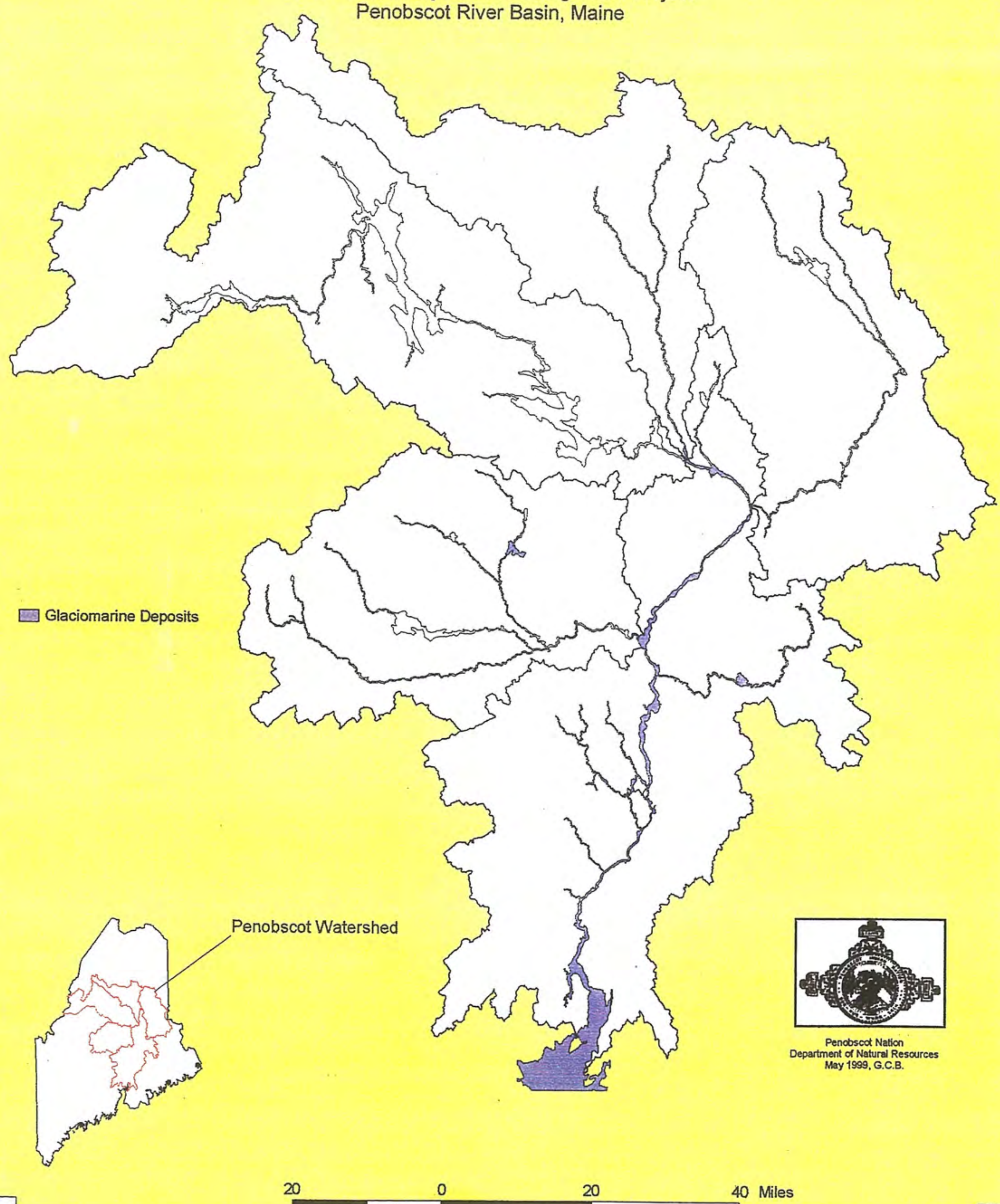
Map 14-E

Channel Geomorphology: Glaciomarine Deposits

Shown in light purple on this map are the locations of glaciomarine deposits that run along the banks of the major river channels in Penobscot River Basin. These "marine clays" are composed of glacial sediments that accumulated on the ocean floor approximately 10,000 years ago, after the late glacial marine submergence of lowland areas in southern and central Maine. In general, these deposits are composed of silt, clay and minor amounts of gravel. Commonly they are present as a clayey silt that is known as the "Presumpscot Formation." Sand is dominant in some places, but may be underlain by finer grained sediment. "Fossil" shells can be found in some of the deposits. The accumulation of marine clays within the Penobscot River Basin has a bearing on surface water drainage and contributes to the presence of many bogs and wetlands. Glaciomarine deposits extend upon the lowlands as far upstream as the confluence of the East and West Branch of the Penobscot River, and represent the furthest inland marine invasion in the state.

Penobscot Basin Channel Geomorphology

Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine



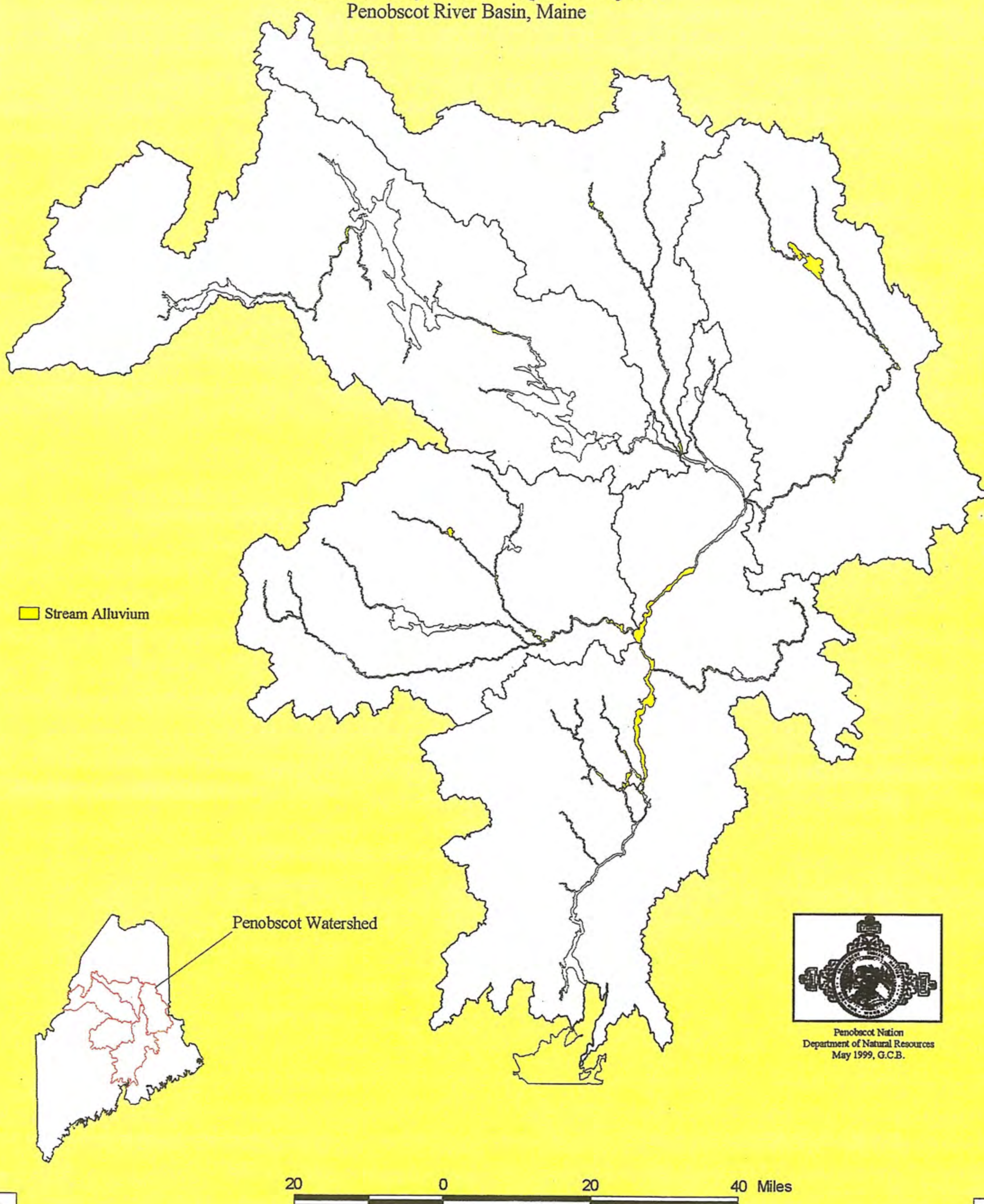
Map 14-F

Channel Geomorphology: Alluvial Deposits

Shown in yellow on this map are the locations of modern depositional environments, where sand, gravel, and silt are seasonally deposited on floodplains adjacent to the rivers. These deposits of stream alluvium are of great interest and importance to the tribe, as these are the floodplains that bear the spring crops of fiddlehead ferns, which are harvested for household and commercial use.

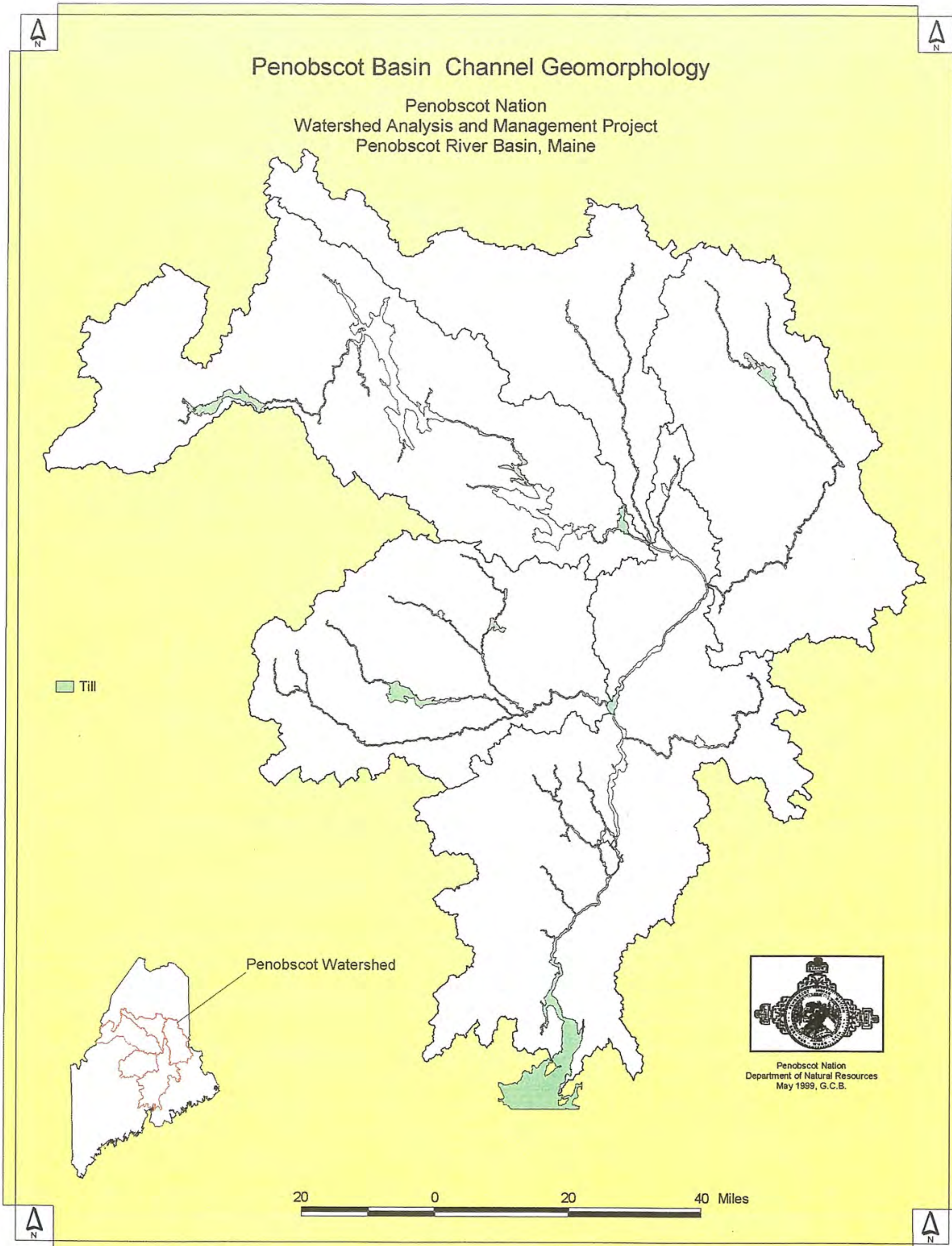
Penobscot Basin Channel Geomorphology

Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine



Penobscot Basin Channel Geomorphology

Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine



THE PENOBSCOT NATION
AND THE PENOBSCOT RIVER BASIN
A Watershed Analysis and Management (WAM) Pilot Project

Part III
TRIBAL VALUES

Here we introduce the values that guide Penobscot Nation management goals for the water resources of the Penobscot River. The protection of tribal cultural practices is the driving force for all Penobscot Nation water quality restoration efforts. These cultural practices represent the "beneficial uses" that can form the basis for drafting future tribal water quality standards.

Introduction
An examination of tribal values was a core component of the Penobscot Watershed Analysis and Management (WAM) project. The project's overall purpose is to set the stage for future Penobscot River restoration efforts and help create the framework for tribal water quality standards. It was important to capture an accurate description of tribal values and cultural practices in relation to water resources of the Penobscot Basin. These "beneficial uses" will form the basis for drafting water quality standards.

The WAM project as a whole stems from value statements made by the Penobscot Nation about important cultural practices within the Penobscot River, especially sustenance fishing. The use of the WAM framework to identify the tribe's beneficial uses of water resources allowed the Penobscot Nation to capture a broad range of tribal uses and values. The WAM emphasis on replicability and scientific defensibility strengthened this effort, and the use of an ecosystems perspective supported the tribe's holistic views.

Methods
We set out to characterize tribal beneficial uses of the water resources of the Penobscot River Basin by asking: "In what ways does the Penobscot Nation value or use the water resources of the Penobscot River Basin?" We chose to rely on existing documentation because much work has already been done on this topic by the tribe and also because of the limited scope allowed by project funds. We consulted written testimony and comment letters for permit and license proceedings. We examined comments in recent videos and oral histories. We reviewed the findings of a river user's survey and the findings of focus

groups. Based on our findings, we drafted a set of beneficial uses that were reviewed by staff and members of the tribal community. The list of beneficial uses that follows is still considered to be in draft form because it has yet to be approved by the Tribal Council.

In addition to characterizing contemporary cultural uses of water resources, we examined historical records to complement our inquiries on geology, fisheries, and water quality. We examined old documents and research to gain insight on watershed functions prior to dams and discharges. We identified surviving Penobscot place names for locations within the watershed and researched their meaning. We created G.I.S. maps of tribal lands to show their relationship to the water resources within the river basin.

Findings

A wealth of written and recorded statements document Penobscot practices in relation to the Penobscot River. We prepared a draft list of beneficial uses based on these sources. We were guided by a set of Tribal Environmental Goals that had been drafted earlier and approved by Tribal Council (Appendix A-1), along with written comments and recorded interviews (Appendix A-2 & 3).

I think that this river really is the backbone of who we are as a Nation.

Our name is derived from the description of the land here in this region. And the river that flows through it bears our name or we bear its name. And so then we would call ourselves Pana'wampskik."

We are people of that place.

- Jerry Pardilla
Former Tribal Governor

It is not easy to reduce the tribe's cultural practices to a simple list, because attitudes and feelings about the river and its condition are as important as the ways that the river is used. Written and taped statements by tribal members are an eloquent expression of the importance of the river to tribal culture and identity. The deep feeling of a personal relationship with the river and of being "one" with the river is repeated over and over again in the recorded interviews with tribal members. The importance of the tribe's cultural identification with the river and life within the river cannot be over-emphasized. When translating tribal cultural values into beneficial uses, one must guard the spiritual and emotional elements that are woven into these practices. Restoration of the Penobscot River ecosystem is not just a set of technical procedures, it is a profoundly personal and spiritually meaningful endeavor to the tribe.

Penobscot language place names persist for many landscape features within the Penobscot River Basin (Appendix A-4). We did not prepare a map to indicate the locations of tribal cultural practices. To do so would be misleading because tribal values and practices are not necessarily restricted in space and time, and they are not fully supported by natural resource conditions in the river basin at this time. The tribe's concerns about constraints to these cultural practices guided the characterization of water resources, fisheries, and geology that follows.

Draft Beneficial Uses

A draft list of tribal beneficial uses was developed based on careful examination of tribal cultural values and practices in relation to the water resources of the Penobscot River basin. Beneficial uses refer to the various ways that water resources of the Penobscot are used and valued by the Penobscot Nation. Beneficial uses can form the basis for drafting water quality standards. The list below is in draft form and will need to undergo extensive review by the tribal community before being finalized.

> *Every day I look at this water and know that my ancestors traveled this river... that the water provided the sustenance for my people...*
>
> – Alasko Glossian

Aquatic Foods and Medicines - Upholding traditional tribal practices of consuming aquatic plants and animals and carrying out treaty reserved sustenance fishing rights.

Aquatic Life Support – Maintaining a healthy aquatic ecosystem that supports sensitive indigenous species in all of their life cycles.

Swimming and Boating – Access to waters of sufficient quality for swimming and boating.

Drinking Water Supply – The use of surface waters and ground waters for present or future drinking water supplies.

Aesthetics – Enjoyment of waters free of objectionable odors, tastes, and appearances.

Cultural and Ceremonial Uses - Access to pure waters for cultural and ceremonial uses.

Wastewater - The present and future use of waters for discharging treated wastewater.

Hydropower - A potential future use.

There is strong tribal support for upholding tribal values that protect the integrity of the aquatic ecosystem, maintain cultural and spiritual practices related to the river, and guard aesthetic values. The tribe is strongly committed to guarding cultural uses of the river, not only as a source of sustenance foods and medicines and drinking water, but also for swimming and boating. We found that the tribe as a whole reluctantly acknowledges the necessity of continuing to use the river for discharge of the tribe's treated wastewaters, as well as the need to maintain the option of future hydropower development, although consensus has not been reached on these issues at this time.

Tribal Lands in Penobscot Basin

Penobscot Nation lands within the Penobscot River basin consist of the tribal reservation, tribal trust lands, and fee lands. The reservation begins at Indian Island in Old Town and extends north to include over 200 islands in the Penobscot River, and more than 6,000 acres. The tribal trust lands in the basin add up to approximately 41,000 acres.

The Penobscot River and islands represent a portion of the ancestral home of the Penobscot people with uninterrupted occupation by the tribe for thousands of years. Important burial and ceremonial sites are located upon these islands, which are generally forested and low-lying, with extensive floodplains and forested wetlands. Traditional activities take place on and around the islands, including hunting, fishing, trapping, gathering, boating, camping, sweat lodges, and ceremonies. Swimming has been an important activity in the past. The floodplains support an annual sustenance and commercial harvest of fiddlehead ferns. Indian Island is the seat of tribal government, and is the only island that is developed with permanent residences and an automobile bridge. The reservation begins approximately 15 miles upstream from tidal waters of Penobscot estuary, and then continues upstream for over 200 miles on all the major tributaries.

The five Penobscot tribal trust lands within the Penobscot River basin are located in Argyle, Lee, Mattamiscontis, Williamsburg, and Matagamon. The trust lands are used for fishing and hunting and other sustenance activities. Basket making materials are gathered at some of the trust lands, and fiddlehead ferns are harvested at some of the river banks in spring. Hiking, boating, and swimming also take place at Trust Land mountains, rivers, and lakes. Portions of the trust lands are managed for timber, pulpwood, and household firewood. Other areas are zoned for wildlife management, or as set-asides for spiritual and ceremonial purposes. Seasonal occupation of camps is the norm, and access is by unpaved roads.

