Changes in Relative Weights between Cool-Water and Warm-Water Species In a Large River Ecosystem

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Abstract

The Upper Mississippi River has populations of warm-water and cool-water fishes. In recent decades, water temperatures in the Upper Mississippi River have increased rapidly (>1 °C in 25 years). We used data from a standardized, long-term monitoring program to assess changes in the body condition and catch per unit effort of Largemouth Bass (Micropterus salmoides), Bluegill (Lepomis macrochirus), and Walleye (Sander vitreus) across three pools in the Upper Mississippi River. Warm-water species tended to display more positive trends in both abundance and relative weight, while Walleye populations tended to show declines in both relative weight and abundance. These trends suggest rising temperatures may be causing substantial changes in the fish assemblages of large rivers.

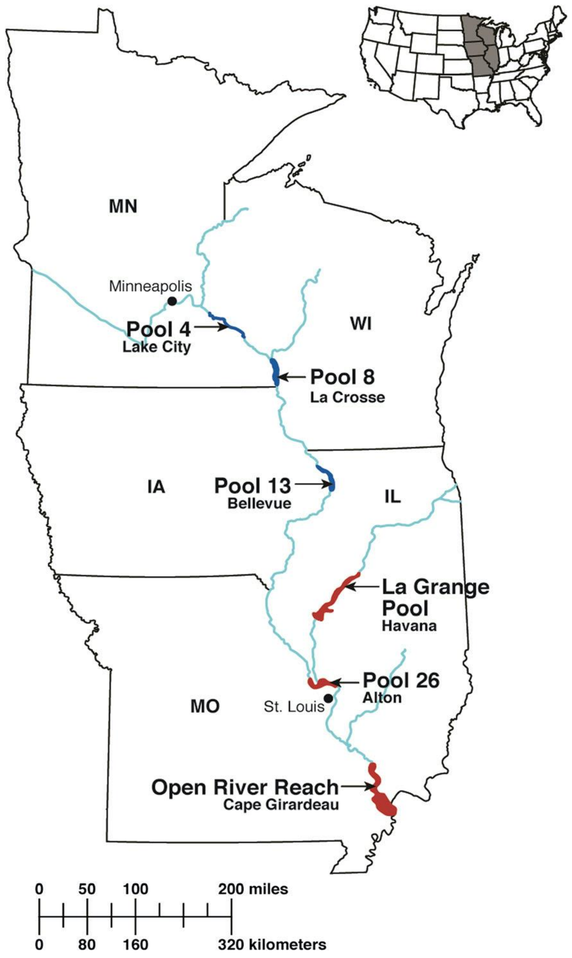

Figure 1. Map of the data collection sites in this study. Data on the abundance and relative weights of the fish species was produced from the most northern three sites (Lake City, La Crosse, and Bellevue).

Methods

We used data from monitoring conducted as part of the Long-Term Resources Monitoring element of the U.S. Army Corps of Engineers Upper Mississippi River Restoration program (LTRM). The LTRM samples fish populations in the Upper Mississippi River from mid-June through the end of October using a stratified random sampling design. We used data collected from 1993 through 2019 in the upper three navigational pools (Pool 4, Pool 8, and Pool 13).

We compared data on catch per unit effort (CPUE) and relative weight (W_r) for Largemouth Bass and Walleye captured by boat electrofishing. All electrofishing was conducted in 15 minute intervals, with effort evenly distributed across the field season. Data on CPUE were processed as pool-wide averages by the LTRM. All fish captured are measured for total length, and weights for Largemouth Bass and Walleye were collected during the final six weeks of each season. We calculated W_r for all individuals over 150 mm total length, discarding <1% of records as outliers (W_r >200 or W_r <50).

