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life in maine's lakes and rivers

OUR DIVERSE AQUATIC HERITAGE









aquatic biodiversity (noun):
the variety of freshwater life in a region

About the Maine Aquatic Biodiversity Project
In 2000, The Nature Conservancy and the Maine Departments of Environmental Protection and Inland Fisheries and Wildlife initiated the Maine Aquatic Biodiversity Project to evaluate the current knowledge of Maine's freshwater plants and animals. The Maine Outdoor Heritage Fund and the Atlantic Salmon Commission provided additional funding. The Maine Natural Areas Program, U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, University of Maine, Natural Resources Council of Maine, and Sportsmen's Alliance of Maine also served on the project's Science Steering Committee.

This project is the first to pull together what we know about Maine's freshwater biodiversity. Using previously published information as well as data from ongoing or recently completed monitoring and survey programs, the project sought to answer the following questions:

- *What plants and animals live in Maine's lakes and streams?*
- *Are there any patterns to where certain plants or animals are found?*
- *What aquatic species can be found together?*
- *How has biodiversity changed over time?*

And, perhaps most significantly,

- *What are the threats to Maine's aquatic biodiversity?*
- *How can Maine ensure a diverse freshwater legacy for future generations?*

The Maine Aquatic Biodiversity Project focused on lakes and streams, on aquatic vascular plants, insects and other invertebrates, fish, amphibians, and reptiles. While Maine's 600 square miles of wetlands and 116 square miles of estuary are integral to the functioning of many freshwater ecosystems and species, they are not included in this assessment. Information on the biodiversity of wetlands is included in *Biological Diversity in Maine: An Assessment of Status and Trends in the Terrestrial and Freshwater Landscape* published by the Maine Natural Areas Program (1996). Mammals and birds associated with freshwater systems were not covered, nor were microorganisms such as plankton.

This publication is a summary of information contained in the project's far more comprehensive technical report, *Freshwater Biodiversity in Maine* (2008). Access to a selection of data sets and maps of species distributions, as well as a copy of this publication, are available online at www.pearl.maine.edu.

The Nature Conservancy. 2008. Life in Maine's Lakes and Rivers: Our Diverse Aquatic Heritage. Brunswick, ME: The Nature Conservancy. 32p.

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DEPARTMENT OF ENVIRONMENTAL PROTECTION
STATE OF MAINE

1865 THE UNIVERSITY OF MAINE

issues & recommendations

Freshwater biodiversity in Maine is in a natural condition in some parts of the state but already significantly degraded in other areas. However, it is vulnerable almost everywhere.

Major threats include:

a) Introduced plant and animal species. Most non-native and invasive plants are introduced from boats and boat trailers moved between lakes. Most non-native animals are introduced by fishermen either from live bait or by intentional (and illegal) release.

b) Barriers to fish migration, including long-distance travel to and from the ocean, locally between streams, and from lakes to streams and back again. While the most noticeable and publicized of these barriers are dams, the vast majority of the barriers in Maine are caused by improperly installed and maintained culverts where roads cross rivers and streams.

c) Habitat degradation from lost and damaged riparian areas, stream and shoreline alteration, channelization, increased stormwater, and impoundments.

d) Degraded water quality from non-point source pollution, including development in the watershed; runoff from roads, roofs and driveways; soil erosion from agricultural lands, lawns, and construction sites; and a lack of naturally vegetated buffers on shorelines.

What can be done to protect Maine's biodiversity?

Improve understanding of key freshwater ecosystems:

- Develop a state program to identify and track the status of priority waters such as ponds with 100% native species, fishless ponds, and waters with rare species of fish, aquatic insects, freshwater mussels or aquatic plants.

- Expand the state's biological inventory programs to collect data on rivers, streams, lakes and ponds.

Protect native species from invasive species:

- Develop regulations to decrease the likelihood of introductions of species into priority waters.

- Prohibit the importation of foreign aquatic species, educate pet stores and pet owners, garden centers and gardeners, fishermen and bait dealers about the dangers of discarding aquarium stock, waterscaping plants and bait species into natural waters.

- Continue education and funding for enforcement to make sure boaters wash weeds from boats and trailers. Expand revenue sources to maintain and improve invasive species management programs, promote statewide surveys for early detection of invasive species.

Reduce barriers that impede movement by aquatic species:

- Inventory barriers and develop database to facilitate prioritization for restoration activities.

- Target restoration funds to those barriers with greatest biological impact.

- Identify common reasons for improper culvert installation and management, and develop education programs and funding to help towns and landowners rectify problems.

- Work with other states on the Atlantic coast to identify and address key needs of diadromous fish species.

Protect aquatic habitat:

- Strengthen implementation and enforcement of shoreland buffers. Support statewide rules to enhance shoreland protection provisions for smaller streams and ponds.

- Provide towns with training and resources for better implementation of Municipal Shoreland Zoning.

- Support local, regional, and statewide land acquisition organizations that protect shoreland and watersheds from the multiple threats of development.

- Develop list of priority waters with high biodiversity value and incorporate in *Beginning with Habitat* maps and materials for planning use by municipal governments, state agencies and land trusts.

- Direct state and federal programs that support conservation land acquisition such as Land for Maine's Future program, Maine Outdoor Heritage Fund, and North American Wetlands Conservation Act toward projects that encompass waters of high aquatic biodiversity value.

- Create a state-wide program for protection of especially noteworthy and pristine waterbodies as "benchmark" examples of streams and ponds in a natural condition across the diversity of Maine landscapes.

Continue improvements to and maintenance of water quality of all state waters:

- Develop watershed management plans for lakes identified as most vulnerable to impacts from non-point source pollution.

- Support and expand existing volunteer lake water quality monitoring programs. Develop a statewide network of stream-watch programs to help collect data to identify aquatic habitat trends and problems.

I: taking the long view: an introduction to maine's freshwater landscape

Our story begins 13,000 years ago, when the glaciers of the last Ice Age were melting. The glaciers created striking physical diversity in Maine's landscape—granite-capped mountains, deep deposits of sand and gravel filtering freshwater, large lakes, and quick-running streams—but left the area essentially empty of living things. As the ice receded, plants and animals that took refuge in ice-free areas to the west, south, and east migrated back into Maine, following drainages created as the ice retreated and the land surface shifted. In the time scales of geologic history—billions of years—this re-colonization happened very recently. Because Maine was covered in ice for so long, our freshwater landscape is much "younger," and less diverse, than other parts of the U.S. that remained ice-free.

Our northern location places Maine at the intersection of three major ecosystem types (Fig. 1). The mixed hardwood-softwood forest that covers much of the eastern U.S. reaches its northern limit in southern Maine, where it gives way to the boreal spruce-fir forest. These overlapping forest types are influenced by the ocean, which sends salt air drifting westward beyond the coast, and dispatches marine fishes into freshwater rivers to feed and spawn. Some of these fish travel hundreds of miles inland, and some have established landlocked populations that no longer migrate to the ocean. This convergence of "bioregions" leads to greater freshwater biodiversity and unique groups of species in the different regions.

Sandy River, Carrabassett Valley

The glaciers left behind a wealth of water. In terms of total surface area of fresh water, Maine ranks fourth in the nation with about 10% of the state's surface covered in freshwater. The thousands of lakes, tens of thousands of stream and river miles, and hundreds of square miles of wetland are home to a diverse array of plants and animals. Many of these freshwater features are closely linked to our 5,260 miles of coastline.

Sebago Lake is Maine's deepest lake, with a maximum depth of 316 feet. Moosehead is the second deepest at 246 feet.

Lakes

Lakes and ponds cover about 4.4% of Maine's surface area (the terms "lake" and "pond" are used interchangeably in this publication). Maine has over 6,000 lakes—a huge number in comparison to most other states. Our lakes range from large, deep bodies of water like Sebago and Moosehead lakes, to thousands of small,

shallow ponds, mountaintop lakes, bogs, and impounded reservoirs. More than half of the lakes in Maine are smaller than 10 acres. Lakes with different characteristics like size, depth, and water chemistry support different kinds of plants and animals.

For example, lakes have varying levels of biological activity (or productivity). Some lakes are crystal clear and nutrient poor (oligotrophic), some lakes are rich with natural acids that stain the water the color of tea, and some lakes are overloaded with nutrients and green with algae (eutrophic). Most Maine lakes fall somewhere between these extremes (mesotrophic).

