STATEWIDE NORTHERN PIKE RESPONSE TO MINNESOTA'S 2018 REGULATION CHANGE

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***Abstract*—Management of northern pike (*Esox lucius*) is challenging because it attempts to balance ecological sustainability with angler interests. Northern pike often stunt their own growth by diminishing the size and abundance of prey fish, their food source. Anglers are often displeased when small pike occur in high population densities. In response to populations of small northern pike, the DNR implemented a new, statewide northern pike regulation in 2018. The objective of this study was to determine whether the regulation successfully changed the mean weight, length, and CPUE of northern pike in Minnesota. The secondary objective was to test whether there were increases in the proportion of fish >30 inches and a decrease in the population of pike <20 inches. The DNR LakeFinder resource was used to obtain information from lakes surveyed by the DNR using specified criteria. The gathered data included CPUE, weight, and length measurements from 1999 to 2024. Regression analysis evaluated significance, yielding p-values for all three measurements in each regulatory zone. Regression analysis was also run on both the proportion of pike <20 inches and those >30 inches. In the Northeast, North-Central, and Southern regulation zones, there were no significant p-values in the seven years following the regulation (*P* > 0.05). Mean CPUE, weight, length, proportion of fish <20 inches, and proportion of fish >30 inches all remained statistically unchanged (*P* > 0.05). The purpose of this study was to better understand the response of pike to fishing regulations, gathering useful insights for informing adjustments to the current fishing guidelines. Future research could look at how ecological factors influence pike size. The findings are useful for understanding the effectiveness of fishing regulations at changing the size structure of pike populations.**

INTRODUCTION

Northern pike (*Esox lucius*) are controversial in North American fisheries management as these fish extensively deplete prey fish populations. Roughly 15 years after their introduction in a Washington reservoir, the estimated biomass of native fish declined by roughly 56% (Mayer et al. 2024). Pike >24 inches are primarily piscivorous, commonly eating yellow perch (*Perca flavescens*) (Kennedy et al. 2018; Pierce et al. 2003a; Sammons et al. 1994; Theis et al. 2025). In one Nebraskan lake, Paukert et al. (2002) estimated that northern pike consumed 49,000 – 77,000 perch annually. This is noteworthy because pike predation on yellow perch can dramatically reduce the abundance of yellow perch, walleye (*Sander vitreus*), black crappie (*Pomoxis nigromaculatus*), largemouth bass (*Micropterus nigricans*), and pumpkinseed (*Lepomis gibbosus*) populations (Anderson and Schupp 1986). When pike predation reduces prey abundance, it also reduces the success rate of stocking programs (Goeman and Spencer 1992; Paukert et al. 2002). Jolley et al. (2008) found that, when pike populations were significantly reduced, both yellow perch and bluegill (*Lepomis macrochirus*) increased in size. Overall, northern pike populations significantly impact the size and abundance of prey fish.

In order to grow effectively, pike require abundant prey fish. However, high densities of northern pike reduce per-capita food availability, slowing and stunting growth (Diana 1987; Margenau et al. 2008; Pierce et al. 2003b). Consequently, lakes that support high distributions of trophy-sized pike have lower population densities (Oele et al. 2016; Pierce et al. 2003b). In some systems, pike densities explain growth patterns better than lake productivity (Pierce et al. 2003b). Reducing pike densities, commonly measured as catch per unit effort (CPUE), is often required to increase the mean size or abundance of trophy-sized fish. However, once pike are abundant in small sizes, it is extremely difficult to reduce their abundance. Goeman et al. (1993) found angler pressure is typically ineffective at removing enough small northern pike to increase growth rates. Since methods of direct removal, including trap netting and angling, have been ineffective in previous studies, intensive measures such as blocked spawning runs have been proposed to reduce pike densities sufficiently to facilitate growth (Goeman et al. 1993; Jacobson 1992). Fisheries managers are faced with these issues when attempting to facilitate northern pike growth.

