# A Diet Comparison of Bluegill and Bluegill x Pumpkinseed Hybrids

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Bluegill *Lepomis macrochirus* and pumpkinseed *Lepomis gibbosus* commonly prey upon macroinvertebrates but have been found to show different preferences to what type of macroinvertebrates. Hybrids of the two species have been found to display physical characteristics of both parents but prey selection of the hybrids compared to the parents is unknown. Therefore, the objective of this study was to analyze the diets of bluegill and bluegill x pumpkinseed hybrids to understand what each species' preference is when it comes to food as well as finding how a hybrid's diet compares to the pure breed of one of the two crossed parents. The target species were caught from Big Bass Lake between the dates of 25 September and 5 October 2023. The stomach contents were then identified to the lowest classification possible and counted. Gastropods were a significant diet source for both sampled species, specifically planorbid snails that were less than 2 mm in diameter. Gastropods made up 97.8% of the hybrid diet items and 68.1% for bluegill. A non-metric multidimensional statistic was run to find relations in diet contents in the species using ordination ellipses. Slight diet overlap occurred due to the significance of gastropods in both species diet contents.

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## Introduction

According to the optimal foraging theory, fish will search for food that is able to provide them the most net energy gain, which is affected by prey type, avoidance of predators, and time spent searching for prey (Werner and Hall 1974). In some field studies, pumpkinseed *Lepomis gibbosus* have been found to primarily feed on gastropods (Seaburg and Moyle 1964). This makes sense according to the optimal foraging theory because they have pharyngeal jaws that are used to break up the shells of the gastropods making them easier to consume. Bluegill *Lepomis macrochirus* do not have the developed pharyngeal jaws and teeth Pumpkinseed have. Bluegill are more commonly found as a generalist when it comes to feeding on macroinvertebrates. Based on a study done in Nebraska, bluegill were found to have diet preference towards macroinvertebrates such as amphipods, chironomids, and trichopterans (Olson et al. 2003).

Hybridization commonly occurs in many species of fish across the world. Many studies have been done finding similarities and differences in genes of hybrids and pure breeds, while far less research has been done in determining behaviors and preferences between them. Sunfish are a great example of hybridization of fish due to how common they occur in natural ecosystem settings. There are 22 combinations within the *Lepomis* genus that can produce viable hybrid offspring (Bolnik 2009). Some of these Lepomis hybrids even have been found to be fertile (Lagler and Steinmetz 1957) while many other hybrids species in different families are sterile. There are a few different ways hybridization occurs in sunfish including habitat overlap (Bolnik 2009), habitat disturbance (Hubbs 1955), and lack of males in the same species (Avise and Saunders 1984). Common occurring crosses in northern Minnesota are bluegill x green sunfish *Lepomis cyanellus* and bluegill x pumpkinseed.

This study looks into the diets of bluegill and bluegill-pumpkinseed hybrid sunfish in Big Bass Lake. This was done in order to analyze the diets of bluegill and bluegill x pumpkinseed hybrids and understand what each species' preference is when it comes to food as well as finding how a hybrid's diet compares to one of the pure breeds of the two crossed parents in the same system.

## Methods

The bluegill, pumpkinseed and bluegill-pumpkinseed hybrids for this study were all caught via angling with standard fishing equipment. All the fish were angled from Big Bass Lake in the fall from

the dates of 25 September to 5 October 2023 before fall turnover. Once a fish was caught, a picture of it was taken and an ID was assigned to that fish based on if it was a bluegill (Figure 1) or a bluegill x pumpkinseed hybrid (Figure 2). Total length (mm) and weight (g) were recorded from each fish as well. The fish was then placed in a bag with its fish ID number and put on ice. Later, they were put in a freezer so their stomachs could be examined in the lab.

**Figure 1.** Bluegill sunfish *Lepomis macrochirus.*

**Figure 2.** Bluegill x pumpkinseed hybrid sunfish *Lepomis macrochirus x Lepomis gibbosus.*

In the lab, every fish stomach was removed and preserved in 70% Ethanol until ready for dissecting. Using a scalpel, each fish stomach was opened carefully to avoid damage to the contents of the stomach. Tweezers were then used to take out the contents of the stomach one by one and placed on a pan where the contents were spread out and sorted by species. Each prey species was then counted and recorded.

Once all the diets were counted and processed, program R was used to analyze the sampled diets. Non-metric multidimensional scaling (NMDS) was used to be able to visualize differences in diet composition between the two target species. The metamds function in the vegan package was run to perform the NMDS visual. The Ordiellipse function was used to create ellipses for both species to find any diet overlap between them.

Frequency of occurrence and prey-specific abundance plots were created.

$$O_i = \frac{J_i}{P}$$

Frequency of occurrence ($O_i$) was calculated by dividing the number of fish diets ($J_i$) containing a specific prey item by the total number of diets sampled (P).

$$P_i = \frac{S_i}{S_{ti}}$$

Prey-specific abundance ($P_i$) was calculated by dividing the total number of the specific prey item ($S_i$) by the total number of items in diets that contained the specific prey item ($S_{ti}$).

The graphical model (Figure 11.3, Chipps et al. 2007) depicting feeding strategy (specialized or generalized), relative prey importance (dominant or rare) and niche variation (individual or population pattern) was used in order to assess specific feeding strategies for each type of prey.

**Results**

Stomach contents were collected from 24 bluegill (128-210 mm TL) and 6 bluegill-pumpkinseed hybrids (148-198 mm TL).

