EFFECT OF WALLEYE FRY STOCKING ON FUTURE GILLNET CPUE

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***Abstract*—Walleye *Sanders vitreus* for many states, is a key attractant of anglers from around North America. Due to immense popularity, management efforts have been conducted to maintain Walleye populations, especially in the form of stocking. The purpose of this study is to analyze the effect of Walleye fry stocking on gillnet catch per unit effort (CPUE). A total of 90 lakes were analyzed for this study within three defined regions of Minnesota, 30 from each region. The regions chosen for this study are the Minnesota Department of Natural Resources northern pike *Esox lucius* regulation regions which consist of the Southern, North-Central, and North-Eastern regions of the state. This is because each area has similar lake types ranging from prairie pothole lakes to Canadian shield lakes, which provides different habitat for Walleyes. Data collected from each lake consisted of CPUE, average fish weight (lbs), and stocking density (fry/littoral acre). There is little evidence to suggest that stocking density alone affects gillnet CPUE, however, there is evidence to suggest that gillnet CPUE is most effected by zone. Average weight had a very similar outcome where the best supported model was correlated with CPUE and zone.**

I. Introduction

Walleyes are an important species throughout North America for their role in recreational, commercial, and tribal fishing (Colby et al. 1979). While they are native to lakes and rivers of Canada and the northern United States, they have since been stocked throughout a large portion of the lakes and reservoirs within much of the United States (Porath and Peters 1997). Due to the Walleye being in such high demand, many agencies have made extensive stocking efforts to improve their fisheries.

Stocking of Walleye is necessary for the fisheries to be maintained due to natural reproduction being marginal in many lakes and reservoirs (Murphy et al. 1983). Lakes can be stocked in several ways including, fry, small fingerling, and large fingerling, which is largely based on the ecosystem of the waterway (Ellison and Franzen 1992). There is variation amongst different areas of the country due to several limiting factors in stocking of many fish species (Diana and Wahl 2008). The primary limiting factors for Walleye include habitat, forage abundance, and water chemistry (Fielder 1992).

This variability in results causes a need to understand how effective Walleye stocking is for a fisheries manager. It is important to understand this due to the massive economic benefits that come from producing Walleye in a fishery. Millions of dollars in revenue can be generated by their presence in a waterway (Fielder 1992). Currently, the most effective method of surveying Walleye abundance is the utilization of gillnets (Li et al. 2011).

The objective of this study is to determine the effects of Walleye stocking on future gillnet CPUE (catch per unit effort). Data from the Minnesota Department of Natural Resources (MN DNR) will be utilized to help collect the necessary data for this study.

II. Methods

The MN DNR “LakeFinder” webpage was the primary source of data collection for this project (MN DNR 2024). Within the database, there are stocking reports for any lake that has been stocked including stocking rate, average weight, and gillnet CPUE. CPUE is a quantitative method used by fisheries around the world (Maunder et al. 2006). In this study, CPUE is defined as the amount of Walleye caught per gillnet.

Fry stocking is historically conducted by the MN DNR at a rate of 1,000 fry/littoral acre. A littoral acre is defined as an acre that is less than 15 feet deep (MN DNR 2023). However, there can be variation in fry stocking densities. For example, Lake Andrusia in Beltrami County, Minnesota, is stocked at a density of 10,613 fry/littoral acre per year. This is due to several factors, with the main reason being that the lake is connected to the Cass Lake chain, which is a large Walleye fishery in Minnesota, creating a demand for a large Walleye population.

The lakes analyzed during this study are separated by the defined northern pike *Esox lucius* management areas in the state of Minnesota (North-central, North-east, and Southern). This is because, in general, the lakes defined by these regions of the state are similar in forage base, lake type, geological region, etc. For example, many of the lakes in the Northeast region are Canadian shield lakes that are low in productivity but provide cold-water refuge for prey species such as cisco *Coregonus artedi* and lake whitefish *Coregonus clupeaformis*. The differences in regions will allow for variation in lake types and areas of the state where Walleyes are stocked.

