SIZE STRUCTURE OF BLACK CRAPPIE AND BLUEGILL IN NORTHERN, EASTERN, WESTERN, AND SOUTHERN MINNESOTA

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***Abstract*— Fish size structure is an important factor in a fishery population. Panfish such as black crappie *Pomoxis nigromaculatus* and bluegill *Lepomis macrochirus* play a major role in the health of fisheries. Five lakes from southern, northern, eastern, and western Minnesota were selected for analysis. Data were collected using standard sampling methods, including gill nets, electrofishing, and fyke nets. Length-frequency distributions were created to assess size structure in each region. Relative abundance was measured using catch per unit effort. Data analysis included a one-way ANOVA to compare Proportional Size Distribution (PSD) values and the distribution of fish sizes among regions. Chi-square tests revealed a significant regional difference in size distribution for both species ($P < 0.001$). Bluegill in the South region shows higher proportions of smaller fish, while black crappies in the West region showed higher proportions of larger individuals. The findings suggest regional variation in panfish population structure, which may influence fisheries management strategies in each individual region.**

I. Introduction

Panfish play a significant role in the overall health of fisheries. In addition to ecological importance, they also provide considerable recreational and economic value. According to a 2014–2015 statewide mail survey, anglers targeted panfish on 27% of their fishing trips—more than any other species or group (Hansen and Wolter 2017). The increased interest among anglers adds pressure on panfish populations, making effective management strategies crucial to sustaining healthy fisheries.

The size of panfish populations influences both genetic diversity and population health. Panfish include rock bass *Ambloplites rupestris*, sunfish *Lepomis* sp., crappies *Pomoxis* sp., and yellow perch *Perca flavescens*. Size structure analysis is one of the most used tools in fisheries assessment (Neumann and Allen 2007). Length-frequency data offers valuable insight into fish population dynamics and can help identify issues such as inconsistent year-class strength, slow growth, or excessive mortality (Anderson and Neumann 1996). These data are often used alongside other assessment tools, such as catch per unit effort.

Fisheries managers may use several strategies to address panfish population issues, especially when large year classes dominate. Common management practices include liberal harvest regulations, netting removal, selective poisoning to reduce overly dominant year classes, intensive piscivore stocking, and supplemental feeding (Hansen and Wolter 2017). Bag limits may also be adjusted to prevent the overharvesting of larger adults, maintaining a healthier population structure.

Size structure analysis can also provide regional insights, helping managers identify beneficial or detrimental trends. The objective of this study was to assess the size structure of panfish populations in lakes across northern, eastern, western, and southern Minnesota. The results are intended to highlight regional differences in fishery health and identify areas that may require management attention.

II. Methods

This study was conducted across four regions of Minnesota: North, East, South, and West. Five lakes were selected from each region based on known populations of bluegill *Lepomis macrochirus* and black crappie *Pomoxis nigromaculatus*, as well as similarities in lake size to ensure comparability. Data was obtained from the Minnesota Department of Natural Resources (MN DNR) Lake Finder resource, which provides comprehensive fish population data collected through standardized sampling methods (MN DNR 2024).

Sampling methods used by the MN DNR include standard gill nets, trap nets, and electrofishing. Gill nets, typically 76.3 meters in length, are used to sample species such as Walleye *Sander vitreus* and northern pike *Esox lucius*, while trap nets are effective for capturing bluegill and other small-bodied fish (MN DNR 2024). Electrofishing is employed to sample fish in shallow, nearshore habitats and provides a representative sample of the fish community (MN DNR 2024).

To assess the size structure of bluegill and black crappie populations, length-frequency distributions were created for each lake. Fish were grouped into 50 mm size classes, consistent with standard practices in fisheries research (Anderson and Neumann, 1996). The proportional size distribution (PSD) index was then calculated to evaluate size structure using the formula:

$$PSD = \left(\frac{Number\ of\ fish\ \geq Quality\ length}{Total\ number\ of\ fish\ \geq Stock\ Length} \right) x\ 100$$

The PSD index provides a standardized measure of the proportion of quality – sized fish in a population, allowing for the comparison across regions (Anderson & Neumann, 1996).