The tribal trust land at Argyle is nearly 5,000 acres in size and lies close to Indian Island on the Birch Stream and Hemlock Stream tributaries of the Penobscot River. Wetlands abound and there is excellent habitat for deer, beaver, bear, partridge, and snowshoe hare. The small tribal trust land at Lee is just under 600 acres, on the East Branch of the Passadumkeag tributary of the Penobscot River. The land is flat to gently sloping with habitat for beaver, moose, deer and bear. The tribe conducts commercial timber and pulpwood harvests at Lee. The northernmost tribal trust land at Lake Matagamon is near the source of the East Branch of the Penobscot River. Just over 9,000 acres in size, this scenic, mountainous tract offers exceptional cold water fisheries and wildlife habitat for moose, deer and bear. Just under 23,000 acres, the trust land at Mattamiscontis Stream drains directly to the Penobscot River, with another large stream that drains to the Piscataquis River tributary. These streams are targeted for Atlantic salmon restoration efforts and there are three large lakes and one named mountain. The 4,400 acres of tribal trust lands at Williamsburg are located on the West Branch of the Pleasant River, which drains into the Penobscot by way of the Piscataquis River. This Trust Land provides significant coldwater fisheries in its streams and important Atlantic salmon habitat.

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THE PENOBSCOT NATION
AND THE PENOBSCOT RIVER BASIN
A Watershed Analysis and Management (WAM) Pilot Project

Part IV
WATER RESOURCE CONDITIONS

This section of the report characterizes current water resource conditions, introduces the project maps that were developed for Penobscot River Basin, and sets watershed restoration priorities. Hydrology, dams, discharges, monitoring sites, current water quality classifications are summarized, along with known impairments to tribal water resources, including fish consumption advisories.

Introduction

The Penobscot Nation used the watershed analysis and management (WAM) project in conjunction with the Unified Watershed Assessment (UWA) to better explain and communicate tribal water resource conditions and set watershed restoration priorities. We prepared maps and summaries of the surface waters, dams, discharges, monitoring sites, and current water quality classifications in Penobscot River Basin. This characterization of water resource conditions will be helpful for education and outreach purposes and will be useful for briefing partner agencies who want to work with the tribe on future Penobscot River ecosystem restoration projects.

Restoration of Penobscot River water quality is one of the top environmental goals for the Penobscot Nation. The Penobscot River has given life to the Penobscot people, and the tribe is committed to giving life back to the river. The tribe's water resources program has been established to restore, enhance, and protect the aquatic ecosystem of the Penobscot River. The tribe conducts water quality sampling at more than 80 sites on the Penobscot River and more than 30 sites on tributaries. The goals of the Penobscot Nation water quality program are to monitor the condition of tribal resources, ensure that water quality standards are being met and that licensed discharges are in compliance with permit conditions, gather data needed for the tribe's role in hydroelectric relicensing, identify sources of non-point source pollution, assess impacts of proposed regulations, and upgrade river classifications.

Centuries of logging, dams, and discharges, have had a pronounced impact on the condition of tribal water resources in the Penobscot River basin. Despite this history, the Penobscot remains home to the largest run of sea-run Atlantic salmon in the United States. Today, the tribe and the salmon share the river basin with five pulp and paper mills and over a dozen major hydro-electric projects. Episodic algae blooms, low dissolved oxygen levels, high water temperatures, and other water quality problems compromise the aquatic ecosystem and interfere with tribal sustenance and cultural traditions. Resident fish are contaminated and unsafe to eat and bald eagle reproduction is depressed due to high body burdens of toxic chemicals.

Methods

G.I.S. maps of water resource features and threats to water quality were developed from existing federal, state, and tribal data layers to portray Penobscot River Basin surface waters, drainage divides, federally licensed dams and point source discharges, current (state) water quality classifications, tribal water quality monitoring sites, and tribal lands. We relied on coverages from the U.S. Geological Survey (U.S.G.S.), U.S. Environmental Protection Agency (E.P.A.), Natural Resource Conservation Service (NRCS), Maine Office of G.I.S., Maine Geological Survey, Maine Department of Environmental Protection, and the Penobscot Nation Water Resources Program, and improved and modified them as we gained more accurate information.

Water Resource Conditions

Penobscot River Basin

The Penobscot River Basin is centrally located within the boundaries of the state of Maine and drains nearly one third of the state. The vast river basin encompasses approximately 8,550 square miles, extending north and south for about 150 miles and spanning east and west for about 120 miles. The river basin is divided into 5 major units or sub-drainages, with a combined total of 1,224 lakes, 188 named rivers and streams, and 7,127 river miles.

Broken down by subdrainage, the Lower Penobscot unit occupies 28% of the land area in the river basin, the Piscataquis unit occupies 17%, the Mattawamkeag unit occupies 17%, the West Branch unit occupies 25% of the land area, and the East Branch unit occupies 13%. Each of these sub-drainage units is described and assessed in more detail at the end of this section in terms of restoration priorities.

The Penobscot tribal reservation begins at the very center of the river basin and extends upriver into each of the 5 subdrainages, placing tribal water resources downstream from land use activities taking place across almost one third of the state of Maine. Land use within the river basin is predominantly industrial forestland and the populations within the river basin are centered in the cities and large towns in the lower part of the river.

Water Quality Classifications

The state of Maine has established water quality standards for the waters of the Penobscot River basin. Tribal water quality standards have not yet been established. The Penobscot Nation is an active player in the state's periodic review of these waterways for upgrades in classification. Maine lakes have one classification, GPA, the highest level of protection. Maine rivers and streams have four classifications, ranging from AA, the highest protected level, to C, the lowest. Classifications are based on levels of oxygen, bacteria, and the health of the aquatic community, measured using macro-invertebrates.

> **Class AA** – Highest Classification by Maine statute. No discharges allowed. In Penobscot basin these include the streams flowing from Mount Katahdin, along with other streams known to have outstanding value for fish and wildlife. Class AA waters shall be suitable for drinking water after disinfection. The habitat shall be characterized as free flowing and natural. The aquatic life, dissolved oxygen, and bacteria content shall be as naturally occurs.
>
> **Class A** – The second highest classification by Maine statute. The habitat shall be characterized as natural. Discharges allowed only if there is no change to water quality. The dissolved oxygen content shall not be less than 7 parts per million or 75% of saturation, whichever is higher.
>
> **Class B** – General Purpose Classification. Shall be suitable for drinking water supply after treatment, fishing, recreation in and on the water, and as habitat for fish and other aquatic life. The habitat shall be characterized as unimpaired. Dams and treated discharges are allowed on class B waters. Dissolved oxygen standards are the same as for Class A, except more stringent standards are in effect from Oct 1 to May 14 to ensure spawning and egg incubation of indigenous fish species. The 7-day mean dissolved oxygen concentration shall not be less than 9.5 part per million and the 1-day minimum dissolved oxygen concentration shall not be less than 8.0 parts per million in identified fish spawning areas. Between May 15 and Sept 30, the number of *Escherichia coli* bacteria of human origin in these waters may not exceed a geometric mean of 64 per 100 milliliters or an instantaneous level of 427 per 100 milliliters. Discharges to Class B waters shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.
>
> **Class C** – Commercial / Industrial Classification. Three segments of the Penobscot River are class C: from the Dolby Pond Impoundment to the Mattawamkeag River, from Lincoln Pulp and Paper to the West Enfield Dam, and within the City of Bangor. The tribe is concerned about the

designation of tribal waters as Class C which does not take into account tribal uses that require a higher level of water quality. The dissolved oxygen content of Class C water may not be less than 5 parts per million or 60% of saturation, whichever is higher, except that in identified salmonid spawning areas where water quality must be sufficient to ensure spawning, egg incubation, and survival of early life stages, water quality sufficient for these purposes. Seasonal E. coli of human origin may not exceed a geometric mean of 142 per 100 ml or an instantaneous level of 949 per 100 ml. Discharges to Class C waters may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

Point Source Discharges

NPDES refers to the National Pollutant Discharge Elimination System, required under the Clean Water Act. The federal permits issued under the NPDES program specify the types and amounts of pollutants that may be released to surface waters from municipal sewage systems and industries. Dischargers must secure permits and meet pretreatment standards to minimize the discharge of pollutants. The intent of the Clean Water Act (as indicated by the 'E' in NPDES) was to make discharge standards stricter as technology evolves, leading to eventual elimination of all pollutants from the nation's waterways.

The Penobscot Nation has been actively involved in the review and comment process for NPDES facilities on the Penobscot River since 1995. Most of the 17 major permits in the basin have been subject to review during this time. Some modest improvements to the discharges have been made during this time. Because the State of Maine does not have NPDES delegation authority, a state discharge license is also required of dischargers. The Penobscot Nation has also been involved in reviewing and commenting on some of the state license proceedings as well.

Public and private facilities discharge 150 million gallons of wastewater a day to the Penobscot River basin, equivalent to approximately 2% of the river's average daily outflow. Major discharges release more than one million gallons of wastewater a day or have the potential to release toxic contaminants in toxic amounts. Six major dischargers discharge directly to reservation waters: Great Northern paper mill at Millinocket, Great Northern Paper mill at East Millinocket, Lincoln Pulp and Paper at Lincoln, and the cities of Millinocket and Lincoln and Guilford-Sangerville (treatment plants). Some of the known constituents of Penobscot River discharges include suspended solids, heat, oxygen depleting substances, chlorinated organics, chromium, copper, dioxin, lead, mercury, phenols, vanadium, and zinc. Minor dischargers number more than 40 and include the tribe's treatment plant. The Penobscot Nation has requested that the

U.S. EPA add the following language to all NPDES Permits issued for Penobscot River Basin:

> *EPA has a trust responsibility to protect the natural resources of federally recognized tribes. Consistent with this trust responsibility, the EPA has an obligation to consult with tribes regarding potential impacts of NPDES discharges to tribal resources. In addition, EPA's trust responsibility requires the Agency, consistent with its Indian Policy, to ensure that NPDES permits are protective of tribal resources and that licensed discharges do not have adverse impacts on tribal uses of these resources for hunting, fishing, gathering, and other cultural practices.*

Dams

Approximately 116 dams are in place within the Penobscot River Basin (FERC, 1997). These dams and other impoundments have a total usable storage capacity of 1,570,000 acre-feet, over 80% of which are located in the drainage of the West Branch of the Penobscot River (Army Corps of Engineers, 1990). Six major hydroelectric power developments are located on the lower Penobscot River. Other dams and impoundments are used for local power generation or water-level control and are "run of the river" structures.

A few of the smaller dams have recently been removed, including the removal of a dam on the Souadabscook Stream in 1998. Fourteen dams in the river basin are major hydropower projects and the generally poor condition of their fish passage facilities is ranked in the Fisheries section of this report. Penobscot Nation and its partners have classified the Penobscot River dams as Class One through Three in terms of restoration priority.

Tribal Water Quality Monitoring Sites

The tribe conducts general ambient water quality sampling at more than 80 sites on the Penobscot River and more than 30 on tributaries. Parameters sampled include temperature, dissolved oxygen, biological oxygen demand (BOD), bacteria (E. coli), color, total suspended solids, turbidity, secchi disk, foam, and conductivity. Other Penobscot Nation water quality monitoring projects include algae and nutrient studies, biomonitoring using benthic macroinvertebrates, continuous temperature monitoring, G.I.S. mapping, toxics studies, and waste load allocation studies. Contaminants such as dioxins, furans, PCBs, heavy metals, chlorinated phenols and AOX have been examined in fish, turtle, muskrat, fiddleheads, freshwater mussels, and sediments.

Fish Consumption Advisories

Fish consumption advisories are currently posted for dioxin and co-planar PCBs for the lower Penobscot River and Penobscot Bay. Mercury consumption advisories are in place for all Maine waters. Dioxin was first detected in Maine in 1984 as part of a national dioxin survey by the U.S. Environmental Protection Agency. By 1987 there was a health advisory in effect on the Penobscot River. A 1988 study of paper mills by EPA found levels of 32 ppq of dioxin associated with Lincoln Pulp and Paper (discharging to Penobscot River). From 1988 to the present, the Maine Dioxin Monitoring Program and the Penobscot Nation have been monitoring dioxin levels in fish tissues of the Penobscot River. State health advisories regarding dioxin in Penobscot River fish have been updated periodically and co-planar PCBs were added to the advisory in the late 1990s. An advisory for lobster tomalley in Penobscot Bay has also been in effect.

Tissues of smallmouth bass and white suckers analyzed for dioxin and co-planar PCBs in South Lincoln (approximately 4 miles downstream from Lincoln Pulp and Paper Company's bleached kraft mill) in Milford (34 miles downstream of the Lincoln draft mill), and in Veazie (7-8 miles below Ford James' bleached kraft mill in Old Town) were found to exceed the Fish Tissue Action Levels for human consumption.

Water Resource Conditions by Sub-Drainage

West Branch Penobscot River

This watershed contains the largest privately owned hydroelectric complex in the country and is heavily manipulated for hydropower generations. The watershed unit also receives wastewater from two pulp and paper mills and two municipalities. Portions of this watershed unit are listed on the Maine 303(d) list as waters not attaining water quality standards. Segments of the unit do not attain the bacteria standards of its classification because of untreated residential wastewater. Also a 4-mile segment of the West Branch does not attain aquatic life standards because it has been dewatered for hydro-electric power generation. Another segment does not attain dissolved oxygen standards due to the discharge of industrial wastewater from a pulp mill and an impoundment used for hydroelectric power generation. Several lakes, created by the numerous hydroelectric dams, located within this unit are in non-attainment or are threatened. The lakes are considered to be impaired because of organic enrichment, dissolved oxygen problems, habitat alterations from hydro-modification, and vulnerability.

Extensive and intensive water quality monitoring by Penobscot Nation further substantiates non-attainment documented by the Maine Department of Environmental Protection and also identifies additional water quality degradation. Tribal data indicate significant algal blooms that originate within the lower West

Branch also affect the main Penobscot River unit. Ongoing monitoring efforts are attempting to identify the factors causing the blooms including licensed wastewater discharges from pulp and paper mills and a municipal wastewater treatment plant, non-point source runoff, or other sources of nutrient enrichment.

At present, a heavily manipulated channel and multiple dams impede traditional travel routes into the West Branch and have cut off vital spawning habitat for Atlantic salmon and other anadromous fish. Flooding by dams, lumbering, river driving and modern pulp cutting have had an impact on the cultural remains left behind by the Penobscots. Effluent from two large pulp and paper mills and one municipal treatment plant discharge pollutants that must travel through the entire Penobscot watershed and to the sea. The presence of fish consumption advisories and the loss of sustainable populations of native, historical species prevent tribal members from exercising their rights to catch and consume fish for sustenance.

The West Branch sub-drainage is not attaining the standard of fishable due to a health advisory for mercury. Also, bald eagles tested from Dolby Pond showed the highest concentrations of mercury in eagles within Maine. The source of much of the mercury throughout Maine is by way of atmospheric deposition. However, the mercury in the West Branch is thought to be a historical discharge from the paper and saw mills where mercury was once used as a slimicide and fungicide. Also, the extreme water level fluctuations at impoundments used for hydroelectric power generation in the West Branch are thought to have increased methyllation and hence bioaccumulation rates of mercury in the West Branch.

Present Water Quality Classifications- West Branch

(1) West Branch of the Penobscot River, main stem.

(a) From the dam at the outlet of Seboomook Lake to a point located 1,000 feet downstream from the dam at the outlet of Seboomook Lake - Class B.

(b) From a point located 1,000 feet downstream from the dam at the outlet of Seboomook Lake to its confluence with Chesuncook Lake - Class A.

(b-1) From its confluence with Chesuncook Lake to Ripogenus Dam - Class GPA as modified by section 464, subsection 9.

(c) From Ripogenus Dam through Ripogenus Gorge to the McKay powerhouse - Class B.

(d) From the McKay powerhouse to its confluence with Ambajejus Lake - Class A.

(e) From the outlet of Elbow Lake to the outlet of Ferguson and Quakish Lakes - Class B.

(f) From the outlet of Ferguson and Quakish Lakes to its confluence with the East Branch of the Penobscot River, including all impoundments - Class C.

(2) West Branch of the Penobscot River, tributaries - Class A unless otherwise specified.

(a) Those segments of any tributary that are within the boundaries of Baxter State Park - Class AA.

(b) Those tributaries above the confluence with the Debsconeag Deadwater, any portion of which is located within the boundaries of Baxter State Park - Class AA.

(c) Millinocket Stream, from the railroad bridge near the Millinocket-T.3 Indian Purchase boundary to its confluence with the West Branch Canal - Class B.

(d) Millinocket Stream from the confluence of the West Branch Canal to its confluence with the West Branch of the Penobscot River - Class C. [1999, c. 277, §10 (amd).]

East Branch Penobscot River

Water quality within the East Branch unit is attaining state of Maine water quality standards. However, fish consumption advisories exist within this unit due to high levels of mercury in tissues of some fish species. Water quality is threatened in the pristine Grand Lake Matagamon due to nonpoint source pollution from silvicultural activities and from seasonal camps. Aerial photographs identify extensive wood harvesting operations within the East Branch watershed unit. Heavy cutting and associated haul roads are known to be a major contributor of non-point source sediment loading.

(1) East Branch of the Penobscot River, main stem.

(a) Above its confluence with Grand Lake Matagamon - Class A.

(b) From the dam at the outlet of Grand Lake Matagamon to a point located 1,000 feet downstream from the dam - Class A.

(c) From a point located 1,000 feet downstream from the dam at the outlet of Grand Lake Matagamon to its confluence with the West Branch - Class AA.

(2) East Branch of the Penobscot River, tributaries - Class A unless otherwise specified.

(a) All tributaries, any portion of which is located within the boundaries of Baxter State Park - Class AA.

(b) Sawtelle Brook, from a point located 1,000 feet downstream from the dam at the outlet of Sawtelle Deadwater to its confluence with the Seboeis River - Class AA.

(c) Seboeis River, from the outlet of Snowshoe Lake to its confluence with the East Branch - Class AA.

(d) Wassataquoik Stream, from the boundary of Baxter State Park to its confluence with the East Branch - Class AA.

(e) Webster Brook, from a point located 1,000 feet downstream from the dam at the outlet of Telos Lake to its confluence with Webster Lake - Class AA. [1989, c. 764, §7 (rpr).]

Mattawamkeag River

The lower most segment of this unit does not attain water quality standards for bacteria due to the presence of untreated wastes. Fish consumption advisories exist within the unit due to high levels of mercury in tissues of some fish species.

Present Water Quality Classifications – Mattawamkeag

(1) Mattawamkeag River, main stem.

(a) From the confluence of the East Branch and the West Branch to the Kingman-Mattawamkeag boundary - Class A.

(b) From the Kingman-Mattawamkeag boundary to its confluence with the Penobscot River - Class AA.

(2) Mattawamkeag River, tributaries - Class A unless otherwise specified.

(a) East Branch Mattawamkeag River above Red Bridge - Class B.

(b) West Branch Mattawamkeag River from Interstate 95 to its confluence with Mattawamkeag Lake - Class B.

(c) Fish Stream - Class B. [1999, c. 277, §11 (amd).]

Piscataquis River

The Piscataquis unit is affected by non-point sources from forestry and agricultural operations. Ninety percent of the area is forested, and an estimated 180 harvesting operations are conducted each year in this watershed. Erosion in or near poorly constructed haul roads, skid trails, and stream crossings contributes sediments to the river thereby increasing the turbidity and silt deposits in the gravely sections of the river. Water quality monitoring, particularly during spring run-off and after storm events, has documented significant turbidity and suspended solids within the river.

The watershed is also subject to agricultural runoffs. More than a dozen livestock farms have no manure storage facilities. Runoff from these sites contributes significantly to the nutrient loading of the watershed. More than 2,000 acres of cropland adjacent to surface waters are highly erodible. Some soils have very coarse texture leading to excessive leaching into ground water. According to Maine 305(b) assessment reports a segment of the Piscataquis River is considered to be in non-attainment of bacteria standards due to untreated wastes from combined sewer overflows. The Piscataquis unit receives treated wastewater from two municipal treatment plants. Excessive macrophyte and algae growth downstream of one of the plants suggests the need for additional treatment controls at the facility. Likewise, low dissolved oxygen levels have been measured in impoundments downstream of the plant. Fish consumption advisories exist within the unit due to high levels of mercury in tissues of some fish species.

Water quality monitoring conducted by Penobscot Nation and a 1998 Waste Load Allocation study by Maine DEP indicate portions of the Piscataquis River between Guilford and Milo are not attaining dissolved oxygen standards. River segments adjacent and below several agriculture areas were greatly impaired by excessive periphytic and metaphytic algae from nutrient runoff. Die-off of algae resulted in odor problems adjacent to the segments. The source of the impairment can be clearly attributed to specific agricultural operations.

Present Water Quality Classifications - Piscataquis.

(1) Piscataquis River, main stem.

(a) From the confluence of the East Branch and the West Branch to the Route 15 bridge in Guilford - Class A.

