Population Structure of Largemouth Bass in the Upper Mississippi River

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Introduction

Largemouth Bass Micropterus salmoides are an important recreational species throughout North America. Recreationally sought-after fish have been traditionally managed through quantifying dynamic rate functions (i.e., recruitment, growth, and mortality). Dynamic rate functions are the drivers used to quantify fish populations (Ricker 1975). Demographic changes reflect biotic responses to various perturbations (e.g., climate change, exploitation). Understanding these changes are important for guiding management decisions. Further, evaluating these responses can help guide habitat rehabilitation programs (e.g., HREPS). As such, we sought to quantify LMBS population dynamics in the Upper Mississippi River.

Age 2 Largemouth Bass Otolith from Field Station 2 (La Crosse)

Methods

Largemouth Bass (LMBS) were collected via daytime electrofishing carried out by the United States Army Corps of Engineers' Long-Term Resource Monitoring (LTRM) element across three field stations in the upper Mississippi River (Ratcliff et al. 2014). Fish were measured to nearest total length (mm) and weighed (g), following LTRM protocols (Ratcliff et al. 2014). Fish were transferred to Missouri State University for further processing. Sagittal otoliths were extracted and aged along a transverse plane. Ages were determined independently by two readers. If there was disagreement between the two readers, the structure was re-examined until an agreement was made (Maceina and Sammons 2006). Mean total length at age data was used to develop a von Bertalanffy growth model for each pool. A suite of natural mortality estimators (e.g., Hoenig method) was averaged to assess LMBS natural mortality. The von Bertalanaffy parameters, natural mortality, and weight-length regressions were used to develop Beverton-Holt yield per recruit models. Each pool was modeled with two minimum vulnerable lengths. We modeled 150mm as this size likely represents size at recruitment to the population. Additionally, we modeled 305mm (~12") as this is a common minimum length limit used across state agencies.

Results

Figure 1. – A total of 55, 334, and 425 fish were measured and weighed in pools, 4, 8, and 13, respectively. Due to low sample sizes in Pool 4 in 2020, it was removed from further analysis. Sizes ranged from 70mm – 488mm and 3g – 1940g in Pool 4. Pool 13 LMBS ranged from 70mm – 511mm and 4g – 2278g. Length-weight regressions were modeled for each pool as,

$$W = aL^b$$

Where, a and b are coefficients, W = weight (g), and L = length (mm).

