

# WHAT'S ON THE MENU?

*Some of the muskie in this study have had extremely large diets, including one that had eaten 101 other fish, 97 of which were yellow perch.*



## STUDY INVESTIGATES DIETS OF MINNESOTA'S MUSKELLUNGE

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Through the years, Minnesota has increasingly become a destination for dedicated muskie anglers from across the country and worldwide. This is no accident, as the state's waters are managed with Leech Lake strain fish, a 54 inch minimum size limit, and stocking rates designed to provide anglers with the best chance at a fish of a lifetime. Multiple fish well beyond the 54 inch minimum are reported by anglers every year throughout the state, and the state records for both length and weight have been broken within the last three years. However, the fish of 10,000 casts has had a polarizing history in the land of 10,000 lakes.

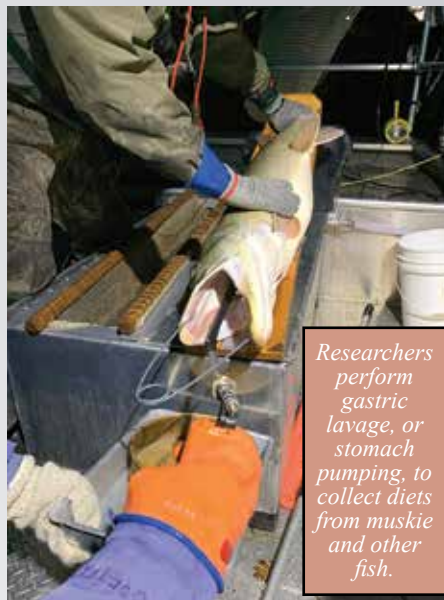
Despite a body of scientific evidence indicating muskies do not negatively impact resident fish populations in the waters where they are managed, muskie management in Minnesota has faced significant pushback in recent years. This is especially true in lakes with introduced muskie populations, as some individuals wondered if adding another predator might upset the balance within these ecosystems. Most recently, the muskie debate reached the Minnesota legislature in 2018 with a proposed bill to change muskie regulations and stocking practices throughout the state. While the original bill was not passed into law, it did indicate a need for additional research into the role of muskies in fish communities. Specifically, biologists, politicians, and other interested stakeholders wanted data to answer two questions: **(1) what are**

**muskie feeding on in Minnesota lakes? and (2) how do muskie diets compare to other popular sportfish such as walleye, northern pike, and largemouth bass?**

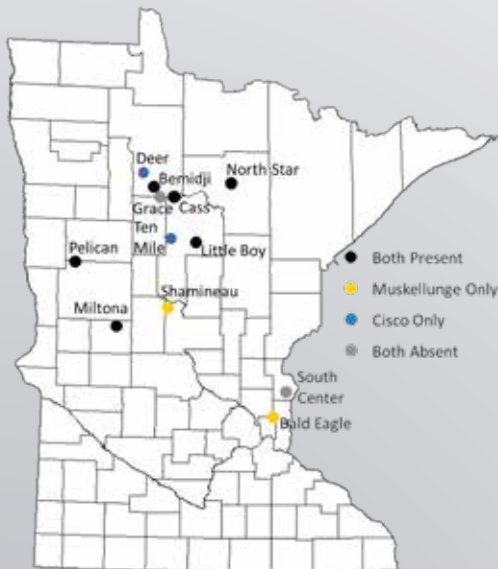
In 2019, we began a multi-year project collecting and analyzing the stomach contents of these four predators and investigating lake food webs through stable isotope analysis (a technique that uses the presence of alternate

forms of elements like Carbon and Nitrogen to identify prey items) with researchers from Bemidji State University, Minnesota Department of Natural Resources (MN DNR), and the University of St. Thomas. This project was designed to build upon a previous study conducted by biologists from MN DNR and the University of St. Thomas, which used stable isotope analysis to investigate the food web in Elk Lake, Itasca State Park. The results indicated muskies relied heavily on the abundant cisco population as their prey. Muskie anglers have long believed muskie prey on cisco where they exist, so this may not surprise them. However, documenting the predator-prey relationship has

been difficult with the methods used in previous diet studies. The Elk Lake project led to our study design, where lakes with and without cisco were included to investigate if diets differ based on the availability of this prey species. Additionally, lakes without muskie were also included to determine if their presence might



*Researchers perform gastric lavage, or stomach pumping, to collect diets from muskie and other fish.*



*Fish diets have been collected from 10 Minnesota lakes since 2019, with lakes split into groups depending on presence or absence of both muskie and cisco. Two additional lakes (Cass and North Star) are slated to be sampled in 2022.*

Stomach contents were collected from 122 muskies in the four lakes with cisco and 71 in the two lakes without cisco. Muskies sizes ranged from 11.2 to 54.9 inches, and roughly 50% of stomachs contained at least one prey item. The percentage of muskies with prey was fairly consistent across seasons and fish sizes, and was quite a bit higher than some of the previous diet studies conducted on muskies. One memorable muskie diet contained 101 individual fish—a bluegill, a sucker, two bullheads, and 97 yellow perch! Other diets contained a single large prey item, such as a 24.6 inch northern pike or a 21.4 inch sucker. Still, others have been even more

*(Article continued on page 18)*

impact the diets of walleye, northern pike, and largemouth bass. This resulted in a study design where lakes fell into one of four categories: both muskie and cisco present, muskie only, cisco only, or both (muskie and cisco) absent.