(b) From the Route 15 bridge in Guilford to the Maine Central Railroad bridge in Dover-Foxcroft - Class B.

(c) From the Maine Central Railroad bridge in Dover-Foxcroft to its confluence with the Penobscot River - Class B.

(2) Piscataquis River, tributaries - Class B unless otherwise specified.

(a) Except as otherwise provided, East and West Branches of the Piscataquis River and their tributaries above their confluence near Blanchard - Class A.

(b) East Branch of the Piscataquis River from 1,000 feet below Shirley Pond to its confluence with the West Branch - Class AA.

(c) Pleasant River, East Branch and its tributaries - Class A.

(d) Pleasant River, West Branch, from the outlet of Fourth West Branch Pond to its confluence with the East Branch - Class AA.

(e) Pleasant River, West Branch tributaries - Class A.

(f) Sebec River and its tributaries above Route 6 in Milo - Class A.

(g) West Branch of the Piscataquis River from 1,000 feet below West Shirley Bog to its confluence with the East Branch - Class AA.

(h) Black Stream - Class A.

(i) Cold Stream - Class A.

(j) Kingsbury Stream - Class A.

(k) Schoodic Stream - Class A.

(l) Scutaze Stream - Class A.

(m) Sebois Stream, including East and West Branches - Class A. [1999, c. 277, §11 (amd).]

Lower Penobscot River

Because the lower stretches of the Penobscot River receive water from all the above-mentioned units and because it is the highest order segment of the watershed, it has the most degraded water quality. Most of the Penobscot River unit (56 miles) is not attaining its designated use of fish consumption due to dioxins and furans present in fish tissues. The source of the dioxin and furan contamination is from two kraft pulp and paper mills that discharge into the river. Additionally, co-planar PCBs and mercury have been identified at unsafe levels in fish tissues. The extent and role of fine grain sediments in contaminant levels is the focus of current studies by the U.S. Geological Survey, the Environmental Protection Agency, and the Bureau of Indian Affairs.

HoltraChem, a chlor-alkali plant located in the lower Penobscot River, is the largest source of mercury in Maine. Sediments located downstream of the plant contain the highest concentration of mercury in Maine and possibly the country. The plant, which was just closed in 2000, has been licensed to discharge up to five pounds of mercury directly to the Penobscot River per year and was permitted to release hundreds of pounds of mercury to the air each year.

According to Maine 305(b) reports and Penobscot Nation data, several segments of the Penobscot River watershed do not attain bacteria standards due to discharges of untreated residential and municipal combined sewage overflow wastes. Several tributaries to the Penobscot River do not attain water quality standards for dissolved oxygen because of agricultural activities.

The biological integrity of the Penobscot River has been greatly degraded. Segments of the river which were at one time free-flowing are now impounded by several dams. The dams impede upstream and downstream migration of anadromous fish including Atlantic salmon, shad, alewives and eels because of inadequate fish passage.

There exists concern regarding thermal loading from throughout the entire Penobscot River watershed (including tributaries) and the migration and resting behaviors of mature adult salmon while returning to spawning grounds. During average and warm summers, the lower Penobscot River regularly reaches temperatures that approach or exceed the lethal tolerance of the species. There is a strong likelihood that some adult salmon succumb to lethal or sub-lethal effects of lower Penobscot water temperatures during most summers. Although most of the deaths are likely never documented, there have been at least two cases where salmon mortalities have been documented and attributed to lethal water temperatures. The sources of human induced warming originate from at least four areas: logging practices that change surface runoff and groundwater hydrology, additions of color from paper mill effluents which increase absorption of energy from the sun, impoundment of free-flowing reaches for hydropower discharge, and point source thermal discharges.

Sampling conducted by Penobscot Nation indicates that the diversity of aquatic insects within the river may also be negatively affected by impoundments. Diversity of aquatic insect life was greater between free-flowing river segments than between impounded sites.

It has also been determined that threatened bald eagles are impaired by discharges within the Penobscot River. The U.S. Fish and Wildlife Service determined that the reproductive rates of bald eagles have been and will continue to be impaired by the discharge of dioxin and furans from one of the pulp and paper mills located on the river.

(1) From the confluence of the East Branch and the West Branch to the confluence of the Mattawamkeag River, including all impoundments - Class C.

(2) From the confluence of the Mattawamkeag River to the confluence of Cambolasse Stream - Class B.

(3) From the confluence of Cambolasse Stream to a point 1.0 mile above the West Enfield Dam - Class B.

(4) From a point 1.0 mile above the West Enfield Dam to the West Enfield Dam - Class C.

(5) From the West Enfield Dam, including the Stillwater Branch, to the Veazie Dam, including all impoundments - Class B.

(6) From the Veazie Dam, but not including the Veazie Dam, to the Maine Central Railroad bridge in Bangor-Brewer - Class B. Further, the Legislature finds that the free-flowing habitat of this river segment provides irreplaceable social and economic benefits and that this use must be maintained.

(7) From the Maine Central Railroad bridge in Bangor to a line extended in an east-west direction from the confluence of Reeds Brook in Hampden - Class B. Further, the Legislature Finds that the free-flowing habitat of this river segment provides irreplaceable social and economic benefits and that this use must be maintained. [1999, c. 277, §9 (rpr).]

Penobscot River, minor tributaries - Class B unless otherwise specified.

(1) Cambolasse Stream (Lincoln) below the Route 2 bridge - Class C.

(2) Great Works Stream (Bradley) and its tributaries above the Route 178 bridge - Class A.

(3) Kenduskeag Stream (Bangor) below the Bullseye Bridge - Class C.

(4) Mattanawcook Stream (Lincoln) below the outlet of Mattanawcook Pond - Class C.

(5) Olamon Stream and its tributaries above the bridge on Horseback Road - Class A.

(6) Passadumkeag River and its tributaries - Class A, unless otherwise specified.

(a) Passadumkeag River from the Pumpkinhill Dam to its confluence with the Penobscot River - Class AA.

(b) Ayers Brook - Class AA.

(7) Souadabscook Stream above head of tide - Class AA.

(8) Sunkhaze Stream and its tributaries - Class AA.

(9) Birch Stream - Class A.

(10) Hemlock Stream - Class A.

(11) Mattamiscontis Stream - Class A.

(12) Medunkeunk Stream - Class A.

(13) Rockabema Stream - Class A.

(14) Salmon Stream - Class A. [1999, c. 277, §11 (amd).]

[1999, c. 277, §§9-11 (amd).]

Results

Water resource conditions and threats to water quality are now comprehensively mapped by the tribe. A digitized base map of the Penobscot River Basin was developed to showing sub-drainages, tribal lands, and water resource features. Samples of these maps are displayed in Part II of this report. The preparation of these maps will make it much easier to investigate cause and effect relationships and understand links within the ecosystem. This written summary of watershed features and water resource conditions was prepared to provide an overview of the surface waters and sub-drainages of the river basin, current fish consumption advisories for dioxin, PCBs, and mercury, the designated water quality classifications, tribal water quality monitoring sites, major and minor dams, and point source discharges

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THE PENOBSCOT NATION
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Part V
MIGRATORY FISHERIES

The Penobscot Nation used the watershed analysis and management project to highlight key issues for tribal resources in the Penobscot River basin. This section of the report describes the condition of Atlantic salmon and other migratory fish species, and summarizes available information on range, potential production habitat, and the adequacy of fish passage at hydropower dams.

Introduction
The fisheries of the Penobscot River are vitally important to the Penobscot Nation. The Penobscot River basin continues to provide the largest and most important habitat for Atlantic salmon in the United States. The tribe is committed to restoring self-sustaining runs of salmon and other migratory species. This section of the report addresses the physical requirements that affect migratory habitat, range, and access within the river basin. The water quality section of this report summarizes the chemical parameters that also have a bearing on habitat quality and the safety of fish consumption.

Methods
Information was compiled on population trends, available habitat, and access for Atlantic salmon, American Shad, alewife, blueback herring, and American eel from published reports, and was updated or expanded with the knowledge of the Penobscot Nation Fisheries Manager. The current status of the Penobscot River Atlantic salmon population was obtained from the Atlantic Salmon Federation. Habitat needs were compiled from a variety of published sources. Maps of potential production habitat were developed using existing published information, and were updated and revised based on queries to the Maine Department of Marine Resources. Anadromous fish passage facilities at 14 hydropower dams in the Penobscot River basin were summarized. Known and suspected problems were noted with respect to upstream and downstream fish passage, based on licensing documents and site-specific observations.

Fish Passage at Dams

The most significant obstacle for migratory fish species in the Penobscot River Basin is the Veazie Dam, because it lies closest to the sea and contains the entire freshwater portion of the Penobscot River. All migratory fish in the Penobscot River Basin must pass Veazie on their journey upstream and downstream. Improvements to this fish passage would make a dramatic difference for Atlantic salmon, shad and alewife, and eels. Removal of this dam would allow restoration of Atlantic sturgeon, short nosed sturgeon, Atlantic tomcod, rainbow smelt, and striped bass. In our ranking of Penobscot River Basin dams by restoration priority, we rank Veazie Dam as a the *Class One* priority dam.

In addition to the Veazie Project, there are five other large hydro-electric projects on the lower Penobscot that are significant for migratory fish restoration: Great Works, Milford, Howland, West Enfield, and Mattaseunk. These are *Class Two* priority dams. Improvements to fish passage at these dams would make a significant difference for the restoration of Atlantic salmon, shad, alewife, and eels.

Dams on major tributaries of the Penobscot River within active fish migratory zones are *Class Three* priorities in the basin. The three dams along the Piscataquis (Lower Dover Dam, Upper Dover Dam, and Guilford Dam) are among the most important of these. They affect passage of Atlantic Salmon to high quality spawning grounds upstream. In addition, three dams located on the Stillwater River, a side channel of the lower Penobscot in Orono and Old Town, have no fishways. However, fish may bypass those dams by remaining in the mainstem Penobscot River.

In a class by themselves, with undetermined priority, are the major complex of hydro-electric dams on the West Branch where no fishways are in place and none are presently planned. Prior to dam construction, several of the migratory species used this sub-basin. Other dams in the Basin include those used for local power generation or water-level control. There may be restoration potential at many of these small dams.

Atlantic Salmon

After a resurgence in Atlantic salmon populations in Maine rivers 20 years ago, there has been a sharp decline for the past 15 years. The average run of Penobscot River salmon in the 1980s was 3,000 individuals. In 1999, less than 1,000 adults returned to the Penobscot, and this year's return of only 500 adults as of August 22, 2000 is the smallest run recorded since 1973 (Watts, 2000). Last year, 37 adult Atlantic salmon were found dead in the trash racks of the Veazie Dam. The exact cause of death could not be determined, but Maine Atlantic Salmon Commission staff have suggested that high water temperatures in the river between Veazie and Great Works dam and fish passage delays are possible causes or contributing factors (Watts, 2000). The Penobscot is home to approximately two thirds of the total U.S. population and restoration efforts on many other New England rivers rely on eggs from sea-run adult salmon taken from the Penobscot River (Watts, 2000). Present day adverse impacts of human origin on spawning habitat and spawning potential for salmon in the Penobscot drainage are summarized below, along with other problems with potential impacts on all life stages.

Access

Upstream access to many of the prime production reaches is diminished or blocked by dams with inadequate or non-existent fish passage facilities. Added to this is the sheer number of dams that salmon must pass to reach prime spawning grounds in the headwaters of the river basin. Salmon must pass at least four major dams, and possibly as many as seven, to reach these prime production areas. Even with the best available technology, no artificial fish passages are completely effective. Salmon encounter fish passage that is poor to very poor at the first 3 dams in the Penobscot, and must pass at least 2 more dams after that to reach prime spawning grounds.

Compounding the problems facing salmon restoration efforts is the lack of effective downstream fish passage facilities at these dams, which cumulatively and substantially impact smolt survival during out-migration to the ocean. Finally, the presence of large number of native (e.g. cormorants) and introduced (e.g. smallmouth bass) predators, in combination with the enhanced predatory environments created by the hydropower impoundments and dams, represents yet another difficult obstacle to tribal and agency restoration efforts.

Inundated Spawning Habitat

The damming of the Penobscot River and its tributaries has inundated former spawning habitats, causing them to be unsuitable.

Siltation of Spawning Gravels

Non-point source pollution within the watershed is also a factor. In this case, the runoff from logging and road building operations in the watershed, and in some cases, artificial flow regulation can cause minor siltation of intragravel spaces, or can cause gravels to become "embedded" in silt. The minor accumulations can cause increased fungal infection of eggs or can diminish the flow of water and oxygen through the redd. Gravel that is severely embedded in silt becomes as hard as concrete, preventing the redd from being dug.

Point Source Pollution

Based on studies of other salmonids, there is potential for decreased viability or increased rates of developmental defects for eggs or alevins incubating in areas below known point source contaminants such as dioxin or PCBs, although the issue needs more study in relation to Atlantic salmon.

Unavailability of the West Branch
The continued unavailability of the West Branch Penobscot (one fourth of the Penobscot River basin) for Atlantic salmon production represents a continuing adverse impact to salmon restoration potential. Historically this portion of the drainage was part of the historical range of the sea-run salmon, prior to the construction of dams.

Water Temperatures
The lower Penobscot River, and especially the waters between Milford Dam and the estuary, regularly reach temperatures that exceed tolerances for adult Atlantic salmon. Numerous adults accumulate each year at the mouths of cooler tributaries and hold there for extended periods to avoid lethal conditions in the river. This behavior has become so prevalent that in 1997 the state was forced to adopt extremely restrictive fishing regulations for some stream mouth areas.

Human induced warming of the river may originate from a combination of logging practices, impoundment of free-flowing reaches, point source thermal discharges, and the discharge of colored substances that increase the absorption of infrared energy from the sun. Without detailed modeling it is not known how much each individual thermal discharge contributes to the problem.

> *My grandfather used to tell us of the time when the river would literally boil from bank to bank as the numbers of salmon were so great in running the Penobscot each spring. The islands would be havens for them as they tired in their journey upriver.*
>
> \- Jim Sappier

Habitat Needs
During the freshwater stages of the Atlantic salmon's life history, two distinct types of habitat are critical to self-sustaining populations. These are the adult spawning habitat and juvenile nursery habitat. Both are fairly well defined in terms of physical character. In addition, but not as well defined or understood, is adult resting and holding habitat, used by mature adults between the time they enter the river and the time they arrive at

their spawning destination. The environments through which seaward-migrating smolts and upstream migrating mature adults must travel can be loosely thought of as "habitat needs," and a number of biotic and abiotic factors can impact survival and successful migration.

By far the scarcest in quantity and the most vulnerable to degradation is the habitat that adult salmon need to successfully spawn. Typical characteristics of a preferred spawning ground are substrates composed of gravel 0.5-4.0 inches in diameter, water depths of 10-30 inches, and moderate current velocities (1-3 ft/sec). Areas with suitable substrate, depth and velocity, and where depth is gradually decreasing and velocity gradually increasing, such as the tail of a pool, or the head of a riffle, are considered ideal. These physical factors help assure adequate flow and oxygen in the intragravel spaces, which is important to survival of the eggs.

Range and Potential Production Habitat

While there is some spawning and production potential in virtually all but the lowest gradient reaches of the drainage, the quality level varies widely. It is generally believed that the highest quality production habitat today is located in the East Branch sub-drainage (above Grindstone), the Piscataquis River (above Guilford) and the Pleasant River (a tributary to the Piscataquis at Milo), and the Mattawamkeag River sub-drainage (above Haynesville). In total, these reaches account for at least three quarters of the prime production habitat currently available for these species.

The East Branch contains about 16% in area of all the potential wild juvenile and smolt production habitat in the drainage. But because of its extremely high habitat quality it represents about 27% of potential wild smolt production. In recent years, up to 100 adults have been counted migrating upstream through the fishway at Weldon Dam (part of the Mattaceunk Hydropower Project, located below the confluence of the east and West branches, nearly all of which are destined for natural spawning in the East Branch. Numbers of adults arriving at Weldon are expected to increase as the restoration program advances.

We prepared a map to indicate the portions of the river basin where spawning habitat has been identified (Map 9. Penobscot Basin Atlantic Salmon). Information on specific location of significant spawning areas is dependent on the recollection of field biologists who have traveled given reaches, and is subject to individual observer bias. Existing piecemeal surveys are fairly outdated and are unlikely to have been conducted under standardized methods to reduce observer bias. We relied heavily on Cutting (1963), and filled in gaps with work by Baum (1983), Baum et al. (1988), Dube (1987), Atlantic Sea-Run Salmon Commission (1988, 1989, 1990), Spencer (1995), and the personal observations of our Penobscot Nation Fisheries Manager (Fay, 1999). Three major factors determine the value of the spawning habitat and its suitability for salmon restoration and management activities: amount, quality, and accessibility. We did not indicate these values on the general map that we prepared.

American Shad, Alewife, and Blueback Herring

American shad, alewife, and blueback herring are native migratory species of the family "Clupeidae" (the "herrings"). While similar in general appearance and life cycle, shad are much larger than alewife and blueback herring, averaging 4 or 5 pounds as adults, and are the more difficult of the species to restore in the presence of numerous dams. All three species were historically very abundant, with annual runs on the order of one to several million per species.

Shad

Prior to the arrival of European settlers, the Penobscots and other tribes in the region utilized shad heavily for subsistence, harvesting them during their migration from a wide region of the basin. Archaeological evidence and historical state fishery agency records show that shad often migrated as far as 120 miles upstream from tidewater, into the East and West branches, upper Piscataquis, and Mattawamkeag rivers, to spawn. By the 1820s, annual commercial fishery landings of shad from the tidal portion of the Penobscot often approached or exceeded the 2 million mark. However, shad populations quickly diminished, and nearly disappeared entirely, shortly after the construction of the first three lower river dams at Milford (1830), Great Works, and Veazie (1835). The present status of shad in the Penobscot is uncertain, but current populations are probably "left-over" at best (perhaps on the order of several thousand), and are restricted to the river below Veazie Dam.

Historically, shad provided for a substantial commercial fishery in Penobscot drainages. Prior to the construction of two major dams on the lower river in the 1830s, shad were documented to migrate as far upstream as Wassataquoik Stream on the East Branch, Monson Junction and Silver Lake on the Piscataquis River, Grand Falls on the Passadumkeag River, and Mattawamkeag Lake on the Mattawamkeag River. Their range also extended into the West Branch, at least to Shad Pond, prior to construction of dams in that sub-basin. Currently, the size of the shad population in the Penobscot is unknown, but is likely in the several thousand fish range at best, and is restricted to the short river segment below the first dam in Veazie. Shad are not as strong swimmers as salmon and have difficulty using "standard" salmon fishways, such as those currently available at most lower river dams.

In the Penobscot River basin, the production potential for adult shad is estimated at 1.5 million, based on average production values from other similar rivers with sustained runs (Penobscot River American Shad Working Group, 2000; Flagg 1984). We have prepared a map indicating potential shad production habitat, based on existing sources (Map 10. Penobscot Basin American Shad).

Until recently, there have been no active shad restoration efforts in the Penobscot basin. However, pursuant to a 1995 Cooperative Planning Agreement between the Penobscot Nation, the State Departments of Marine Resources and Inland Fisheries and Wildlife, and the U. S. Fish and Wildlife Service, the "Penobscot River American Shad Working Group" prepared a Strategic Plan for the active restoration of shad. The signatories have approved this plan, and next steps include the preparation and implementation of an operational plan. Key components to active restoration include substantially improved fish passage at lower river dams, and a commitment of resources toward developing a hatchery stock for "seeding" upriver habitat reaches while fish passage improvements are underway.

Alewife and Blueback Herring

In mapping the potential production habitat for alewife in the Penobscot River Basin, we relied heavily on Flagg (1984), and filled in gaps with work by others, including the observations of our Penobscot Nation Fisheries Manager. Currently, there are no active alewife or blueback herring restoration efforts on the Penobscot. However, populations seem to be rebuilding slowly on their own, based on the occasional appearance of adults and juveniles in recent years above the Milford or Howland dams, where for many years there have been none. Unfortunately, as with salmon and shad, fish passage limitations at lower river dams are known to be impeding the restoration. Improvements are needed at these facilities before populations in the Reservation above Milford Dam can be restored to the self-sustaining levels needed for subsistence or commercial use by the Penobscot Nation. Such improvements may result from the implementation of the American Shad Restoration Plan.

Externally, blueback herring are nearly indistinguishable from alewife. However, their spawning habitat preferences are more similar to those of shad. Thus, while we did not prepare a separate map for this species, generally speaking, the lowermost two thirds of the range map for shad is an adequate representation of blueback herring production habitat in the basin.