Angler frustration often results from small northern pike occurring in high population densities. In 2014, roughly 35% of the licensed anglers in

Minnesota reported specifically targeting northern pike (Schroeder and Fulton 2014). Northern pike anglers typically prioritize catching trophy-sized pike rather than catching numerous fish (Schroeder and Fulton 2013). Additionally, most recreational fishing methods target pike >20 inches (Pierce and Tomcko 2003). This results in the exploitation rate for pike >20 inches to be two to nine times higher than for smaller fish, and pike >24 inches constitute a large portion of harvested fish (Cook and Younk 1998; Pierce et al. 1995; Pierce and Tomcko 2003). So, many anglers fish to catch large pike, but their selective harvest reduces the abundance of large pike. When questioned, approximately two-thirds of anglers from North-Central Minnesota expressed support for regulations intended to increase northern pike size (Lovelace 2024). However, to optimize pike growth, selective harvest of small fish must be applied (Theis et al. 2025). Many anglers are not interested in harvesting small pike. Additionally, management that wishes to improve pike size structure must severely restrict the harvest of large fish (Pierce and Tomcko 2003; Pierce 2010). In other words, the pressure for trophy pike is substantial, but the regulations that facilitate pike growth are counter to many angling practices.

Aside from walleye, the Minnesota Department of Natural Resources (MN DNR) has studied northern pike more than any other fish (Reed et al. 2023). Several experimental and observational studies have examined different harvest regulations. Goeman et al. (1993) found that liberalized bag limits did not improve size structure and would remain ineffective unless angler harvest increased substantially. Likewise, Paukert et al. (2001) concluded that bag limits are only effective if anglers regularly harvest their limit. Pierce (2010) experimented with minimum, maximum, and slot limit regulations. Though the regulations consistently improved pike size structure, the CPUE of large fish did not increase. Of the regulations they tested, Oele et al. (2016) found that allowing the daily harvest of one pike >30 inches was most effective at increasing pike size structure in Wisconsin. However, this regulation was installed over lakes with low pike abundance, making it more apt to succeed. Bethke et al. (2021) examined various regulations, including slot limits and minimum length regulations. Both succeeded at increasing pike size structure, but the regulations were applied to lakes with favorable morphometry and angler effort. Collectively, these studies indicate regulations can shift pike size distributions, but outcomes depend strongly on pre-regulation fish density, lake characteristics, and angler behavior, making large-scale management of northern pike difficult.

In 2018, Minnesota introduced new pike regulations. The first major change was that the state was split into three regulation zones: Northeast, North-Central, and Southern. The following regulations were the DNR's effort to facilitate change. For the Northeast zone, the regulation allows the harvest of two pike, where only one can be >40 inches in length. All fish ranging from 30 to 40 inches must be released. The spearing regulation for this zone allows the harvest of two pike, with only one being >26 inches in length. The North-Central zone regulation allows the harvest of 10 fish, but only two >26 inches, and all fish 22 to 26 inches must be released. Spearing has the same regulation except it allows the harvest of one fish between 22 and 26 inches or two >26 inches. Finally, the Southern zone allows the harvest of two fish >24 inches in length for both angling and spearing. The objective of this study is to determine whether these regulations have been successful in achieving their goal of increased abundance of large northern pike. From a management perspective, specific emphasis is placed on the North-Central regulation zone, as this area historically contains the most problematic pike densities.

Methods

Data Sources and Downloads. – Data collection began with compiling a list of all lakes surveyed by the MN DNR. The shapefile *DNR Hydrography – Fisheries Surveyed Lakes* was downloaded from Minnesota Geospatial Commons on 12 – 20 – 2025 (https://gisdata.mn.gov/dataset/env-lakes-surveyed-by-mndnr). From the shapefile, the following metadata fields were used: DOWLKNUM, PW_BASIN_N, PW_Parent, and ACRES. Fish surveys were retrieved from the Minnesota LakeFinder website (https://www.dnr.state.mn.us/lakefind/index.html) for every lake surveyed by the DNR.