Twelve different diet contents were able to be identified across the 30 total stomachs processed. Gastropoda was the most common diet item to be found, as they had accounted for 97.8% of the diet items in the hybrids with one of the six stomach samples containing 413 gastropods. Gastropods accounted for 68.1% of diet items for bluegills. Other common occurring prey categories for bluegills were adult diptera (9.8%), amphipoda (6.0%), and hemiptera (5.3%). While odonata (0.8%) and hymenoptera (0.4%) were the next biggest prey categories for the hybrids.

Gastropods commonly occurring in the diets in both species likely resulted in overlap of ellipses for within the nonparametric multidimensional plot (Figure 3). This demonstrates the importance of Gastropods in sunfish diets in Big Bass Lake during the time of year that the fish were sampled.

Frequency of occurrence and prey specific abundance plots were used to differentiate the sampled populations feeding habits from an individual's feeding habit. Bluegill were found to have specialization towards gastropods (Figure 4) while in bluegill x pumpkinseed hybrids diets they were represented as a dominant prey type (Figure 5).

**Discussion**

A key finding of this study shows bluegill and bluegill x pumpkinseed have overlap when it comes

to what the diets consisted of in Big Bass Lake in the fall season. This diet overlap suggests that feeding habits are passed onto the hybrid generation and that there is some interspecific competition happening between bluegill and their hybrid offspring.

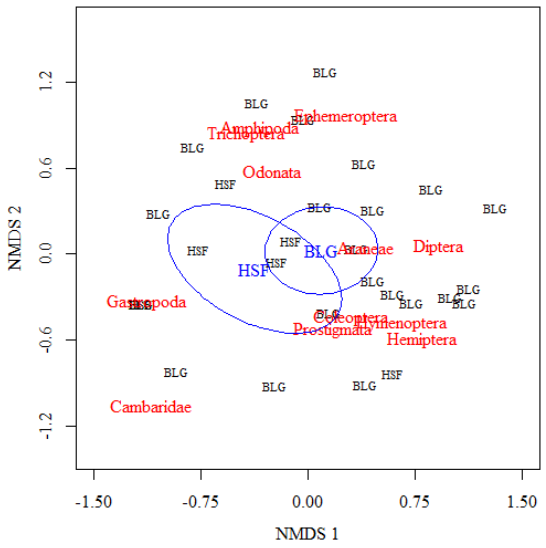


**Figure 3.** Nonparametric multi-dimensional scaling ellipses based on number of invertebrates classified by order for bluegill (BLG) and hybrid sunfish (HSF).

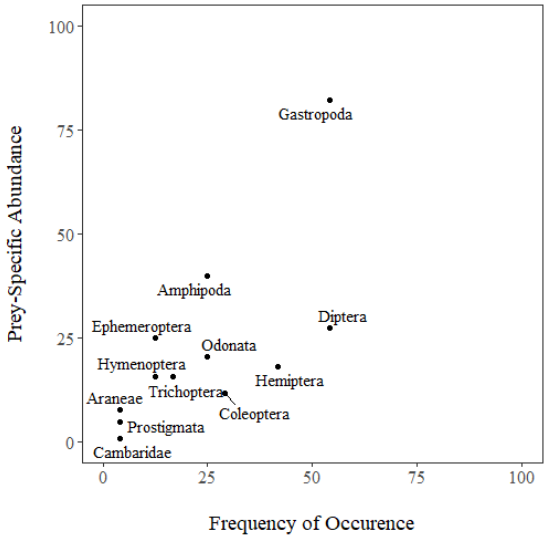


**Figure 4.** Prey-specific abundance plotted against frequency of occurrence for each of the prey species in bluegill diets.

The results also show that the availability of gastropods are significant enough in Big Bass Lake for both targeted species to show preferences toward them. Individual diet specialization is presumed to maximize an individual's fitness because it can optimize foraging behaviors and limit competitive interactions (Werner et al. 1981). In past studies bluegill have been found to not show specialization towards gastropods. While they do not normally consume them, research has found bluegill fully capable of consuming gastropods, but they have a longer handling time compared to the pumpkinseed that normally specialize in consuming shelled organisms (Mittelbach 1984).

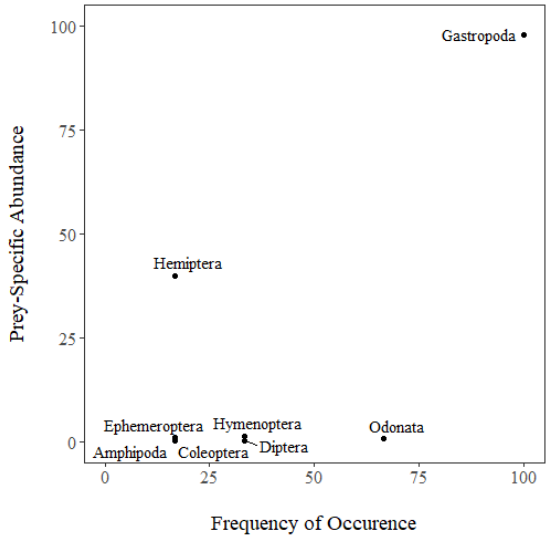


**Figure 5.** Prey-specific abundance plotted against frequency of occurrence for each of the prey species in bluegill x pumpkinseed hybrid diet.

Another finding in this study is that almost all the shells that were found in bluegill stomachs were completely intact. While some shells in the hybrid diets were intact, most of the shells were partially crushed up. This is due to the pharyngeal jaws of the bluegill x pumpkinseed hybrid being intermediate compared to its parents (Lagler & Steinmetz 1957).

The results of this study concluded that slight diet overlap occurs in bluegill and bluegill x pumpkinseed hybrid sunfish in the fall season in Big Bass Lake. This happens due to the significance of gastropoda in both species diets. While a hybrids diet overlap occurs with one of the parents, more research should be done to learn how their diets compares to pure breeds of both parents to analyze if there is more similarities between one parents diet than the other.

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