Electrofishing, which uses a generator to produce an electric field that temporarily stuns fish, was conducted at nighttime to collect fish throughout the open water period. A major advantage of this method is that we can release the fish alive after collecting our samples. However, electrofishing for muskies can be challenging because their large bodies can detect electricity farther away than smaller fish. They are powerful enough to avoid the boat if they notice it too soon. To give ourselves better odds at capturing muskies, we use spotlights to locate them in relatively shallow water without the electricity running. We then maneuver the boat directly above the fish before flipping the switch and hope we're quick enough to net them before they recover and escape. Additional fish were captured in MN DNR survey nets and by angling, although our angling attempts were largely unsuccessful! Stomach contents were collected by pumping lake water into a fish's stomach, which causes any recent prey items to be regurgitated and allowed fish to be released following the procedure. Prey items were identified and measured, and equations were used to estimate the weight of each prey item. Finally, an index of relative diet importance was calculated for each predator, while a separate value was calculated to investigate diet overlap among the different predators.

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Muskies occasionally consume large non-fish prey, such as this goldeneye duck and partially digested muskrat.

unexpected, such as the three muskies that consumed muskrats or three others that consumed birds (a gull and a duck and a coot, oh my!).

While these surprising diet items were always fun to collect, they were rare and contributed relatively little to our overall diet trends in the study lakes. In lakes with cisco present, yellow perch were the most important prey item for muskies, making up 36% of the diet. Other relatively important prey species in this lake group included suckers (16%) and bullheads (7%). In lakes without cisco, northern pike (20%), sunfish (13%), and bullheads (12%) made up the bulk of muskie diets. Surprisingly, cisco were not a key

component of muskie diets in the four lakes with cisco present, contributing less than 1%. However, this could be due to the limitations of our sampling gears and angling abilities, as almost all our samples came from less than 6 feet of water, coinciding with the depth of water in which electrofishing is most efficient. Finally, while three muskies in cisco lakes did consume walleye, they were not an important diet component at less than 1%. No walleye were detected in muskie diets in lakes without cisco.

Additional stomach contents were collected from 1,043 northern pike, 1,178 walleye, and 1,105 largemouth bass. Interesting prey items recovered from these species (especially largemouth bass) included one duckling, two baby snapping turtles, numerous frogs, and even a bone from a chicken drumstick! Yellow perch, black crappie, and sunfish accounted for over 65% of northern pike diets in all four lake categories. A similar pattern was true for walleye, with yellow perch and sunfish contributing over 64% of their diets across lake groups. While largemouth bass consumed these prey groups as well, they relied much more on crayfish and other invertebrates, which made up over 70% of their diets in most lakes.

An index of diet overlap between each species pair was calculated for each lake. Overlap between muskie and the other species was low in lakes with and without cisco. This is likely due to the wide range of prey that muskies consumed, including prey that was too large for the other species. Largemouth bass diet overlap was also low in lakes where crayfish were important,



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The largest fish of this study was 54.9 inches and was caught twice—first in May 2021 (left) and again in August 2021 (right).



Some of the larger prey items need some extra encouragement to be removed, including this large sucker. We've found that kitchen tongs work well for this!

whereas shared use of sunfish as prey led to higher overlap in lakes without muskie and cisco. Conversely, northern pike and walleye had the highest overlap of any species pair in all lake groups. This is likely due to the importance of yellow perch and sunfish in both species' diets.

Our results indicate muskies in Minnesota lakes consume a broader range of prey species compared to walleye, northern pike, and largemouth bass, which leads to low levels of diet overlap with these predators. While muskie did consume shared prey resources such as yellow perch and sunfish, their ability to exploit large-bodied prey items such as suckers, bullheads, and northern pike gave them a unique niche in the food web and kept overlap levels relatively low. In conjunction with the minimal presence of walleye in their diets, these results are consistent with previous studies showing that muskie can co-exist with other popular fish species.

This project is in its final stages, with diet collections on two additional lakes wrapping up this fall. Stable isotope analysis is also ongoing, which will help us understand longer-term feeding patterns and energy sources on an expanded set of lakes. This technique will give us a better idea of predation on cisco in lakes where they are present, as it is not reliant on capturing fish in shallow water that had recently consumed their prey. Finally, in two of the study lakes, a bioenergetics project is underway to build on this diet work by estimating how much of each prey species is consumed by each predator population, based on adult population estimates, diet data, and growth rates.

These concurrent studies will give biologists much-needed information on aquatic food webs and how predators may interact, providing critical information to help assist in fisheries management decisions. These decisions will be incorporated into management plans for individual lakes throughout the state and the next statewide long-range muskie management plan, all to give anglers a shot at the biggest fish of their life. And, hopefully, it doesn't take them 10,000 casts to catch it. ■ ■ ■



A muskie swims away following diet collection.

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