SIZE STRUCTURE COMPARISON OF BLUEGILL IN LAKES WITH AND WITHOUT SPECIAL REGULATIONS

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***Abstract*—Lots of individuals have mixed feelings about special regulations for all sorts of game fish species such as northern pike *Esox lucius*, crappie *Pomoxis spp.*, sunfish *Lepomis spp.*, and so on. One species commonly sought after by many is bluegill *Lepomis macrochirus*. Bluegill are often deemed easy to find, catch, and clean. This study looks at three different categories of lakes (all lakes contain bluegill populations). The three categories are lakes with a five sunfish limit, lakes with a ten sunfish limit, and lakes without any special regulations. This study provides valuable insight into the size structures of bluegill populations in ninety different Minnesota lakes. The observed differences in bluegill size structure in various lakes highlight the importance of considering the possibility of more implementation of special regulations for additional lakes statewide. There is an upward trend regarding bluegill weights after the five sunfish limit regulations were enacted. Weights from surveys after special regulation implementation increased for both the five and the ten sunfish limit. For the five sunfish limit, average weights increased by 0.05 lbs (P = 0.025) and CPUE (catch per unit effort) decreased from 24.3 to 14.61. For the ten sunfish limit, average weights increased by 0.04 lbs (P = 0.053) after special regulation implementation. The CPUE also decreased from 23.5 to 17.76. It is hypothesized that the ten sunfish limit regulations take significantly longer to portray their efficacy. Understanding the results illustrating bluegill size structures and special regulation efficacy can be important for informing management decisions and looking at implications of fisheries management in general.**

INTRODUCTION

When researching the differences in certain fish populations regarding size structure, it is important to look at various factors to get a representative analysis. This can be done by analyzing lakes all over a certain state or area of interest to obtain data on the bigger picture. Due to the bluegill's popularity and ease of catch or fishability (among other things), there have been many studies done on all sorts of variables in bluegill containing aquatic ecosystems. For instance, besides factors to make note of when researching a topic such as this, one might wonder how long it takes for the special regulations (five or ten sunfish limits) to start showing progress or results. Progress of special regulations can be illustrated by the increased size structure of larger fish, but some may additionally think of increased numbers of bluegill as well since fewer are being legally harvested. The main focus of this study is answering the question of whether or not there are increased amounts of larger fish.

In additional bluegill studies, not only were bluegill size structures in general studied, but also with variables such as Secchi depth (water clarity), total alkalinity, conductivity, percent of littoral zone, among other variables (Tomcko 2001). A study with origins in Wisconsin also studied the efficacy of reduced bag limits on bluegill size structure. Treatment lakes were also those with a ten sunfish limit (opposed to a limit of twenty-five). Broadly speaking, the lengths of bluegill improved due to the special regulations (Rypel 2015). Another study had a lot to do with creel survey information, but one thing particularly interesting was the research on what seemed to be the threshold of what anglers would throw back or keep. The data on this indicated that the length threshold where people decided to start keeping more of the fish were deemed as those that measured 5.9 inches or more (Paukert 2002). Certainly, anglers keep bluegill at many sorts of lengths, so it is important to make note of that since each lake may be fished differently and at different frequencies: a very dynamic system. Previous studies regarding bluegill special regulations in general have primarily focused on the effects and management implications of reduced bag limits, angler acceptance of length limits, effects of harvest, and interpopulation variation in growth rates or size structure. That knowledge can be utilized for informing future management decisions while simultaneously acknowledging known management implications.

The purpose of this study was to determine to what extent special regulations have on the size structure of bluegill in Minnesota. Observed closely throughout this study were lakes with five and ten sunfish limits, and additionally, lakes without special regulations. The regular lakes consisted of a harvestability of twenty sunfish as a daily bag limit. In

general, the twenty sunfish limit per day refers to any members of the sunfish family, but this study only looks at bluegill due to their astounding popularity, and it is the type of fish out of the sunfish family that anglers are most willing to keep or eat. In addition, they are studied far more frequently than their counterparts. By utilizing morphometric data from LakeFinder, this study aims to provide insights into the size structure and effectiveness of special regulations on a statewide scale. Ongoing research on bluegill populations is integral for fisheries management as a whole, along with the satisfaction of stakeholders such as frequent panfish anglers. The information this study provides, along with related bluegill studies, is critical for informing fisheries management decisions impacting numerous lakes.

