Northeast Salmon Team Fact Sheet Collection

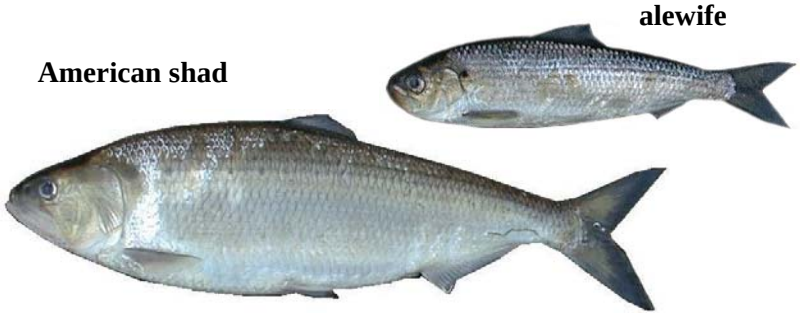
Maine's Native Complex of Sea-run Fishes

"The Penobscot fairly swarmed with the finest fish …salmon, shad, and alewives were taken in quantities that now seem almost incredible."

(In Ford's 1882 "History of Penobscot County, Maine")

Atlantic salmon have a very complex life history, inhabiting and migrating throughout freshwater streams and rivers, brackish estuaries, coastal waters, and the North Atlantic Ocean. In Maine, juveniles typically reside in freshwater for two years before migrating into marine environments. Maturing at sea, adults return to their natal river to spawn. Completion of this anadromous life cycle not only requires unobstructed access among freshwater, estuarine, and marine environments, but also properly structured and functioning ecosystems. In other words, species assemblages (the structure) and the interactions among these species (the function) play an important role throughout a salmon's life.

Anadromous Atlantic salmon co-evolved and historically shared the rivers of Maine with a number of other diadromous, or sea-run, fish species. Diadromous fishes are those that undertake a spawning migration from the ocean to rivers (i.e. the anadromous alewife, American shad, Atlantic sturgeon and tomcod, blueback herring, brook trout, rainbow smelt, sea lamprey, shortnose sturgeon, and striped bass) or vice versa (the catadromous American eel). Historically, diadromous communities were diverse and abundant; conversely, the resident fish species that would compete with or feed on Atlantic salmon were quite few.



Before the construction of dams, the upstream migrations of sea-run fishes extended well into the headwaters of Maine's largest rivers. Fisheries abounded, with commercial catches reportedly reaching into the millions for some species. Based on historical catch data and the writings of Charles G. Atkins (one of the first Commissioners of Fisheries for Maine), we can infer that sea-run fishes were substantially more abundant historically than they are today.

Recreational anglers at the Bangor Salmon Pool in 1926. (Bangor Daily News, used with permission).

At historic abundance levels, sea-run fishes likely played key ecological roles, such as providing alternative sources of food for both predators of salmon and the salmon themselves. Consequently, the diminishment of this native complex of fishes, via mechanisms such as dams, pollution and overfishing, may be partly responsible for the currently low returns of Atlantic salmon in Maine. However, the anecdotal nature of available historical sources makes it difficult to pinpoint the degree to which ecological interactions between co-evolved sea-run fishes impacted Atlantic salmon. Therefore, NEST researchers are exploring untested hypotheses related to the ecological importance of an intact sea-run fish assemblage and its potential role in Atlantic salmon recovery success.

The anadromous alewife and American shad co-evolved with Atlantic salmon. At historical abundance levels, these two species likely provided a significant prey buffer for the various life stages of Atlantic salmon against predators.

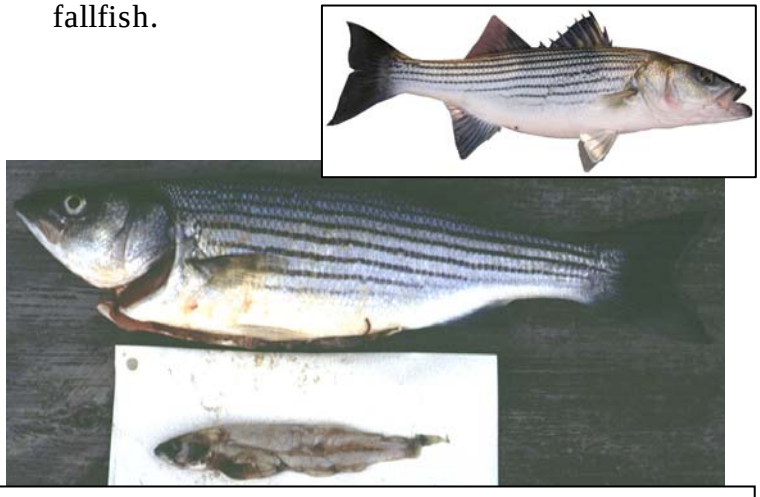
Ecological roles of co-evolved sea-run fishes

Prey Buffering. Historically, several sea-run fish species likely provided a robust alternative food source for native predators of Atlantic salmon. As a "prey buffer", these fish might have played an important role in minimizing predation on salmon during their many life stages. Likewise, their relatively low abundance today likely limits their capacity as a prey buffer for salmon.

- Pre-spawn adult alewives overlap in time and space with Atlantic salmon smolts. As adult alewives are migrating upstream Maine's rivers to spawn, Atlantic salmon smolts are migrating to sea. With a similar body size and numbers that exceeded smolts by several orders of magnitude, alewives probably acted as a substantial prey buffer. As such, they would have protected salmon smolts from native predators such as double-crested cormorants, river otters, striped bass and ospreys.

