LARGEMOUTH BASS DIET CHANGES THROUGH THE SUMMER IN CENTRAL MINNESOTA

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***Abstract*— Largemouth Bass *Micropterus nigricans* is one of the most widespread fish species in the world, due in part to human introduction for angling. Largemouth Bass are opportunistic predators that will consume the largest prey they can often find; however, it has been shown that their diet mainly consists of invertebrates such as crayfish, with less focus on other fish species. This research aimed to determine what the Largemouth Bass diets in Central Minnesota consist of, and how they may change from the beginning of summer through the beginning of fall. A total of 174 Largemouth Bass were sampled from late May through late August from 19 lakes across Cass and Crow Wing County in Central Minnesota. There was not a significant change in overall fish and invertebrate consumption over the 3-month sampling period ($p = 0.08$); however, there was a significant change in which fish species were consumed over time ($p < 0.01$). Contrary to past research, Largemouth Bass in this study primarily consumed other fish species, especially Bluegill *Lepomis macrochirus* and Yellow Perch *Perca flavescens*, rather than invertebrates. These findings challenge previous studies, and the results provide greater insight into the diets of Largemouth Bass in a previously understudied region.**

INTRODUCTION

Invasive species can have devastating effects on native flora and fauna, leading to biodiversity loss, ecosystem degradation, and widespread ecological disruption (Pyšek and Richardson 2010). While this issue is often overlooked in discussions about game fish, it is highly relevant to species like the Largemouth Bass (*Micropterus nigricans*). One of the most popular game fish in the United States, Largemouth Bass attract millions of anglers each year, drawn by the chance to catch a trophy-sized fish. This widespread enthusiasm has driven their introduction far beyond their native range, from the southern tip of Florida to the west coast of Washington. Although they have been documented in scientific literature since the early 1900s (Pereira and Vitule 2019), their long-standing presence does not exempt them from the ecological consequences of invasive species. In many non-native systems, Largemouth Bass can disrupt food webs, outcompete native predators, and alter community structure, especially in lakes and rivers where native fish have not evolved alongside such aggressive piscivores.

The impact that Largemouth Bass have on a system is closely tied to their feeding behavior. In Minnesota, they are often less piscivorous than many other predatory fish species (Glade et al. 2023). Largemouth Bass consume a wide range of prey, from fish to invertebrates, however, the main diet is thought to consist of Crayfish and other invertebrates. This diet is not uniform across their range, however, and depends heavily on local prey availability, habitat conditions, and seasonal patterns. Understanding what Largemouth Bass consume in different regions is essential to evaluating their ecological role and potential management strategies in both native and non-native systems.

Largemouth Bass are highly opportunistic predators whose diet shifts significantly with age, habitat, and seasonal conditions. Juvenile bass typically feed on zooplankton and aquatic insects, while adults transition to larger prey such as crayfish, frogs, and fish. Their feeding behavior is driven by energy optimization; they prefer prey that offers high caloric return with minimal effort, often targeting the largest item they can fit in their mouths, regardless of species (Hambright 1991). Seasonal changes also influence diet composition; bass may consume more fish in the summer and fall when prey fish are abundant, while relying more on invertebrates during colder months (Ward and Neumann 1998). This dietary flexibility allows Largemouth Bass to thrive in diverse ecosystems, but it also contributes to their ecological impact in non-native systems, where they may disrupt native prey populations and alter trophic dynamics.

Diet is a key factor in understanding the ecological impact of Largemouth Bass, and it varies significantly across their geographic range. In the Southern United States, where the species is native and environmental conditions support rapid growth, extensive research has documented their consumption of fish, amphibians, and invertebrates, often at high trophic levels. However, in the Northern United States, including regions like Central Minnesota, colder temperatures limit the growing season. Despite their popularity among anglers, relatively little is known about their seasonal feeding habits in these northern systems. To address the gap in research, this study aimed to collect diet samples from Largemouth Bass in Central Minnesota to examine how their prey composition may shift from June through August. Understanding these patterns can help fisheries managers assess the species' ecological role and inform decisions, habitat management, and conservation priorities.