Spatial Processing. – All mapping occurred in Arc GIS Pro (Version 3.6 Patch 2 (3.6.2)) using the coordinate system NAD 1983 UTM Zone 15N. A polygon layer was created using official DNR regulation maps (https://www.dnr.state.mn.us/fish/northern/zones.html) to define the pike regulation zones. Lakes were assigned a regulation zone by performing a spatial join between the DNR surveyed lakes shapefile and the regulation zone polygon layer. If a lake intersected multiple zones or international boundaries, MN LakeFinder was used to identify the regulation in place.

Survey Selection. – Every lake was manually located on the MN LakeFinder website, and only those with lake surveys between 2018 and 2024 (inclusive) were retained. Lakes were only included if they fit all of the following criteria: (1) it was >100 acres in size, (2) there were no special pike regulations on the system since 2018, (3) it was not surveyed more than three times since the statewide regulation was installed, (4) it was surveyed using trap and gill nets with no additional surveying equipment yielding pike, and (5) there were at least five pike sampled in the survey.

These specifications ensured a standard sampling technique, focusing the study on larger bodies of water, where most angler activity occurs.

Data Processing. – Lake survey data were collected from the LakeFinder report for every lake that met the study's criteria. Each survey included CPUE, mean weight, and length of northern pike. The DNR reports CPUE and weight by specific nets while reporting length ranges for all sampling equipment together. To report weight and CPUE in the same format as length, the data from the two nets were averaged. Weighted averages were calculated using the formula $x = \frac{n_1 x_1 + n_2 x_2}{n_1 + n_2}$ where n_1 and x_1 are the gill net sample size and mean weight, respectively, and n_2 and x_2 are the trap net sample size and mean weight, respectively. The same procedure was followed for CPUE. Annual averages were calculated for CPUE, weight, and length in each zone.

Data analysis. – Mean annual CPUE, weight, and length in each regulation zone were plotted as a line graph with 95 percent confidence interval error bars. Confidence intervals were calculated as $M \pm 2 \times SE$, where $M = \frac{summation\ of\ X}{n}$ and $SE = \frac{SD}{\sqrt{n}}$ where n is the number of lakes. All graphs were created in Excel (Version 2602). To test the statistical significance of the data, regression models were run on CPUE, weight, and length for each of the zones after the regulation was installed. This test analyzed whether there were trends in the seven years following the regulation change. Additionally, the mean proportions of fish >30 inches and those <20 inches were calculated. The proportions were also graphed using line graphs with 95% confidence intervals. Regression analysis was applied to the mean proportions after the regulation was installed.

RESULTS

From the 4,383 lakes surveyed by the DNR, 855 fit the criteria (Figure 1). The Northeast, North-Central, and Southern zones contained 94, 679, and 82 lakes, respectively. In total, there were 1,063 surveys done from 2018 to 2024 that fit the study criteria. Only surveys done after 2018 (inclusive) were part of the statistical analysis. The Northeast zone had 113 surveys, the North-Central zone had 825, and the Southern zone had 125. The average number of surveys done in the Northeast, North-Central, and Southern zones was 16, 118, and 19, respectively (SD = 4, 27, and 7). The fewest surveys done in one year was six, which occurred in the Southern zone in 2020. All other year classes after 2018 recorded 10 or more surveys. The mean number of fish sampled annually was 658, 9,234, and 526 for the Northeast, North-Central, and Southern zones, respectively (SD = 267, 1,890, and 221). Data was also collected from an additional 2,362 surveys done on the same lakes from 1999 through 2017 for graphical comparison.

Mean CPUE remained statistically unchanged in the Northeast, North-Central, and Southern zones (p = 0.17, 0.35, and 0.93). However, regression slopes were positive in all three zones, indicating a weak, insignificant, increasing trend after the regulations were installed (Table 1; Figure 2A). Mean weight of northern pike also shows no significant change in the Northeast, North-Central, or Southern zones (p = 0.29, 0.71, and 0.76). No consistent trends appeared among the three zones (Table 1; Figure 2B). Similarly, regression analyses of mean length detected no significant trends (p = 0.58, 0.22, and 0.67; Table 1; Figure 2C).