- Adult American shad likely provided a similar prey buffer for Atlantic salmon adults against river otters, harbor seals, and, perhaps, odontocete cetaceans (i.e. toothed whales, dolphins, and porpoises).

- Juvenile American shad and blueback herring may have also acted as a substantial prey buffer for Atlantic salmon fry and parr by native opportunistic predators such as mergansers, great blue herons, mink, and fallfish.



Striped bass are a co-evolved anadromous predator of smolt-sized fish. Above, a smolt found inside the stomach of a striped bass. Inset, a Penobscot River "schoolie.".

Prey for Salmon. Atlantic salmon are significant predators of various aquatic organisms during most of their life stages.

- The larvae of other sea-run fishes probably provided a significant source of food for juvenile salmon. Salmon parr may opportunistically consume juvenile alewives and other small fish to supplement their primary foraging base of aquatic invertebrates.

- The historical availability of rainbow smelt as a potential food source for post-spawn Atlantic salmon adults (kelts) in lower river zones may have been important in sustaining the viability of this salmon life stage. Conversely, the broad declines in rainbow smelt populations may be partially responsible for the declining occurrence of repeat spawners in Maine's salmon rivers.

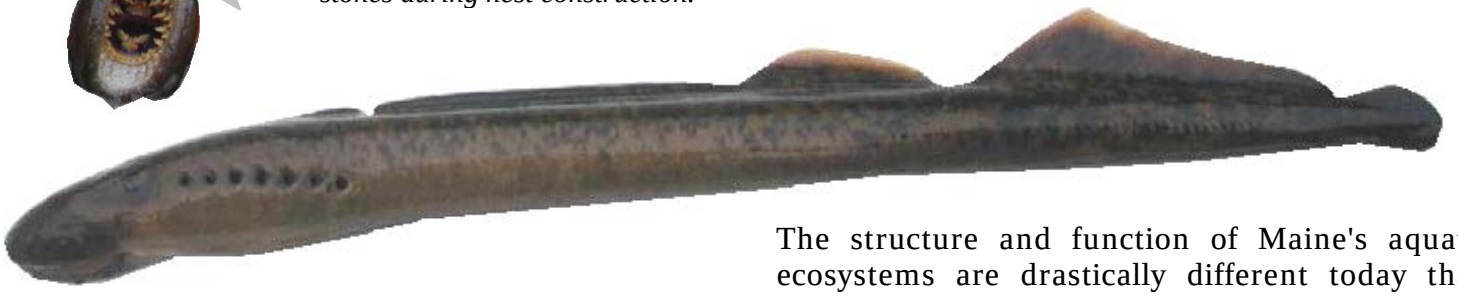
Rainbow smelt (pictured spawning in the Penobscot River) likely provided a significant food source for Atlantic salmon kelts. Historically, smelt were very abundant and provided a valuable fishery on the Penobscot, Kennebec, Sheepscot, and Pleasant Rivers. Today, the rainbow smelt is listed as a species of concern by NOAA-Fisheries Service.

Nutrient Cycling. Nutrient cycling (i.e. the continuous movement of minerals, compounds, or elements through an ecosystem) via sea-run fishes likely influenced the tremendous production potential of Maine's rivers greatly. The upstream migration of anadromous species from the sea to spawn provided a conduit for the import and deposition marine-derived nutrients (MDN) into freshwater systems. These are elements sequestered in the marine environment (particularly nitrogen and phosphorous). For example, due to the semelparous nature of sea lampreys (spawn once and die), they provide an important source of MDN at about the same time that salmon fry emerge from redds.

Habitat Conditioning. Some sea-run species may have also improved the condition of shared habitat. For example, in constructing their nests, sea lamprey deposit stones in loose piles and scour silt off stones already at the site. The stones and silt-free habitat preferred by lampreys appeal to spawning Atlantic salmon. In addition to creating an attractive spawning area, the lamprey's silt-cleaning activities during nest construction may improve the "quality" of the surrounding environment with respect to potential diversity and abundance of aquatic invertebrates.

The sea lamprey pictured below was captured in one of NEST's rotary screw traps on the Narraguagus River. Sea lampreys may play an important role in both nutrient cycling and habitat conditioning.

The jawless sea lamprey uses its mouth (pictured left) to move stones during nest construction.



Aquatic invertebrates (particularly caddisfly larvae) eat the carcasses of post-spawn adult lampreys and then provide a source of food for juvenile fishes, including juvenile Atlantic salmon.

Sampling the aquatic invertebrate community on the Dennys River in 2005. The MDN that anadromous fishes bring back to freshwater systems as adults influence primary production and food sources for juvenile life stages of Atlantic salmon.

The structure and function of Maine's aquatic ecosystems are drastically different today than they were historically. Sea-run fish abundance has declined precipitously and with them their roles as prey and prey buffers, sources of nutrients and habitat conditioners. Today, Maine's coastal rivers are resident species rich and diadromous species poor. Non-native residents found in Maine's coastal rivers now include predatory species such as smallmouth and largemouth bass, chain pickerel, Northern pike and brown trout. These new species now also compete for limited in-stream resources.

Restoring the native suite of diadromous fishes and the ecological functions they perform, may enhance Atlantic salmon survival at key life history events. As such, current efforts to restore sea-run fishes, such as the Penobscot River Restoration Project, could substantially advance the direction of Atlantic salmon recovery efforts.