METHODS

Data collection — The entirety of all bluegill data was obtained while using the Minnesota Department of Natural Resources' website through the search tool called LakeFinder (MNDNR 2025). Lakes around the state of Minnesota were selected right from the LakeFinder map with the intention of homogeneously scattering them across the state of Minnesota, and also to have the three different regulation type lakes uniformly distributed statewide as well. A lake was picked, then it was annotated whether it was a five or ten sunfish limit lake, or just a regular lake, and put into the assigned study category accordingly. This was done by using both the Minnesota Department of Natural Resources fishing regulations booklets (present and prior ones) and LakeFinder. One other paramount parameter was the requirement of a bluegill population within the lake. Each piece of data entered was double checked, due to high possibility of error due to the large amount of data categories and numbers throughout various years and lakes.

After a lake was chosen, many variables were documented. These included elements such as the Lake identification number (also known as DOW), the county the lake was in (to eliminate the possibility of mixing up lakes due to duplicate names), the lake size in acreage, and the percent littoral zone of each lake. In addition, for each year of data that was available for each chosen lake on LakeFinder, the following data on bluegill was collected: weight (lbs), type of trap net used, the count of bluegill, and CPUE. Information was obtained from thirty five-sunfish limit lakes, thirty ten-sunfish limit lakes, and thirty regular (no special regulation) lakes for a total of ninety Minnesota lakes analyzed. There were various types of trap nets used: standard, special, ¼ inch, single-frame, musky, ½ inch, and mini fykes; the majority of which were special or standard trap nets. In addition, each lake was mapped on ArcGIS Pro illustrating the dispersal of the lakes across the state of Minnesota to get a good, representative analysis of bluegill populations in various Minnesota lakes (Figure 1).

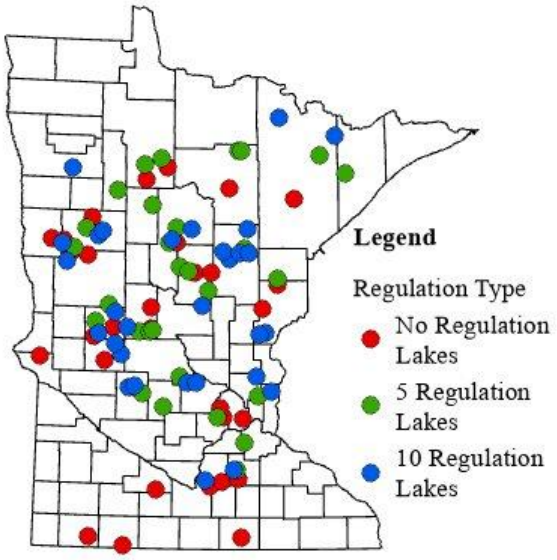

Figure 1. Map of the ninety lakes included in this study divided into three categories based on their special regulation assignments across Minnesota.

Data Analysis—To test for significance between the three different regulation types, ANOVA was used in program R. In addition, a pairwise t-test was also utilized for statistical analysis of weights and years for all categories. In each of the three special regulation categories of lakes, a variety of lake sizes were picked in an attempt to get a widespread analysis across the state of Minnesota. The average amount of lake acres in this study was 1165.77 acres (SD = 1874.7). The average percentage of littoral zone in study lakes was 57.7% (SD = 23.65).

Table 1. Table depicting the difference in mean bluegill weights from fisheries lake survey data for all three different categories of lakes, along with the respective standard deviation. In addition, the average CPUE for each of the three different categories is illustrated in the table, along with the respective standard deviations of such.

Lake Type Category	Wts (lbs)	SD of Wts (lbs)	Avg. CPUE	SD of CPUE
5 Sunfish Limit Lakes	0.23	0.16	22.08	22.86
10 Sunfish Limit Lakes	0.20	0.11	22.69	28.67
Non-regulation Lakes	0.20	0.16	26.21	36.29

RESULTS

Average bluegill weights obtained from LakeFinder documented in this study ranged from 0.01 to 1.48 lbs with an average of 0.208 lbs (SD = 0.145). For the five sunfish limit category, survey results indicate that the weights range from 0.01 to 0.92 lbs with an average of 0.23 lbs (SD = 0.16). For the ten sunfish limit category, weights range from 0.01 to 0.75 with an average of 0.20 lbs (SD = 0.11). For the lakes without special regulations, the weights range from 0.02 to 1.48, with an average of 0.20 lbs (SD = 0.16) (Figure 2). The average CPUE of all lake survey data was 23.57 (SD = 29.62). The weights from the lake survey data in the five sunfish limit category were the largest (Table 1). The five sunfish limit implementation is affiliated with a statistically significant difference in regard to bluegill weights. The bluegill weights from lakes with no regulations and bluegill weights from years after the five sunfish limit was implemented were statistically significant ($P < 0.01$). The bluegill weights from survey years after the special regulation implementation of the five sunfish limit deemed as "Post5" (Figure 2) and the bluegill weights from survey years before the ten sunfish limit was implemented were statistically significant ($P < 0.01$). The p-value of this test was smaller than the analysis between weights from lakes with no regulations and those from years after the five sunfish limit was implemented, indicating increased statistical significance.