Size-structure metrics were also constant and insignificantly changed through the study period. The proportion of fish >30 inches in length exhibited no significant change for the Northeast, North-Central, and Southern zones (p = 0.66, 0.38, and 0.75; Table 2; Figure 3A). The proportion of fish <20 inches also remained constant (p = 0.83, 0.10, and 0.56; Table 2; Figure 3B). Collectively, these results indicate no significant change in mean CPUE, weight, length, proportion of pike >30 inches, and proportion of pike <20 inches across all three zones for the duration of the study period.

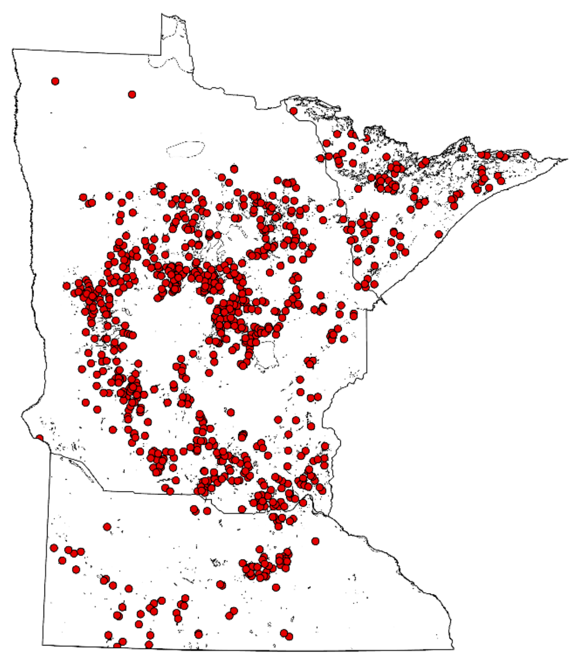

Figure 1: Map of the 855 lakes that fit the study criteria and were sampled by the MN DNR from 2018 through 2024. Data from these same lakes collected from 1999 to 2017 were used for graphical representation.