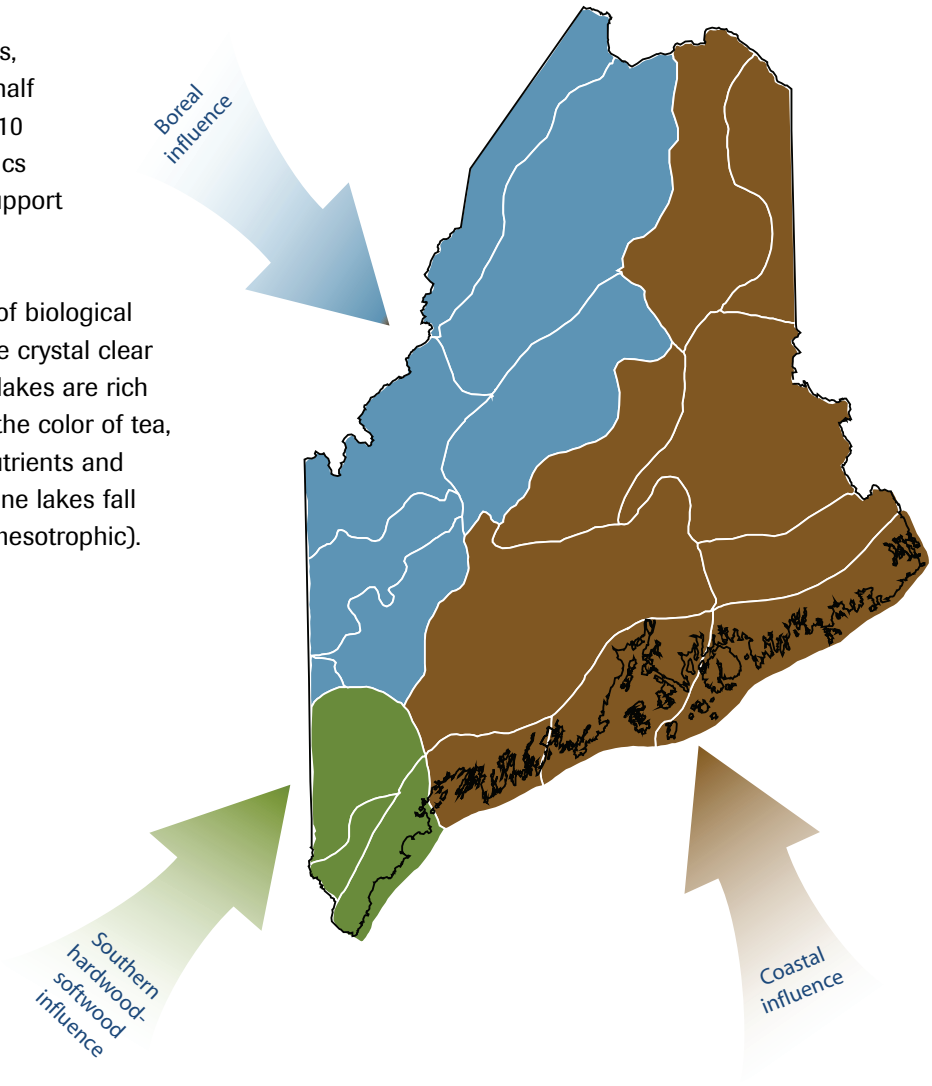


Figure 1: Maine's bioregions (as delineated by Keys)

Seepage lakes, such as this one, are fed by rain and groundwater.

Maine's unique lakes: A few examples

One aspect of biodiversity is naturalness: how many plants and animals in a lake or stream are naturally occurring or original? How many are introduced? Maine's natural diversity developed over the past 12,000 years; most introductions by humans have occurred in just the past 400 years, following European colonization of the Western Hemisphere. Typically, a natural community is distinguished by the plant species composition,

Crater Pond, TB R11 WELS

physical structure (such as forest, shrubland, or grassland), and a specific combination of soil and water chemistry, drainage, climate, and other physical conditions such as slope and elevation. Natural community types of aquatic systems are less well defined, but are usually classified based on the species that are present, and/or location in the landscape.

Habitat loss, water quality degradation, and illegal fish introductions are threats to these unique lake communities.

High-elevation lakes

Only 2% of Maine's lakes can be considered "high-elevation lakes" (above 1,800 feet elevation). Because the watersheds of high-elevation lakes are so small, very few nutrients and minerals wash into them from the surrounding landscape. As a result, many of these lakes are acidic, and some are very sensitive to air pollution. High elevation lakes appear to have lower numbers of fish species than would be expected based on their size: nine are known to be fishless, while others have between one and five fish species (often introduced) including brook trout, lake chub, blacknose dace, rainbow smelt, and finescale dace.

Seepage lakes

Seepage lakes have no streams flowing in or out and instead are fed by rain and groundwater. Many are found in sand and gravel deposits. Because they are isolated from the network of streams, there are fewer opportunities for species to migrate into or out of the system, and in this way the lakes are able to maintain unique groupings of plants and animals.

Acidic lakes & Alkaline lakes

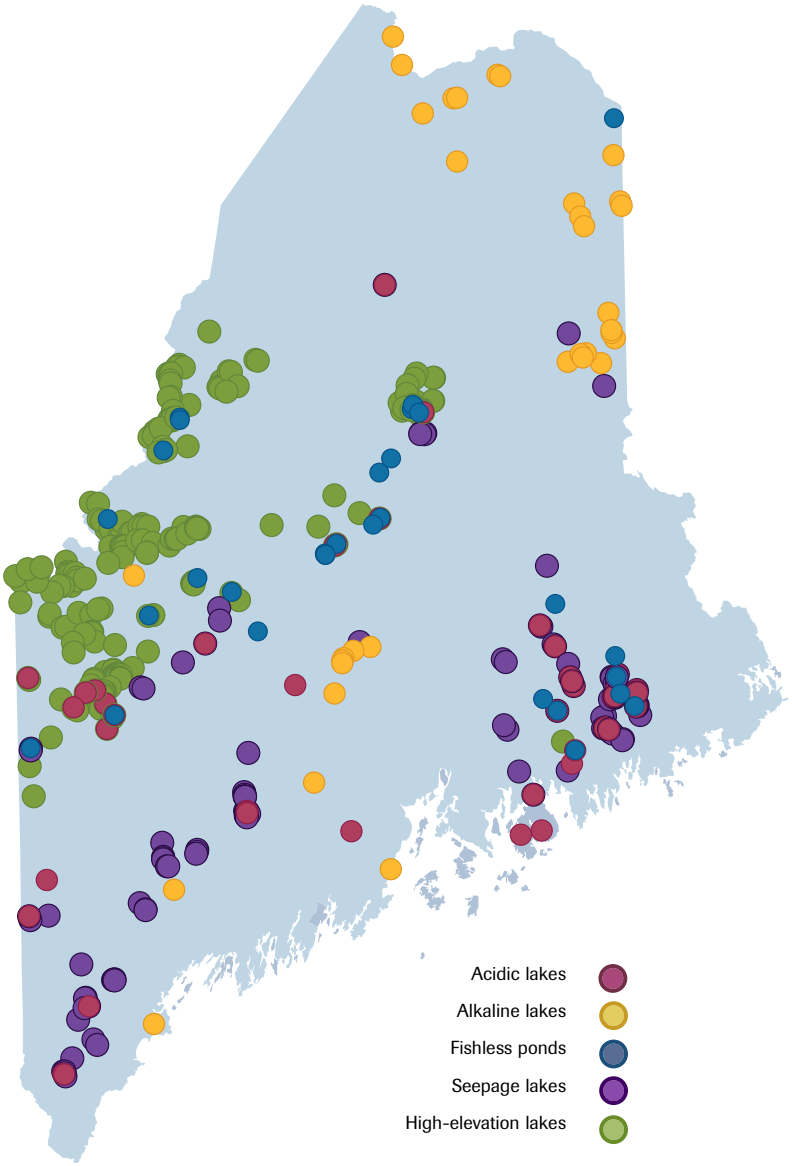
About 90 lakes are known to be highly acidic (pH less than 5.5). Most of these lakes are at high elevations or are in the Downeast region and are often located within or downstream from acidic peatland areas.

While most Maine waters are neutral to acidic, there are a few lakes and ponds that formed in lime- and calcium-rich soils of northeastern and central Maine. The dissolved minerals make the water alkaline (pH>7.5) and in some cases may produce a chalky appearance.

Water chemistry can affect the number and types of plant and animal species a lake contains. For example, alkaline lakes are favored by several threatened and endangered plants, including Fries' pondweed and straight-leaf pondweed.

Fishless ponds

Fish are known to be absent from at least 31 ponds. Most of these ponds are small and inaccessible to fish. Some are blocked by waterfalls or high-gradient stream



Top: Straight-leaf pondweed is an endangered species found only in Maine's alkaline lakes. **Bottom:** Davis Pond (Baxter State Park) outlet blocks fish access to the lake.

sections, others have no streams flowing in or out, and some have unsuitable habitat conditions like freezing solid in the winter or being too acidic. In the absence of fish, other organisms that would normally fall prey to fish can thrive, allowing different situations of competition and predation to develop. Such conditions offer biologists the chance to study the interactions between species, and in turn learn more about managing ponds that do have fish. There used to be more fishless ponds in Maine, but a number have been legally or illegally stocked (there is currently a moratorium on stocking fishless ponds). When fish are stocked in a fishless pond, they upset the natural balance that has evolved over many years: fish disrupt insect and amphibian populations and compete with birds for food. There are so few documented fishless ponds that protecting their unique status is of major importance. Over 3,700 ponds in Maine have not been surveyed for fish, of which 1,200 are less than 10 acres.

Rivers and Streams

Stanley Brook, Acadia National Park. Over 60 rivers flow into the ocean along the Maine coast.

Allagash River

Maine's freshwater ecosystems are contained within six major river basins and coastal watersheds. The total length of Maine's running waters is approximately 32,000 miles; another 13,500 miles of streams flow only seasonally or after heavy rains. These "intermittent" streams are often located in upper reaches of watersheds—the headwaters—where clean, cold, fresh groundwater reaches the surface and supplies our downstream waters. When habitat surrounding the headwaters becomes degraded, the impacts are often seen in the lower reaches of streams.