Methods

The study was conducted across 19 lakes in Crow Wing and Cass counties (Table 1), and fish were collected from May 31st, 2025, through August 25th, 2025. A total of 172 Largemouth Bass were sampled with experimental gill nets and double-frame trap nets, and two more fish were sampled via angling to practice stomach removal. Gill nets were 250 feet long and divided into five 50-foot sections, each with mesh sizes of 0.75, 1, 1.25, 1.5, and 2 inches, allowing effective sampling of offshore fish across size classes. Trap nets consisted of five hoops with 0.75-inch mesh attached to a rectangular frame measuring 6 by 3 feet. These nets were set 40 feet from shore, with a lead line running perpendicular to the shoreline to guide fish into the trap for collection. Nets were set for 24 hours as part of the Minnesota DNR's Standard Lake Survey.

All Largemouth Bass captured in nets were sampled. Bass were measured while on the boat to the nearest millimeter before their stomachs were removed and placed in a sterile Whirl-Pak bag containing 70% ethanol. Stomachs were labeled with the date of capture, length, lake name, and notes that collectors found important. Stomachs were then stored until content analysis began. To analyze the diets, the Whirl-Paks were opened, and the stomachs were removed and dumped into a metal tray. The stomach was then placed on a scale to get the weight when full to the nearest milligram. The stomach was then cut open using a scalpel, and all contents were removed and weighed individually. Contents were then identified to the lowest possible taxonomic level before being disposed of.

All data was recorded into a spreadsheet for further analysis. Bass diets were characterized by using non-parametric multi-dimensional scaling (NMDS) ordinations in Program R, which allowed for visualization of diet niches and overlap throughout the sampling period based on prey abundance. The vegan package was used for the NMDS analysis by running the metaMDS function to find similarities in the dataset (Oksanen et al. 2008). The ellipse package was also run to insert ellipses, which show the confidence region between the prey abundance and the month (Murdoch and Chow 2020).

Frequency of occurrence and prey-specific abundance were compared to show the distribution of individual prey types. Frequency of occurrence was calculated by taking the number of fish that ate a specific prey species divided by the sum of individuals found with stomach contents (Amundsen et al. 1996; Costello 1990). Prey-specific abundance was

Table 1. Summary of the lakes included in the study. Each entry includes the lake name, county, number of samples from the lake, the surface area of the lake, and the maximum depth of the lake.

Lake Name	County	Samples	Surface Area (ac)	Maximum Depth (ft)	Notes
Clearwater	Crow Wing	19	905	54	
East Fox	Crow Wing	9	240	65	
George	Crow Wing	2	223	32	
Gull	Cass/Crow Wing	18	10010	80	Gull Lake chain
Hubert	Crow Wing	11	1287	83	
Little Pelican	Crow Wing	18	271	34	
Love	Crow Wing	1	78	27	
South Long	Crow Wing	20	1309	47	
Nisswa	Crow Wing	7	219	23	Gull Lake chain
Ray	Cass	5	142	27	
Rogers	Crow Wing	6	240	64	
Round	Crow Wing	5	1650	51	Gull Lake chain
Roy	Crow Wing	4	319	26	Gull Lake chain
Sunset	Crow Wing	2	221	43	
Upper Dean	Crow Wing	2	259	24	
Upper Gull	Cass	7	421	54	Gull Lake chain
Upper South Long	Crow Wing	13	804	47	
West Fox	Crow Wing	24	449	55	
White Sand	Crow Wing	1	413	27	

calculated by dividing the total number of prey items by the total number of stomachs containing that prey type. These values were then multiplied by 100 to get a percentage for each prey item.

Pearson's chi-squared tests were used to evaluate whether diet composition changed over the course of the sampling period (Sölpük Turhan 2020). Prey items were categorized as either fish or invertebrates, and a table was constructed to compare the frequency of these prey groups across the 3-month sampling period. Analysis was conducted in Program R using base statistical functions. To further assess shifts within piscivorous diets, prey fish were divided by species, and additional chi-squared tests were performed to determine whether consumption of specific fish species varied by month throughout the study.

