

Studying the Genetics and Population Size of Muskellunge in Little Shoepack and Shoepack Lakes

First of all, what are muskellunge? Muskellunge (*Esox masquinongy*), also known as muskies, are large, predatory fish native to some Minnesota lakes and rivers. They look similar to northern pike (*Esox lucius*), but the bodies of native muskies have darker markings (bars or spots) on a light background; northern pike have the opposite—light markings on a darker background (Minnesota Department of Natural Resources 2024). Muskies are generally big fish. In Minnesota, a muskie has to be at least 54 inches long (that's 4.5 feet!) for an angler to keep it. Within Voyageurs National Park (NP)—a park with a lot of lakes—muskie populations are present only in Little Shoepack and Shoepack lakes, which are located about 1,020 feet apart.

Little Shoepack and Shoepack lakes are small—51 acres and 304 acres, respectively. Because of the lakes' small sizes, and the predicted small sizes of their muskie populations, resource managers are concerned about the continued persistence of this native fish in the lakes. A 2019 population assessment completed for Shoepack Lake muskies found that the estimated population had decreased from a previous estimate in the early 2000s. Once populations reach a certain (low) level, they can suffer from a lack of genetic variability that may lead to an increased risk of extirpation.

In 2021, researchers at Voyageurs NP partnered with the Minnesota Department of Natural Resources to study the genetics of muskellunge in both lakes and the muskellunge population size in Little Shoepack Lake (Figure 1).

How Did Researchers Study Muskies?

The field methods, genetic analysis, and data analysis are described in detail in the study report. In brief, researchers used a mark-recapture study design using a non-lethal sampling method (angling) to estimate the population size of muskies in Little Shoepack Lake. They captured fish by angling from a canoe and from the shore. They conducted initial sampling (and marking) from June–September 2021 and recapture sampling from May–September 2022. All captured fish were handled carefully using rubberized



Figure 1. Park biologist releasing a muskellunge, after collecting information on it, back into Little Shoepack Lake. NPS photo.

landing nets, a mesh cradle, and 15-gallon tubs of fresh lake water. For each muskie captured in 2021, researchers sedated it, measured its total length, weighed it, and tagged it with an individually numbered tag between the dorsal fin rays. Researchers also clipped a small piece of the left pelvic fin as a secondary mark and for the genetic analysis (Figure 2). Fish were released after recovering from sedation. Researchers used the same methods during the recapture phase in 2022, except that 1) no new tagging was done (and therefore fish were handled less and were not sedated), and 2) fish were recorded as recaptures or new captures. Genetic samples were collected from Shoepack Lake muskies during previous studies in 1993, 2001, and 2019.

Voyageurs' Muskies are Unique

Genetic information for muskellunge in Little Shoepack Lake (57 fish total from this study) indicate that muskies from the lake had the lowest genetic diversity of all Minnesota and Wisconsin populations examined (that is, of Shoepack Lake, eight other locations in the state, and one lake in



Figure 2. How do you handle a muskellunge? Very carefully. Here, a park biologist is working on a sedated muskie to clip its left pelvic fin (as a secondary mark and for the genetic analysis). They have already tagged the fish with a t-bar anchor tag that is visible just below the dorsal fin (within the red circle added to the image). Note that muskies in these lakes are smaller in size than muskies in other areas. NPS photo.

Wisconsin). The Little Shoepack and Shoepack populations were genetically similar to one another, relative to the other muskie populations, but they were also genetically distinct from one another.

How Many Muskies are in Little Shoepack Lake?

Twenty-nine muskies were marked and released in 2021, and 34 were caught (including 7 recaptures marked in 2021) in 2022. Using this information and population-estimation models, researchers estimated the 2021 abundance of muskies \geq 16.5 inches long in Little Shoepack Lake to be 137 individuals, with a 95% confidence interval of 87 to 277 (meaning that the actual population size is likely somewhere between 87 and 277). Knowing the size of the lake and assuming that muskellunge inhabited its entirety, the density of muskies \geq 16.5 inches long in Little Shoepack Lake was 2.7 fish per acre (6.6 fish per hectare). This density is the highest known of any muskie population in the state. The muskie density in Shoepack Lake was 1.4 fish per acre (3.5 fish per hectare) based on the 2019 population estimate.

Summary & Recommendations

The native populations of muskellunge in Little Shoepack and Shoepack lakes are genetically distinct and important for maintaining regional biodiversity. The two populations are very similar to one another (but not the same) and very different from other regional populations in Minnesota and Wisconsin. These park populations have probably existed since the formation of the two lakes, estimated at 7,100 years ago (Shoepack) and 8,900 years ago (Little Shoepack) (Gorman et al. 2014). Despite the small number of individuals, these populations have shown great resilience. To help sustain the muskie populations, researchers recommended that resource managers continue to use fishing regulations, controls on angling pressure, and the prevention of introductions of non-native fish and aquatic invasive species (e.g., zebra mussels [*Dreissena polymorpha*]).

Literature Cited

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This Brief is Based on:

Maki, R. P., K. Patterson, J. W. Amundson, E. J. Carlson, L. Miller, S. M. Shroyer, J. LeDuc, R. Banta, J. Glase, J. Horvath, and M. Howard. 2024. Little Shoepack Lake muskellunge (*Esox masquinongy*) population estimate and genetic evaluation of muskellunge from Shoepack and Little Shoepack lakes. Science Report NPS/SR—2024/164. National Park Service, Fort Collins, Colorado. <u>https://doi.org/10.36967/2305092</u>.