From its source at the outlet of Moosehead Lake, the **Kennebec River** drains 5,893 square miles in central Maine. Since the removal of the Edwards Dam in Augusta in 1999, sea-run fishes have unobstructed access to spawning habitat upstream to Waterville, an additional 17 miles. This dam removal set a national precedent and made Maine a leader in large river restoration.

Extending from Umbagog Lake, just over the New Hampshire border, to where it joins the Kennebec at Merrymeeting Bay, the **Androscoggin River** flows over 161 miles draining 3,460 square miles of watershed (most of which is in Maine). The 80+ dams in the watershed continue to alter hydrology and block fish movements, and mills and cities along the river continue to affect water quality.

The 827-square mile **Saco River** basin contains the most extensive and best remaining floodplain ecosystems in New Hampshire and Maine. The Saco connects the foothills of southwestern Maine to the coastal lowlands, with their sandy plains and gravel deposits. These areas contain significant groundwater aquifers and provide for unique habitats like pine-oak barrens and grasslands. These aquifers maintain good water level conditions even during drought.

The **St. John River** basin includes the Allagash and Fish rivers, and three smaller rivers that join the St. John in Canada: Aroostook, Meduxnekeag, and Prestile. The eastern half of the watershed contains much agricultural land, while the western half is largely forested. The 250 miles of the St. John above Grand Falls is the longest free-flowing stretch of river east of the Mississippi. The St. John tends to be more "flashy" than other large rivers of Maine, because fewer lakes in the watershed provide less water storage, with the result that river flows respond more rapidly to precipitation events. Scouring flows provide a specialized riparian habitat for the federally endangered endemic plant, the Furbish's lousewort.

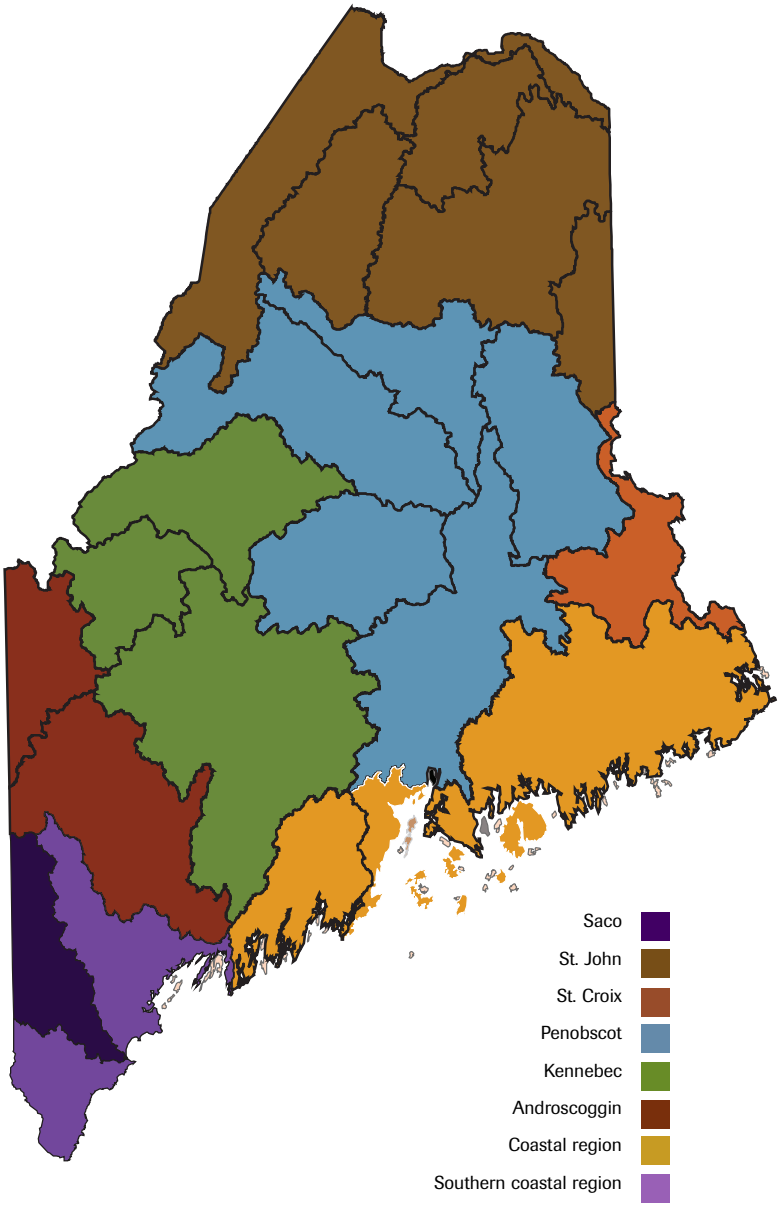
Draining approximately 8,750 square miles, the **Penobscot River** has the largest watershed in Maine. The Penobscot basin is mostly forested with extensive

wetlands. Many waters of the St. John and upper Penobscot basin are free of introduced species. This region of Maine may be one of the largest areas of intact natural aquatic systems in the lower 48 states.

The **St. Croix River** drains approximately 1,500 square miles, part of which is in New Brunswick. The West Branch consists almost entirely of large lakes and impoundments connected by short stream segments. The Tomah Stream tributary is home to the largest known population of the Tomah mayfly, a globally rare species.

Maine's coastal region is drained by a series of smaller rivers, including the **St. George**, **Sheepscot**, **Union**, **Narraguagus**, **Pleasant**, **Machias**, **East Machias** and **Dennys**, and to the south, bordering the Saco River watershed, the **Presumpscot** and **Piscataqua–Salmon Falls**.

The Sheepscot River, Ducktrap River, Cove Brook, and the Downeast rivers are designated as habitat for genetically distinct populations of Atlantic salmon.



Waterboro Barrens, Waterboro

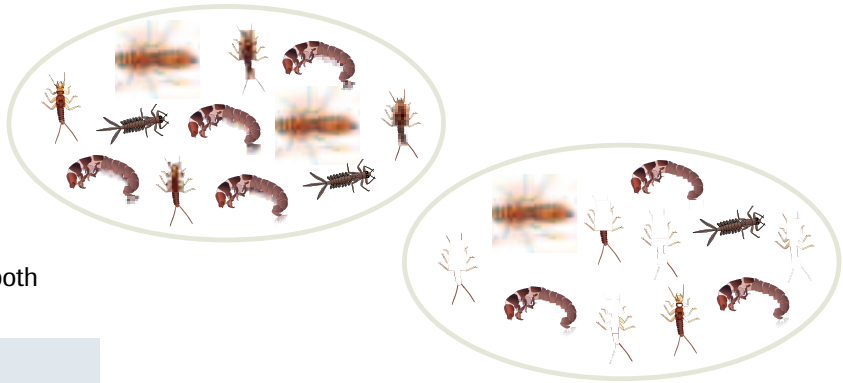
30% of state waters flow into Merrymeeting Bay.

II: what we know about freshwater biodiversity in maine

Each of Maine's lakes and rivers is a unique environment. Together, they support over 130 aquatic plant species, 25 species of amphibians and reptiles, 63 species of fish, and over 1,500 species of macroinvertebrates.

What is biodiversity?

The number of species that a place contains, or *species richness*, is only one measure of biodiversity. Of equal importance is the relative abundance (or density) of different species from place to place (*species evenness*). For example, both



of the two ponds depicted above have a total of four different species. Natural communities tend to have populations like that represented on the right, with a few very abundant species and a number of less abundant or rare species. The two ponds have identical *species richness* but very different *species evenness*.

Another aspect is the *geographical diversity*: where individual species and groups of species occur. While records of species occurrences are to some extent a function of sampling effort (see box), they are an indication of biodiversity patterns across the state.

Individual animals or plants of the same species have different traits that may make them more suited to one environmental condition or another. This *genetic diversity* gives a species the ability to respond to change. For example, only a handful of Maine lakes are home to resident, wild populations of Arctic charr, yet the charr in each lake has a different genetic makeup specific to that population, even though they are all the same species. Losing the charr in just one lake would also mean a loss of genetic diversity.

You can only find what you're looking for…

When reviewing species information, it is important to acknowledge that species richness is in part a function of collection effort. Areas of the state that have been intensively surveyed have a greater number of species recorded. In other words, the longer and harder you look, the more you'll find. Some groups, such as fish, dragonflies and damselflies, and mussels, have been well-surveyed. For other groups, survey effort has been geographically patchy or else very limited in intensity. For example, there has been more surveying for plants in southern Maine, in part because more people live there. Absence of a species may simply be a result of inadequate sampling. A single survey of a lake, even with multiple types of equipment, may not capture all fish species present, particularly those that occur in low abundance and species that move around from season to season and year to year.

Staff from Acadia National Park and Maine Dept. of Inland Fisheries & Wildlife sample for brook trout.

Why does biodiversity matter?

Together, these characteristics of biodiversity—of ecosystems, populations, and species—determine the ability for species to respond to brief, local disturbances such as flood or drought, and long-term, widespread disturbances like climate change or disease.

Plants and animals can be indicators of environmental health. In many ways, animals and plants are more sensitive to environmental changes like increased temperatures, drought, and pollution. A rapid decline in some population might be a signal of a much larger problem. In this way, biodiversity serves as our canary in the coal mine. By monitoring the populations of species sensitive to environmental change, we can figure out if a stream is healthy or polluted, and in turn if human health is at risk.