Data analysis was performed using R software. Chi - square tests were used to assess the differences in size class distributions.

III. Results

The overall PSD for all regions indicate that a majority of the panfish populations falls within the smaller size categories (Figure 1). Specifically the range between 0 – 127 mm. This range includes roughly 45% of the total catch. The secondary majority fall into the 132-178 mm range, this range includes 40% of the total catch.

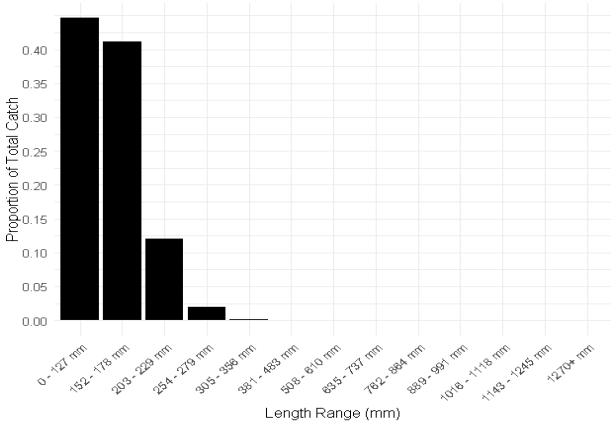

Fig.1. Overall proportional size distribution (mm) of both bluegill and black crappie combined across all sampled Minnesota lakes. Frequency is presented as a percentage of total catch. The distribution shows a dominance of smaller size classes (0-127 mm), with a sharp decline in larger individuals.

Regionally there were some noticeable differences. The North and West regions displayed the highest proportion of fish in the 132-178 mm range, with both regions having nearly 50% of their total catch in this size category. The East region had the highest catch in the 0 – 127 mm range with over 50% of its total catch in this range. This was closely followed by the South region where 49% of its fish fell in this range. The on commonality between all the regions that the class sizes beyond the 203 mm were not represented across all the regions.

There was a significant difference in bluegill size distributions among region ($\chi^2(12) = 4812.4$, $P < 0.001$; Figure 2). The South region displayed notably high frequencies of smaller individuals in the population (0 – 127 mm), while larger size classes were noticeably uncommon in all regions (Table 1).

TABLE 1. CHI SQUARE RESULTS FOR BLUEGILL SIZE DISTRIBUTION ACROSS FOUR MINNESOTA REGIONS (NORTH, SOUTH, EAST, WEST). SIZE CLASSES ARE GROUPED INTO 50 M INTERVALS. SIGNIFICANT DIFFERENCE WAS OBSERVED AMONG REGIONS, INDICATING VARIATION IN POPULATION STRUCTURE.

Region	0–127 mm	128–178 mm	179–229 mm	230–279 mm	280–355 mm
North	3232.204	2926.486	335.6872	29.0117	5.610752
South	8653.039	7834.593	898.6792	77.66816	15.020729
East	4134.191	3743.159	429.365	37.10778	7.176504
West	7599.565	6880.762	789.2686	68.21237	13.192014

There was a significant difference in black crappie size distributions across the regions (χ^2 (12) = 1891.7, $P < 0.001$; Figure 2). The South region contained the highest proportion of individuals in the 179-229 mm range, suggesting a population dominated by mid-sized fish. In comparison, the West region showed the greatest frequency of fish in the 230-270 mm class, indicating a stronger presence of larger presence of larger individuals (Table 2). These findings reflect substantial regional variation in black crappies population structure.