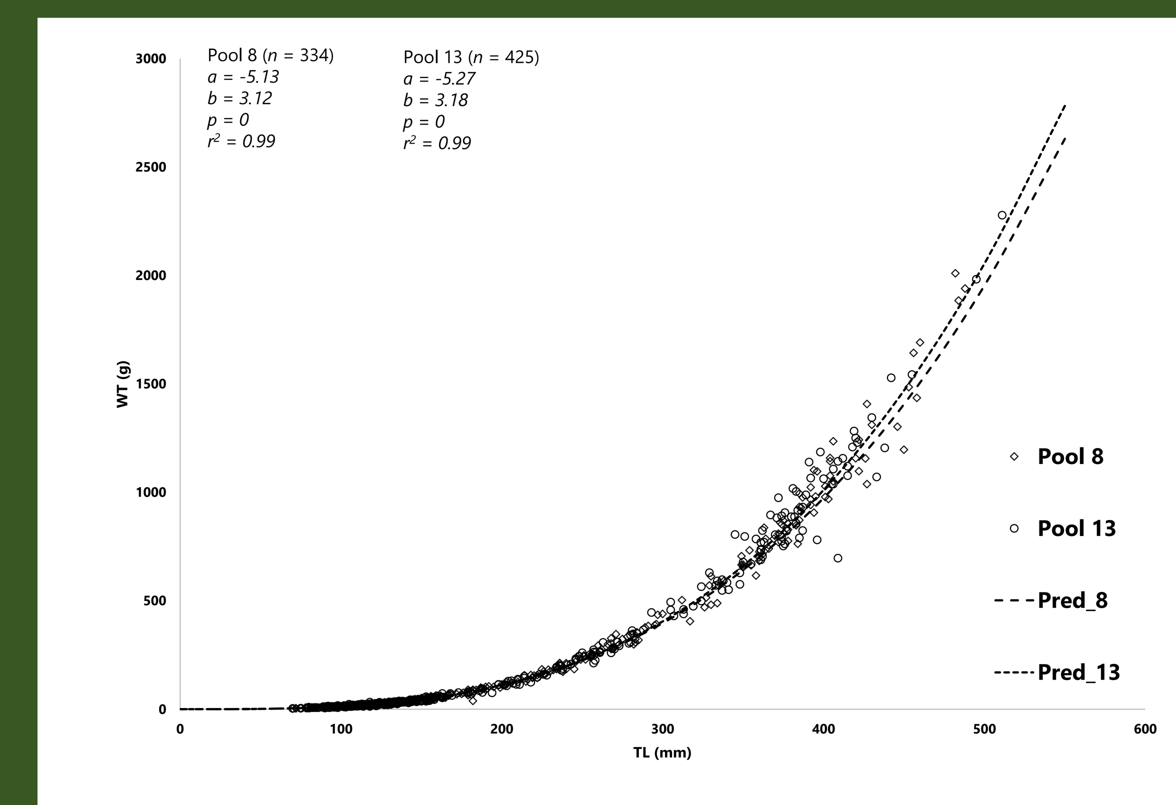


Figure 2. – Growth was modeled using the von Bertalanaffy equation as

$$L_T = L_\infty\left(1 - e^{-k(t-t_0)}\right)$$

Where, L_∞ = maximum theoretical length that can be obtained, k = Brody growth coefficient, t = time or age in years, and t_0 = is the time in years when length would theoretically equal zero. Ages ranged from 0 – 16 in Pool 8 and 0 – 11 in Pool 13.