A diverse ecosystem can also assure a healthy aquatic environment. Animals and plants function to stabilize habitats, store and cycle energy, filter bacteria and particles from the water, breakdown wastes, and recycle materials. Having a diverse community with redundant roles assures that functions are maintained under changing conditions.

Aquatic animals and plants sustain our tourism and recreation economy. Twelve species of fish, including brook trout, pickerel, and white perch, support significant fisheries in the state. While it seems that much attention is given to fish species such as Atlantic salmon and brook trout, preserving their habitat also protects the diversity of many lesser known organisms, keeping the whole system healthy. Anglers spent $251 million in Maine in 2001.

In addition to drawing people to visit the state, these recreational opportunities have been enjoyed by generations of Maine families. In fact, you could argue that without the diversity of lakes, wetlands, and rivers, and the plants and animals that fill them, life in Maine would not be the same. ***Biodiversity is part of Maine's high quality of life.***

And finally, ***the rarity and uniqueness of Maine's aquatic environment is valuable in itself.*** The convergence of three major ecosystem types in Maine (Fig. 1) presents a unique set of conditions. Because of this overlap, many species are at the northern or southern extent of their ranges. Collectively, this produces aquatic communities that cannot be found elsewhere and in such healthy condition.

Twenty-seven aquatic species and eight Distinct Population Segments of Atlantic salmon are listed as threatened or endangered by the federal government or the State of Maine (page 31). An additional 54 aquatic species are considered rare and are tracked by the Maine Department of Inland Fisheries and Wildlife or Maine Natural Areas Program.

Aquatic Plants

Plants are natural features of our lakes and rivers. While non-native invasive species are a concern (page 15), in most cases the presence of aquatic vegetation is characteristic of a healthy body of water.

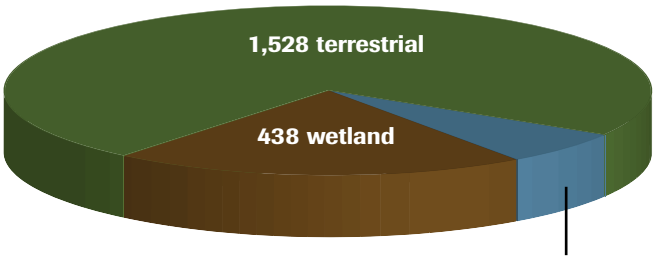


Figure 2. Plant species in Maine

Of the 2,096 species of plants in Maine, 568 are found in wetlands or aquatic environments, which is about half of the wetland/aquatic species of northeastern North America; 130 of these are considered fully aquatic (Fig. 2).

"Fully aquatic" plants occupy different habitats within lakes and streams: water lilies, water shield, and duckweed float on the surface of ponds. Elodea and pondweeds are submerged below the surface. Others, like pipewort and bladderwort, may keep their leaves underwater, but send their flowers shooting up above the surface. The multi-storied canopy of plants provides shelter and food for fish and other animals, and adds oxygen to the water.

Maine Natural Areas Program tracks 27 rare aquatic plant species; two of these, the prototype quillwort and the Acadian quillwort, are considered to be rare throughout their global range. Many of the rare aquatic plant species are restricted to specific areas of Maine.

We don't have a lot of information about plant communities; what information we do have is from a small percentage of lakes and rivers. In Maine, the number of plant species collected from individual lakes ranges from three to over 25, depending on lake size. Elevation and water quality influence the distribution of some species, but many other aquatic plant species are widespread.

The **pondweed** family (Potamogetonaceae) is the most species-rich aquatic plant family in Maine, with 25 species. Perfoliate pondweed, *Potamogeton perfoliatus*, is one of several that prefers neutral or alkaline waters. One species, *Potamogeton confervoides* or alga pondweed, grows only in acidic waters. >

Prototype quillwort

Quillworts are ancient species of plants somewhat related to ferns and mosses. The prototype quillwort, *Isoetes prototypus*, is considered rare throughout its global range. It grows in clear, shallow, sandy-bottom ponds and has only been documented from three locations in Maine. <

Perfoliate pondweed

...AQUATIC PLANTS...7 arrowheads...2 water parsnips...3 duckweeds...3 hornworts...3 water-worts...8 milfoils...4 tape-grasses...

THREAT: Invasive Aquatic Plants

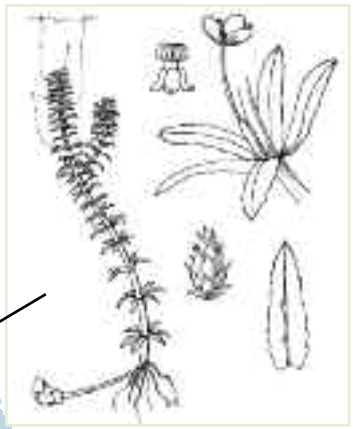
While plants are natural components of many lakes and rivers, four non-native aquatic plant species considered nuisance or invasive (variable water-milfoil, Eurasian water-milfoil, hydrilla, and curly-leaf pondweed) and one hybrid of variable water-milfoil have been documented in Maine waters. These aggressively spreading plants can be difficult if not impossible to remove, as well as costly. Invasive species have already been found in 21 lakes and seven rivers in Maine.

Plants will spread beyond the site of introduction. An introduction of variable leaf milfoil in Lake Arrowhead in Limerick has extended down the Little Ossipee River to the Saco River as far downstream as Dayton.

Maine has several laws to prevent the spread of invasive species and control existing infestations. Realizing that prevention and early detection are the strongest defense, the state's initial alarm about invasive plant species has evolved into a broader management and control program for invasive plants and animals, coordinated by both Maine Dept. of Environmental Protection and Maine Dept. of Inland Fisheries & Wildlife as well as several nonprofit organizations.

Documented invasive plants in Maine (2007)

Hydrilla (Hydrilla verticillata)



Hydrilla

Curly-leaf pondweed

Variable water-milfoil or hybrid (25 locations)

Eurasian water-milfoil

...9 bladderworts...5 quillworts...6 water lilies...25 pondweeds...1 featherfoil...8 bur-reeds...4 water-starworts...1 pickerelweed...

Insects & Other Invertebrates

Macro-invertebrates are those animals without backbones that are visible with the naked eye: mussels, clams, insects and insect larvae, crayfish, and snails. We still have a lot to learn about these animals in Maine. Species such as dragonflies and damselflies, freshwater mussels, crayfish, and mayflies, have been well surveyed. We know less about the distribution of stoneflies, caddisflies, blackflies, beetles, and snails, and practically nothing of more obscure animals like sponges, bryozoans, and worms.

The rest of us may notice insects only when they land on the bow of our canoe, or chase us from the woods in bloodthirsty swarms. Yet the diversity of the insect community can tell us about the health of our lakes and rivers. For example, mayflies, caddisflies, and stoneflies are typically found in unpolluted waters; fishflies and dobsonflies are particularly good indicators of oxygen-rich environments. They are an important tool for those charged with monitoring water quality. We know that watersheds with more acreage of land covered with pavement, rooftops, and other impervious surfaces have lower macroinvertebrate diversity than forest, wetland, and agricultural areas (Fig. 3).

Mayflies and dragonflies are among the most ancient of flying insects, their ancestors appearing during the Carboniferous period 280-350 million years ago. These insects, like many others, spend their early life stages in the water, scraping algae from rocks on the bottom, filtering little food particles from the current, and shred-

Mussels: North America contains the greatest diversity of freshwater mussels on earth. Ten of the approximately 300 North American species are found in Maine. The tidewater mucket is Maine's rarest mussel species; it and the yellow lampmussel are found only in the Penobscot, Sebasticook, and lower Kennebec rivers. The brook floater, which is found mainly in streams and rivers of central and Downeast Maine, has more populations in Maine than elsewhere in the Northeast, and therefore is of high conservation value. One of the most endangered faunal groups in the world, mussels are threatened by pollution and dams.

Crayfish: Eight crayfish species have been recorded from the state, four are not native.

Snails: A total of 58 freshwater snail species have been recorded from Maine, including three globally-rare species. Aquatic snails have been used as indicators of acidification, as well as general water quality.

Freshwater snail

...6 rushes...1 pipewort...INSECTS...170+ mayflies...158 dragonflies/damselflies...123+ stoneflies...54+ true bugs...163 midges...

ding leaves that have fallen into the water. Unseen and unheard until they hatch into adults, sometimes all at once in great clouds above the water surface, insects and their larvae are vital components of the food web, providing sustenance to fish as well as amphibians, reptiles, and birds.

In the stream ecosystem, insects like stoneflies and caddisflies are food for game fish, often comprising more than half the diet of trout and salmon, while emerging adults are an important food source for birds and bats. Those of us who fly fish are well acquainted with these characters, since we create flies in their likeness to draw hungry fish from deep pools and weedy shallows.