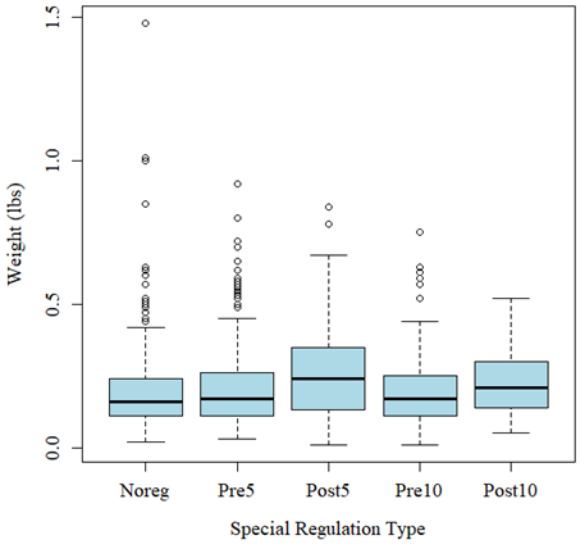

Figure 2. Box and whisker plot of the bluegill weights from the 90 chosen study lakes. The lakes are divided into three categories and further divided into "no regulation lakes" or whether they were pre or post regulation. The graph depicts the most evident effectiveness of the five sunfish limit, compared to the other two categories. Outliers decrease when they get closer to the ten sunfish limit.

DISCUSSION

The trap net data on the five sunfish limit lakes after the special regulation was implemented had the largest bluegill weights compared to other categories, illustrating that it had the greatest effect on producing quality bluegill. The "post five" category of weights obtained from the fisheries survey data in the study lakes were larger after special regulation implementation. In one study regarding redear sunfish *Lepomis microlophus* and bluegill in a reservoir, data was obtained on both species and later population models were developed (Sammons et al. 2006). It was anticipated that the reduced bag limit for bluegills with no minimum length would decline the number of fish harvested and allow for larger amounts of fish with desirable lengths; though as a whole regarding population dynamics models, it was thought that there would be no significant benefits to bluegill size structure, but it was apparent for redear sunfish (Sammons et al. 2006).

In general, special regulations are controversial with the angling public on whether or not they lead to bigger fish and if they are worth the effort. In this study, there was no statistically significant relationship regarding the effectiveness of the ten sunfish limit. This could be attributed to the need for longer implementation periods on lakes in order to see visible results. Overall, the majority of the lakes with special regulations (sixty out of the ninety lakes for this study) had special regulations implemented during the Minnesota DNR's "quality sunfish initiative," where most changes for lakes documented in this study have taken place around 2021 and 2022. In similar studies in the future, the efficacy of ten sunfish limits can be reevaluated; after a longer amount of time, one can suspect that the ten sunfish regulations would at least show greater efficacy, even on a small scale. Very few special regulations in lakes chosen for this study have been in place for more than two decades. The lake that had a special regulation (five sunfish limit) in place the longest in this study was Carnelian Lake in Stearns County, which was implemented in 1997. In addition, the eldest survey data utilized in this study dates back to 1951. One study took place in Minnesota and had lakes that were either control (which was a thirty sunfish limit) or treatment, with an equal number of lakes in each category. The treatment lakes had the ten sunfish limit. Bluegill lengths from control lakes were smaller than those from lakes that were deemed treatment lakes (Jacobson 2005). Special regulations that are in an attempt to reduce harvest from angling have potential to be worthwhile (Jacobson 2005); from the aforementioned study it was not directly deemed effective in it's entirety due to lots of variables.

It is important to understand the dynamics of bluegill populations and how angling affects said populations. Now more than ever, bluegill special

regulation efficacy seems to be a controversial topic with the angling public, and studies such as this are important to understand if they are meaningful, productive, or deemed worthwhile. In Minnesota, bluegill size structure has deteriorated (Jacobson 2005). Some life-long panfish anglers feel as if there is a large amount of increasing fishing pressure or amounts of anglers keeping limits of fish rather often, which could likely be associated with the size structure deterioration. Future studies could look into determining an estimate of how long it takes for special regulations to be declared effective for moderate to heavily fished aquatic systems.

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