

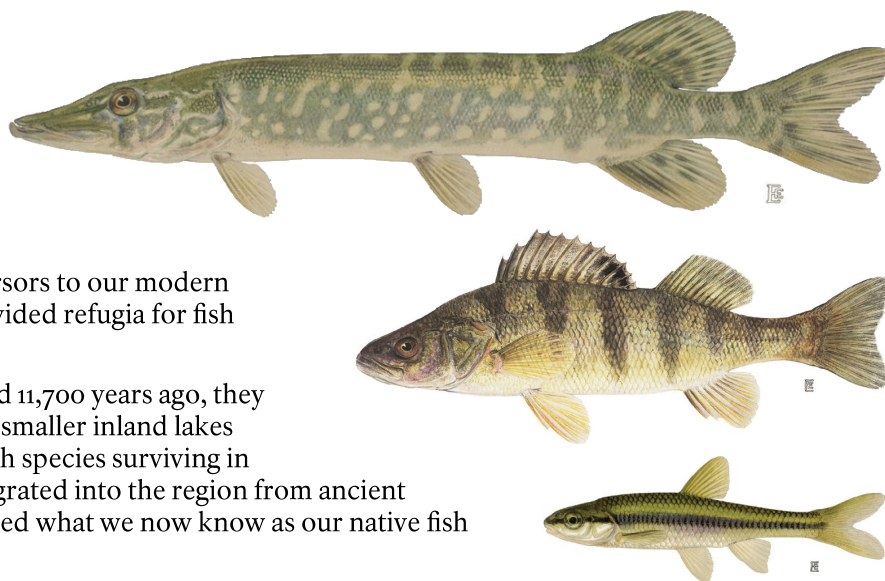


From Whence They Came: Fish Community Biogeography

The Great Lakes region was shaped by massive ice sheets during the Pleistocene Epoch—the geological time period sometimes called “the ice age,” which began 2.5 million years ago and ended approximately 11,700 years before present. At their maximum extent, the ice sheets covered much of the upper Midwest, disrupting and altering the pre-glacial fish communities in the region’s lakes and rivers. However, glacially-formed precursors to our modern Great Lakes and the rivers connected to them provided refugia for fish species.

As the ice sheets began their final retreat northward 11,700 years ago, they formed the modern Great Lakes and thousands of smaller inland lakes throughout the region. At the end of the ice age, fish species surviving in the glacial refugia lakes, along with species that migrated into the region from ancient connections within the Mississippi Basin, established what we now know as our native fish communities.

Isle Royale National Park (ISRO), Voyageurs National Park (VOYA), and Sleeping Bear Dunes National Lakeshore (SLBE) each contain many inland lakes. The patterns of fish species distribution across the three parks provide clues about the original composition and origin of inland lake fish communities both in the parks and throughout the region. The main objectives of this research were to estimate the ages of inland lakes and examine the current inland lake fish communities of these parks to gain a better understanding of how they might have been shaped by glacial history and how they may be changed in the future by human-driven influences.



Three of the most common species in fish community assemblages across the three parks were (from top) northern pike, yellow perch, and blacknose shiner. Art work from Kraft et al. 2006. *Inland Fishes of New York (online)*, Version 4.0. www2.dnr.cornell.edu/cek7/nyfish/index.html.

Each park contained a diversity of fish communities. Differences in the composition of fish communities were mostly related to the gradient of available lake habitats, based on lake size and depth and corresponding changes in temperature, oxygen, and water clarity. Nine faunal assemblages were identified among the three parks (*Table 1*). (Faunal assemblages refers to a specific combination of fish species within a lake’s larger fish community.)

Isle Royale

ISRO’s 32 inland lake communities contained assemblages 1, 2, 3, 6, 8, and 9. The most widespread were assemblage 2 (northern pike, yellow perch, and blacknose shiner) and assemblage 1 (northern pike and yellow perch), represented in 13 and 10 lakes, respectively. Coolwater and coldwater assemblages (3 and 9) were represented in two lakes each. Hatchet Lake lacked both northern pike and yellow perch (assemblage 8). Desor also lacked these species even though it contained a coldwater

Table 1. Faunal assemblages present in the inland lake fish communities at Isle Royale, Sleeping Bear Dunes, and Voyageurs.