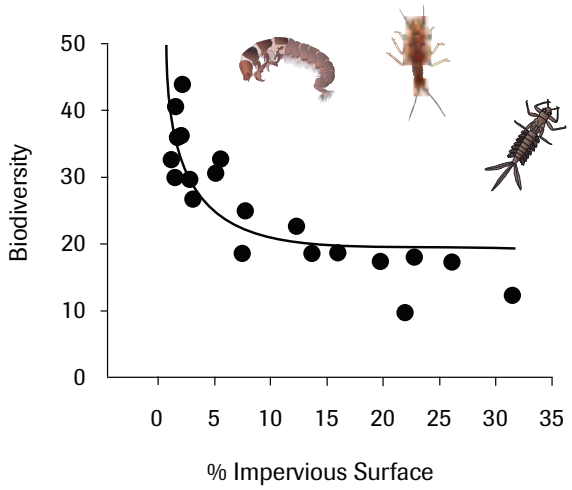
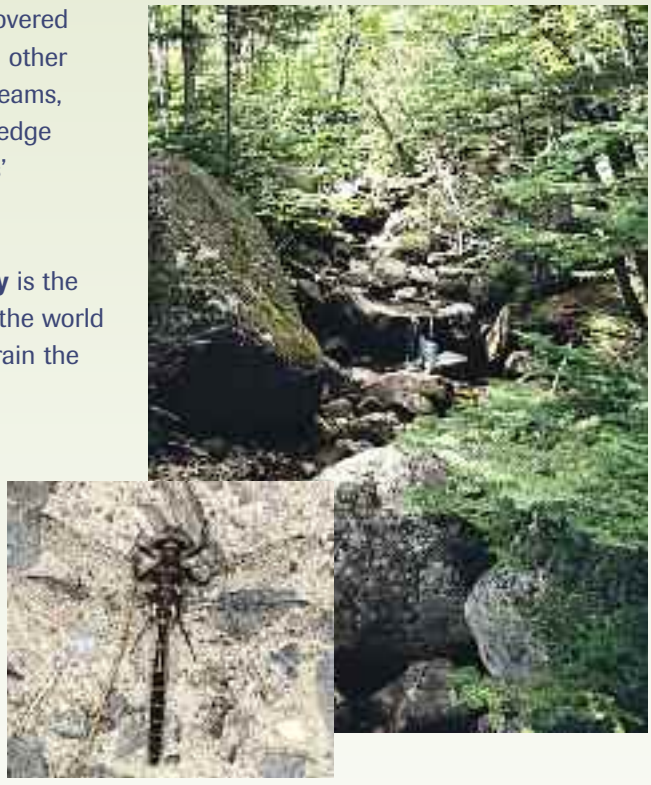


Figure 3. Relationship between impervious surfaces and stream biodiversity. The term biodiversity is used here to define the number of different types of invertebrates per sample.

Once considered extinct, the **Tomah mayfly** was rediscovered in eastern Maine in 1978, and has been found at several other locations since then. Dam construction on rivers and streams, leading to destruction of the Tomah mayfly's preferred sedge meadow habitat, may be a primary cause of this species' limited distribution.

Of our 170 species of mayfly, the **Roaring Brook mayfly** is the only one that is federally endangered. The only place in the world to find this mayfly is in the boulder-filled streams that drain the slopes of Katahdin in remote areas of Baxter State Park.

The **ringed boghaunter**, a dragonfly found only in southern Maine, is listed as threatened; another two species of dragonflies are threatened or endangered, and 25 are listed as being of special concern in Maine. They are the most collected and best documented invertebrate group in Maine, thanks to the Maine Damselfly and Dragonfly Survey, which documented 158 species.



Ringed boghaunter

342 caddisflies...278 aquatic beetles...42 mosquitoes...49 blackflies...5 phantom midges...OTHER INVERTEBRATES...10 mussels...

Amphibians & Reptiles

Four-toed salamander

Spotted salamander

Wood frogSpotted salamander

The multitude of plants, invertebrates and insects provide food for reptiles and amphibians, most of whom require use of a lake, pond, stream or spring at some point, although some spend more time in the water than others. There are 18 amphibians and seven non-marine turtles in Maine and most are associated with our freshwaters.

Maine's nine species of salamander range from the very aquatic eastern newt and Northern spring salamander, to the redback salamander, our most abundant amphibian that spends much of its life in upland forests. The blue-spotted salamander and the four-toed salamander are uncommon. One species, the mudpuppy, is not native. It was introduced to the Belgrade Lakes region in 1939.

From the snowmelt chorus of spring peepers to the baritone croak of the bullfrog, Maine's nine species of frogs and toads fill our spring and summer nights with sound. Like salamanders, frogs and toads vary in how much time they spend in and near the water as adults, however their early life stages are completely dependent on a freshwater environment. For example, the mink frog only occasionally ventures onto land, while the wood frog stays in forested wetlands and uplands until it is time to breed in vernal pools (see box).

Maine is the northern limit for several turtle species, such as the musk turtle, spotted turtle, and Blanding's turtle. These turtles are only found in the southern parts of the state. As for snakes, only the northern water snake frequents aquatic areas; other snakes are found near, but not in, water.

THREAT: Habitat Fragmentation

Because reptiles and amphibians use both land and water, they are vulnerable when moving between the two. Forest management practices and land development, even beyond the riparian zone, can fragment the connectivity between upland forested habitat and aquatic breeding or feeding sites. Roads serve as partial barriers to amphibian movement and many animals are killed by cars and other vehicles.

...58 snails...25 leeches...1 freshwater jellyfish...8 crayfish...6 crayfish worms...25 fingernail/pea clams... REPTILES *...7 turtles...*

Vernal Pools

Vernal pools or "spring pools" are shallow depressions that usually contain water for only part of the year. They are often found within larger areas of forested wetlands. Vernal pools are essential predator-free breeding habitat for wood frogs, spotted and blue-spotted salamanders, and fairy shrimp. Many amphibians return to breed in the pond where they were born. The loss of vernal pools and the surrounding terrestrial habitat leads to local loss of amphibian species, a decrease in biodiversity, and a decline in food available for many other animals.

Vernal pools are essential breeding habitat for some amphibians

Vernal pools that provide habitat for threatened or endangered species or that contain a notable abundance of vernal pool species are designated as "significant" by the state. Starting September 1, 2007, significant vernal pool habitat, which includes the pool itself and the area within a 250 foot radius, is protected by law under the Natural Resources Protection Act. The law prohibits disturbance within the pool and limits activity around it.

Blanding's turtle

Spotted turtle

While common in the Midwestern U.S., **Blanding's turtles** in Maine are part of a separate population inhabiting eastern New England. Less than 1,000 **spotted turtles,** one of two state-listed endangered turtle species, are thought to occur in small acidic wetlands and vernal pools in southern Maine.

...1 water snake...AMPHIBIANS...9 frogs & toads...9 salamanders & newts...FISH...2 catfish (1 non-native)...1 eel...2 killifish...

Fish

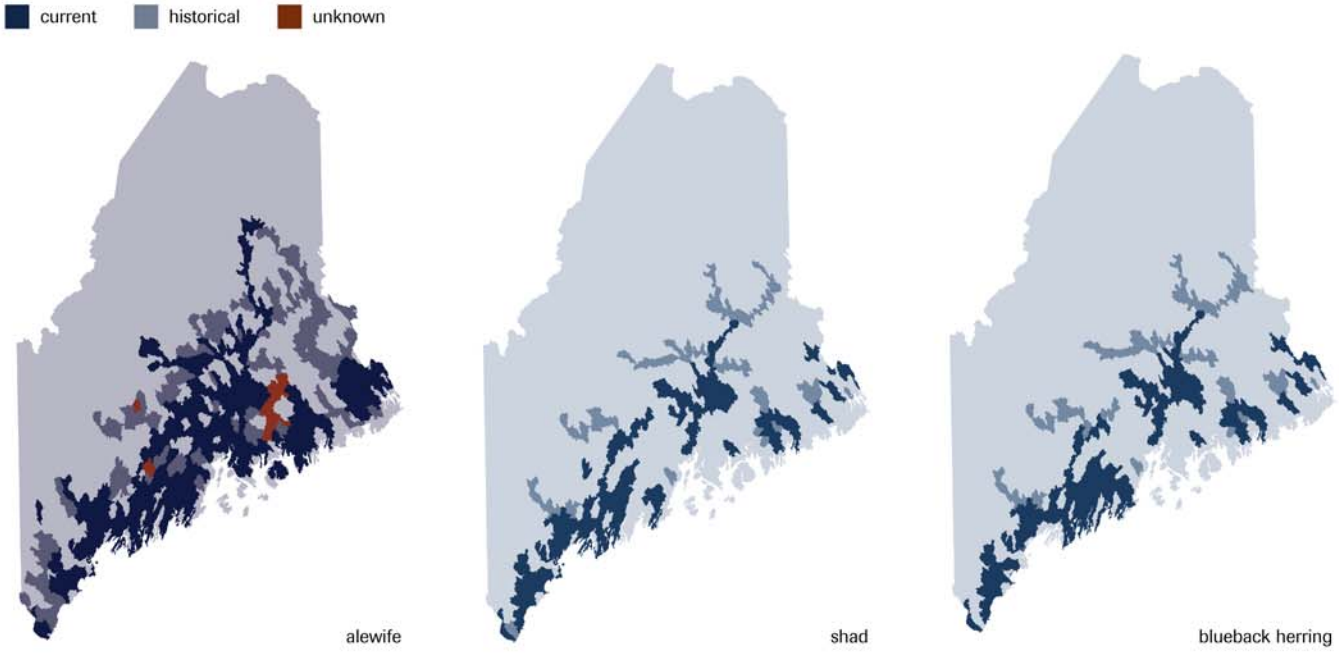
Any one of us could probably name a dozen or so species of fish that live in Maine; yet we have a grand total of 67 species of freshwater fish, including species that spend part of their lives in ocean waters. There are minnows and trout, bass and sunfishes, salmon and whitefish. Seventy percent are native to the state, meaning they are believed to have been present in the region prior to European settlement. When compared to the other parts of the U.S., Maine has relatively few non-native fish species; however this number is increasing as a result of illegal introductions (page 23). Many waters, especially in northern Maine, still contain only native species.