We have compiled specific information about the problems with existing fish passage for shad and alewife (Appendix C). Upstream passage for Clupeids at the first 3 dams on the lower Penobscot varies from very poor (at Veazie) to extremely poor (at Great Works and Milford in Old Town).

American Eel

The American eel (*Anguilla rostrata*) is another native migratory fish of the Penobscot drainage that was very important historically to the Penobscot people. The Penobscot word for eel is *Naha'mu* and the tribe's eel clan (Neptune family) appears to be one of the older clans with mythical origins that date back with the other aquatic families (Speck, 1940). Eels were an important traditional food source for the tribe. Weirs, splint basket traps and spears were used. Freshly caught eels were tossed in a pit to rid themselves of slime. Some pits remain as archaeological features of the region. During winter, eels hibernating in the mud were speared through a hole in the ice. At times whole tribal communities subsisted on eels when food was scarce. The Passadumkeag River was noted as an important tribal eel fishery, along with Kenduskeag Stream, Maliseet for "eel weir place" Eckstorm, 1941).

Eels are extremely important ecologically, in their role as bottom feeding predators and scavengers, and as forage for a wide variety of fish and wildlife, including bald eagle, osprey, mink, otter, striped bass, and smallmouth bass. Eels exhibit a "catadromous" life cycle. Reproduction occurs in the Sargasso Sea, an area of the Atlantic Ocean near Bermuda where sargasso weed, a floating marine plant, flourishes. The larvae drift northward along the coast with the Gulf Stream currents, entering tidal areas of nearly every river and stream that drains into the Atlantic Ocean. Upon reaching a river estuary, juveniles gradually and progressively migrate upstream into freshwater zones, over 5-15 years of growth and maturation. Mature adults migrate downstream to the ocean and Sargasso Sea to spawn and all adults die after spawning.

Eels are highly tolerant of a wide range of environmental conditions while in freshwater, and can colonize virtually every type of habitat to which they have access. However, they are vulnerable to low dissolved oxygen levels because of poorly developed gills, to direct and indirect effects of environmental contaminants and toxins, and to upstream and downstream passage impacts at dams. In addition, eels are fished commercially and recreationally at virtually every stage of their life history, via dipnets, trap nets, weirs, baited pots (traps), and other gear, and all commercial and recreational harvest occurs prior to mature adults having an opportunity to reproduce. No other fishery in the world (except for other species of eel) experiences this nature of human exploitation.

Eels have received little attention in terms of research or active management. Historically common throughout the Penobscot River drainage, current populations are more are restricted in distribution, and seem to be declining all along the Atlantic Coast. Managers feel these changes may be due to overfishing of young or adult stages, impacts of dams on migration, and in some cases, water quality problems. Maine has recently adopted new, tighter commercial eel fishing regulations and has increased enforcement. In addition, eels are becoming much more visible in relation to the impacts of dams on their migrations. DNR has been instrumental in both of these efforts. Recommendations for providing upstream and downstream passages for eels at dams are now routinely included by state and federal agencies in their comments on pending hydropower licensings, when just a few years ago, eels would hardly even be mentioned. Together with the tribe's efforts to conserve and enhance this resource, this increased level of attention by others should allow the species to re-expand into presently unoccupied or under-utilized production habitat in the Penobscot drainage. Obtaining upstream and downstream passage for eels at dams is considered critical to maintaining populations and fisheries for long-term.

While Penobscot River eel populations presently support substantial commercial fisheries in the basin, current tribal use is much lower than it was historically, due to fish consumption concerns resulting from tissue contaminants present in Penobscot River eels. Contaminant testing of Penobscot River eels was performed by the Surface Water Advisory Toxics (SWAT) at sites in Bangor downstream of the Reservation for mercury, dioxin, and pesticides. Results indicate that eel accumulate more pesticides than other fish species from the same location. Testing das not performed in other parts of the Basin, where contaminant levels may differ.

Upstream Range

The documented current upstream range of American eel in the Penobscot River basin is listed by sub-basin as follows. This information was taken from Flagg et al. (1996), and compiled from Maine Department of Inland Fish and Wildlife lake fish population surveys conducted primarily for other fish species. Much of the information is over 20 years old. Thus, upstream distribution information should be viewed as general and preliminary, and should not be considered comprehensive in terms of current eel distribution in the drainage.

Upstream Range of Penobscot Basin Eels

Kenduskeag Stream
Garland Pond

Passadumkeag River
Nicatous Lake and Number 3 Pond

Piscataquis River
Bald Mountain and Harlow Ponds and Hebron Lake; Upper Wilson Pond and Lake Onawa (Sebec River); Silver Lake and Houston Pond (W Branch Pleasant); B Pond (E Branch Pleasant); Seboeis and East Branch Lakes (Seboeis River)

Mattawamkeag River
Mattawamkeag, Pleasant, Wytopitlock, Baskahegan Lakes

West Branch
Pemadumcook Chain of Lakes and Millinocket Lake

East Branch
3rd Matagamon, Scraggly, Grand Seboeis Lakes, Upper Shin Pond

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THE PENOBSCOT NATION
AND THE PENOBSCOT RIVER BASIN

A Watershed Analysis and Management (WAM) Pilot Project

Part VI. GEOLOGICAL SETTING

The Penobscot Nation used the Watershed Analysis and Management Project to characterize features of the Penobscot River Basin that have a bearing on tribal water resource conditions. This section of the report describes the physical setting in terms of the bedrock geology, surficial geology and geomorphology. Alice R. Kelley, of the Department of Geological Sciences, University of Maine, wrote this section of the report.

Introduction

Because geology creates the framework in which the river and its tributaries flow, an understanding of the geology of the drainage basin is critical in understanding the development and characteristics of the region. Bedrock geology determines the local topography, shapes the drainage network of various portions of the basin, and influences the course of the river. Surficial geological processes in the form of glaciation and modern riverine activity overprint the bedrock geology through the contribution of sediment to the river system, and limited modification of the bedrock landscape. The sediment type encountered at many localities within the basin often shows a direct compositional connection with nearby surficial deposits.

One goal of the Penobscot Nation characterization of the Penobscot River Basin is to identify specific habitats important to the life cycle of specific aquatic organisms. Because the link between local geology and sediment type is so strong, predictions are made on the location of potential favorable riverine substrates necessary in critical aquatic habitats. This information is then compiled with both historic and modern information to create a more complete understanding of the location and distribution of important aquatic habitats in the basin.

A second goal of this project is to identify potential contaminant reservoirs. Because contaminant storage in ecosystems is often related to substrate type, this investigation allows a reconnaissance level survey for substrate types and geomorphological locations most frequently at risk of riverbed contamination. This is accomplished by combining local sediment source information with analysis of geomorphology and river flow conditions to indicate areas most likely to contain sediment types associated with contamination. The results of this study may also be applied to defining areas favorable for other important tribal resources. This may include habitats associated with particular plants or animals which have specific habitat requirements determined by sediment type and/or location within a specific geomorphic setting.

Methods

The geological characterization of the Penobscot Nation Watershed Analysis and Management Project consisted of three steps.

1. Literature Review and Summary
A literature search was undertaken to identify pertinent publications, studies, theses/dissertations, and web sites.

2. River Basin Characterization
A geological and geomorphological characterization of the river basin was completed using the 1:500,000 scale Bedrock Geologic Map of Maine (Osberg, et al., 1985) and the 1:500,000 scale Surficial Geologic Map of Maine (Thompson and Borns, 1985), along with 1:100,000 scale topographic maps (United States Geological Survey).

3. Channel Characterization
The geological and geomorphological information for specific river and tributary reaches was plotted on a map of the river basin, taking into consideration the bank composition and the degree of channel confinement. Five categories were used to describe bank composition (rock, glacio-marine, glacio-fluvial, till, or alluvial) and three categories that were used to describe the degree of confinement (confined, moderate, unconfined).

Physical Setting

The Penobscot River drainage comprises of 8,750 square miles of Central Maine, and on the basis of drainage and average discharge (16,434 cfs) it is the largest river in the state (Army Corps, 1990). The Penobscot Basin is bounded to the north by the St. John drainage, to the east by the watershed of the St. Croix River, to the west by the Kennebec basin, and drains into Penobscot Bay (Atlantic Ocean) to the south. The river has six major tributaries, the East and West Branches of the Penobscot River (the headwater tributaries), the Mattawamkeag River, the Passadumkeag River, the Piscataquis River, and Kenduskeag Stream. The East Branch drains the northern portion of the basin through Allagash, Chamberlain, and Grand Lakes. It has a length of over 100 miles, and a watershed of 1,100 square miles which includes the drainage basin of Chamberlain Lake (240 square miles) diverted from the Allagash River, originally a part of the St. John drainage. The West Branch originates in Seboomook Lake, and drains the northwestern portion of the basin. It flows ninety-seven miles through a series of lakes, including Chesuncook, Ripogenus, and North and South Twin Lakes, to its junction with the main stem of the Penobscot River at Medway.

The main stem of the Penobscot flows a distance of seventy-four miles from Medway to the head of tide at Bangor. The course of the river continues an additional thirty-one miles to its mouth at the head of Penobscot Bay. The Mattawamkeag River drains the northeastern portion of the basin, and composed primarily of the two main tributaries, the West Branch, fifty miles in length, and East Branch, thirty-seven miles long. The Mattawamkeag River has a watershed composed of 1,490 square miles, and drains the region to the north and east of the East Branch of the Penobscot River. The Piscataquis River flows seventy-six miles in a generally west to east direction and drains 1,454 square miles in the west-central portion of the Penobscot River drainage. It has two major tributaries, the Pleasant and Sebec Rivers. The Passadumkeag river is composed of two main branches, the East and West, and flows a distance of forty-three miles. It has a drainage area of 385 square miles in the eastern portion of the Penobscot drainage. Kenduskeag Stream is the smallest of the primary tributaries of the Penobscot drainage, with a length of twenty-eight miles watershed of 215 square miles. It drains a portion of the south-central Penobscot Basin, and enters the Penobscot River at Bangor (Army Corps of Engineers, 1990).

Dendritic drainage networks are developed throughout most of the region, although radial drainage is associated with the higher mountains in the region (Hanson and Caldwell, 1989). Channels are confined by bedrock and large boulder lag deposits in the steeper portions of the drainage, while channels through finer-grained surficial deposits and alluvium are moderately to poorly confined.

The Penobscot Drainage Basin has 116 existing dams (FERC, 1997). These dams and other impoundments have a total usable storage capacity of 1,570,000 acre-feet, over 80% of which are located in the drainage of the West Branch of the Penobscot River (Army Corps of Engineers, 1990). Six major hydroelectric power developments are located on the lower Penobscot River. Other dams and impoundments are used for local power generation or water-lever control and are "run of the river" structures.

Bedrock Geology

Bedrock type influences the topography and shape of drainage networks within a region and controls the location and size of waterfalls and rapids. Underlying bedrock geology can also affect geochemistry of surface water, particularly lakes, ponds, and headwater streams (Kahl, 1998). Most of the lowlands and broad valleys of the Penobscot River basin are underlain with metasedimentary bedrock (Map 13. Bedrock Geology) , while granitic plutons are often associated with the lakes. Work by Hanson and Caldwell (1989) demonstrates that quartzite and felsic volcanic rocks are the primarily rock types associated with the ridges and steep-sided mountains of this region. Granitic bodies and metamorphic rocks of the Penobscot River drainage are of low to intermediate metamorphic grade and are less resistant to erosion.

The upper Penobscot drainage is dominated by the Katahdin Pluton, a Devonian igneous body of primarily granitic composition. Felsic and mafic volcanic rocks are also found in the upper Penobscot drainage, as well as low grade, lower Paleozoic metasedimentary facies. These broadly up-warped rocks are part of the western portions of the Weeksboro-Lunksoos and Munsungan-Winterville Anticlinoria. The erosion resistant rock types of these structural features contribute to the rugged topography of the region (Osberg, et al., 1985).

The central Penobscot drainage is characterized by low-grade, fine-grained metamorphic rocks, primarily the lower Paleozoic Vassalboro and Madrid Formations of the gently folded Kearsarge-Central Maine Synclinorum. In appearance, these rocks have a bedded appearance, varying from dark colored slates or mudstones, to brown or tan colored siltstones or impure sandstones. These rocks are more easily eroded than the rocks of the basin headwaters and form the broad valley which characterizes this portion of the Penobscot drainage. Exposures of slightly more resistant facies form a series of rapids in from Old Town to Bangor (Osberg, et al., 1985).

The lower portion of the Penobscot drainage from Bangor to the sea is composed of the western portion of the Coastal Lithotectonic Block, a tectonic unit of rocks quite different from those in the other portions of the Penobscot drainage. These units include small granite plutons, volcanic rocks, and high-to medium-grade metamorphic rocks, all of lower Paleozoic age. The topography reflects this change in rock type, and is steeper than the region immediately upstream. Several hills in this area have more than 300 feet of relief (Osberg, et al., 1985).

Several northeast-southwest trending faults cut through the Penobscot drainage. The most prominent of these is the Norumbega fault zone which is composed of a series of northeast-southwest trending faults. It is located to the south and east of Bangor, and cuts across the southern portion of the Penobscot drainage at Orrington (Osberg, et.al., 1985).

Surficial Geology

The surficial geology of the Penobscot River Basin is highly variable. In some locations, glacial deposits are large enough to affect the course of the river and its tributaries. The greatest influence, however, is the link between surficial deposits as sediment sources and the sediment type found in the banks and bed of the river. Although fluvial substrate is greatly controlled by channel shape and flow rates, the proximity of an easily eroded sediment source can shape local riverine habitats.

The surficial geology of the Penobscot River drainage varies from north to south. The northern portion of the drainage is a high-relief area and is characterized by thick deposits of till except in the highest elevations where exposures of bare rock are common. Throughout the area, the till is present as "ground moraine", a blanket of till of varying thickness which overlies the landscape. To the south of the Katahdin massif, the till is shaped into ribbed moraines which form a series of hummocky, sub-parallel ridges. Glacial outwash deposits composed of sand and gravel also occur in this area, and may contribute to the formation of small meadows in the upper portions of the river valleys. (Thompson and Borns, 1985)

Extensive terraces occur in the central Penobscot Valley, in the segment from Old Town to Bangor and Brewer. The terraces are found on both sides of the valley, and are composed of glaciofluvial and glaciomarine deposits. Smaller series of terraces are also associated with tributary streams to the river in the upper portion of the valley.

Alluvial deposits are mapped in many of the larger river valleys in the Penobscot drainage. Extensive deposits occupy a portion of the East Branch, the Piscataquis River, the Mattawamkeag River, and the central region of the main stem of the Penobscot River. These deposits form broad floodplains and terraces, and are composed of sand, gravel, and silt. Terraces are particularly well developed in the central portion of the main stem in the vicinity of Old Town and Bangor. Limited aeolian deposits also occur on both sides of the central portion of the main stem of the Penobscot River near the towns of Lincoln and Howland (Thompson and Borns, 1985).

The most distinctive surficial deposit of the central Penobscot drainage is the Presumpscot Formation. This fine-grained glaciomarine deposit mantles the lowlands over much of the lower Penobscot drainage basin, creating a rolling, gullied topography. A large number of swamps and bogs are coincident with the distribution of the Presumpscot Formation. Glaciomarine deposits also form steep bluffs along the banks of the central and lower portions of the main stem of the Penobscot River (Thompson and Borns, 1985).

The lower Penobscot River drainage is characterized by a decrease in the presence of fine-grained glaciomarine deposits. Till deposits are more widespread in this area. Eskers, outwash, and coarser-grained glaciomarine deposits are also found directly adjacent to the river. (Thompson and Borns, 1985)

Geologic History of the Penobscot River

While evidence exists for pre-Wisconsian drainage patterns in Penobscot drainage, the geologic history of the present day Penobscot River began in the late Pleistocene, approximately 13,000 years ago. In some portions of the basin the current river occupies what appears to be an older channel, developed prior to the most recent glaciation In other areas the river is characterized by falls and rapids, evidence of a geologically young river valley. While older channels of an earlier river system existed prior to Wisconsian glaciation, these features were filled with glacial deposits. The post-Wisconsian Penobscot River began as the ice sheet withdrew, and a new drainage system was established.

The margin of the melting Laurentide ice sheet reached the Maine coast by 14,000 years ago, and disappeared from the lower and central Penobscot River Valley, as far north as present day Millinocket by 13,000 years ago (Dorion, 1997). Following and contemporaneous with the retreat of the ice sheet, the isostatically depressed land surface was inundated by marine waters. This marine transgression created a broad embayment extending up the Penobscot valley as far north as the site of present day Millinocket (Thompson and Borns, 1985). Glaciomarine deposits associated with this inundation cover the region below the 300 foot contour (Thompson and Borns, 1985). Coarse-grained outwash and deltaic deposits are found at the embayment margins, while fine-grained deposits composed primarily of silt and clay blanket much of the region. These fine-grained deposits were defined by Bloom (1960) as the Presumpscot Formation, named for its type locality in southern Maine. Investigations of the mineralogy of the Presumpscot Formation showed that the fine-grained fraction is composed of illite and chlorite with subordinate amounts of quartz and feldspar (Kelley, 1989).

Marine conditions in the main stem Penobscot valley persisted until approximately 12,000 years, when isostatic adjustment brought the land surface above sea level (Belknap, et al., 1987). After the marine regression, surface drainage was established, and the present day Penobscot River took shape. In some places the river has reoccupied an older river valley, while in others, the river has excavated a new valley, often with characteristic waterfalls and rapids.

Isostatic adjustments resulted in tilting of the earth's surface as it adjusted to the removal of the weight of the ice (Barnhardt, et al, 1995; Balco, 1996). This tilting most likely took the form of a wave approximately 25 meters in height moving at a rate of slightly less than a kilometer per year (Barnhardt, et al, 1995; Balco, 1996). Balco's (1996) work in Moosehead Lake, Maine, suggest that this isostatic tilting caused the outlet of Moosehead Lake to shift from a northern position which drained into the Penobscot River to a southern outlet into the Kennebec drainage approximately 9,000 to 8,500 years ago. This change would have resulted in an estimated 12% decrease in the discharge of the Penobscot River and a 25% increase in the discharge of the Kennebec (Balco, 1996). Analysis of stratigraphic exposures in the central Penobscot Valley support this interpretation, showing coarse-grained deposits at the base of the alluvial section, with an abrupt change to fine-grained sediments at approximately 8,000 years ago. (Kelley, 1998)

Stratigraphic research by Kelley in the central Penobscot valley suggests that the Penobscot River in this region had become established in its present location by approximately 8,000 years ago, based on radiocarbon ages on charcoal in alluvial sequences. While some lateral channel migration has probably taken place, the river's course has not change dramatically since that time.

Sediments in the upper portions of stratigraphic exposures in the central Penobscot valley are uniformly fine-grained. Patterns of deposition appear to have varied by amount due to climatic conditions. Paleosols identified at locations in this portion of the drainage generally correlate with Holocene climatic dry periods identified by Almquist and Sanger (1995).

Geologic evaluation of limited stratigraphic exposures in the Medway area revealed primarily fine-grained alluvial deposits of varying thickness (Sweeney and Mack, 1995). Where the complete alluvial sequence could be examined, fine-grained sediments were deposited on eroded till surfaces (Sweeney and Mack, 1995).

The last major event in the geologic history of the Penobscot Valley was the construction of dams throughout the region, beginning in the late 18th century and continuing into the 20th (Army Corps of Engineers, 1990). The construction of these features changed the response of the river to climatic events by creating storage of water for release at specific times for electric power generation or log drives. While larger flows are still experienced in the spring, water storage may have decreased late summer and fall discharge. Bank erosion caused by raised water levels and ice movement has been experienced by shorelines within impoundments.

Geomorphology

Early work divided the main stem of the Penobscot River valley into four distinct geomorphic units (Kelley, et al., 1984): mountainous upland, island/bar, rapids/terrace, and tidally influenced. The current study has produced a much finer division of the Penobscot and its major tributaries based on a variety of geomorphic factors, including presence of rapids, steepness of river banks, and sinuosity of the river course (Map 14. Channel Geomorphology: A. Confinement, B. Surficial Units).