Image Courtesy of Maine Dept. of Fisheries and Wildlife

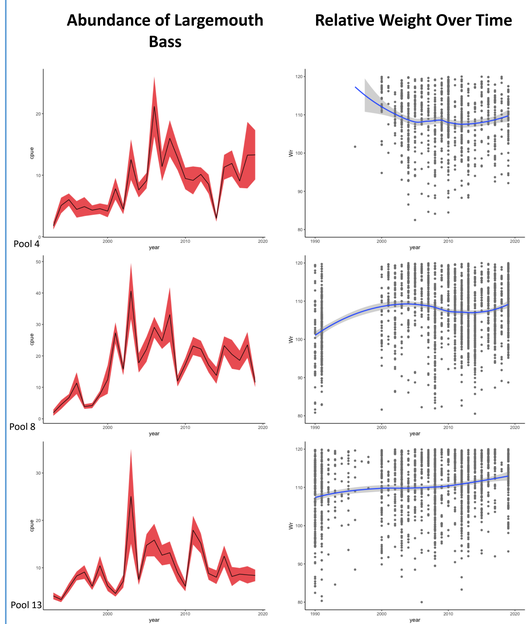

Figure 2. The trend in abundance of the Largemouth Bass species in pools 4, 8, and 13 over a period of approximately three decades.

Figure 3. Distribution of relative weight among Largemouth Bass population in three data collection pools (Lake City, La Crosse, and Bellevue) over a period of approximately three decades.

Results

According to Figure 2, the population size of the Largemouth Bass has held steady or increased between 2000-2020. In accompaniment of that, the relative weights within the population of Largemouth Bass have largely been either stable or seen an increase over the past few decades. Conversely, the Walleye population has significantly diminished within the last three decades. Specifically, the Lake City collection site (pool 4) reported a drastic decrease in the abundance in the Walleye population. The abundance of this species is approximately a quarter of the size of the population prior to the onset of the 21st century. Additionally, the relative weights of this species have demonstrated steady decrease or leveling of size within the past three decades.

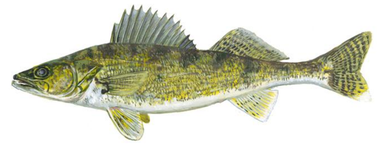

Image Courtesy of Wisconsin Dept. of Natural Resources

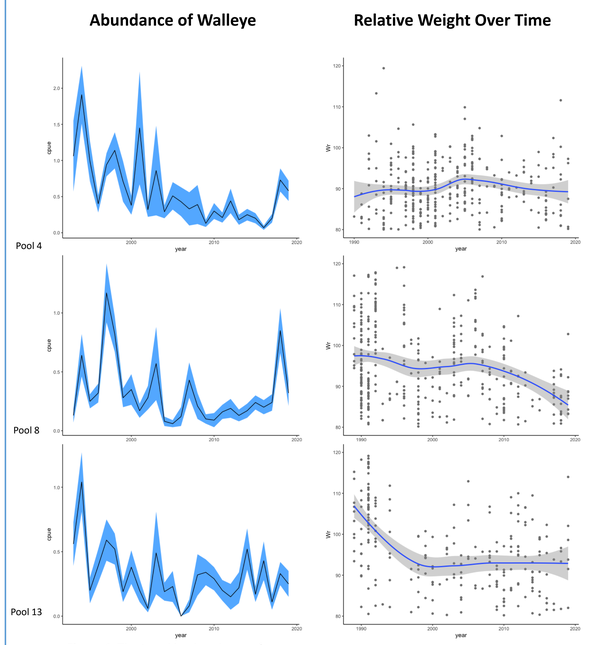

Figure 4. The trend in abundance of the Walleye species in pools 4, 8, and 13 over a period of approximately three decades.

Figure 5. Distribution of relative weight among the Walleye population in three data collection pools (Lake City, La Crosse, and Bellevue) over a period of approximately three decades.

Conclusions

In general, the data displays that the abundance of Walleye present in the Upper Mississippi River has decreased over the past two decades, while the abundance of Largemouth Bass has either remained steady or increased. Specifically, the relative weight of the Walleye have decreased. Conversely, the relative weight of Largemouth Bass has seen an increase. With this information, it is likely that this phenomenon alludes to something outside of the realm of competition within a species.

The trends in population size, along with those relating to relative weights of the present species indicate that an environmental factor may be the driving factor. Specifically, the dependence of fish on temperature for growth indicates the impact of a warming climate is a strong candidate for the phenomenon present in these species. Walleye are well adapted for a cool-water environment and conversely Largemouth Bass are a warm-water species. In the presence of warming water temperatures, Walleye may be adversely affected due to their inability to grow at a consistent rate and maintain a healthy population size.

This increase in both population size and relative weight among Largemouth Bass demonstrates a sufficient ability to feed and therefore a higher consumptive demand. Conversely, the condition of the Walleye, in reference to population size has steadily decreased which alludes to a decreased consumptive demand.

References

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