Alewives. ©2003 Heather Perry.

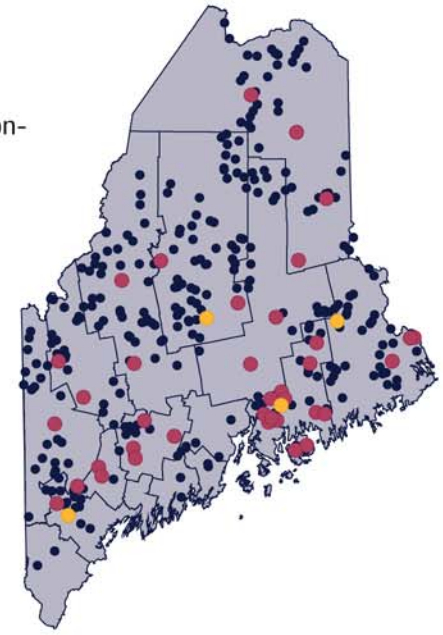
Geographically, the number of fish species increases from north to south, with one-third more species present in the southern half of the state. The lower Kennebec and Penobscot watersheds have the most fish species. In general, the larger (and deeper) the lake or river, the more species it contains. In addition, lower elevation lakes and streams have more species than high elevation waters. The higher diversity of southern Maine is partly a result of introduced warm-water fishes. In southern Maine, these non-natives make up a much larger proportion of the fish fauna than in northern Maine. For example, lakes in western and northern Maine tend to contain a higher number of native minnows, which are vulnerable to introduced predators such as largemouth and smallmouth bass.

As evidence of the ocean's influence on Maine's biodiversity are the 12 species of "sea-run" or diadromous fish that move between fresh and salt water. Anadromous fish spend most of their lifetime at sea, and enter fresh-

Distribution of diadromous fish species in Maine



...19 minnows/carp (6 non-native)...3 perch/darter (1 non-native)...1 mudminnow (non-native)...4 pike/pickerel (2 non-native)...



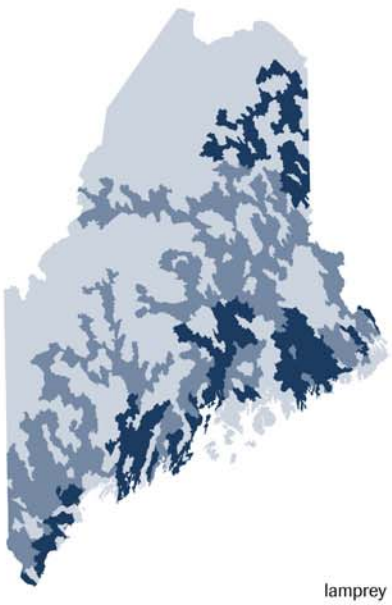
water to breed or search for food. In contrast, the American eel is the only catadromous fish in North America; eels breed in the ocean but spend most of their adult life in freshwater.

American eels have been recorded from 32% of Maine's surveyed lakes. Historically, the American eel is estimated to have comprised 25% of the total fish biomass in coastal streams of the U.S., but eel populations are in decline due to fishing and barriers to migration.

Some fish have both sea-run and landlocked populations. Sea-run **alewife** populations have been recorded for 122 Maine lakes, with landlocked populations occurring in another 37 lakes as a result of introductions, since landlocked alewives are not known to occur naturally in Maine. **Rainbow smelt** are native to coastal watersheds, but the species has been widely stocked around the state as food for landlocked salmon, which also have been widely stocked. Most salmon in Maine today are of the landlocked variety. It is believed that before stocking began in the mid-1800s, wild **landlocked salmon** populations existed in four river basins: St. Croix (West Grand Lake), Union (Green Lake), Penobscot (Sebec Lake) and Presumpscot (Sebago Lake). Beginning in the late 1860s, landlocked salmon were stocked throughout much of Maine and today are found in over 300 lakes.

Perhaps our best-known anadromous fish is the **Atlantic salmon**, which once swam in most Maine rivers that had unobstructed coastal access. Today, sea-run Atlantic


eel


lamprey


atlantic salmon

...1 lamprey...6 salmon/trout (2 non-native)...2 whitefish...1 sculpin...2 seabass...4 sticklebacks...2 sturgeon...3 suckers...1 smelt...

salmon are limited to the Penobscot, St. Croix, and the lower Kennebec drainages and eight smaller Downeast watersheds that are home to the federally-designated Distinct Population Segments of this endangered species.

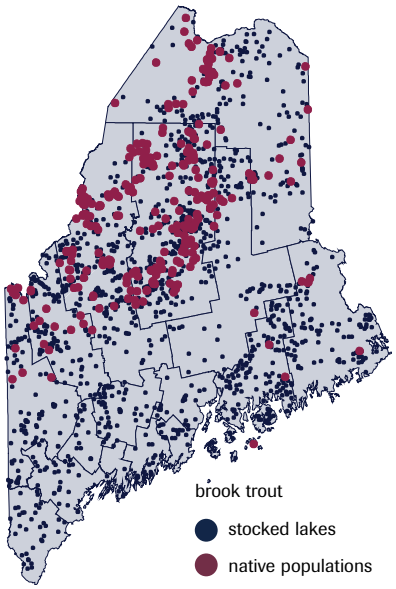
In a free-flowing river, most anadromous species will ascend upstream to smaller streams and lakes. An exception is the **shortnose sturgeon**, which does not go beyond the estuary. Shortnose sturgeon, a federally endangered species, have been documented in the Kennebec, Androscoggin and, most recently, Penobscot rivers in Maine.

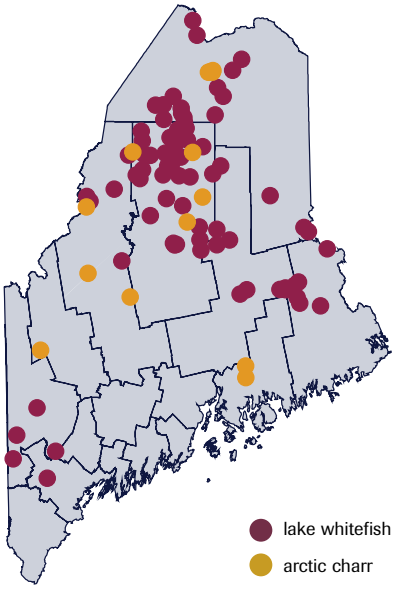
The **white perch** is originally a coastal species whose range has been expanded substantially in Maine via sportfish and illegal introductions; it now occurs in 25% of all surveyed lakes.

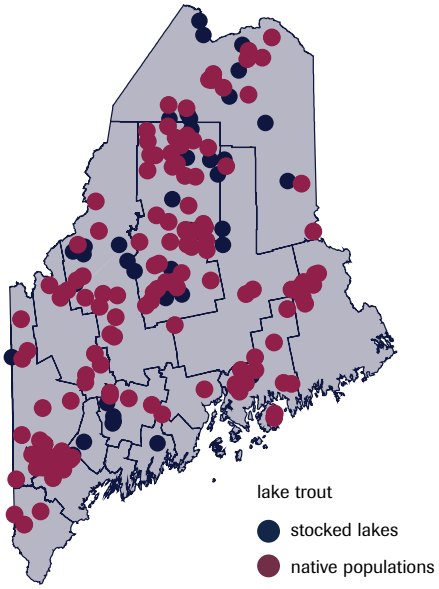
Brook trout are the most widely distributed fish in Maine, occurring in 69% of surveyed lakes and an estimated 22,250 miles of streams. Maine possesses the most significant native brook trout resource remaining in the U.S., and this species is one of the state's most sought-after game fish. An estimated 305 lakes contain wild brook trout populations that have never been stocked. Habitat degradation and introduced species have resulted in declining brook trout populations in Maine and elsewhere. Maine also has some of the few remaining sea-run populations of brook trout in the Northeast.

American eel. ©2003 Heather Perry.

Arctic charr (blueback trout) are present in just 14 lakes in Maine and these represent the only native populations of this species in the lower 48 states. Like the Arctic charr, **lake trout** (togue) live in deep lakes that have cool water throughout the year; about 78% of lake trout populations are wild. **Lake whitefish** are found in 75 Maine lakes, but several populations, including Sebago, have diminished to relict numbers.







*...1 cod...7 sunfish/bass (5 non-native)...3 herring...*AQUATIC PLANTS*...7 arrowheads...2 water parsnips...3 duckweeds...3 hornworts...*

THREAT: Species Introductions

Maine's freshwater fish communities result from two sets of processes: natural colonization following glacial retreat, and human-associated introductions. Introduced species fall into three categories: 1) not native to North America; 2) native to North America but not native to Maine; 3) native to Maine but not to an individual waterbody or river basin.