RESULTS

A total of 174 Largemouth Bass stomachs were sampled and examined, of which 84 contained identifiable prey items, and 90 were empty. Fish dominated the diet by both count and biomass. Yellow Perch were the most frequently consumed prey, occurring 62 times in 27 stomachs and contributing 172.62 g, or 26% of the total diet by weight (Figure 1). Although less common, Bluegill accounted for the greatest biomass, with 26 individuals totaling 323.87 g, and they represented 49% of the total diet by weight. Among invertebrates, crayfish were the primary prey consumed, with 16 individuals found in 11 stomachs, contributing to 67.79 g of the diet, or roughly 10%. All six of the other observed invertebrate species combined to be less than 1% of the total diet by weight, weighing just 4.36 g. The lack of a dominant prey item is consistent with what is expected of opportunistic predation, with everything being clumped into the lower left quadrant of the graph (Figure 1). One instance of cannibalism was observed, where a 382 mm Largemouth Bass ate a single 117 mm Largemouth Bass.

There is evidence that fish length influenced Largemouth Bass feeding patterns. Larger individuals consumed proportionally higher biomass fish prey, particularly Bluegill and large invertebrate species such as crayfish. Smaller bass relied more heavily on invertebrates and unidentifiable small fish. This pattern was reflected by the vector associated with fish length (Figure 2). However, there is little evidence to suggest that seasonal changes influenced overall Largemouth Bass feeding patterns in this study. This is indicated by the heavily overlapping monthly ellipses (Figure 2).

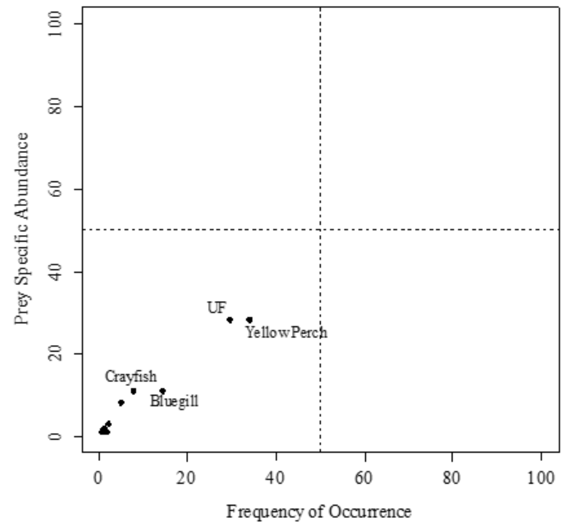

Figure 1. Each point represents a distinct prey type, plotted by its prey-specific abundance and frequency of occurrence in Largemouth Bass diets (Amundsen et al. 1996). The lack of dominant prey items and the clumped distribution of points in the lower left quadrant of the plot suggests a generalized feeding strategy, consistent with what is expected of opportunistic predation.