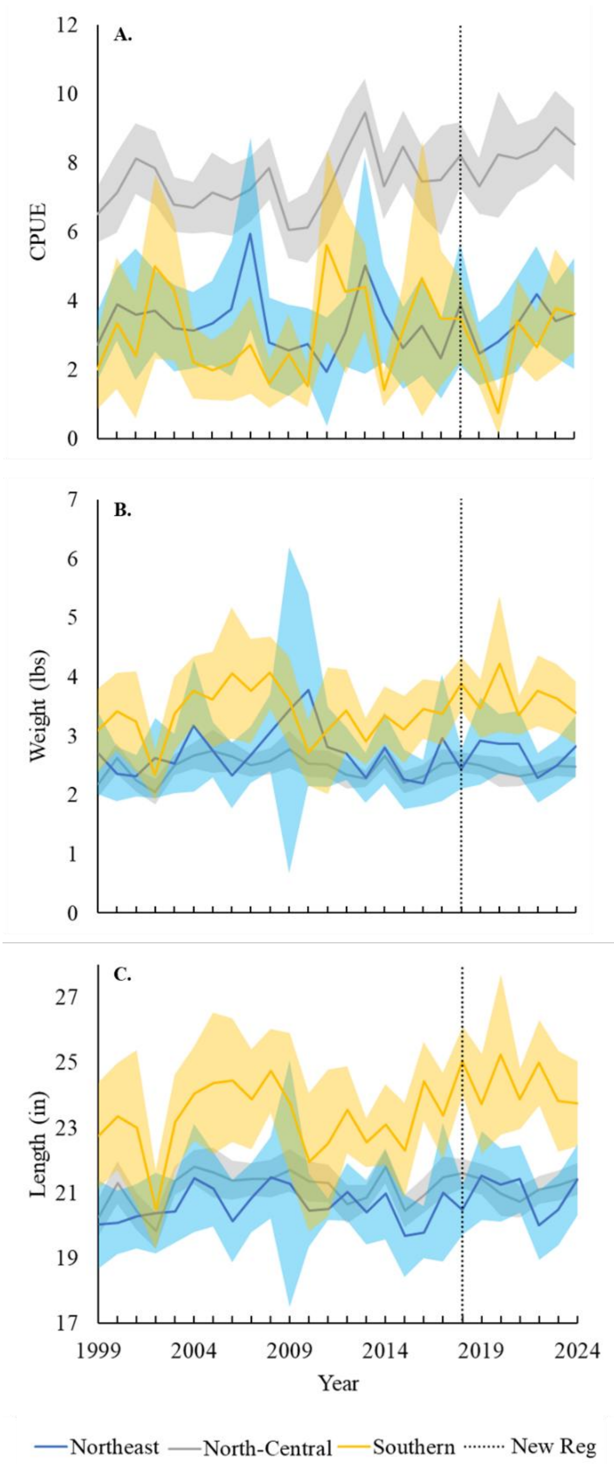

Figure 2: Mean CPUE, weight, and length plotted against year from 1999 to 2024. These graphs represent all the data from lakes that fit the study's criteria between 1999 and 2024 available on the DNR LakeFinder website. For graphical representation, lake surveys done before 2018 are separated into the regulation zones based on where the lake was classified in 2018. The dashed line indicates when the current regulation was installed (2018). Only data after that line was used in the statistical analysis. Error bars show a 95% confidence interval around the mean.

DISCUSSION

In the first seven years of implementation, the fishing regulation introduced to Minnesota in 2018 has been ineffective at changing the size structure of northern pike. Following the regulation change, pike CPUE, weight, and length have not changed significantly ($P > 0.05$). The proportions of fish >30 inches and those <20 inches also lack significant change ($P > 0.05$). Most notably from a management perspective, the objective of decreasing CPUE in the North-Central zone has not been met. The Southern and Northeast zones also remain statistically unchanged.

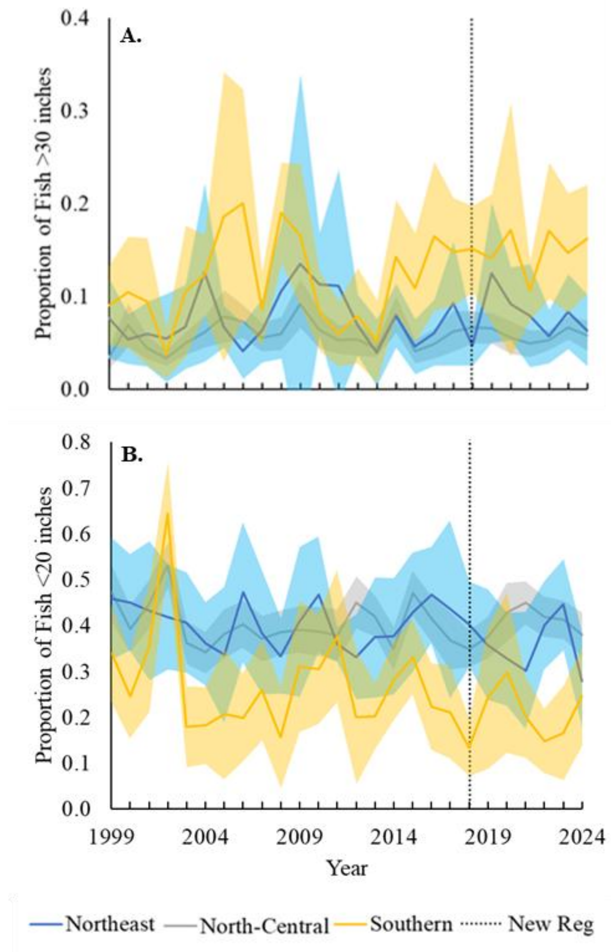

Figure 3: The proportion of fish >30 and <20 inches in length plotted against year from 1999 to 2024. These graphs represent all the data from lakes that fit the study's criteria between 1999 and 2024 available on the DNR LakeFinder website. For graphical representation, lake surveys done before 2018 are separated into the regulation zones based on where the lake was classified in 2018. The dashed line indicates when the current regulation was installed (2018). Only data after that line was used in the statistical analysis. Error bars show a 95% confidence interval around the mean.