Fish have been stocked in Maine for more than 100 years, by people trying to create or enhance a fishery. The practice became common in the late 19th Century, and continues today as game and bait fish are introduced legally, illegally, and accidentally into Maine waters. New species, such as green sunfish and northern pike, and species that are either native to Maine or have been here for a long time, continue to be moved to waters in which they were not originally present. Largemouth bass are found in six times as many lakes today as in 1945. In the southern part of the state, in the last 60 years, the number of lakes with brown trout have increased 290%, white sucker, 91%, and redbreast sunfish, 68%.

Illegal introductions of fish species have been increasing at an epidemic rate. From January 2005 to January 2007, Maine Dept. of Inland Fisheries & Wildlife documented 50 cases of new introductions. Commonly introduced species include largemouth and smallmouth bass, northern pike, black crappie, white and yellow perch, rainbow smelt, and as bait-fish, white sucker, and a number of minnow species.

Once an illegal species establishes a breeding population, it cannot be removed without removing all fish species. Species will spread far beyond the site of introduction. A recent introduction of smallmouth bass to the St. John River near the Canadian border is expected to spread to lakes and streams far upstream. Maine Dept. of Inland Fisheries & Wildlife is attempting to construct a barrier on the Fish River before the bass can access the large chain of lakes in that watershed.

New species can be ruthless predators, reducing fish diversity in many of Maine's lakes and streams, or they can out-compete resident fish for food and habitat.

Northern pike. ©2003 Heather Perry.

Big Reed Pond, T8R10, hosts one of only 12 Maine populations of Arctic charr, each population genetically unique. The illegal introduction of rainbow smelt and creek chub in the 1990s has led to collapse of the charr population due to competition for food and direct predation of young charr. Fisheries managers are now faced with a high-risk, high-cost restoration effort to save this invaluable genetic resource.

What we don't know

We still have much to learn about Maine's aquatic biodiversity. The extent of our knowledge varies.

For example, we know a lot about the different species and geographic distribution of fauna such as fish, mussels, crayfish, frogs, dragonflies and damselflies.

For other groups, like snails, salamanders, mayflies, stoneflies, caddisflies, midges, mosquitoes, even black flies, we have some information about species numbers but our geographic records are incomplete. Many lakes and streams have little or no documentation of the species they contain.

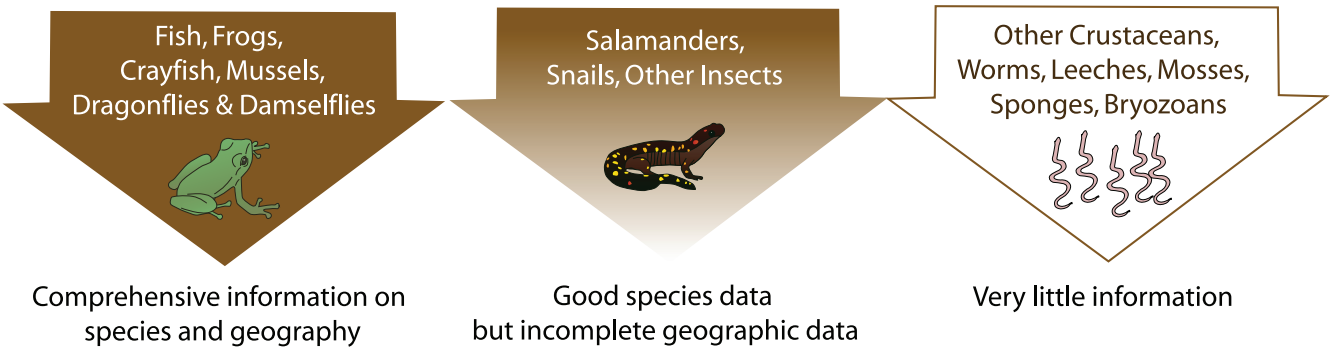
Then there are the plants and animals that we know very little about. We lack comprehensive information on mosses, sponges, worms, leeches, or crustaceans other than crayfish. Some organisms, like algae, protozoans, and bryozoans ("moss animals") are tiny or even invisible, yet they influence life in our lakes and streams.

Scientific study has favored larger organisms and accessible habitats, which leads to bias in our assessment of biodiversity. Many of the smaller organisms represented in the "poorly known" groups may have some of the greater numbers of species, so the total documented number of species reported by the Maine Aquatic Biodiversity Project is actually a small fraction of our total species.

This patchy information weakens our understanding of community relationships, both within natural communities and as species are introduced or lost. We need better ways to value (and thus appreciate) biological diversity at the species, population, and ecosystem levels.

This lack of information reduces our ability to determine if threats are increasing or decreasing, or to evaluate how changes in management (e.g., waste treatment, dam removals) are affecting our resources. The following recommended actions would address information and knowledge gaps:

- Develop a state program to identify and track the status of priority waters such as ponds with 100% native species, fishless ponds, and waters with rare species of fish, aquatic insects, freshwater mussels or aquatic plants.
- Expand the state's biological inventory programs to collect current data on rivers, streams, lakes, and ponds. Re-assess and report on the status of Maine's aquatic biodiversity every 10 years.
- Develop a statewide inventory and database of natural and human-built barriers to help managers prioritize restoration sites.
- Expand revenue sources to maintain and improve invasive species management programs, and develop statewide surveys for early detection of invasive species.



III: threats to freshwater biodiversity in maine

Freshwater ecosystems have lost more plants and animals than any other environment on earth. The decline in aquatic communities is happening here in Maine, too, for multiple reasons. We can rank threats by looking at the cost and feasibility of reversing their negative effects.

Introductions

Introductions of non-native species, global contaminants, and climate change pose the most severe threats, since none may be reversible within any foreseeable time frame. For these threats, all attention must focus on prevention.

Modifying culverts can aid in fish migration

Land development, especially in or close to the water, and barriers, such as large hydropower dams, represent the next most serious threat since solutions often involve large economic investment. For example, dam removal projects have successfully restored some waters, but they require difficult social choices and significant expense.

Other threats, such as water pollution and small stream barriers, are reversible and relatively low cost.

We have already seen how introductions of non-native plants are spreading through Maine's waters (page 15). Legal and illegal stocking of fish has altered many aquatic communities, in some cases threatening species with extinction, as with the Arctic charr in Big Reed Pond (page 23). Diseases and parasites can also be introduced, such as the infectious *chytrid* fungus that affects amphibians. Species introductions are leading to a relentless "homogenization" of Maine's flora and fauna. Communities are becoming more alike, erasing the unique lakes and rivers that give Maine its natural character.

Toxic Chemicals

Global contaminants that travel long distances from their source, such as acid rain, mercury, and other persistent pollutants, can be difficult to control because they often originate outside of Maine's borders. Yet because of Maine's location downwind from many pollution sources, we often have higher concentrations of toxic chemicals.

Changing Climate

Higher temperatures that accompany global climate change will reduce cold water habitat required by species like brook trout and Atlantic salmon. Changing ice-out patterns may result in a loss of habitat-forming processes like ice scour on northern rivers. An altered seasonal hydrology will affect species that depend on temperature and flow cues to complete their life cycle. As the climate warms, species that are currently at the southern extent of their range, like Arctic charr, will retreat north as more and more species from the south become established in Maine. Climate change will also affect the quality and quantity of freshwater. Climate change adds a layer of complexity and uncertainty to all the other threats faced by aquatic plants and animals.

Fort Halifax dam, Kennebec River

Threats from residential development are increasing

Consumer demand for drinking water can alter water levels in lakes and streams

Altering Habitat

Habitat loss can directly and indirectly impact plants and animals, as with forest fragmentation effects on vernal pool amphibians (page 19). Timber harvesting, agricultural practices, and road construction can alter habitat through reduction of riparian vegetation, increasing light, temperature, and erosion of stream banks. Shifting land cover will result in a change in organic matter quality and quantity, with magnified effects throughout the food web. Some animals may suffer from the loss of large woody debris and other materials that create habitat. Pollution can result from elevated contaminant levels, nutrients and pesticides from farms or forests, deicing compounds, etc.

Threats from residential, commercial, and industrial development are increasing. Already in southern and coastal Maine, the rate of land development greatly exceeds population growth. Stormwater runoff from impervious surfaces contains dirt, salt, excess nutrients, ogasoline, and other contaminants. In addition, research has shown that impervious surfaces are associated with higher density of non-native riparian vegetation that can adversely affect wildlife habitat (Fig. 3). Stormwater not only carries pollutants, but the runoff from roads, roofs, and parking lots can seriously alter flow and water temperature, especially in small streams. According to Maine Dept. of Environmental Protection, non-point source pollution is the dominant cause of impaired water quality in Maine lakes and streams.

Consuming Water

Water presents a unique conservation challenge; as a public resource it is owned by all, and needed by all. The uses and demand for fresh water are expanding, yet our supply remains fixed. Unlike other areas in the Northeast, Maine has not reached a crisis state where competing uses threaten biodiversity, although conflicts on certain waters are affecting aquatic plants and animals. When we take water out of a pond or river—for irrigating crops, making snow, or for drinking water—we can alter the flow and inadvertently impact species that have grown accustomed to the natural cycles of high and low water.