There were 30 lakes from the three described zones, totaling 90 lakes, that were selected based on stocking data availability, and the primary form of stocking was fry stocking. The specific lakes selected were those that are stocked with Walleye fry, lakes entirely within the state of Minnesota, and are <1,000 acres in size, with a few exceptions. All lakes selected had lake survey data from 2013-present day and data from the most recent lake survey was collected.

Lakes from every county in this study were selected in alphabetical order, following the criteria listed above. Lakes from the north-central region were selected starting from Beltrami County, where the starting 15 lakes were selected. No more than 15 lakes were taken from any county within this study. Counties targeted contained lakes that have known walleye fisheries such as Aitkin County, Itasca County, Hubbard County, etc. All lakes from the north-east zone came from the three counties within the zone (St. Louis; Lake; Cook). The southern zone has limited walleye fisheries that tend to be concentrated within certain counties, or primarily fingerling stocking. The primary counties that had walleye fry stocking were Freeborn, Rice, and Le Sueur.

Gillnet CPUE can be analyzed against average weight and stocking densities to create a linear regression model. Natural log transformation plots will be used for analysis over standard plots because it reduced problems with heterogeneity in variance and non-linearity within the plots (Leydesdorff and Bensman 2006). The Akaike Information Criterion (AIC) scores will be used to determine the best supported models where lower scores equate to higher support (Sakamoto et al. 1986). The predictor values represented in the models were average weight and CPUE, and the response values were CPUE and Density.

III. Results

The highest density of fry stocked was 10613.2 fry/littoral acre and the lowest density was 465 fry/littoral acre, with the average density for all lakes being 1309 fry/littoral acre (SD = 491.6). The highest average weight was a north-east zone lake at 5.12 lbs. and the lowest was also a north-east lake 0.64 lbs., with the average weight of 1.9 lbs. (SD = 1.3). across all zones (Table 1).

Table 1. Averages for all data throughout the study. Average weight (wt) per walleye, average stocking density (Fry/littoral acre), and average CPUE are shown for each zone north-central = NC; southern = S; north-east = NE. Numbers shown within parantheses are representative of standard deviations

Zone	$\bar{x}$ Wt (lbs)	$\bar{x}$ Density	$\bar{x}$ CPUE
NC	2.1 (0.8)	1732.1 (2306.1)	4.2 (4)
S	2.3 (1.1)	769.7 (279)	10.6 (8.8)
NE	1.9 (1.3)	1425.2 (1014.8)	5.8 (5.4)

While the highest weight of fish in gillnets came from the north-east zone, the lowest weight also came from that same zone. The highest CPUE recorded came from the southern zone at 33.33, while the lowest CPUE came from the north-east zone at 0.22. The average CPUE for the north-central zone was 4.2 (SD = 4.0), 10.6 (SD = 8.8) for the southern zone, and 5.8 (SD = 5.4) for the north-east zone (Table 1).

The best supported model at explaining variation for average weight of fish included both ln(CPUE) and Zone (Table 2). When explaining variation in ln(CPUE), the best supported model included only zone as a factor (Table 3).

Table 2. Linear regression models used to test for the effect of CPUE and zone on Average weight of Walleyes in Minnesota lakes. The best supported models were determined using Aic scores (lower scores = more support).

Formula	AIC	ΔAIC
ln(Avg.Weight)~ln(CPUE)+Zone	108.0	0
ln(Avg.Weight)~ln(CPUE)*Zone	109.6	1.7
ln(Avg.Weight)~ln(CPUE)	114.7	6.8
ln(Avg.Weight)~1	130.4	22.4
ln(Avg.Weight)~Zone	130.6	22.7

Table 3. Linear regression models used to test for the effect of stocking density and zone on gill net CPUE of Walleyes in minnesota lakes. The best supported models were determined using Aic scores (lower scores = more support).