East Branch of the Penobscot River

The East Branch of the Penobscot River begins in the northern portion of the Penobscot drainage and flows through a series of lakes and streams to its junction with the main stem of the Penobscot River at Medway. The upper portion of the drainage of the East Branch will be diverted from the Allagash River (St. John River drainage) by the construction of a dam at the Eagle Lake outlet of Chamberlain Lake combined with the creation of the Telos Canal between Telos and Webster Lakes in the mid-nineteenth century (Barrows and Babb, 1912). The East Branch has a watershed area of 1,100 square miles and a course of slightly more than 100 miles. (Army Corps of Engineers, 1990)

The upper portion of the East Branch Drainage is a mixture of mountainous and open, rolling terrain. The moderate relief (700 feet of relief) of the region west of Allagash Lake reflects the presence of underlying erosion-resistant volcanic and sedimentary rocks. In contrast, the area between Chamberlain and Allagash Lakes has a more gently rolling, open topography due to the presence of more easily eroded, weakly metamorphosed rocks of the Seboomook Formation. The area surrounding the natural head of the East Branch of the Penobscot River is located in the mountainous terrain of the western portion of the Munsungan-Winterville Anticlinorium. This structural feature is composed of mafic to felsic volcanic rocks and associated sedimentary facies. A low area at the head of Grand Lake Matagamon Lake indicates the presence of easily eroded sedimentary rocks, while the rugged terrain sough of Grand Lake Matagamon is formed in felsic volcanics and resistant sedimentary rocks. Throughout this region, surficial deposits are limited to till of varying thickness with some alluvium in broader valley bottoms.

Within the upper East Branch drainage, the stream channel is narrow and confined in mountainous regions of resistant bedrock. In areas underlain by less-resistant sedimentary rocks the valley is broader, and may have accumulations of alluvial material (Osberg et al., 1985, Thompson and Borns, 1985).

South of Grand Lake Matagamon the river widens and flows through an alternating series of rapids and flat water to its junction with the main stem of the Penobscot River at Medway. Where resistant volcanic and sedimentary rocks are encountered, the stream course is straight channel in a narrow valley with rapids. The steepest portion of the river occurs in this reach, 7 miles south of the outlet of Grand Lake Matagamon where the river falls 130 feet in 2.5 miles (Army Corps of Engineers, 1990). More open valleys with a meandering course typify areas of less resistant bedrock. Alluvial deposits are coincident with the broader valley segments. Other surficial deposits in the central and lower portions of the East Branch include till, eskers, and glaciofluvial outwash. Both the eskers and outwash are major sources of sand and gravel to the stream bed (Osberg et al., 1985, Thompson and Borns, 1985).

West Branch – Penobscot River

The West Branch of the Penobscot River flows to the east from its source in Seboomook Lake near the northwestern boundary of the drainage to its junction with the main stem of the Penobscot River at Medway. The river flows through a number of large lakes, including Chesuncook, Pemadumcook, and North Twin Lakes. The river's course is almost 100 miles long, and it drains an area of 2,100 square miles (Army Corps of Engineers, 1990). Dams in several locations along the river's course have flooded the natural channel and increased the size of pre-existing lakes.

The westernmost portion of the West Branch flows from Seboomook Lake to Chesuncook Lake. In this region the river flows through a broad, open valley formed in the easily eroded meta-sedimentary rocks of the Seboomook Formation. The topography is low and rolling, and swamps are present in many locations along the gently meandering river course. Along much of this reach, the river flows through fine-grained lake deposits formed during the Late Pleistocene/Early Holocene period (Thompson and Borns, 1985).

The character of the valley West Branch changes dramatically at the southern end of the Chesuncook/Ripogenus Lake system. The topography becomes more rugged, with mountains standing almost at 1,000 feet above the river. The river flows through a well-defined valley with a series of falls and rapids, with the steepest portion in the seventeen mile reach beginning at the southern end of Chesuncook/Ripogenus Dam, where the river drops 455 feet (Army Corps of Engineers, 1990). A hydroelectric dam, Ripogenus Dam, utilizes a portion of this drop.

This abrupt change in topography is due to a change in bedrock lithology. Instead of the less resistant rocks of the Seboomook Formation, the river cuts through the western portion of the Weeksboro-Lunksoos Anticlinorium, a structural feature formed of resistant volcanic and metasedimentary rocks. Southeast of the anticlinorium, the river flows through the margin of the Katahdin massif. The Katahdin massif is formed of easily eroded granite, but is capped by a resistant layer of fine-grained, erosion-resistant granitic material which formed on the margins of the igneous pluton (Hanson and Caldwell, 1989). The surficial geology of this area is dominated by till of varying thickness, ranging from thin ground moraine to thick deposits of ribbed moraine.

South of Abol Falls to Medway, the topography of the river changes again. The river is bounded by swamps, and hills of over 300 feet are widely spaced. In this region the valley is underlain by more readily eroded metasedimentary rocks, which give the landscape a more subdued pattern. Surficial deposits in the region are primarily till, with some exposures of glacial outwash, glaciomarine delta and esker deposits.

A dam at the outlet of North Twin Lake has significantly altered the drainage of the West Branch of the Penobscot in the vicinity of Millinocket. Prior to dam construction, the West Branch flowed from North Twin Lake through a series of smaller lakes into a well-defined channel south of the city of Millinocket. Currently, flow controlled by the North Twin Lake dam routes flow northward into Millinocket Lake and into the West Branch by way of Millinocket Stream, avoiding the original channel south of the town. From its confluence with Millinocket Stream, the West Branch flows to its confluence with the East Branch to form the main stem of the Penobscot River. A hydroelectric dam at East Millinocket creates a headpond which includes Dolby Lake. Downstream of the dam, the West Branch flows in a straight, well-defined channel.

Lower Penobscot River

The lower Penobscot River (also known as the main stem) extends from the junction of the East and West Branches of the Penobscot near the town of Medway south to Penobscot Bay, a distance in excess of 100 miles. The lower 30 miles of the river south of Bangor is tidally influenced, and only the portion between Verona Island and Bangor is included in this study.

The main stem of the Penobscot River from Medway to the confluence with the Mattawamkeag River is characterized by a straight channel with few islands. Islands are bedrock-cored, alluvial, or esker segments. The uppermost portion of the main stem is ponded by the Mattaseunk Dam, located 6.5 miles (10.5 km) downstream from Medway. Low, rounded hills with relief of 300 feet (100 meters) are interspersed with small streams and swamps on either side of the valley. The banks of the river are composed of a wide range of sediments from till to fine-grained silt and clay. Sand and gravel derived from coarse-grained glaciomarine deposits dominate the valley below the Mattaseunk dam.

South of the confluence with the Mattawamkeag River to Old Town, the river widens and contains alluvial and bedrock islands of a variety of sizes. Alluvial islands, such as Snow, Long, and Freese Islands, are elongate in shape and are of low relief. Bedrock islands, such as Olamon, Sugar, and Gordon Islands are topographically higher and are more irregular in shape. Rapids occur in several locations and are associated with bedrock outcrops. The valley is generally broad and of low relief, with the exception of a series of rounded hills on the east side of the river between North Lincoln and Enfield. These hills are part of the Center Pond Pluton, a granite/granodiorite intrusive body (Osberg, et al. 1985). They stand approximately 300 feet above the surrounding landscape, and are accompanied by numerous ponds and lakes. The Piscataquis River joins the Penobscot from the west at Howland. A hydroelectric dam at West Enfield just south of this confluence controls the flow of the Penobscot in this region. The Passadumkeag river enters this portion of the Penobscot from the east at Passadumkeag. A wide range of sediment types are encountered in the banks along this portion of the river. Till dominates the surficial deposits north of Lincoln Center, and erodes to produce sediment which ranges in size from boulders to silt. Sand and gravel is contributed by a large esker segment on the west bank of the river between Lincoln Center and South Lincoln, the valley is dominated by the silt and clay of glaciomarine deposits as well as modern alluvial deposits consisting of gravel, sand, or silt.

The character of the main stem of the Penobscot River changes dramatically in the vicinity of Orson Island, 1.5 miles upstream from Old Town. At this point the river divides into the main stem and a channel to the west, the Stillwater River. Both channels are characterized by the presence of rapids, formed by exposed bedrock in the channel. In several locations these rapids are the site of dams used to control flow for hydroelectric power generation. The main stream continues south with a slightly meandering channel through an alternately bedrock and sediment bounded valley. Banks are composed of till, fine-grained glaciomarine deposits, or alluvial sediments, and may be low in relief, or form bluffs up to 20 feet in height. The Stillwater River flows around Orson, Indian and Marsh Island, and rejoins the main stem at Orono. The banks of the Stillwater River are generally lower than those on the main stem. A series of late Pleistocene-Early Holocene terraces are well-developed on the west bank of the main stem in Old Town, and along portions of the Stillwater River in Orono.

From Orono south to Bangor the river flows in a generally straight channel with steep banks, 10 to 30 feet in height. River banks in this segment are composed primarily of glaciomarine deposits, although bedrock and till outcrops form limited exposures, and esker segments parallel the river in several locations. Exposed flood plain deposits are limited and most often associated with the confluence of the river and a tributary stream. The river flows in a bend around a large glaciomarine/glaciofluvial deposit at Eddington Bend. Eddington Bends is also the site of a large set of rapids which now serve as the base for a hydroelectric dam and generating station.

From Bangor south the river is tidally influenced. In the segment of the main stem from Bangor to Verona Island, the river is entrenched with steep banks composed of bedrock, till, and glaciomarine deposits. In the vicinity of Bangor, bedrock exposures are more extensive, and form vertical cliffs adjacent to the river in a few locations. To the south, the river banks are steep bluffs of glaciomarine and glacial deposits with some bedrock exposures. Fringing wetlands are developed in protected locations, and become more extensive downstream. A large saltwater marsh is located on the west bank of the river at the mouth of the Marsh River in the towns of Frankfort and Prospect. The river valley becomes more topographically varied south of Bangor. Low, rounded hills having relief of 300 feet are formed by granitic plutons and higher grade metamorphic rocks which are more resistant to erosion.

Mattawamkeag River

The Mattawamkeag River has a watershed of 2,110 square miles in the northern portion of the Penobscot basin. The East Branch flows a distance of 38 miles, and the West Branch a distance of 50 miles to join at the village of Haynesville to form the main stem of the river which is 48 miles in length. (Army Corps of Engineers, 1990)

The geology of both the West and East Branches of the Mattawamkeag River is similar. Both branches begin in mountainous terrain underlain by the resistant igneous and metasedimentary rocks of the Weeksboro-Lunksoos Anticlinorium. The central portion of the West Branch flows through a broad open valley, while that of the East Branch encounters a region of slightly more relief. Surficial deposits in this region consist of primarily till with some eskers.

South of the confluence of the East and West Branches, the character of the Mattawamkeag River changes dramatically. The river broadens and flows in a meandering course through a broad valley for most of its course. This region is underlain by easily eroded low-grade metasedimentary rocks. Surficial deposits in the area are primarily alluvium and modern swamp deposits. West of the town of Kingman, approximately 5 miles from the confluence of the Mattawamkeag and the Penobscot Rivers, the channel makes a sharp bend, and then straightens. Relief increases slightly in this area, and falls and rapids are encountered along the river.

Piscataquis River

The Piscataquis River flows a distance of seventy-six miles, and drains 1,454 square miles in the west-central portion of the Penobscot River drainage. The East and West Branches of the river drain the region immediately to the south of the Moosehead Lake drainage. The valleys of both branches are of generally moderate relief, underlain by low grade metasedimentary rocks of the Carrabassett Formation Falls and rapids occur occasionally where resistant bedrock ledges trend across the stream. Just north of the confluence of the two branches, each stream cuts through a small intrusive body, and the terrain becomes much more rugged. Surficial deposits in the East and West Branch area are primarily till, with some eskers and glacial outwash within the stream valley.

From the confluence of the East and West Branches at Blanchard, the Piscataquis River flows in a generally southeast direction to the town of Guilford. The channel in this reach is generally straight, with alternating regions of flatwater and rapids. The valley is underlain by metasedimentary rocks of the Carrabassett and Seboomook Formations. Till, esker segments, glaciofluvial outwash, and alluvium are the surficial deposits found along the river in this region. A dam at Guilford has created a headpond which has altered part of the river's course.

At Guilford the flow of the Piscataquis River changes to almost due east/northeast. The underlying bedrock is a limestone member of the Sangerville Formation. The erosion of this relatively soft unit forms a broad valley which controls the direction of flow of the river for much of its course to its confluence with the main stem of the Penobscot. Between Guilford and Dover-Foxcroft the channel is primarily straight, and flows through alluvium, till, and glaciomarine outwash. East of Guilford, the river parallels the trend of a large esker segment.

East of Dover-Foxcroft the straight channel of the Piscataquis River becomes broadly meandering in a wide valley. Alluvial deposits are the most common sediment type in the valley. Meander scars are common, and now filled with wetland vegetation and ephemeral lakes. At the town of Medford, ten miles west of Howland, the Piscataquis River turns abruptly northward and follows the trend of a large esker for a distance of one mile. After this, the river flows to the southeast in a meandering channel. Several large islands, remains of glacial deposits, are located in the river just west of its confluence with the main stem of the Penobscot River.

Passadumkeag River

The Passadumkeag River is composed of two main branches, the East and West, and flows a distance of forty-three miles. It has a drainage area of 385 square miles in the eastern portion of the Penobscot drainage, and joins the main stem of the Penobscot River at the town of Passadumkeag.

The upper portion of the Passadumkeag River drains the Passadumkeag River Pluton, and igneous intrusive body composed of quartz syenite. The river flows in a generally southerly direction through extensive swamp deposits in a broad valley. Several large eskers segments trend in a north/south direction through this region, but rarely parallel the course of the river.

Near Saponac the river's course swings to the west. The channel continues to flow through swamp and glacial deposits, and has a meandering course with many small tributaries. West of Saponac Lake the Passadumkeag river widens and flows over a series of rapids and rips. West of Lowell the river resumes its course through a broad, low relief valley with few rapids to its confluence with the main stem of the Penobscot River. Sedimentary deposits in this reach vary widely from modern alluvium and swamps to till, eskers, and fine-grained glaciomarine deposits.

Kenduskeag Stream

Kenduskeag Stream is the smallest of the primary tributaries of the Penobscot drainage, with a length of twenty-eight miles watershed of 215 square miles. It drains a portion of the south-central Penobscot Basin, and flows to the east to enter the Penobscot River at Bangor.

The western portion of the stream flows through low relief, rolling terrain characterized by thick deposits of fine-grained glaciomarine sediment. In this area the stream has a gently meandering course, and drains a region of low-grade metasedimentary rocks. Near Bangor the stream is entrenched first in a steep-sided valley. Bedrock exposures with many falls and rapids are very common in the western portion of this reach. Sedimentary deposits are limited to small alluvial terraces within the valley. Within a mile of the stream's confluence with the Penobscot River, the valley widens and the bedrock cliffs are replaced with bluffs of fine-grained glaciomarine sediment and alluvium.

Geologic Research – Penobscot River

Little geological research has been conducted specifically on the sedimentology or geomorphology of the Penobscot River. Mapping efforts have been concentrated on the description of bedrock and surficial deposits, at varying levels of investigation. Side scan sonar surveys have been made of the river bottom south of Bangor and in the waters of the Penobscot Nation near Indian Island. Detailed stratigraphic descriptions of Penobscot valley sediments have been developed as the focus of one Master's Thesis (Brady, 1982). The geologic evaluation of several archaeological sites within the river valley have been carried out as a part of relicensing applications for the dams in the central Penobscot River valley.

The United States Geological Survey maintains 24 river gauging stations within the Penobscot drainage, 10 in the lower Penobscot drainage (main stem and tributaries), 3 in the East Branch drainage, 4 in the Mattawamkeag basin, and seven on the Piscataquis River or tributaries (U.S.G.S., 1999). The Eddington Bend gauge records information relating to water chemistry as well as flow amounts.

This summary has been completed at a reconnaissance level. It represents a solid starting point for interdisciplinary investigations which relate the geology of the region to other natural resources of the watershed. Examples of such potential cooperative efforts include:

1. Identification of habitats important to the life cycles of important fish species. Substrate composition is important to the spawning success of several fish species. Because river and stream substrate is frequently determined by local sediment sources, an understanding of local geology is critical to any investigation which seeks to identify these habitats.

2. Identification of potential contamination reservoirs. Fine-grained sediment is frequently associated with sediment contamination. Areas of fine-grained sediment can be best identified through detailed geological and geomorphological analysis of areas indicated by reconnaissance level mapping.

3. The effect of dams on sediment erosion and deposition within headponds. Erosion of banks and riverine islands by flowing water and spring ice out may be related to the creation of headponds and water management practices associated with electric hydropower generation.

Summary

The Penobscot River drainage comprises 8,750 square miles of central Maine, and is the largest in the state. The bedrock geology of the area is composed primarily of low grade metamorphic rocks and igneous plutons and associated volcanics, and has shaped the topography and drainage networks within the basin. A wide range of surficial deposits, both the result of glaciation and modern fluvial processes, are found within the drainage. The greatest influence of these deposits in their contribution to sediment which greatly affects local river substrate.

The present day Penobscot River began to take shape following the recession of the Laurentide ice sheet and the subsequent marine invasion of the central and lower Penobscot valley. During the early Holocene, the discharge of the river was affected by the loss of the input of the Moosehead Lake drainage due to isostatic adjustment of the earth's crust following glaciation. Stratigraphic evidence from the central Penobscot River valley suggests that the river was established in its course by approximately 8,000 years ago.

The construction of dams has had an effect on the geology of the river valley. Seasonal discharge volumes have been altered as a result of water storage in reservoirs for hydroelectric power and water level control. Bank erosion associated with higher water levels and ice movement have been observed.

Geological research in the Penobscot River drainage has focused on bedrock and surficial mapping, with this study representing the first integration of bedrock geology, surficial geology, and geomorphology. Limited stratigraphic work has been

conducted in the valley. Characterization of the river sedimentology has been extremely limited. Gauging stations are located in 24 locations in Penobscot River drainage, 10 in the lower Penobscot drainage (main stem and tributaries), 3 in the East Branch drainage, 4 in the Mattawamkeag basin, and seven on the Piscataquis River or tributaries (U.S.G.S., 1999).

This report combines bedrock surficial geologic map interpretation with geomorphological analysis of topographic maps to produce an integrated reconnaissance level study which may be used to aid in the investigation of habitat, contamination, and other issues facing users of the Penobscot River drainage.

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THE PENOBSCOT NATION AND THE PENOBSCOT RIVER BASIN

A Watershed Analysis and Management (WAM) Pilot Project

Part VII
SYNTHESIS BY SUB-BASIN

The synthesis portion of the report integrates information about tribal cultural values, the geological setting, fisheries issues, and water quality concerns for each sub-basin in the Penobscot River drainage. Here, the Penobscot Nation highlights the unique features of the West Branch, East Branch, Mattawamkeag, Piscataquis, and the Lower Penobscot and emphasizes the issues of greatest management concern.

West Branch Penobscot River

Cultural Values

The West Branch Penobscot unit is very important, culturally, to the Penobscot Nation. Known as *Kettetegwewick* (the main branch), the extensive system of lakes, rivers and streams of the drainage retain many of their Penobscot names. It was through this system of waterways that the Penobscot people gained canoe access to the rivers of Quebec. Canoe routes in the West Branch drainage lead to the base of Katahdin, the tribe's most sacred place, and the highest mountain in Maine. Annually, tribal members travel by canoe and foot from Indian Island to the base of the sacred mountain. This drainage is rich with tribal legends and stories, with fish and wildlife and outstanding natural beauty. Stream watersheds within the West Branch are linked with specific Penobscot family and clan names, including the wolf clan in the Debsconeag area.

Geological Setting

The West Branch of the Penobscot River flows eastward approximately 100 miles from its source in Seboomook Lake to its junction with the East Branch in Medway. The river flows through a number of large lakes, including Chesuncook, Pemadumcook, and North Twin Lakes, and it drains an area of 2,100 square miles. Dams have flooded the natural channel and increased the size of pre-existing lakes. A portion of the West Branch has a very rugged topography, with steep drops and mountains over 1,000 feet. Many large boulders can be found in the river's swift current due to thick deposits of ribbed moraine that are more prevalent here than anywhere else in the river basin.

