Effect of Abiotic Factors on Bluegill Size Structure in Nine Central Minnesota Lakes

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Bluegill are the most targeted species of fish in Minnesota. In recent years, the abundance of slow growing, small Bluegill has increased within the state. Angler harvest of Bluegill can reduce the average length of Bluegill up to four times the original length. Abiotic factors such as maximum depth, average water clarity, littoral area, and percent littoral area can influence the dynamics of a lake system. There has been limited research on whether these abiotic factors can influence the size structure of a Bluegill population. The objective of this study is to determine if there is a direct relationship between each of these abiotic factors and the average size of Bluegill in Central Minnesota lakes. Each abiotic factor measured was related to average length of Bluegill through linear regression analysis. It was concluded there was not enough evidence to suggest there is significant relationship between any of the abiotic factors and the average length of Bluegill. This conclusion suggests other factors such as angler harvest may have a larger influence on Bluegill length in these systems.

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Introduction

Overpopulated Bluegill *Lepomis macrochirus* with stunted growth are an issue in central Minnesota lakes. These Bluegill populations can take away from the value of a fishery. Anglers who target Bluegill may choose to fish other lakes due to a lack of harvestable fish. Past research has suggested the primary factor driving Bluegill size structure is harvest by anglers (Beard and Essington 1999). One study suggests angling can reduce the average size of Bluegill in a system by as much as four times the original size (Beard and Essington 1999). It has been well documented angling can heavily influence size structure of a Bluegill population, however, many lakes also exist that have low fishing pressure and an abundance of stunted bluegill.

Abiotic factors are nonliving components that influence the productivity of a lake system. Maximum depth, average water clarity, lake area, and littoral area are all abiotic factors that have been measured for many Minnesota lakes. Shallow depths and low water clarity are typically related to higher production levels in lake ecosystems. These lakes can be characterized as eutrophic (Carlson 1977). Higher production levels in those systems should result in increased forage opportunities for Bluegill. This increase in forage could potentially increase Bluegill growth rates. Therefore, abiotic factors influencing overall lake productivity should also be related to the average length of Bluegill within lakes.

In a past study, there was evidence to suggest Age-3 Bluegill length had an inverse relationship to water clarity in Minnesota lakes (Tomcko and Pierce 2005). While this study was able to determine that water clarity was related to Bluegill growth, it did not analyze the relationship between Bluegill average size and other abiotic factors. Therefore, the objective of this study was to determine if there is a relationship between abiotic factors such as maximum depth, percent littoral area, littoral area, water clarity and the average length of Bluegill. In this study, average Bluegill length was hypothesized to be larger in lakes that had a lower maximum depth and lower average water clarity.

Methods

Study Site

Sampling was done on nine lakes in Morrison and Todd Counties in Central Minnesota. These lakes are all included in a MNDNR panfish sampling program that is cycled between lakes yearly in the Morrison County and Todd County area. The lakes sampled were Big Swan, Long, Mons, Lady, Lily, Long, Big, Platte, and Guernsey Lake. Lakes varied in size from 8 - 672 ha (Table 1).

Bluegill Sampling

Bluegill were captured using large frame Fyke nets set perpendicular to shore, left overnight and pulled the following day. Net locations were randomly selected. Sampling was primarily conducted in May of 2017, with some of the sampling carrying over into June. All fish in the net were placed in a tub, and then sorted by species. All Bluegill had their total length measured (mm).

Table 1. Bluegill average length and abiotic factors for nine sample lakes from Spring of 2016.

Lake	Bluegill Length (mm)	Max Depth (m)	Water Clarity (m)	Littoral Area (%)	Littoral Area (ha)
Big Swan (77002300)	160.27	13.72	1.34	45	358.96
Long (77002700)	164.85	19.81	2.87	20	160.66
Mons (77002200)	150.88	24.38	4.91	22	8.51
Lady (77003200)	176.53	18.91	4.08	39	70.42
Lily (77035800)	189.48	11.58	3.35	45	25.09
Long (77035700)	166.12	13.72	2.13	57	41.68
Big (77006300)	162.81	6.40	1.74	56	118.57
Platte (1800800)	157.23	7.01	1.07	97	672.18
Guernsey (77018200)	224.03	5.79	0.88	97	48.97

Abiotic Factors

All data for maximum depth, average water clarity, littoral area, and percent littoral area was accessed on the MN Department of Natural Resources Lakefinder program (MNDNR 2017) or on the MN Pollution Control Agency website (MPCA 2017).

Data Analysis

Using the averaged Bluegill lengths and the abiotic factor data collected, linear regression models were run to test if any of the abiotic factors were related to average Bluegill length.

Results

Average Bluegill length in the nine study lakes varied from 150-224 mm (Table 1). The largest average length of Bluegill was found in Guernsey Lake, the most productive lake in the study. Guernsey Lake has a maximum depth of 5.79 m, and an average water clarity of 0.88 m. There was not enough evidence to suggest there is a relationship between any of the abiotic factors and the average length of Bluegill ($P > 0.05$; Figures 1-4).