Formula	AIC	ΔAIC
ln(CPUE)~Zone	274.6	0
ln(CPUE)~ln(Density)+Zone	275.9	1.3
ln(CPUE)~ln(Density)*Zone	278.9	4.3
ln(CPUE)~1	280.5	5.9
ln(CPUE)~ln(Density)	282.3	7.6

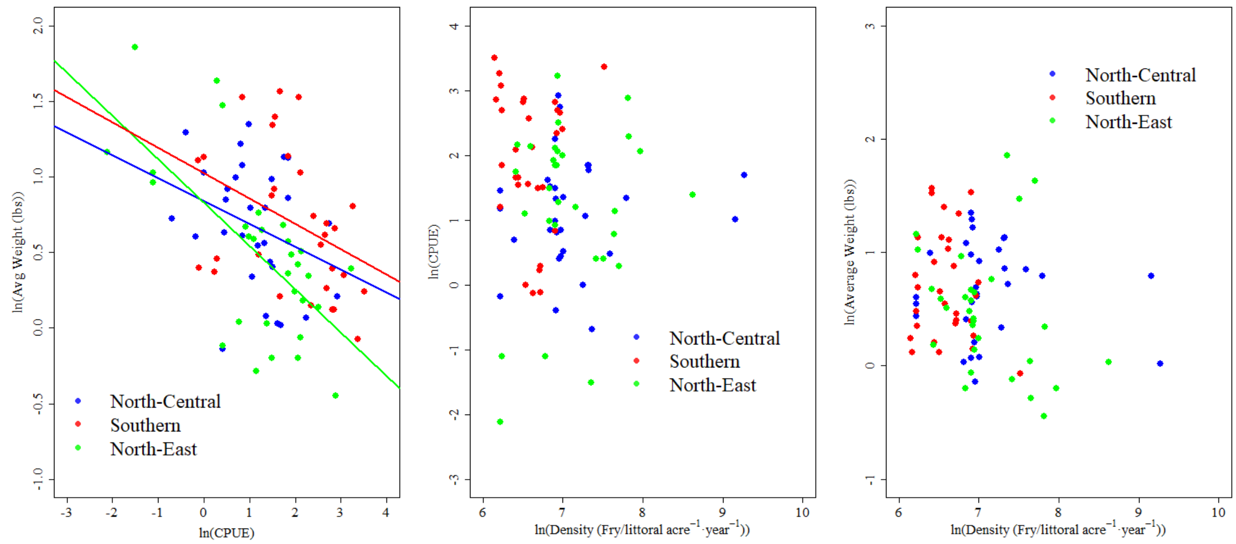

Fig. 1. Gillnet ln(CPUE) of Walleyes plotted against ln(Avg.Weight) and ln(Density) found in gillnets as well as ln(Avg.Weight) plotted against ln(Density). Blue dots indicate the north-central lakes; red dots indicate southern lakes; green dots indicate north-east lakes.