The dam at the outlet of North Twin Lake has significantly altered the drainage of the West Branch of the Penobscot in the vicinity of Millinocket. Prior to dam construction, the West Branch flowed from North Twin Lake through a series of smaller lakes into a well-defined channel south of the city of Millinocket. Currently, flow controlled by the North Twin Lake dam routes flow northward into Millinocket Lake and into the West Branch by way of Millinocket Stream, avoiding the original channel south of the town. From its confluence with Millinocket Stream, the West Branch flows to its confluence with the East Branch to form the main stem of the Penobscot River. A hydroelectric dam at East Millinocket creates a headpond which includes Dolby Lake. Downstream of the dam, the West Branch flows in a straight, well-defined channel.

Fisheries Issues
At present, a heavily manipulated channel and multiple dams impede traditional travel routes into the West Branch and have cut off vital spawning habitat for Atlantic salmon and other anadromous fish. Flooding by dams, lumbering, river driving and modern pulp cutting have had an impact on the cultural remains left behind by the Penobscots. Effluent from two large pulp and paper mills and one municipal treatment plant discharge pollutants that must travel through the entire Penobscot watershed and to the sea. The presence of fish consumption advisories and the loss of sustainable populations of native, historical species prevent tribal members from exercising their rights to catch and consume fish for sustenance.

Water Quality Concerns
The West Branch watershed contains the largest privately owned hydroelectric complex in the country and is heavily manipulated for hydropower generation. The watershed unit also receives wastewater from two pulp and paper mills and two municipalities. Portions of this watershed unit are listed on the Maine 303(d) list as waters not attaining water quality standards. Segments of the unit do not attain the bacteria standards of its classification because of untreated residential wastewater. Also a 4-mile segment of the West Branch does not attain aquatic life standards because it has been dewatered for hydro-electric power generation. Another segment does not attain dissolved oxygen standards due to the discharge of industrial wastewater from a pulp mill and an impoundment used for hydroelectric power generation. Several lakes, created by the numerous hydroelectric dams, located within this unit are in non-attainment or are threatened. The lakes are considered to be impaired because of organic enrichment, dissolved oxygen problems, habitat alterations from hydro-modification, and vulnerability.

The West Branch sub-drainage is not attaining the standard of fishable due to a health advisory for mercury. Also, bald eagles (whose diet is predominantly fish) tested from Dolby Pond showed the highest concentrations of mercury in eagles within Maine. The source of much of the mercury throughout Maine is by way of atmospheric deposition. However, the mercury in the West Branch is thought to be a historical discharge from the paper and saw mills where mercury was once used as a slimicide and fungicide. Also, the extreme water level fluctuations at impoundments used for hydroelectric power generation in the West Branch are thought to have increased methyllation and hence bioaccumulation rates of mercury in the West Branch.

Extensive and intensive water quality monitoring by Penobscot Nation further substantiates non-attainment documented by the Maine Department of Environmental Protection and also identifies additional water quality degradation. Tribal data indicate significant algal blooms that originate within the lower West Branch also affect the main Penobscot River unit. Ongoing monitoring efforts are attempting to identify the factors causing the blooms including licensed wastewater discharges from pulp and paper mills and a municipal wastewater treatment plant, non-point source runoff, or other sources of nutrient enrichment.

East Branch Penobscot River

Cultural Values

The Penobscot name for the East Branch is *Wassategwewick*, referring to the spearing of fish. This waterway forms an important canoe travel route to the Allagash lakes and Aroostook watershed. The river is swift with difficult carries past thundering falls, but several tributaries provide easier access upstream. The large lake at the headwaters of the East Branch is called Lake Matagamon. The Penobscot Nation holds Trust Lands at this lake that are highly valued and utilized for hunting and fishing. Therefore, the East Branch forms a natural connection between this valuable Trust Land and the reservation islands.

Geological Setting

The East Branch of the Penobscot River begins in the northern portion of the Penobscot drainage and flows through a series of lakes and streams to its junction with the West Branch at Medway. The upper portion of the drainage of the East Branch includes waters diverted from the Allagash River in St. John River drainage ever since the construction of a dam and a canal in the mid-nineteenth century. The East Branch has a watershed area of 1,100 square miles and a course of slightly more than 100 miles.

The upper portion of the East Branch Drainage is a mixture of mountainous and open, rolling terrain, on erosion-resistant volcanic and sedimentary rocks and more erodible weakly metamorphosed rocks. Surficial deposits consist of till of varying thickness with some alluvium in broader valley bottoms. The upper stream channel is narrow and confined in mountainous regions of resistant bedrock. In areas underlain by less-resistant sedimentary rocks the valley is broader, and may have accumulations of alluvial material. South of Grand Lake Matagamon the river widens and flows through an alternating series of rapids and flat water to its junction with the main stem of the Penobscot River at Medway. Where resistant volcanic and sedimentary rocks are encountered, the stream course is straight channel in a narrow valley with rapids. The steepest portion of the river occurs 7 miles south of the outlet of Grand Lake Matagamon where the river falls 130 feet in 2.5 miles. Alluvial deposits are coincident with the broader valley segments. Other surficial deposits in the central and lower portions of the East Branch include till, eskers, and glaciofluvial outwash. Both the eskers and outwash are major sources of sand and gravel to the streambed.

Water Quality Concerns
Water quality within the East Branch unit is attaining state of Maine water quality standards. However, fish consumption advisories exist within this unit due to high levels of mercury in tissues of some fish species. Water quality is threatened in the pristine Grand Lake Matagamon due to nonpoint source pollution from silvicultural activities and from seasonal camps. Aerial photographs identify extensive wood harvesting operations within the East Branch watershed unit. Heavy cutting and associated haul roads are known to be a major contributor of non-point source sediment loading.

Fisheries Issues
The East Branch unit is extremely important to the restoration of self-sustaining populations of Atlantic salmon to the Penobscot River basin. The unit contains the highest quality habitat of all the reaches in the river basin and represents about 27% of potential wild smolt production for the drainage. Currently Atlantic salmon populations are not attaining self-sustaining restoration goals and are heavily supported by stocking of hatchery reared juveniles. Although many of the factors responsible for the depressed salmon and other anadromous fish stocks occur elsewhere in the basin, some also occur within the East Branch. The dams that control water to the East Branch are currently being operated with a regulated flow regime that is not optimal for salmon and other river species. Also the intensive forest harvesting operations occurring within the watershed unit threaten salmon habitat and water quality. Because of the extreme high quality of the East Branch, protection of this watershed is very important for attaining anadromous fish population goals.

Mattawamkeag River

Cultural Values
The Mattawamkeag River was an important canoe route from the Penobscot River to regions east, similar to the smaller Passadumkeag Stream. Mattawamkeag, which means, "at the mouth, a gravel bar," divides into east and west branches. The east forms an ancient, important canoe route to the St. John River and the west forms a connection to the East Branch of the Penobscot River. The drainage was useful for travel due to its low relief, numerous swamps, and slow run-off.

Geological Setting
The Mattawamkeag River has a watershed of 2,110 square miles in the northern portion of the Penobscot basin. The Mattawamkeag's East Branch flows a distance of 38 miles, and its West Branch flows a distance of 50 miles to join at the village of Haynesville to form the main stem of the river which is 48 miles in length. Both branches begin in mountainous terrain underlain by the resistant igneous and metasedimentary rocks. Surficial deposits in this region consist of primarily till with some eskers. At their confluence, the Mattawamkeag River changes dramatically, widening and flowing in a meandering course through a broad valley. This region is underlain by easily eroded low-grade metasedimentary rocks. Surficial deposits in the area are primarily alluvium and modern wetland deposits. Five miles from the confluence with the Penobscot Rivers, the channel makes a sharp bend, and there are some falls and rapids.

Fisheries Issues
The Mattawamkeag River is not attaining the tribe's fisheries restoration goals for self-sustaining populations of native migratory fish species.

Water Quality Concerns
The lower most segment of this unit does not attain water quality standards for bacteria due to the presence of untreated wastes. Fish consumption advisories exist within the unit due to high levels of mercury in tissues of some fish species.

Piscataquis River

Cultural Values
Numerous campsites in the Piscataquis drainage testify to its long and important role in prehistoric Maine. One campsite has been dated at 10,000 years old. The Piscataquis, which means "little branch stream," flows west to east for eighty miles, draining the large area south of Moosehead Lake and the land south of the West Branch of the Penobscot lower lakes. The Piscataquis and its tributaries, Sebois Stream, and Pleasant and Sebec Rivers, form traditional canoe routes into the heart of the Maine woods. The *Piscataquis Ahwangan* was what the Penobscots collectively called the routes that compose this travel network.

Geological Setting
The Piscataquis River flows a distance of seventy-six miles, and drains 1,454 square miles in the west-central portion of the Penobscot River basin. The river is the only major sub-drainage that runs predominantly west to east, crossing many structural features, and changing its character many times. Headwaters drain the region immediately south of Moosehead Lake, underlain by low grade metasedimentary rocks of moderate relief. Falls and rapids occur where resistant bedrock ledges trend across the stream. Surficial deposits in the East and West Branch area are primarily till, with some eskers and glacial outwash within the stream valley. From Blanchard, the Piscataquis River flows in a generally

southeast direction to Guilford in a straight channel with alternating regions of flatwater and rapids. The valley is underlain by metasedimentary rocks. Till, esker segments, glaciofluvial outwash, and alluvium are the surficial deposits found along the river in this region. A dam at Guilford has created a headpond which has altered part of the river's course. At Guilford the flow of the Piscataquis River changes to almost due east/northeast. The underlying bedrock is a limestone. The erosion of this relatively soft unit forms a broad valley which controls the direction of flow of the river for much of its course to its confluence with the main stem of the Penobscot. Between Guilford and Dover-Foxcroft the channel is primarily straight, and flows through alluvium, till, and glaciomarine outwash. East of Guilford, the river parallels the trend of a large esker segment.

East of Dover-Foxcroft the straight channel of the Piscataquis River becomes broadly meandering in a wide valley. Alluvial deposits are the most common sediment type in the valley. At the town of Medford, ten miles west of Howland, the Piscataquis River turns abruptly northward and follows the trend of a large esker for a distance of one mile. After this, the river flows to the southeast in a meandering channel. Several large islands, remains of glacial deposits, are located in the river just west of its confluence with the main stem of the Penobscot River.

Water Quality Concerns

The Piscataquis unit is affected by non-point sources from forestry and agricultural operations. Ninety percent of the area is forested, and an estimated 180 harvesting operations are conducted each year in this watershed. Erosion in or near poorly constructed haul roads, skid trails, and stream crossings contributes sediments to the river thereby increasing the turbidity and silt deposits in the gravely sections of the river. Water quality monitoring, particularly during spring run-off and after storm events, has documented significant turbidity and suspended solids within the river.

The watershed is also subject to agricultural runoffs. More than a dozen livestock farms have no manure storage facilities. Runoff from these sites contributes significantly to the nutrient loading of the watershed. More than 2,000 acres of cropland adjacent to surface waters are highly erodible. Some soils have very coarse texture leading to excessive leaching into ground water. According to Maine 305(b) assessment reports a segment of the Piscataquis River is considered to be in non-attainment of bacteria standards due to untreated wastes from combined sewer overflows. The Piscataquis unit receives treated wastewater from two municipal treatment plants. Excessive macrophyte and algae growth downstream of one of the plants suggests the need for additional treatment controls at the facility. Likewise, low dissolved oxygen levels have been measured in impoundments downstream of the plant. Fish consumption advisories exist within the unit due to high levels of mercury in tissues of some fish species.

Water quality monitoring conducted by Penobscot Nation and a 1998 Waste Load Allocation study by Maine DEP indicate portions of the Piscataquis River between Guilford and Milo are not attaining dissolved oxygen standards. River segments adjacent and below several agriculture areas were greatly impaired by excessive periphytic and metaphytic algae from nutrient runoff. Die-off of algae resulted in odor problems adjacent to the segments. The source of the impairment can be attributed to specific agricultural operations.

Fisheries Issues
As a whole, the Piscataquis River watershed is as important for Atlantic salmon spawning as the East Branch of the Penobscot. In particular, the Pleasant River sub-unit and the Piscataquis River above Guilford provide excellent spawning habitat. Currently Atlantic salmon populations are not attaining self-sustaining restoration goals and are heavily supported by stocking of hatchery-reared juveniles. Factors from within the Piscataquis watershed that prevent anadromous species populations from attaining self-sustaining levels include the presence of four dams downstream of the reaches that contain the high quality spawning habitat and nonpoint source pollution from forestry and agriculture. Low diurnal dissolved oxygen levels in segments of the Piscataquis River impair the biological communities resident to those segments.

Lower Penobscot River

Cultural Values
The lower Penobscot River unit contains Indian Island, the longtime seat of the tribal government and main residency for Penobscot people. Indian Island is the center for tribal traditional and cultural activities. Currently tribal members are unable to exercise traditional and legally protected rights to fish for sustenance without fear of consuming contaminated fish. Additionally many Penobscot people fear conducting other traditional activities such as gathering and consuming fiddlehead ferns, medicinal plants, and muskrat. Native migratory fish including salmon, shad, eels and alewife are no longer available in numbers that would allow the tribe to fish for these species.

Geological Setting
The lower Penobscot River extends from the junction of the East and West Branches of the Penobscot near the town of Medway south to Penobscot Bay, a distance in excess of 100 miles. Downstream of Medway, the river channel is straight with a few islands and the uppermost portion is ponded by the Mattaseunk Dam. South of the Mattawamkeag River, the river widens and contains varied islands. The alluvial islands are elongate in shape and low in relief. The bedrock islands are higher and are more irregular in shape. Several rapids occur at bedrock outcrops. Near the confluence with the Piscataquis River, the West Enfield hydroelectric dam controls the Penobscot. Banks are gravel, sand, silt, and clay. A few miles upstream of Indian Island, the river changes

dramatically and divides into a west side channel, the Stillwater River. Exposed bedrock in both channels creates rapids which have been used for hydroelectric power generation. South of Orono, the river flows in a bend around a large glaciomarine/glaciofluvial deposit at Eddington Bend, a large set of rapids which now serves as the base for a hydroelectric dam and generating station. From Bangor south the river is tidally influenced for the last 30 miles.

Fisheries Issues

The biological integrity of the Penobscot River has been greatly degraded. Segments of the river which were at one time free-flowing are now impounded by several dams. The dams impede upstream and downstream migration of anadromous fish including Atlantic salmon, shad, alewives and eels because of inadequate fish passage.

There exists concern regarding thermal loading from throughout the entire Penobscot River watershed (including tributaries) and the migration and resting behaviors of mature adult salmon while returning to spawning grounds. During average and warm summers, the lower Penobscot River regularly reaches temperatures that approach or exceed the lethal tolerance of the species. There is a strong likelihood that some adult salmon succumb to lethal or sub-lethal effects of lower Penobscot water temperatures during most summers. Although most of the deaths are likely never documented, there have been at least two cases where salmon mortalities have been documented and attributed to lethal water temperatures. The sources of human induced warming originate from at least four areas: logging practices that change surface runoff and groundwater hydrology, additions of color from paper mill effluents which increase absorption of energy from the sun, impoundment of free-flowing reaches for hydropower discharge, and point source thermal discharges.

Water Quality Concerns

Because the lower stretches of the Penobscot River receive water from all the above-mentioned units and because it is the highest order segment of the watershed, it has the most degraded water quality. Most of the Penobscot River unit (56 miles) is not attaining its designated use of fish consumption due to dioxins and furans present in fish tissues. The source of the dioxin and furan contamination is from two kraft pulp and paper mills that discharge into the river. Additionally, co-planar PCBs and mercury have been identified at unsafe levels in fish tissues.

HoltraChem, a chlor-alkali plant located in the lower Penobscot River, is the largest source of mercury in Maine. Sediments located downstream of the plant contain the highest concentration of mercury in Maine and possibly the country. The plant is licensed to discharge mercury directly into the Penobscot River and is licensed to release mercury into the air.

It has also been determined that threatened bald eagles are impaired by discharges within the Penobscot River. The U.S. Fish and Wildlife Service determined that the reproductive rates of bald eagles have been and will continue to be impaired by the discharge of dioxin and furans from one of the pulp and paper mills located on the river.

According to Maine 305(b) reports and Penobscot Nation data, several segments of the Penobscot River watershed do not attain bacteria standards due to discharges of untreated residential and municipal combined sewage overflow wastes. Several tributaries to the Penobscot River do not attain water quality standards for dissolved oxygen because of agricultural activities.

Sampling conducted by Penobscot Nation indicates that the diversity of aquatic insects within the river may also be negatively affected by impoundments. Diversity of aquatic insect life was greater between free-flowing river segments than between impounded sites.

Results

Synthesis of cultural, geological, fisheries, and water quality information for each of the sub-drainages within the Penobscot River Basin provides a more complete picture of water resource conditions and supports Penobscot Nation efforts to determine restoration priorities. Tribal restoration and protection priorities are based on the severity of water resource impairments, along with the risks they pose to tribal health and culture.

The lower Penobscot River sub-drainage is the highest restoration priority for the tribe for the immediate future because of its level of impairment and associated risk and importance to the tribe. Concentrations of dioxins, furans, PCBs, and mercury in the lower Penobscot River provide significant risk to tribal members who choose to exercise sustenance fishing rights. Lack of adequate upstream and downstream fish passage at dams within the Lower Penobscot prevent sustainable populations of anadromous species including salmon, shad and alewife from being established within the entire Penobscot River basin. These impairments are governed by regulatory processes for dams and discharges. Thus, management priority will be given to restoration projects that support Penobscot Nation involvement in assessing and documenting the impacts of dams and discharges on tribal resources.

APPENDIX A - 2

Recorded Speech by Penobscot Nation Elder Butch Phillips

The speech transcribed below was given at the 3rd Annual New England Tribal Environmental Training Conference on March 29, 2000 in Hyannis, MA

Good Morning, again. The Penobscot River, as most of you know is very important to the Penobscot People. During the last few days you have seen slide shows, computer generated pictures and various reservations and land zonings within Indian Territory. We saw the beautiful map of the Vineyard and we've been down East Maine, Northern Maine and down the Penobscot River. You've seen the visual effects of modern technology bringing you Indian Country. I'd like to take a few moments this morning and bring you the traditional way, the oral history, tradition of our people when we talk about our lands. In the older days the oral history was very important. It set the stage for teaching our children right and wrong. In the cold winter months, deep in the woods of Maine, in the snug Wigwam there'd be a fire in the middle, people and children would sit around the fire, in a circle, much as we are here today and the elders would tell the history of the people. There are many stories, these stories dealt with the way our people lived. Stories of power, forces of nature, power of the medicine people, animals, good and bad spirits, there were many spirits and the force behind the power.

All the stories began long ago, with some spanning 1000 years, but when the story was told, people had the perception that the story could have been only a couple days ago or for a lifetime of the storyteller. Time was not a factor. The stories always began around the fire of the elder "jix a dowie" Listen to me. The stories were of the things gained by traveling and living on the river. They gained their sustenance from the living being, our river, which flowed around our central high place in our aboriginal land, K'tadn. This went on for along time. The people were very happy, as were the ancestors and the spirit, because the people respected the land and took care of it. The land had to be taken care of, the spirits had to be appeased because it was the land, the spirits and everything there that provided for the well being and the livelihood of the people. Then one day, change came, the people from Europe, the Europeans, and overnight, change came. All of a sudden there were villages springing up along the Penobscot River. Where once there were Indian villages with an occasional canoe going by a spot, now from shore to shore was clogged with logs from the white man taking our timber and sending it down river for lumber to build ships.

Where once the beaver built his dam on the tributaries, to assist the travel of canoe by our people, now huge dams were built to impede that canoe travel. Where once our people enjoyed a free flowing cool, pure river, now had become clogged with pollution generated by those towns and later the mills on the Penobscot River. Where once my people enjoyed a carefree environment, was now being destroyed. Where once multitudes of moose and caribou and all the animals provided for the people, the change had come. The caribou and people were gone. The eagles and osprey flew away. The salmon, shad and alewives, they didn't come because they couldn't get over the dams to come up to reservation lands. Along with that change came changes to the way of life and traditions for the people, as well. In the olden days when there were troubles among the tribes the people would call out to our cultural hero Gluskabe. We called out to Gluskabe, "We need your help, these people have this strange power. This power to destroy and change our people. We need you, We need you, come help us." But the power was so strong by the people who had came, Gluskabe knew his power, his medicines couldn't overcome that.