Discussion

In this study, there was not sufficient evidence to suggest abiotic factors were related to average Bluegill length. Although the lake with the largest average Bluegill length had the lowest maximum depth and lowest average water clarity, there were no significant relationships found between abiotic factors and Bluegill size. A similar study conducted on Missouri reservoirs concluded there was evidence to suggest Gizzard Shad *Dorosoma cepedianum* mean length at age-1 was negatively correlated to mean lake depth and correlated with reservoir productivity (Michaletz 1998). Another study conducted on the relationship between trophic state indicators and fish biomass provided evidence to suggest total fish biomass was positively correlated to increased nitrogen and phosphorous loads, and negatively correlated to Secchi disk transparency (Bachmann et al 1996). These two studies provide evidence that when system productivity increases, fish production and growth will also increase.

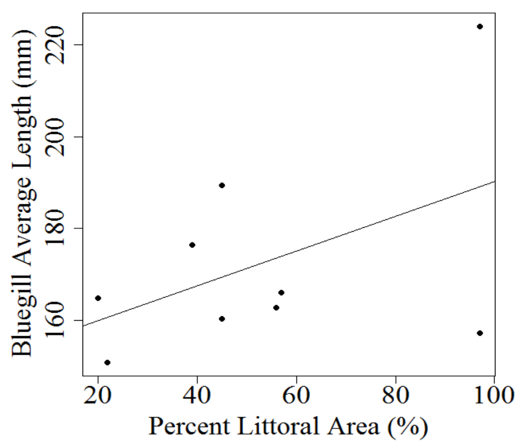

FIGURE 1. Relationship between percent littoral area and Bluegill average length from Spring of 2016 in nine central Minnesota lakes ($P = 0.20$, $R^2 = 0.22$). Black line represents a line of best fit.

This conclusion that there is not a significant relationship between abiotic factors and Bluegill average size, directs attention to another likely cause for the average Bluegill size in each lake. The two lakes that had the largest average size of Bluegill are both quite small, secluded, and harder to access. It is possible the larger average Bluegill size in these two systems is the result of lower angling harvest. In order to maintain/improve the size structure of a Bluegill fishery, it is important that anglers understand the effect of their harvest. A future

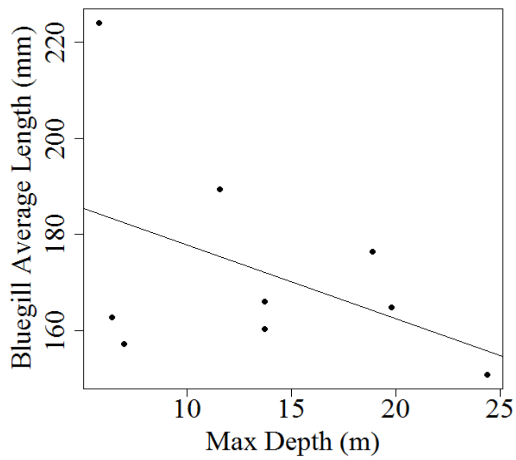

FIGURE 2. Relationship between max depth and Bluegill average length from Spring of 2016 in nine central Minnesota lakes ($P = 0.22$, $R^2 = 0.20$). Black line represents a line of best fit.

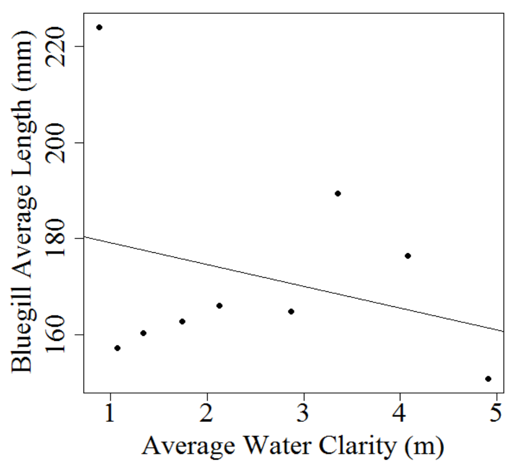

FIGURE 3. Relationship between average water clarity and Bluegill average length from Spring of 2016 in nine central Minnesota lakes ($P = 0.46$, $R^2 = 0.08$). Black line represents a line of best fit.

recommendation for similar studies is to include a creel survey to estimate Bluegill harvest on these bodies of water. It would also be ideal to replicate the study using lakes in varying regions and varying levels of angling pressure.

Acknowledgements

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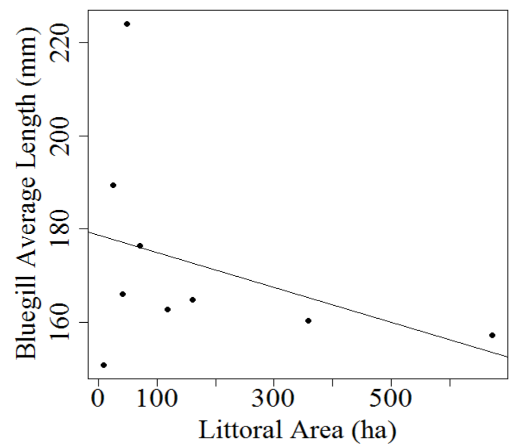

FIGURE 4. Relationship between littoral area and Bluegill average length from Spring of 2016 in nine central Minnesota lakes ($P = 0.33$, $R^2 = 0.13$). Black line represents a line of best fit.

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