1. northern pike, yellow perch
2. northern pike, yellow perch, blacknose shiner; subgroup with golden shiner
3. northern pike, yellow perch, and coldwater species cisco and slimy sculpin
4. northern pike, yellow perch, and largemouth or smallmouth bass
5. northern pike and largemouth or smallmouth bass; *yellow perch absent*
6. *northern pike absent*; yellow perch, blacknose shiner, pearl dace; *no predators*
7. largemouth or smallmouth bass present; *northern pike and yellow perch absent*
8. *northern pike and yellow perch absent*; *no predators*
9. coldwater assemblage: cisco, lake whitefish, trout-perch, ninespine stickleback, spoonhead or slimy sculpin, and lake trout

assemblage. Overall, northern pike with yellow perch were present in 25 of the 32 lakes (78%).

Sleeping Bear Dunes

SLBE's 19 inland lakes contained assemblages 1, 4, 5, 6, 7, and 8. The most widespread was assemblage 4 (northern pike, yellow perch, largemouth bass, and bluntnose minnow), which was found in 11 lakes. Assemblage 5 (northern pike *without* yellow perch) occurred in three lakes, and assemblage 7 (*lacking* northern pike, but containing yellow perch and largemouth or smallmouth bass) occurred in three lakes. Assemblage 1 (northern pike and yellow perch *without* largemouth bass and bluntnose minnow) was found only in Florence Lake. Assemblage 8, which lacked northern pike, yellow perch, and basses, was found only in Hidden Lake. Overall, northern pike together with yellow perch were present in 12 of the 19 lakes (63%).

Voyageurs

VOYA's 26 inland lakes contained six assemblages—1, 2, 3, 5, 6, and 8. The most widespread was assemblage 2 (northern pike, yellow perch, and blacknose shiner), represented in 11 lakes. However, in two of those 11 lakes (Shoepack and Little Shoepack), muskellunge is the functional substitute for northern pike. Assemblage 3 (coldwater species with northern pike and yellow perch) was found in four lakes. Overall, northern pike (or muskellunge) together with yellow perch (assemblages 1, 2, and 3) were present in 19 of the 26 lakes (73%).

Inland lake fish communities at ISRO are the most similar to those likely present at the end of the last ice age. Isle Royale communities remain closest to the Pleistocene source pool as a result of being situated in Lake Superior, which moderates the climate and stops colonization of park lakes by thermally tolerant and warmwater species. VOYA is at about the same latitude as ISRO but has experienced greater changes in fish communities, primarily because of its inland location and historic drainage connections to the upper Mississippi basin during the retreat of the glaciers. SLBE, which is more than 300 km (186 miles) south of ISRO and VOYA, has a warmer climate, so the lakes are more conducive to warmwater species. Many of SLBE's lakes were formerly bays on the precursors to modern Lake Michigan, which many warmwater species colonized from the Mississippi basin during the late Pleistocene, about 13,000 years before present.

Estimating the ages of inland lakes (which range from about 100 years to nearly 12,000 years old) provides a historical context for the fish communities. Older lakes generally host populations of fish that have been present since the land emerged and created inland lakes out of what were once Great Lakes bays. These old, relatively pristine “heritage communities,” and the “heritage species” they contain merit preservation because they are unique components of the regional biodiversity.

North American freshwater fishes exhibited a limited ability to adapt to the climate changes that occurred throughout the last ice age and since the retreat of the glaciers. Faced with an unprecedented rate of expected climate change in the 21st century, there is a potential for cool- and coldwater fish, many of which are heritage species, to become locally extinct. Generally, heritage lakes can support coldwater fish. Lakes with heritage communities and sufficient habitat to allow these fish species to survive could be designated as “refuge lakes.” Among four heritage lakes at ISRO (Siskiwit, Sargent, Desor, and Richie), Siskiwit is the best candidate to support the survival of all heritage fish species because of its large size, depth, and diverse habitat. Among three potential heritage lakes at VOYA (Cruiser, Little Trout, and Mukooda), Cruiser is the only one with an apparently self-sustaining population of lake trout (a heritage fish species). SLBE has no refuge lakes, and there are no coldwater species left there.

Unique heritage species in non-refuge lakes could be relocated to refuge lakes, if park managers believe this could keep a species from becoming locally extinct. New or increased surveillance and management of heritage fish communities may aid park managers in devising strategies to ensure that these important species remain present as long as suitable habitat exists.



This work was a cooperative effort between the National Park Service and the U.S. Geological Survey.



Smallmouth bass are found in many lakes at Sleeping Bear Dunes National Lakeshore. *NPS photo.*



Cisco is a coldwater fish species found in heritage lakes at Voyageurs and Isle Royale national parks. *NPS photo.*

Gorman, O., L. Kallemeyn, and R. Maki. 2014. Biogeographic patterns of inland lake fish communities at Isle Royale, Voyageurs, and Sleeping Bear Dunes national park units. Natural Resource Technical Report NPS/GLKN/NRTR—2014/893. National Park Service, Fort Collins, Colorado.