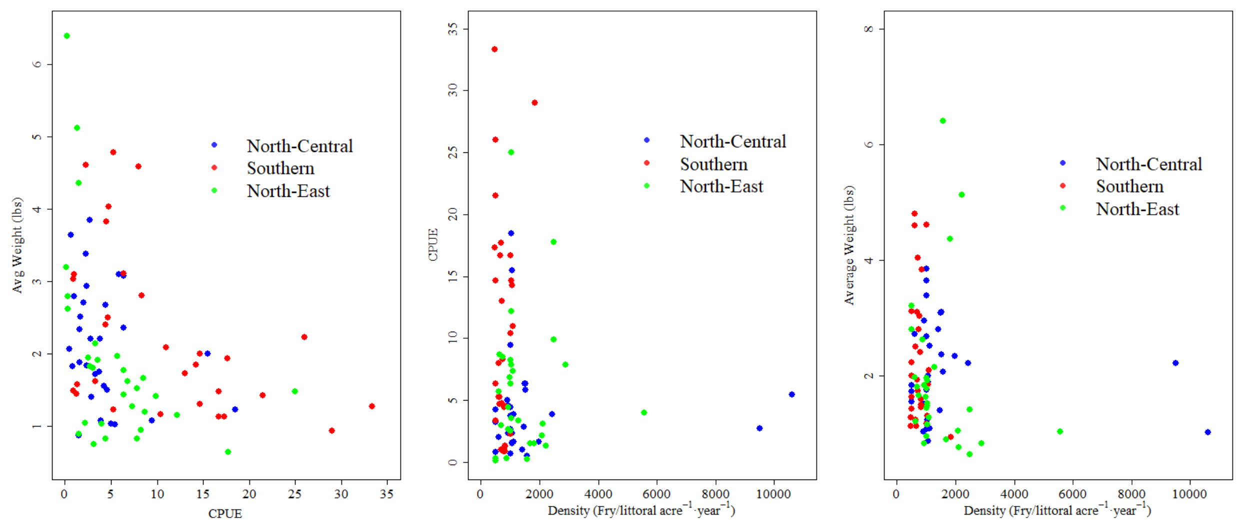

Fig. 2. Gillnet CPUE of Walleyes plotted against average weight (lbs) of individuals and density of fry stocked (Fry/littoral acre[1]). Blue dots indicate the north-central lakes; red dots indicate southern lakes; green dots indicate north-east lakes.

IV. DISCUSSION

Over the range of stocking densities throughout this study, there is little evidence to suggest that stocking density directly affects gillnet CPUE. However, there is evidence to suggest that the zone in which the stocking occurs will influence gillnet CPUE. The southern lakes had on average the lowest stocking density at 769.8 (SD = 279), while also having the highest average CPUE at 10.6 (SD = 8.8) (Table 1). The most expected cause for this discrepancy between zones is the increased productivity of southern lakes, allowing for increased growth rates (Eddy and Carlander 1940). The north-central and north-east lakes had similar rates of stocking effectiveness in relation to future CPUE, this could be caused by numerous factors such as lake latitude, lake type, species present, etc.

There is evidence to suggest that average weight is significantly affected by zone and CPUE. The southern zone had the highest average weight of fish on average ~2.3 lbs. (SD = 1.1) while also having the highest CPUE on average at 10.62 (SD = 8.8), this is likely caused by the high productivity of southern Minnesota lakes in relation to their northern counterparts, allowing for plentiful forage and large size. The north-east and north-central zone had very similar results in weight (NC = ~2.12 lbs.; NE = ~1.92 lbs.) and CPUE (NC = ~4.23; NE = 5.75).

TABLE 4. LINEAR REGRESSION MODELS USED TO TEST FOR THE EFFECT OF STOCKING DENSITY AND ZONE ON AVERAGE WEIGHT OF WALLEYES IN MINNESOTA LAKES. THE BEST SUPPORTED MODELS WERE DETERMINED USING AIC SCORES (LOWER SCORES = MORE SUPPORT).

Formula	AIC	ΔAIC
ln(Avg.Weight)~ln(Density)	129.3	0
ln(Avg.Weight)~1	130.4	1.1
ln(Avg.Weight)~ln(Density)+Zone	130.5	1.2
ln(Avg.Weight)~Zone	130.6	1.4
ln(Avg.Weight)~ln(Density)*Zone	133.2	3.9

Based off the data, there is sufficient evidence to determine that stocking densities do marginally influence average weight. The average weight of fish does have a positive relationship with lower stocking densities, but there isn't a major discrepancy. The average weight per fish in the southern zone was 2.3 lbs (SD = 1.1) and the north-central zone was 2.1 lbs (SD = 0.8), while maintaining a large gap of 962.4 fry/littoral acre per year stocked on average. This would suggest that while there is an effect on average weight from fry stocking densities, it is very minimal.

There is evidence that suggest gillnet CPUE differs by zone. It should be noted that regional variance has a larger effect on gillnet CPUE than stocking densities. There is a variation of at least 1.5 fish per net on average between the zones, with the largest gap found between the southern zone at 10.6 CPUE (SD = 8.8) and the north-east zone at 4.2 (SD = 4). The likely candidate for this variation is the difference in zone productivity. The north-east zone is comprised of oligotrophic Canadian shield lakes whereas the southern zone is comprised primarily of prairie pothole, eutrophic lakes, with the north-central zone lying between the productivity levels.

It can be concluded that while stocking densities may not directly affect gillnet CPUE, it does have an influence when different areas are considered as a factor. This is not to say however, that fry stocking doesn't work. Even for the lakes that have lower numbers of fish, stocking is still an effective tool for managing specific fishes. If stocking were to be removed, this could potentially cause crashes in target fish populations.

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