Gluskabe never came. At this point in time, what could the people do? Their medicines didn't work anymore; Gluskabe was gone away; all the animals were gone away; the people had pulled back from the river because they couldn't drink the water anymore. They couldn't fish anymore. The leaders of the tribes got together and decided to call upon the powers of the white man. Let's go to Augusta, to the State of Massachusetts first, then to Augusta; the power of the legislature. They did that but they were ignored. They didn't listen to the people and the river became more and more polluted to a point when I was a child on the river there was no more than open sewer. I didn't know any better, I still swam in that river, I still drank that water and ate the fish, not knowing the tremendous dangers that were within the river. And because our voices fell on deaf ears within the state we had lost our last chance of saving the river. We had no power. We were powerless at that time, and the state ignored us. Then there was good news as well. There was more change. In 1954 there was the Federal Governments River Pollution Act. In 1960 the Fish Restoration, as you all know in 1972 the Clean Water Act came about. In all this time we were appealing to the State of Maine, "Use your power to help us."

They ignored us. Only when the Clean Water Acts came along, which was generated by the Federal government did the state act because it got some money. Only then did the Penobscot Nation still look at their river and they wept and their ancestors wept. At this time in our history the only pure water within our river were the tears of our ancestors as they wept. The river that they had preserved for us, for our future generations, slowly, because of the federal programs, began to clean itself. Our dealings with the state of Maine, our history with the state of the Maine, have not being very good. They have not treated the Indian people with the honor that we deserved, we were not given the respect that we deserve. When we got Federal recognition, the state of Maine still did not recognize us nor appreciate us, as the aboriginal people in this area. We have made great strides in the past 25 years. Along the Penobscot River is has only been the last ten to fifteen years that the water has become the pure, the fish, the salmon, the eagles, and the osprey have all come back to the river, but, the ancestors still weep because they know what we did not know when I was a child, that there are still unseen dangers along the river. That there are still unseen poisons in that river. They are taking the lives of our people, killing our people, just like my ancestors died hundreds of years ago.

That is where we are at today. The cleaning of the Penobscot River must take place now. We must take steps to get rid of the unseen dangers. As an elder, I stand up. Here I speak for my people, most importantly, I speak for my ancestors. As a leader of my tribe when I took my oath of office I had to take the responsibility of my ancestors, my people, the present day people, and the future generations. I can speak for my ancestors. I can warn my people living there today not to eat the fish, but, who will be here to speak to future generations? Who will warn my grandchildren? My great grandchildren? Those children seven generations out? The Penobscot people now, by themselves are powerless because we do not have the power, nor the resources, to bring back the river to where it once was many generations ago. That power lies here in this room, only with you, the government, the federal government with the funds and the influence can speak for our children. You can make this happen, through this project, so that our children of the Penobscot River can once again enjoy the sustenance. What good is having the right to the river when you exercise that right by eating the fish and put your health very likely in danger? So on behalf of my ancestors, on behalf of my grandchildren, on behalf of the future children of the Penobscot people I am appealing to you, the partners, in the EPA and the federal government, to work together with the Penobscot Nation on this project to bring back this river.

APPENDIX A - 3

Excerpts from Recorded Interviews in the River Video

Excerpts from the video produced by Penobscot Nation in 1995 titled, Penobscot: The People and Their River, *distributed by the Penobscot Nation Museum. history.*

PRISCILLA ATTEAN
There's a certain amount of personal peace by being close to the river. It's something I grew up with. It was part of my upbringing. I lived here before there was a bridge to the mainland. We kids swam in it, polluted as it was. We skated in the winter. We used the river for everything. Everything.

JERRY PARDILLA
I think that this river really is the backbone of who we are as a Nation. Our name is derived from the description of the land here in this region. And the river that flows through it bears our name or we bear its name. And so then we would call ourselves "Pana'wampskik." We are people of that place.

GENE LORING
I love the river. It was the means of our ancestors long ago, of life.... Like the salmon that came up through ... We depended on them.... And we depended on the game...deer, moose, partridge... That's who we depended on for our lives, our livelihood.

PRISCILLA ATTEAN
The river has always been our lifeblood if you will. It's been the highway between here and there. The roads to our hunting grounds and our fishing grounds. We didn't have any U.S. 1 going down to the coast. We used the river.

ALASKO GLOSSIAN
Every day I look at this water and know that my ancestors traveled this river... that the water provided the sustenance for my people. The overflowing banks in the spring provided the water for the fiddleheads, for the animals, up and down (stream). I do some trapping on the river here and it's a very spiritual thing for me because the very animals I trap are descendants of the very animals that my ancestors trapped and used.

BARRY DANA
It just seems to me, the river being as natural as it is, should have the right to move freely in the course it was (intended). The glaciers created this land - the water moves in accordance to it and should be allowed to do so. Having canoed down and up it is really disturbing to come to such an obstruction as a dam...

PRISCILLA ATTEAN

There's always environmental issues. And now there will be an important one that I expect will surface next year. .. Clearly there's a danger to the public health. The tiniest amounts of dioxin into the food chain in the river can only contribute to the problem.

BARRY DANA
We've got people dying of cancer all the time. There's got to be a connection with just being near the river, if not drinking it and eating the fish. There's a real sickness involved to the river right now because of the pollution. So I'd like to be able to enjoy it much more than just going our for an hours paddle. Being on the water in a healthy sense would feel a lot better than fearing splashing water up off your paddle onto your hands or onto your face.

PRISCILLA ATTEAN
I remember growing up here and fishing myself, although I don't fish anymore, and eating the fish and we can't even do that anymore. I think we've lost a great deal of our culture and our identity by not having the river available to the extent it used to be. Our goal is to have no dioxin in the river or any other contaminants.

JERRY PARDILLA
In some ways I see the survival of the Penobscot Nation tied greatly to the vitality of the river. It has given us life. And if we could view it as a living entity, if we could preserve its life, our bond to it and it to us will survive. Improving the river, the river's ability to produce safe foods for us to eat. It also nurtures us. That's one way I'd see as having a special connection to the river. The other is, that we've lived on these lands for thousands of years. When we walk into the cemeteries or on the Earth here we are really walking on the same lands our ancestors did. I think as long as we are here, the river will remain in a more natural state. And that there really are the spirits here. Call them whatever you will. But they are here. In this very place, and there's a responsibility that I feel to make certain that this place will forever be . . . Pana'wampskik.

APPENDIX A - 4

Penobscot Place Names

Indigenous Place names in Penobscot River sub-basins shown on USGS 1:500,000 scale topographic maps

PISCATAQUIS VALLEY
Piscataquis (River)
Sebec (Pond and River and Sebec village)
Schoodic (Lake & Village)
Scutaze River
Seboeis Lake & Stream (and W. Seboeis village)
Onawa (Lake & Village)
Manhanock (Pond)

MATTAWAMKEAG VALLEY
Mattawamkeag (River, Village, Lake)
Molunkus (Village, Stream, Lake)
Macwahoc (Village, Stream, Lake)
Wytopitlock (Village, Stream, Lake)
Mattakeunk (Stream, Pond)
Baskahegan (Stream, Lake)
Mattagodus (Stream)
Skitacook (Lake)
Rockabema (Lake)

EAST BRANCH
Allagash (Stream, Lake)
Telos (Lake)
Matagamon (Lake)
Millimagasset (Lake)
Lunksoos (Lake)
Seboeis (River and Grand Lake Seboeis)

WEST BRANCH
Nollesemic (Llake)
Quakish (Lake)
Nahmakanta (Lake)
Pemadumcook (Lake)
Ambajejus (Lake)
Togue (Ponds)
Third Debsconeag (Lake)
(Mount) Katahdin
Nesowadnehunk (Stream and Lake)
Ripogenus (Lake)

Cuxabexis (Lake)
Umbaxooksus (Lake)
Caucomgomoc (Lake)
Gero (Island)
Chesuncook (Lake and Village)
Seboomook (Lake; Village is in other drainage)
Penobscot (Lake and West Branch Penobscot River)
Millinocket (Lake and Town)

<u>LOWER PENOBSCOT</u>
Mattaceunk (Lake)
Pattagumpus
Medunkeunk (Stream)
Mattanawcook (Pond)
Eskutassis (Pond)
Madagascal (Stream and Pond)
Saponac (Pond)
Passadumkeag (Village and River)
Olamon (Village and Stream)
Mattamiscontis (Stream)
Sunkhaze (Stream and Refuge)
Chemo (Pond)
Kenduskeag (Stream and Village)
North Penobscot
Alamoosook (Lake)

Within Penobscot River Basin there appear to be 93 indigenous (mostly Penobscot) place names printed on the topographic maps consulted, compared to 229 English place names. Indigenous place names account for one fifth of all place names at this map scale. The East Branch has the highest proportion of indigenous names, at almost half. The West Branch drainage ranks next, at closer to one third. The Piscataquis, Mattawamkeag, and lower Penobscot have closer to one fifth native place names. South of Bangor, enduring tribal names are sparse. Additional Penobscot place names have been documented by Cook (1985), Eckstorm (1978), Siebert (no date), Speck (1997), and Treat (1820).

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Penobscot Basin Place Names Linked to Geology and Landscape

EXAMPLES
Pemtegwatook, the "main river" (the Penobscot River from Bangor down*Penobscot* "steeply inclined ledgy place"
Pannawambskek "where ledges spread out"
Mitanganessuk "head of tide," literally, end of the high tide." (Old First Falls, at Edddington Bend, once flowed out by the Bangor Dam). *Mitan- / metin* - "end of," -*angawessuk*, "high tide." This more recent Wabanaki word, replaced an older Maliseet version, *Wequ'agawaysuk* of the same meaning.

FEATURES (NONSPECIFIC, SINGULAR, NOT PLURAL)
Menahan (island)
Watcho /
Wadjo (hill or mountain)

PLACE NAME WORD BEGINNINGS
pen- (downward) as in *Penobscot*, "steeply inclined ledgy place"
panna- / pem- / -bem/ pehem-/ baam- (extended) as in Pannawambskek, "where ledges spread out"

MIDDLE PARTS OF PLACE NAMES
-ampsk- (ledge) as in *Pannawambskek,* above
-amk- / -umk- (sand) as in *Manumkook,* "sandy islands"
- idjewan- / bedjwan/ -ijiwock (rapids) as in *Kwelbejwanosik*, "where the waters turn where they meet" (describing the area near Orson Island where the Stillwater forks off of the Penobscot), or *Pemjeedgewock,* "falls raggedly dropping down," (later called Treat's Falls, now the site of the breached Bangor Dam)
- esk- / ask (grass or green herbage) as in *Manaskoos,* Green Island
-adene- (hill or mountain)

PLACE NAME WORD ENDINGS
-ek / - ot / -eag (locative endings)
-sik (diminutive locative ending)
- tikuk / ticook (locative for stream) (teguk may mean current or wave)
-tuk (river)
-pawnook / -bawnook (first pond upstream), as in *Saponac*, correctly *Chibanook*
-hunk / -unk (steep rapids or falls) as in *Sededunkehunk* "rapids at the mouth" (referring to the stream that forms the outlet of Fields Pond and Brewer Ponds)
-amkeag (gravel bar or sand beach) as in *Passadamkeag,* "above the gravel bar;" -*kinamkeag* refers to a bed of coarse gravel

Note: This information was derived from the work of Fanny Eckstorm. The more recent works of Frank Siebert should be consulted for greater accuracy.

Penobscot Basin Place Names Linked to Fisheries

ALEWIFE - *MADAMOSWOK, AMASWAK*

The Penobscot word for a single alewife is *madames*, and the plural form is *madamaswok or amaswak* (possibly related to the word *mada,* "comes in," which FEH used in reference to a stream on p. 50) . FEH documents these references to alewives in Penobscot Basin:

> *Madamiscomtis, "plenty of alewives"* (Blackman Stream, outlet of Chemo Pond in Bradley) p. 25.
>
> *Madamascontes* (a tributary to the Penobscot River in Mattamiscontis plantation,) "plenty of alewives." FEH interviewed an old man who remembered settlers carting off alewives from the stream with horse-sleds (she was published in 1941), p. 51.
>
> *Madamaswok*, a former name of Cold Stream in Enfield, p. 48.

SHAD - *M'NAWAMSWAK*

M'nawamswak is the word for shad (plural). No place names in Penobscot Basin were cited. However, an earlier name of French Island (before it was called Treat Island or Webster Island) was Shad Island, p. 30.

(Treat depicted "Shad Rips" on the upper east shore of French Island on his 1820 map).

TROUT

Skootam is the word for trout. *Skutahzis,* or "brook trout stream" is a tributary to the Passadumkeag in Burlington. *Schoodic* Point is located along the Piscataquis River in Medford.

Note: This information was derived from the work of Fanny Eckstorm (FEH). The more recent works of Frank Siebert should be consulted for greater accuracy.

APPENDIX B-1

Summary of Tribal Nonpoint Source Assessment, January 2000

The Penobscot Nation Tribal Trust Lands and the Indian Island portion of the Tribal Reservation were assessed for nonpoint source pollution (NPS). The Trust Lands assessment is considered complete, whereas the assessment of the Tribal Reservation covers only Indian Island in detail, and uses a broader approach to identify the most obvious threats and impairments for the remainder of the Reservation. The assessment distinguishes between NPS problems that the tribe is responsible for, versus problems that will require cooperative efforts with other entities to solve. A series of screening questions were used in the NPS assessment to identify priority waters:

> *Does NPS pollution cause waters to fail to meet current state water quality standards or make it likely to fail these standards in the future?*
>
> *Does NPS pollution cause waters to fail to support tribal beneficial uses (aquatic life support, fish consumption, swimming, boating, aesthetics, cultural and ceremonial, drinking water supply) or is it likely to fail to support these uses in the future?*
>
> *Does NPS impair or threaten a tribally managed fisheries resource?*
>
> *Does NPS impair or threaten Atlantic salmon restoration habitat?*

Our findings revealed that every tribal water body is affected by some form of NPS pollution. Non-tribal sources are responsible for the most serious impairments to water quality, where present water quality standards are not met, or waters fail to support treaty reserved sustenance fishing rights. Threatened waters are those that may not meet water quality standards in the future unless preventative measures are taken.

All tribal waters are impaired because fish contain unsafe levels of mercury for tribal sustenance. Other impairments include algae blooms and degraded fish habitat. Advisories for mercury are present on all tribal waters, and for dioxin and PCBs on 30 miles of the Penobscot River Reservation. Episodic algae blooms affect up to 60 miles of the Penobscot River Reservation. Fish habitat is impaired by flow regulation at Grand Lake Matagamon and the "Back Channel" of the Penobscot River due to excessive dewatering of riparian habitat. Embedded spawning gravels and thermal pollution are additional factors that impair fish habitat for over 100 miles in the Penobscot River. None of these impairments can be attributed to tribal sources. Thus, cooperative efforts will be required to address the problems of atmospheric deposition of mercury, flow regulation, industrial point sources, and cumulative thermal impacts.

Major Findings – NPS Assessment

Type of NPS Impairment or Threat	Water Bodies Affected (Trust Land or Reservation)	Major Contributor (Tribal or Nontribal)
Mercury - Impaired	Trust Land and Reservation (10 lakes, 5 rivers, 32 streams)	Nontribal
Logging Roads – Threat	Trust Lands (21 streams)	Tribal
Junked Car – Threat	Trust Land (1 lake)	Tribal
Riparian Buffers – Threat	Reservation (<1 river mile)	Tribal
Salt Pile – Threat	Reservation (<1 river mile)	Tribal
Shorefront Camps – Threat	Trust Lands (4 lakes)	Nontribal
Algae Blooms – Impaired	Reservation (60 river miles)	Nontribal
Thermal Pollution - Impaired	Reservation (>100 river miles)	Nontribal
Dioxin/PCBs – Impaired	Reservation (30 river miles)	Nontribal

Half the streams at the Tribal Trust Lands are threatened by old logging roads. Without preventive measures by the Tribe, 21 streams will not be adequately protected from sedimentation and nutrient enrichment at their road crossings. Four of the tribe's 10 lakes and ponds are threatened by nontribal shorefront camps that are in need of vegetation buffers, treatment of greywater and removal of dumps. Those actions will require Tribal initiative to gain voluntary compliance from non-Tribal neighbors. One of the lakes will be better protected once the Tribe removes an abandoned car dumped nearby. Some camps that pre-date the tribe's land use plan will require more protective vegetation buffers. On the Indian Island portion of the Tribal Reservation, threats stem from inadequate riparian buffers and an uncovered salt storage pile. Nontribal threats to the Reservation were not assessed as that would have involved reviewing land use practices for one third the state of Maine. It is likely that well over 100 miles of the Penobscot River Reservation are vulnerable to contaminant and erosion threats from industrial, residential, commercial, agricultural, and recreational uses. Towns and highways adjacent to the Reservation should be assessed in the future, including the 104 RCRA/Superfund sites that EPA has listed within Penobscot River Basin.

The Tribe's January 2000 NPS Management Plan provides recommendations for solving problems that were identified in the NPS assessment.

APPENDIX B-2

Penobscot River Water Quality Four Hundred Years of Change

What did the Penobscot River look like before the timber harvests, the sawmills, the log drives, and the factories? It is difficult to go back this far, for the forests of the river basin have been intensely harvested for almost four hundred years. Even though 95% of the watershed remains in industrial forestlands today, we know that the condition of the Penobscot River has changed greatly for at least two hundred years.

We know that cutting of the forests began in the 1700s, and the first dams and sawmills appeared on the river in the early 1800s. We have records to show that industrial discharges from paper mills, tanneries, and textile mills began in the 1870s and worsened until the passage of the Federal Clean Water Act Amendments of 1972. Water quality records indicate that since then, many water quality problems on the Penobscot have begun to improve, although many watershed resources once available to the Penobscot Nation still remain absent, depleted, or contaminated.

The chronology that follows is the start of our effort to piece together the fragments of the river's story, so that we may better see the series of events leading back to the Penobscot River in its natural state. You will see that there are large gaps in the story, but this is just a beginning. We have relied on general summaries of Penobscot River water quality conditions prepared by the Four Rivers Working Group (1995) and Siek and Dubey (1986). We have divided the story of the river into three time periods: Pre-Industrial, Industrial, and Post-Clean Water Act.

Pre-Industrial

Few records describe the condition of the Penobscot River before the earliest logging, sawmill, and damming operations began, save for the observations of the commercial ice cutters who were said to prize the excellent taste and clarity of Penobscot River ice, even long after the milling operations began. We do have the stories of the abundant fisheries, and evidence for tribal traditions that relied on the presence and abundance of certain aquatic plants and animals. Information about ecological conditions of the pre-industrialized river continues to emerge from archaeological test-pits, and from the corings done in lake sediments and peat bogs by the paleo-ecologists. All of this historical and ecological information has yet to be compiled in one place. It is difficult to place a date at the time the pre-industrial conditions ended, and the industrialization of the river began, but it may be appropriate to place this date sometime during the 1700s.

Industrial

The first dams in the Penobscot River basin were constructed in the 1820s for sawmills, which produced sawdust and wood waste until the 1870s when the lumber industry declined. Then pulp and paper mill wastes were released. (The Penobscot River Study Team, *in* Four Rivers Working Group)

1888 The Commissioner of Fisheries and game protested releases of industrial wastes to the Penobscot because of the decline in the salmon run caused by paper mill effluents (Penobscot River Study 1972 *in* Four Rivers Working Group).

1904 WC Kendall visited the junction of the East and West Branches and observed waste paper pulp material coating the bottom, and shrubs and bushes of the main river and West branch (Kendall, 1935 *in* Four Rivers Working Group).

1918 The Maine Public Utilities Commission reported pulp and paper developments at Millinocket, Dolby, East Millinocket, Lincoln, Howland, Enfield, Orono, and Great Works in Old Town (State of Maine, *in* Four Rivers Working Group).

1946 Autopsy results revealed that salmon had reportedly been killed by acid, presumably from industrial wastes (Pratt, 1946, *in* Four Rivers Working Group).

1954 The cumulative effect of all the industrial and domestic sources discharge into the river was a biochemical oxygen demand equivalent o the domestic sewage produced by a population of 2,475,920 (New England - new York Inter-Agency Committee, 1955 *in* Four Rivers Working Group).

1956

Cutting reported that river bottom accumulations of wood fibers were abundant in the upper Penobscot down to and below the Mattaseunk Dam, with problems in areas of heavy concentration and slow current between the Salmon Stream confluence and Mattaseunk Dam, causing excessive decomposition when the water temperature rose. Masses of wood fibers floated into and clogged the meshes of a fishing net (Cutting, 1956 in Four Rivers Working Group).

1959

Other industrial discharges cited in addition to pulp and paper wastes included sawmills, woolen mills, slaughter houses, shoe factories, shoddy mills, tanneries, meat packing plant, bottling plants, dairies. Domestic sewage effluents were also largely untreated (Cutting, 1959 *in* Four Rivers Working Group).

