Effects of Bigmouth Buffalo Commercial Harvest on Ecosystem Resilience to Nutrient Loading

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Introduction

Bigmouth buffalo fish (*Ictiobus cyprinellus*) are commercially harvested from shallow lakes throughout Iowa. These fish are primarily planktivores, consuming zooplankton that graze on algae. Despite the economic importance of bigmouth buffalo, little is known about their ecological impact on lakes or if commercial harvest can offset those potential effects. In this project, researchers investigated if bigmouth buffalo harvest reduces population density enough to induce a trophic cascade. Trophic cascades occur when predators limit the density or behavior of their prey, which enhances survival of the next lower trophic level. In this case, fewer bigmouth buffalo could release zooplankton from predation, and decrease algal populations through zooplankton grazing. Also investigated was how the varying densities that result from bigmouth buffalo commercial harvest alters ecosystem resilience to external disruptions such as nutrient loading during storm events.

Methods and Materials

In the experimental ponds at the Aquatic Research Facility, three food web configurations were constructed—ambient bigmouth buffalo densities, harvested bigmouth buffalo densities, and no fish. All ponds also were seeded with zooplankton and phytoplankton (Figure 1). The biomass of algae and zooplankton were measured regularly prior to and following the addition of buffalo to the ponds to determine if a trophic cascade occurred. In order to evaluate the resilience of harvested ponds to external disruptions, one replicate of each fish density treatment received a one-time nutrient addition of nitrogen and phosphorus equivalent to the loading that would occur during a large storm event. The response of algal biomass and dissolved oxygen in the nutrient addition ponds was compared with the dynamics in the reference ponds.

Results and Discussion

The ponds with harvested densities of bigmouth buffalo had the same algal biomass as ponds without buffalo, indicating commercial harvest can induce a trophic cascade (Figure 2), resulting in a decline in algal biomass. This shows bigmouth buffalo harvest could be used as a management strategy in a broader plan for managing shallow lake water quality.

There also were large differences in ecosystem resiliency to nutrient loading among the various fish treatments. The higher the buffalo density, the earlier and more severe the algal blooms were following the nutrient addition (Figure 3). The pond with ambient buffalo density became hypoxic sooner than the other ponds. These results provide evidence that harvesting buffalo can be used as a management tool to increase ecosystem resilience to nutrient loading.

Acknowledgements

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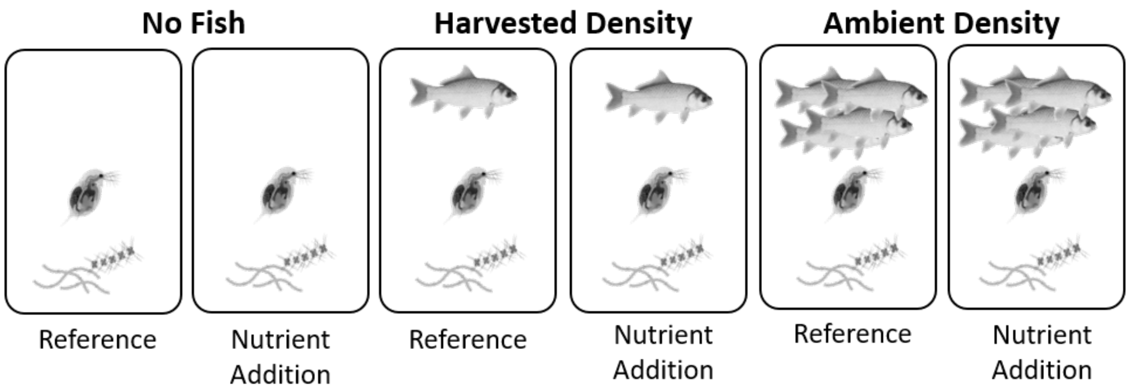

Figure 1. Experimental treatments and food web configurations including algae, zooplankton, and varying densities of bigmouth buffalo.

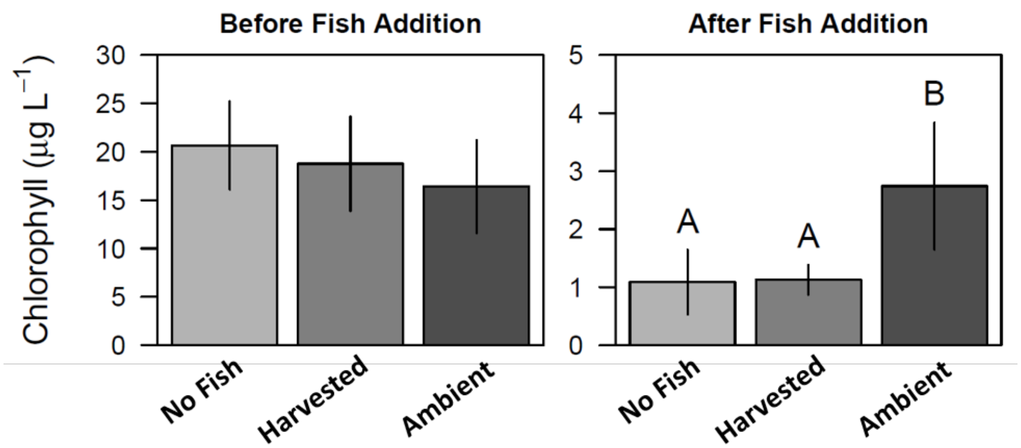

Figure 2. Mean algal biomass (± standard deviation) in each treatment prior to (left panel) and after the addition of buffalo (right panel). While there were no significant differences in algal concentrations prior to the addition of fish, the ambient concentration was significantly higher after the addition of buffalo ($P < 0.05$).

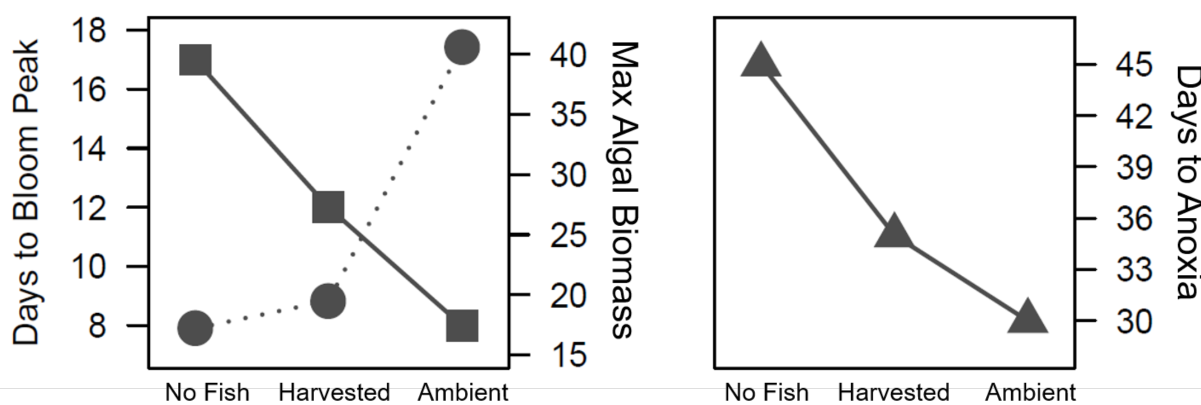

Figure 3. The number of days (left panel, squares) after the nutrient addition to the maximum algal biomass (left panel, circles) and the number of days to anoxia (right panel) across buffalo treatments illustrating the difference in ecosystem resilience among food web configurations.