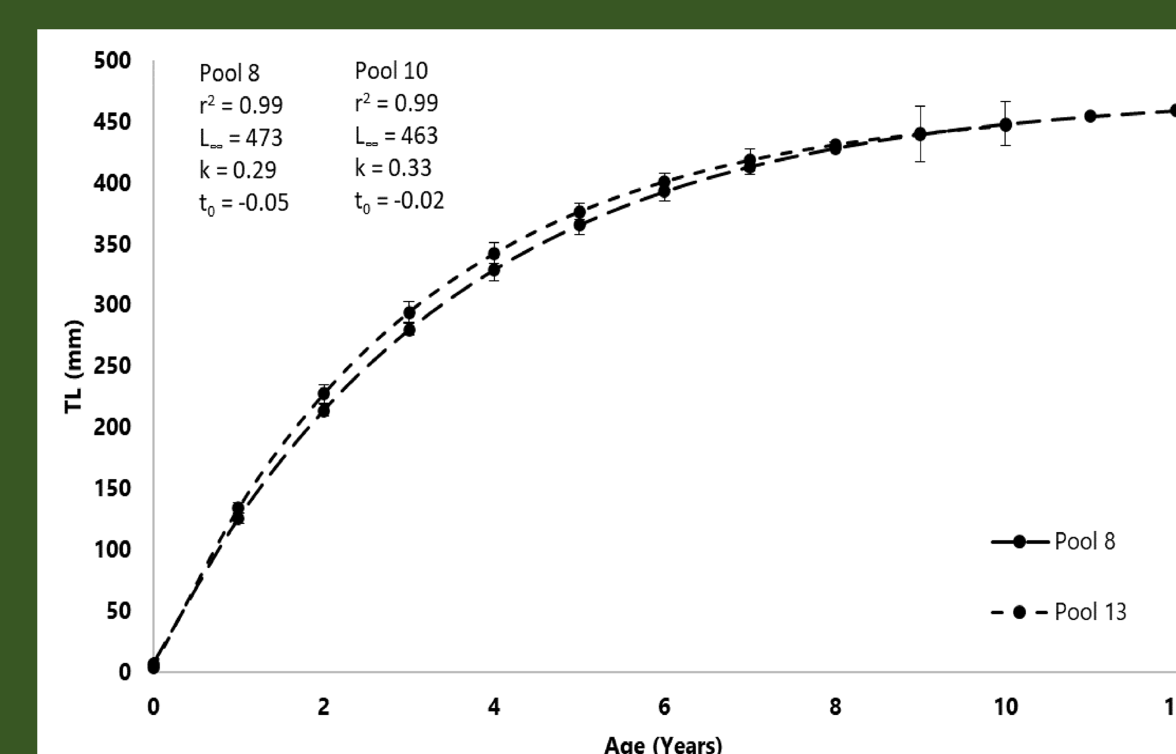
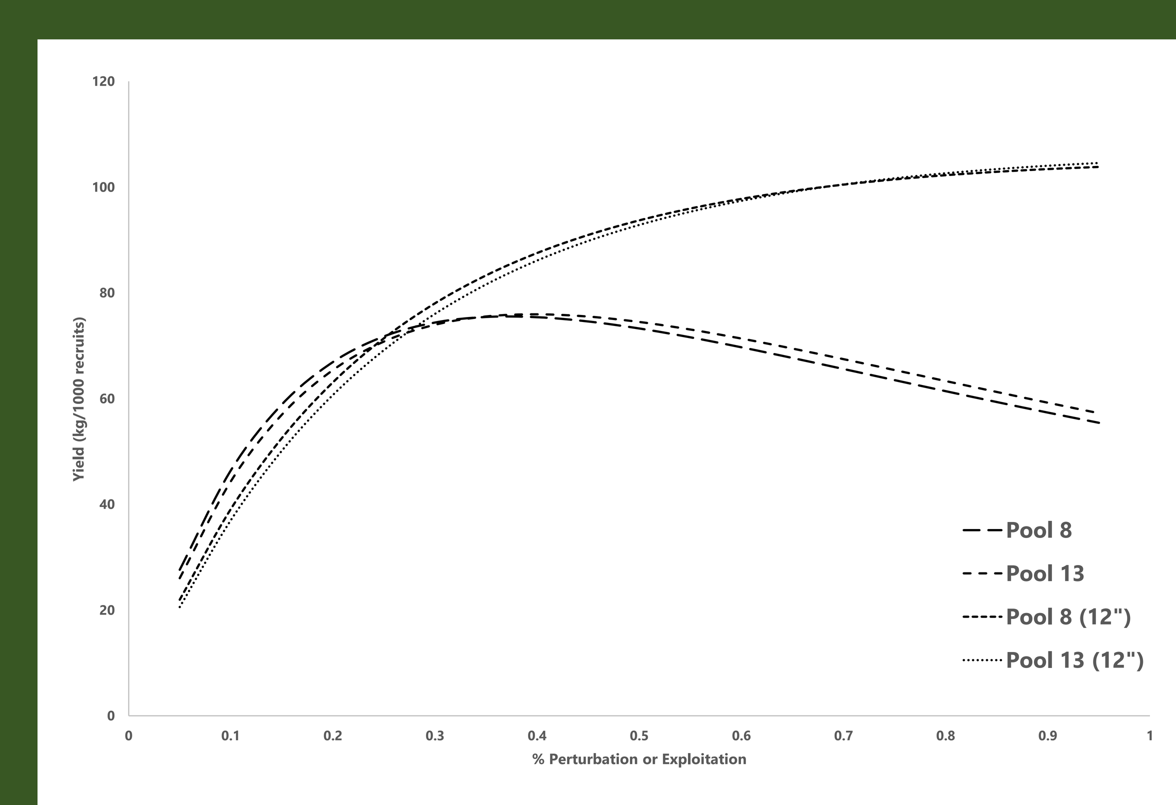


Figure 3. – Natural mortality estimates were 33% and 35% in Pool 8 and Pool 13, respectively. We modeled each pool using 12 years and 11 years as max age in Pool 8 and Pool 13. Dashed lines represent models under the 150mm minimum vulnerability white dotted lines represent 305mm (~12") minimum vulnerability.



Discussion

Upper Mississippi River Largemouth Bass are reaching fairly old ages (>10 years). Long-lived populations need proper management. Growth appeared to be similar across both pools. Further, our models displayed similar population level growth responses to various perturbations or exploitation. The Upper Mississippi represents a nationally recognized Largemouth Bass fishery. Under commonly used minimum length limits (12") our models suggest growth overfishing would not occur across all exploitation levels. However, the lower minimum vulnerability length (i.e., 150mm model) suggests yield decreases above 40% perturbation or exploitation to the Largemouth Bass population. Population level responses can also reflect abiotic and biotic changes to the environment. While these models have traditionally been used to evaluate length based harvest regulations, changing model parameters offers unique insights. Lower length models can help assess population level perturbations beyond traditional harvest scenarios. Our results provide a biological benchmark for Upper Mississippi River Largemouth Bass. Further, our models may help better understand various abiotic and biotic influences and population level responses.

References

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