1963

Two additional mills were developed at Brewer and Bucksport (Cutting, 1963 in Four Rivers Working Group). The increase in pulp production capacity alone caused Cutting to estimate that the BOD had increased to an equivalent population of 2,750,000 in 1963, compared to the 1954 estimate.

Post- Clean Water Act

1979 U.S. Geological Survey begins to monitor flow, temp, pH, and conductivity in Eddington, about one half mile below the Veazie Dam (Siek and Dubey, 1986).

1982 Maine Rivers Study finds that the wastewater controls and cessation of log drives have dramatically improved water quality. Portions of the river and its branches are cited to be outstanding geologic, hydrologic ecologic, scenic fisheries, boating, canoeing resources (Maine Dept of Conservation and U.S. National Park Service, 1982 *in* Siek and Dubey, 1986).

1984 NOAA reports on Maine enforcement record in water pollution control reports that Maine's performance is not strong. (Siek and Dubey, 1986).

1986 Maine Legislature amended state surface water classification system and adopted more stringent surface water "use" classifications to be approved by EPA. State legislation also enacted WQS amendments applicable to hydroelectric project development ME Pub. L., 112th Leg., Ch. 772, L.D. 2107. EPA responded that the statutes were not in compliance with federal criteria because they did not protect underlying use designations previously approved for the waters of the state and allowed for a variance procedure where water quality standards could be reduced to allow for existing or proposed hydroelectric power development. Because the new WQS did not comply with the CWA, EPA formally withdrew the state's authority under section 401 of the CWA to certify the water quality standards compliance of hydro-electric projects (Siek and Dubey, 1986).

1986 EPA issued national Pollutant Discharge Elimination System (NPDES) permits to twelve point sources on the Penobscot River from Old Town north to East Millinocket. Several municipalities are discharging untreated sewage into the river in apparent violation of the Clean Water Act (Siek and Dubey, 1986).

1986

Maine DEP Waste Load Allocation for the Lower Penobscot River.

1990

Water Quality at several sites failing to meet water quality objectives. Sebec River in Milo fails to meet class C standards for bacteria due to untreated residential discharges. Piscataquis River between Guilford and Medford the same. Eight miles below Guilford fail to meet class C aquatic life standards because of discharges of untreated municipal and industrial wastewater (prior to construction of secondary treatment plant). Piscataquis in Howland not meeting Class C because of untreated municipal wastewater. Periodic bacteria problems below Veazie. (U.S. Army Corps of Engineers, 1990)

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APPENDIX C

Summary of Anadromous Fish Passage Facilities at Penobscot River Hydropower Dams

Prepared March 1999
by Clem Fay,
Fisheries Manager,
Penobscot Nation

Scope and Applicability of Fish Passage Summary Table

Except for the Guilford Industries Dam, which is not a FERC project (included because it obstructs anadromous fish passage in a main subdrainage of the Penobscot), this summary addresses **only fish passage issues for anadromous fish at existing FERC-licensed or FERC-exempted projects within the river zones currently targeted for anadromous fish restoration**. Thus, the proposed new Basin Mills Dam (license has been denied by FERC but decision is under appeal), all dams on the West Branch Penobscot (no current anadromous fish restoration plans), the Matagamon Lake Dam (storage only), and all smaller, non-FERC dams located on tributary waterbodies in the watershed, are not addressed in this summary. In addition, fish passage needs for resident fish, or for the catadromous American eel (which need special fishways that differ from those for anadromous species), are not addressed, regardless of whether or not the dam is included in this summary. Finally, this summary does not address other fisheries issues at these FERC projects, such as minimum flows in bypass reaches (dryways), fish tissue contamination, water temperature issues/impacts, etc..

Definitions and Explanations of Column Headings and Information Codes

(not including "problems" and "additional notes" columns/codes which are defined immediately below the spreadsheet)

Drainage: **PASSAD** = Passadumkeag R.; **PEN** = Mainstem Penobscot; **PEN(SW)** = Stillwater Branch Penobscot R.; **PISC** = Piscataquis R.; **SEBEC** = Sebec R..

FERC Licensing Status: PST = Post-licensing Phase; **PST-A** = Post-licensing Phase with Licensing Orders under appeal by one or more parties; **PRE** = Currently in relicensing proceedings; **EXE** = FERC Exemption (a special license for small facilities, with NO EXPIRATION date, and with only LIMITED OPPORTUNITY to mandate fish and wildlife mitigation or enhancement measures, including fish passage).

Fishway Type: **VSL** = Vertical Slot Fishway; **DEN** = Standard Denil Fishway; **PWO** = Pool, Weir, and Orifice Fishway; **SPDEN** = Steeppass Denil Fishway; **SLU** = gated sluiceway, originally installed and used for passing trash/ice through dam; **WEIR** = Surface Bypass/Overflow Weir(s) along forebay trashracks; **SPL** = dedicated spillage, usually provided through one or more downed flashboards.

Ratings ATS/CLU: **Fishway Quality Ratings** are provided for upstream facilities only, for Atlantic Salmon (=**ATS**) and Clupeids (=**CLU**, a collective term for both American Shad and Alewife). Ratings often differ between salmon and clupeids because of differing swimming capabilities, life history requirements, and migratory behavior. Ratings are based on a scale of 1-10 (1=worst) and represent the collective consideration of all anadromous fish passage issues and needs at each site, as well as pertinent cumulative (i.e. entire restoration watersheds) fish passage issues. All ratings reflect the status of these facilities as of 3/3/99, and may change if/when new licensing conditions are implemented. Ratings are not provided for downstream facilities because the science and engineering is still being developed, and we have yet to see a facility on the Penobscot that attains the required passage efficiency goals (including West Enfield, theoretically a state-of-the-art facility). Thus, there is no good standard for comparison.

Status: For downstream passage facilities; **I** = Interim; **P** = Permanent.

... fish passage facilities at Penobscot River watershed hydropower dams, with known or suspected problems at each (as of March, 1999). Definitions for problem area numerical codes, and for additional project-specific notes, are provided below. For other column definitions/codes, see reverse.

			Upstream Fishway-Powerhouse				Upstream Fishway-Spillway				Downstream Passage		
Dam	FERC No. & Lic. Status	Drainage	Type	Problems	Addit. Notes	Ratings ATS/CLU	Type	Problems	Addit. Notes	Ratings ATS/CLU	Type	Status	Problems
Veazie	2403/ PST-A	PEN	VSL	3,4,5,6,9	VZ-1	6/3	NONE	8			SLU	I	5,11,12
Great Works	2312/ PRE	PEN	DEN	2,3,4,5,9	GW-1	4/1	DEN	2,3,4,5,6,9	GW-1	3/1	SLU	I	5,11,12
Milford	2534/ PST-A	PEN	DEN	2,3,4,5,7,9	MF-1	5/2	SPDEN	2,3,4,5,6,7,9	MF-2	2/1	WEIR	I	11
Orono	2710/ PST-A	PEN (SW)	NONE		OR-1		NONE	8	OR-1		SPL	I	
Stillwater	2712/ PST-A	PEN (SW)	NONE	1			NONE	8			SLU	I	5,11,12
West Enfield	2600/ PST	PEN	VSL			10/8	NONE				WEIR	P	5,10
Mattaceunk	2520/ PST	PEN	PWO	2,3		7/1	NONE				WEIR	P	5,10
Howland	2721/ PRE	PISC	DEN	2,3,4,5,7,9		4/1	NONE	8			SLU	I	5,11,12
Browns Mills	5613/ EXE	PISC	NONE	1,9			DEN	5,6,7,9		3/1	SLU	P	11,12
Upper Dover	5912 / EXE	PISC	DEN	6,7,9		7/1	NONE				NONE		
Guilford Ind.	NONE	PISC	DEN	6,9		7/1	NONE				NONE		
Milo	5647/ EXE	SEBEC	NONE	1?			NONE				NONE		
Sebec	7253/ EXE	SEBEC	NONE	1?			NONE				NONE		
Pumpkin Hill	4202/ PST	PASSAD	DEN	2,3?,9		7/2	NONE				NONE		

Problem Areas:

1 = A powerhouse upstream fishway is or may be (=?) needed at this site to meet PIN and agency fish restoration goals.

2 = Fishway is of inappropriate type for passing shad and/or alewives at targeted passage efficiency goals.

3 = Fishway is or may be (=?) of insufficient capacity for targeted restoration populations of shad and alewives at this site.

4 = Fishway trapping, counting, or other monitoring facilities are needed but are absent or inadequate.

5 = Fishway attraction flow is insufficient or improperly located.

6 = Fishway entrance locaton is less than optimal for attracting target species.

7 = Fishway not fully operational at high river flows.

8 = Frequent spillage at facility warrants separate spillway fishway and/or spillway entrance to powerhouse fishway.

9 = Attraction and upstream passage efficiency has not been adequately studied.

10 = Downstream bypass efficiency has been studied but passage goals have never been achieved.

11 = Downstream bypass efficiency has not been adequately studied.

12 = Downstream facility does not fully meet USFWS design criteria for target species/populations.

Additional Project-specific Notes:

VZ-1: Because this is the first dam encountered by upstream migrating anadromous fish and has two power plants, a second powerhouse fishway is needed, in addition to improvements in the existing one.

GW-1: In addition to the problems cited, both the powerhouse and spillway fishways at this site are either only partially operational, or non-operational, when the flashboards are down. Boards are typically down for substantial periods between May 1-June 30 each year, which includes the shad and alewife migration and much of the early-season salmon run.

MF-1: The Milford Project also includes the non-generating, partially breached Gilman Falls Dam on the Stillwater Branch. Because of the significant breach, fish passage is not a serious concern at this dam.

MF-2: The steeppass Denil fishway at this dam is not PIN/agency approved, and is solely an effort by the licensee to circumvent the need for more formal and appropriate spillway fish passage at this dam.

OR-1: The Orono Project was recently taken off-line due to deteriorating project facilities, and all inflow now passes over the spillway. While ideal for downstream passage, it also warrants full and formal upstream passage facilities at the spillway segment. If this project is ever re-developed, a powerhouse upstream fishway would be required.

APPENDIX D - GEOLOGY

Geomorphological Characterization of Selected River Channels in Penobscot River Basin

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West Branch Penobscot River (WB)
East Branch Penobscot River (EB)
Seboeis Stream (SB)
Penobscot Main Stem (P)
Mattawamkeag River (MR)
Piscataquis River (PQ)
Pleasant River (PL)
Sebec River (SE)
Passadumkeag River (PD)

Prepared by:
Alice Kelley, Steve Toth, and Tammis Coffin, April 1998

WEST BRANCH OF THE PENOBSCOT RIVER - WB

River Segment	Valley C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf-Glaciofluvial; T - Till; A - Alluvial R	 Gm	 Gf	 T	 A	Comments
WB1	c				T		up to the outlet of Dolby Pond
WB2	c			Gf	T		up to Shad Pond; ribbed moraine
WB3	c			Gf	T		up the dewatered "back channel" - the true course of the Penobscot River
WB4	impoundment						up through Quakish Lake through Twin Lake to Ambejejus Lake inlet
WB5	impoundment				T		up to the top of the Debsconeag Deadwater
WB6	c				T		to Nesowadnehunk Falls near Appalachian Trail
WB7	m				T	A	to Big Eddy below the Cribworks
WB8	c	R					to Ripogenus Dam
WB9	impoundment						Chesuncook Lake up to where the West Branch narrows above Pine Stream flowage
WB10	m				T	A	W. Branch inlet of Chesuncook (Ragmuffin Stream)
WB11	m				T		to Elm Stream; plus lake deposits, fine grained
WB12	m	R			T		through Seboomook Lake up the North Branch to upstream of Pittston Farm
WB13	m				T		South Branch to Canada Falls Lake Dam

PENOBSCOT RIVER - EAST BRANCH - EB

River Segment	Valley C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf-Glaciofluvial; T - Till; A - Alluvial R	 Gm	 Gf	 T	 A	Comments
EB1	M		Gm	Gf	T	A	from confluence with main stem in Medway up to Meadow Broook Rips
EB2	M	R		Gf	T		Meadow Brook Rips, Crow Foot Falls almost to Hay Brook
EB3	M			Gf	T		up to Deer Island; esker and outwash
EB4	U			Gf	T	A	up to Whetstone Falls
EB5	M			Gf		A	; broad alluvial valley
EB6	U			Gf		A	past Monument Line on map - CHECK; alluvial valley narrows
EB7	M			Gf	T		to near (almost to? Little Messer Pond - CHECK; esker
EB8	M			Gf		A	to small wetland - REEXPLAIN; esker
EB9	U			Gf		A	to the "t" in East on the map REEXPLAIN
EB10	U			Gf		A	to dam at outlet of Grand Lake Matagamon; outwash

SEBOEIS STREAM -SB (in East Branch sub-basin)

River Segment	Valley C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf-Glaciofluvial; T - Till; A - Alluvial R	Gm	Gf	T	A	Comments
SB1	m					A	Seboeis Stream from East Branch Penobscot confluence up to Moose Brook
SB2	c					A	Seboeis Streamup to Gagnon Flat
SB3	m					A	Seboeis Stream up to Jerry Pond
SB4	c					A	Seboeis Stream up to 1 km above Shin Brook
SB5	vc				T		Seboeis Stream up to Hobart Brook
SB6	m			Gf	T		Hobart Brook to Whitehorse Lake: has esker

PENOBSCOT MAIN STEM - P

RivSeg	Valley C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf-Glaciofluvial; T - Till; A - Alluvial R	Gm	Gf	T	A	Comments
P1	c	R	Gm		T		Tidal
P2	c	R	Gm		T		Below Veazie Dam
P3	c		Gm		T		Above Veazie Dam
P4	c	R	Gm	Gf	T		to Stillwater branch
P5	c	R	Gm		T		below Great Works dam
P6	c	R	Gm				below milford dam
P7	U	R	Gm			A	Indian & Orson Islands
P8	c	R	Gm				above Orono dam
P9	c	R	Gm	Gf			above Stillwater dam
P10	U	R	Gm	Gf		A	below Passadumkeag R
P11	c	R	Gm	Gf		A	below Piscataquis R
P12	c		Gm		T	A	above Howland Dam
P13	c		Gm	Gf			below Mattanawcook I.; esker
P14	c		Gm		T		below Mattawamkeag R
P15	c		Gm	Gf			below Medway forks

MATTAWAMKEAG RIVER - MR

River Segment	Valley C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf-Glaciofluvial; T - Till; A - Alluvial R	Gm	Gf	T	A	Comments
MR1	c	R	Gm		T		from Penobscut River up to Stratton Rips
MR2	c	R	Gm		T		up to Gordon Falls
MR3	m			Gf	T		up to Rocky Brook; esker
MR4	m			Gf	T	A	Very low gradient for about 30 miles; swampy until east/west confluence
MR5	m				T	A	East Branch Mattawamkeag follows an esker all the way to Smyrna Mills
MR6	m			Gf	T	A	West Branch Mattawamkeag through Mattawamkeag Lake, Island Falls, all the way to Bradford Brook in Moro Plantation; esker
MR7	c	R			T		West Branch headwaters up to Rockabema Lake

PISCATAQUIS RIVER - PQ

River Segment	Valley C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf-Glaciofluvial; T - Till; A - Alluvial R	Gm	Gf	T	A	Comments
PQ1	U		Gm		T	A	above Penobscot River; some aeolian deposits
PQ2	U			Gf		A	above Lowell Is
PQ3	U					A	above Hardy Brook?
PQ4	C				T		includes rapids, to near Scutaze Stream; entrenched; 100 foot bluffs
PQ5	M			Gf			to river bend at Schoodic Stream
PQ6	M?			Gf?			to Little Schoodic Stream
PQ7	M		Gm		T	A	to above rapids; bluffs, point bars, floodplain
PQ8	M	R				A	to Pleasant River, includes rapids; low banks

PISCATAQUIS RIVER - PQ

River Segment	Valley Confinement C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf-Glaciofluvial; T - Till; A - Alluvial					Comments
		R	Gm	Gf	T	A	
PQ9	U					A	above Garland Pond stream; meander scars
PQ10	M				T	A	to above Dover Foxcroft; urban
PQ11	C				T		Dover Foxcroft; urban; falls
PQ12	M			Gf	T	A	to Snagerville, includes RR trestle, Salmon Stream Confluenc no meander scars below Lows Bridge
PQ13	M				T		Guilford; along esker
PQ14	U			Gf			Above Monson Junction; meander scars

Segment Number	Valley C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf-Glaciofluvial; T - Till; A - Alluvial					Comments
		R	Gm	Gf	T	A	
PQ15	M				T		above rapids; LIMITED POINT BARS
PQ16	C	R					to Parrot Village area
PQ17	U			Gf			to Blanchard; meander scars
PQ18	C				T		to unnamed stream off Breakneck Ridge
PQ19	U			Gf		A	includes east west fork
PQ20	C	R			T		east branch below unnamed brook
PQ21	M						east branch below Bear Pond Br.
PQ22	U						below Shirley Pond
PQ23	C						west branch rapids along Brink Ridge
PQ24	C	R			T		up near Marble Brook; narrow valley
PQ25	C	?		Gf	?		Hatch Falls - Bedrock or Till?
PQ26	U	R			T		below Shirley Bog

General Comments: River runs east west and cuts across many geological formations; hence many units

PLEASANT RIVER - PL (in Piscataquis sub-basin)

River Segment	Valley C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf-Glaciofluvial; T - Till; A - Alluvial R	Gm	Gf	T	A	Comments
PL1	u					A	Pleasant River upstream from confluence with Piscataquis River where valley narrows north of Milo village
PL2	c		Gm	Gf			Pleasant River up above the Brownville RR bridge about 600 m., near unnamed tributary on east shore
PL3	m		Gm			A	Pleasant River up to the east and west forks, Brownville
PL4	m				T		W. Branch Pleasant River up to outlet of Silver Lake
PL5	m	R				A	W. Branch Pleasant River up to The Hermitage
PL6	c	R					W. Branch Pleasant River trending nw to Bear Brook
PL7	m				T		W. Branch Pleasant River up to source (Big Lyford Pond)
PL8	m		Gm	Gf	T		E. Branch Pleasant River up to Ebeemee Lakeoutlet
PL9	u				T		Ebeemee Lake
PL10	m			Gf	T		E. Branch Pleasant River above Ebeemee Lake to Mud Gauntlet brook
PL11	m	R		Gf	T		East Branch Pleasant River up to unnamed brook 1.5 km before Guernsey Brook (which drains B Pond)
PL12	m			Gf			up to source (Big Spring); all in ribbed moraine

SEBEC RIVER -SE (in Piscataquis sub-basin)

River Segment	Valley C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf-Glaciofluvial; T - Till; A - Alluvial R	Gm	Gf	T	A	Comments
SE1	m				T	A	Sebec River from Piscataquis confluence, up above rt 6/16 bridge, Milo
SE2	u		Gm		T		Sebec River, past last river bend in Milo before Sebec town line
SE3	m		Gm	Gf	T		Sebec River, to bridge in Sebec Villageat Sebec Lake outlet
SE4	m				T		Sebec Lake , up to the bridge at Earley Landing
SE5	m			Gf	T		Big Wilson Stream up to fork with Davis Brook (Willimantic)
SE6	c	R				A	Big Wilson Stream up to fork with Thompson Brook
SE7	c	R					Big Wilson Stream headwaters (to Wilson Ponds)

PASSADUMKEAG RIVER - PD

River Segment	Valley C-Confined M-Moderate U-Unconf.	Surficial Geology (banks) R-Rock; Gm-Glacio-marine; Gf- Glaciofluvial; T - Till; A - Alluvial; S - swamp or bog						Comments
		R	Gm	Gf	T	A	S	
PD1	u		Gm				S	from Penobscot confluence up 13 km to Lower Lord Brook
PD2	u		Gm			A	S	up to Eskutassis Stream
PD3	m			Gf				up to Saponac Pond outlet; includes esker
PD4	m		Gm	Gf			S	up to Upper Lord Brook; includes end moraine and esker
PD5	m		Gm		T			up to Grand Falls (very short distance)
PD6	u			Gf	T	A	S	up around 25 km to confluence east/west branch of the Passadumkeag; includes eskers & glacial outwash
PD7	m			Gf	T			up east branch Passadumkeag to Egg Pond headwaters; has an esker
PD8	u			Gf	T			up west branch of Passadumkeag to outlet of No. 3 Pond; has an esker