Constructing Dams and Other Barriers

River and stream barriers range from large hydroelectric dams and small run-of-the-river dams to derelict log driving dams, beaver dams, and improperly constructed or maintained culverts. Dams, culverts, and other barriers disconnect breeding, feeding, and nursery areas. Without access to the multiple habitats needed for their life cycle, populations of many species decline. For

Tunk Lake outlet, T10 SD

example, the American eel has lost access to 90% of its habitat in New England due to dams and other modification structures. Dams and barriers can have a positive impact by preventing invading species from spreading upstream. Dams must be evaluated on a case-by-case basis, because there can be value in keeping a dam in place. For instance, beaver dams on some of the smaller streams in the St. John River basin are preventing introduced muskellunge from moving into new habitat. Also, hydroelectric power generation is a valuable source of renewable energy in Maine.

While some hydroelectric dams have efficient fish passage, dams can block or reduce fish passage, depending on their size and the type of fishway (if any). For example, smaller dams that may be passable by climbing eels and leaping salmon can be insurmountable by alewife and smelt. Some animals are killed outright, as with downstream-traveling eels that are caught in the spinning turbines on hydroelectric dams.

Barriers alter river hydrology by changing the water temperature or changing how water and sediment travels in a river. For example, water releases from dams can flood downstream nesting habitat for animals like wood turtles. Other animals that are adapted to natural fluctuations in water flows, like some mayflies, will disappear when downstream flows are controlled.

What about beaver dams?

While beaver dams are a natural part of the landscape and are relatively temporary, they can be a major obstacle for some stream species such as brook trout, and they can raise water temperatures and reduce oxygen concentrations. While beaver dams are sometimes removed to enhance fish populations, they do have some benefits, such as blocking access for invasive species and creating habitat for species that require the disturbance of flooding and draining.

Beaver dam © Nancy Sferra

IV: conserving our diverse aquatic heritage for future generations

Without biodiversity, Maine's unique natural character is diminished and our landscape begins to resemble every other place. Conserving biological diversity—of ecosystems, populations, and species—preserves resilience in the world around us, which ensures the continuing existence of all species.

Brook floater

The threats described previously have one thing in common: they are the result of human actions, and only our actions can protect and promote biodiversity for future generations. We need to work together to protect the natural heritage of our lakes and rivers, and the good news is that we are in an excellent position to do just that. Maine's extensive land area, much of which has remained in working forest, means that our rivers and streams are less affected by significant land use change and introduced species, especially in northern and eastern Maine. Our backyard is the last refuge in the Northeast for self-sustaining populations of wild brook trout, Atlantic salmon, and other threatened species.

Conserving Land and Water

Conservation ownership, easement, or other protection is one way of preserving the biodiversity of Maine's freshwater ecosystems. Roughly 15% of the state is protected from development through public and private conservation. However, conservation needs to take place at the watershed scale to include interconnected lakes, streams, and wetlands in order to support the full array of species and their life cycle requirements.

More conservation action is needed for unprotected systems like remote lakes and fishless ponds, which may be more "pristine" than lakes that are settled or have easy road access. For example, lakes in the unorganized territories of northwestern Maine have higher percentages of native species, especially wild brook trout and native minnows. These lakes present an opportunity to protect high-value ecosystems, but we need a state program to identify and track the status of these priority waters.

As part of its ecoregional planning process, The Nature Conservancy is currently evaluating and ranking Maine's rivers and lakes and their watersheds from a series of landscape-level and biodiversity perspectives. These watersheds constitute an initial list of candidate areas for future conservation efforts. Evaluation of watersheds relies on three broad sources of information:

- Biodiversity data, including native and rare species and exemplary communities;

Autumn meadowhawk

- Expert opinions from regional biologists, researchers, and other partners;
- Geographic data, including land use and land cover, dams, pollution sources, roads, and existing conservation lands.

Following evaluation of all these information sources, a list of priority, high-quality streams, lakes, and watersheds is in development. The results will be an additional tool in guiding conservation and management activities.

Climate change is setting the stage for new ways of looking at conservation—as species expand and contract their ranges, they will need a place to go. Maintaining connected, high quality habitat will allow pathways for range expansions. Biologists are beginning to incorporate climate change predictions into management plans to ensure that on-the-ground actions are adequate to protect native plants and animals.

Improving Water Quality

Healthy ecosystems start with clean water. In the decades since the Clean Water Act was passed in 1972, water quality in Maine's lakes and rivers has greatly improved. Insect populations have recovered,

Acadian quillwort

and coldwater fish species that were extirpated during the days of uncontrolled waste discharge have returned to many miles of rivers. For example, after significant cleanup efforts, the Kennebec River now supports a coldwater fishery for its entire length and the Kennebec estuary has seen a resurgence of sea-run fish. The Kennebec River's classification has been continually upgraded as these improvements have occurred.

Yet we still have a long way to go. Over 1,000 miles of Maine rivers and streams are still impaired by pollution. Native species cannot survive in some polluted lakes and stretches of river in Maine. Better information about water quality trends in Maine waters, and how those trends may change in the future, will help us plan to

Maine's Water Classification System

Maine is one of a few states that classifies surface waters based on aquatic life requirements and uses. The Maine Legislature assigns each waterbody a classification (of four classes of rivers and streams, AA, A, B, C, and one class for lakes, GP-A), and reviews these classes every few years, making changes as improvements in water quality are achieved and to establish goals for management.

Distribution of River/Stream Water Classes
(Source: Maine DEP)

Class	Percent of Major Mainstem River Miles	Percent of Total River and Stream Miles
AA	21.0%	6.5%
A	41.8%	45.9%
B	29.4%	46.3%
C	7.8%	1.3%

protect biodiversity. Best management practices and low-impact development can reduce negative impacts of non-point source pollution, however restoration in established urban areas can be difficult and costly.

Managing Flows

While Maine is a water-rich state, water is not always available in sufficient quantities, in the right place, or at the right time to meet demand. Maine has enacted first-in-the-nation flow and water level requirements that are based on the needs of aquatic life. The new rule will provide for natural flow and water level variability along with minimum requirements, and encourage development of storage facilities and alternative water sources to meet expanding needs.

Expanding Awareness

In order to make informed decisions that protect our natural aquatic heritage, we need to know the values of and threats to biodiversity. Pollution or introduced species can spread throughout entire regions or watersheds. Conserved land is not immune to these activities, nor from global effects occurring outside a watershed. Public awareness of this interconnectedness will benefit other efforts to protect biodiversity.

What can you do?

- Become a water quality monitor. Join the Volunteer Lake Monitoring Program or the Maine Stream Teams program.
- Watch for invasive species. Prevent and report illegal species introductions.
- Build and landscape with lakes and rivers in mind.
- Support funding for state and federal programs.
- Support land and water conservation and restoration efforts.

Contributors: Written by Catherine Schmitt with contributions from: Peter Bourque, David Courtemanch, Joshua Royte, Nancy Sferra, Peter Vaux and Barbara Vickery.

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maine's threatened & endangered aquatic species

As of September 20, 2007.
E = endangered; T = threatened

Spotted turtle

Plants

Featherfoil [T]
(*Hottonia inflata*)
Acadian Quillwort [T]
(*Isoetes acadiensis*)
Prototype Quillwort [T]
(*Isoetes prototypus*)
Yellow Pond-lily [E]
(*Nuphar advena*)
Pygmy Water-lily [T]
(*Nymphaea leibergii*)
Fries' Pondweed [E]
(*Potamogeton friesii*)
Spotted Pondweed [T]
(*Potamogeton pulcher*)
Straight-leaved Pondweed [T]
(*Potamogeton strictifolius*)
Vasey's Pondweed [T]
(*Potamogeton vaseyi*)
Northern Slender Pondweed [T]
(*Stuckenia filiformis ssp alpinus*)
Slender Pondweed [E]
(*Stuckenia filiformis ssp occidentalis*)
Columbia Watermeal [T]
(*Wolffia columbiana*)
Water Stargrass [T]
(*Zosterella dubia*)

Invertebrates

Dragonflies and Damselflies

Rapids Clubtail [E]
(*Gomphus quadricolor*)
Boreal Snaketail [T]
(*Ophiogomphus colubrinus*)
Ringed Boghaunter [T]
(*Williamsonia lintneri*)

Freshwater Mussels

Brook Floater [T]
(*Alasmidonta varicosa*)
Tidewater Mucket [T]
(*Leptodea ochracea*)
Yellow Lampmussel [T]
(*Lampsilis cariosa*)

Mayflies

Flat-headed Mayfly (Roaring Brook Mayfly) [E]
(*Epeorus frisoni*)
Tomah Mayfly [T]
(*Siphlonisca aerodromia*)

Reptiles

Turtles

Blanding's Turtle [E]
(*Emydoidea blandingii*)
Box Turtle [E]
(*Terrapene carolina*)
Spotted Turtle [T]
(*Clemmys guttata*)

Fish

Atlantic Salmon (select rivers only) [E*]
(*Salmo salar*)
Redfin Pickerel [E]
(*Esox americanus americanus*)
Short-nosed Sturgeon [E*]
(*Acipenser brevirostrum*)
Swamp Darter [T]
(*Etheostoma fusiforme*)

*Species listed through the Maine Dept. of Inland Fisheries and Wildlife under Title 12 § 12803. Marine species listed separately under Title 12 § 6975 are not included in this list. *Federal listing only.*

Maine's lakes & rivers