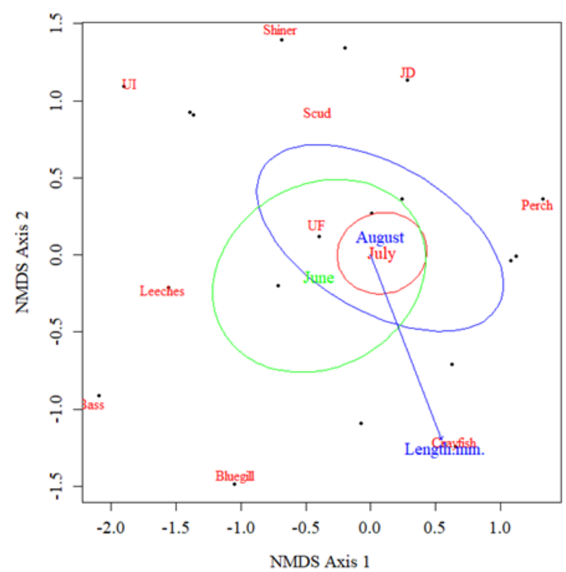

Figure 2. Non-metric multidimensional scaling (NMDS) ordination of Largemouth Bass diet composition across three summer months. Points represent individual Largemouth Bass that were sampled. Each ellipse represents the 95% confidence interval around diet profiles for June (green), July (red), and August (blue). The sampled prey species are labeled as follows: UI (Unidentified Invertebrate), Bass, Shiners, UF (Unidentified Fish), Bluegill, Scuds, JD (Johnny Darters), Leeches, Perch, and Crayfish.

The overall composition of prey remained consistent from late May through August, with similar proportions of fish to invertebrates consumed, approximately one invertebrate for every five fish. When prey was grouped broadly as fish versus invertebrates, overall diet composition did not differ significantly across the sampling period ($\chi^2 = 5.03$, df $= 2$, $p = 0.08$). A total of 18 invertebrates were observed in the study, with 9 of them appearing in July. Fish were observed more often, with 71 observations, and again, July was the month with the highest number of these observations, at 43 fish. When prey fish were subdivided by species, a significant shift in species-specific consumption was detected from May through August ($\chi^2 = 52.86$, df = 12, $p < 0.01$). This shift seems to be in the overall consumption of Yellow Perch and unidentifiable fish, which both increased in July and August, and the decrease in overall Bluegill consumption after June.

Discussion

The results of this study indicate that Largemouth Bass in Central Minnesota rely heavily on fish species throughout the summer, consuming mostly Bluegill and Yellow Perch. These results conflict with a previous study in Minnesota, where it was reported that Largemouth Bass diets contained lowered fish species concentrations while observing an increase in invertebrate consumption, mainly crayfish, in the bass diets (Glade et al. 2023). In this study, crayfish made up roughly 10% of the diet, with all other invertebrate species accounting for less than 1% of the diet combined, whereas prior research found that inverts made up 67% of the diet (Glade et al. 2023). The dominance of prey fish consumption aligns with the opportunistic feeding patterns often associated with Largemouth Bass. It is probable that bass have more interactions with Bluegill and Yellow Perch than with many invertebrate species.

Seasonal changes did not significantly affect the overall proportion of fish and invertebrates consumed. However, when prey fish were broken down by species, a shift was observed. The length of the bass also appeared to influence the prey items consumed, with many larger fish eating more Bluegill and all the crayfish. These findings are somewhat similar to a previous study in Connecticut lakes. It was found that a noticeable shift from inverts to fish was recorded over time, which differed from the results of this study. However, they also observed that as bass grew, their diet shifted from small aquatic insects to larger prey such as Bluegill, White Perch, and Crayfish (Ward and Neumann 1998). This directly aligns with the findings here. One instance of cannibalism was observed, indicating that Largemouth Bass generally avoid cannibalism unless under stress or pressure.

There are a few limitations to consider within this study, such as the sampling period. To obtain a more complete diet dataset, sampling should begin as early as possible and run as long as possible. Having a higher count of small fish in the study may also influence the data. Larger fish were easier to sample; they made up a higher percentage of the sampled fish, which may have resulted in the shift in diet to primarily fish shown in this study. The high level of fish consumption by Largemouth Bass may play a previously unforeseen role in regulation for panfish in Minnesota lakes. Bluegill are a popular recreational fish targeted by many anglers and managed by the state of Minnesota in some systems to influence growth. The bass may be shifting the size structure and growth rates of the Bluegill in lakes where they are present, and further research should be considered.

Overall, this study provided new insights into Largemouth Bass diets in central Minnesota, a previously understudied region. Contrary to what was believed previously, the fish in this region target mainly Yellow Perch and Bluegill. Although overall diet composition did not change over time, specific prey items did see a shift during the summer. These findings offer a valuable look into the diets of Largemouth Bass, specifically how predator-prey relationships may affect local populations and provide a foundation for future research and management decisions.

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