TABLE 2. CHI-SQUARE RESULTS FOR BLACK CRAPPIE SIZE DISTROBUTIONS ACROSS FOUR MINNESOTA REGIONS. THE FREQUENCY OF INDIVIDUALS WITHIN EACH SIZE CLASS REVEALS A SIGNIFICANT REGIONAL SIZE DIFFERENCES IN SIZE STRUCTURE, IN PARTICULAR THE 179-229 MM AND 230-279 MM RANGES

Region	0–127 mm	128–178 mm	179–229 mm	230–279 mm	280–355 mm
North	406.92	440.17	455.06	102.64	8.21
South	2416.45	2613.93	2702.37	609.51	48.74
East	1804.78	1952.27	2018.32	455.23	36.4
West	180.85	195.63	202.25	45.62	3.65

IV. Discussion

This study identified significant differences in size class distribution for both bluegill and black crappies across regions. Bluegill in the southern region of Minnesota were generally smaller, while those in the western region included more individuals in the mid-to-large size classes. This suggests potential regional differences in growth conditions or harvest pressure. Black crappie size distributions showed similar trends, with the southern region having more fish in the mid-size length ranges and the western region showing a higher proportion of larger individuals.

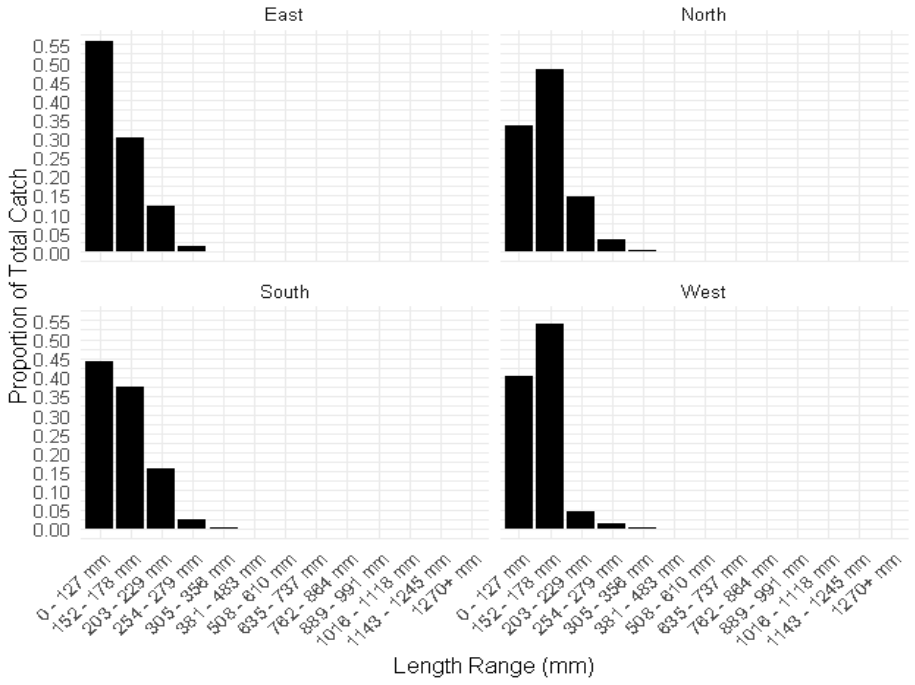

Fig. 2. Proportional size distribution by region (mm) of bluegill and black crappie combined across all sampled Minnesota lakes by region (North, East, South, West). Each region's distribution highlights the differences in population structure, with the South region showing a higher percentage of smaller individuals and the West region displaying more mid-to-large sized fish.

These patterns may reflect regional environmental or anthropogenic factors influencing size distribution in both species. Previous studies have shown that angling pressure can significantly affect the size structure of bluegill populations, often resulting in a dominance of smaller individuals in heavily fished areas (Rypel et al. 2015). Similarly, the implementation of minimum length limits (MLLs) for black crappies has produced mixed outcomes. Some lakes exhibited improvements in size structure, while others showed no significant change—possibly due to factors such as noncompliance or variability in recruitment (Isermann et al. 2007).

These results emphasize the importance of localized fisheries management to maintain balanced size distributions and support sustainable fish populations. Tailoring management strategies to region-specific conditions—such as adjusting harvest regulations or implementing targeted habitat management practices—may be necessary to address the observed disparities. Future research should further investigate the ecological and human-driven factors contributing to regional differences in panfish size structure.

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