There have been no significant shifts towards large northern pike or changes in CPUE in response to the 2018 regulation change. Bethke et al. (2021) tested multiple regulations, including a slot limit similar to the North-Central regulation zone. One regulation protected fish from 24 – 36 inches, allowing a three-fish bag limit with only one fish being >36 inches. Lakes with this slot limit reported reductions in pike <20 inches. In all three Minnesota fishing zones, the proportion of pike <20 inches remained constant after the 2018 regulation. Possible factors contributing to the different outcome include the selection of lakes with favorable morphology and angler activity in the study done by Bethke et al. (2016). Additionally, their control lakes showed similar directional changes of smaller magnitude. This indicates the regulations were installed in areas favorably disposed towards pike growth. They also found no consistent change in overall CPUE. Bethke et al. (2016) reported an increased proportion of large northern pike, but CPUE did not show a consistent increase. This pattern is consistent with lower pike densities prior to the regulations being installed. This would allow pike growth without reductions to CPUE. In contrast, the lack of detectable CPUE shifts in Minnesota after the 2018 regulation may reflect high pre-regulation densities of small pike, unsuitable morphometry, or insufficient time since regulation implementation.

Table 1: Summary of the regression results, where the three independent variables are the different regulations as categorized by zone. The dependent variables included mean CPUE, weight, and length. Summary values include p-values, slopes, F-values, and F significance.

Measurement	Zone	Sample Size	P-value	Slope	F	Significance F
CPUE	Northeast	113	0.349	0.078	0.913	0.3414
CPUE	North-Central	825	0.174	0.074	1.977	0.1601
CPUE	Southern	125	0.932	0.009	0.010	0.9210
Weight	Northeast	113	0.705	0.020	0.685	0.6852
Weight	North-Central	825	0.288	-0.016	0.976	0.3235
Weight	Southern	125	0.759	-0.014	0.074	0.7858
Length	Northeast	113	0.579	0.077	0.416	0.5201
Length	North-Central	825	0.218	-0.044	0.990	0.3201
Length	Southern	125	0.667	-0.430	0.115	0.7353

Table 2: Summary of the regression results, where the three independent variables are the different regulations as categorized by zone. The dependent variables included mean proportion of fish >30 and <20 inches in length. Summary values include p-values, slopes, F-values, and F significance.

Measurement	Zone	Sample Size	P-value	Slope	F	Significance F
Proportion >30"	Northeast	113	0.659	-0.002	0.188	0.6653
Proportion >30"	North-Central	825	0.378	-0.001	0.742	0.3894
Proportion >30"	Southern	125	0.749	0.002	0.111	0.7399
Proportion <20"	Northeast	113	0.831	-0.002	0.038	0.8455
Proportion <20"	North-Central	825	0.096	0.007	2.933	0.0872
Proportion <20"	Southern	125	0.557	0.006	0.359	0.5501

Since 2018, there has been no significant change to the proportion of northern pike >30 inches. In his research, Pierce (2010) examined the impact of various maximum, minimum, and slot length limit regulations. In general, the regulations improved pike size structure, though the degree of improvement varied. All three regulation types resulted in a larger overall size structure with increased proportions of fish over 30 inches. Slot limits were most reliable at improving size structure. Even though some of the regulations were comparable to the ones installed in Minnesota in 2018, the resulting size structure shifts contrasted. For the Northeast, North-Central, and Southern regulation zones, there is no evidence of increased proportions of fish >30 inches. Possible causes of this difference are lake selection and insufficient time for the regulation to make an impact.

Mean weight and length have remained statistically unchanged since the pike regulation was introduced in 2018. Oele et al. (2016) investigated the impact of three different regulations on various Wisconsin lakes. Of the three regulations tested, they concluded the best regulation for increasing pike size structure was allowing a minimum length of 32 inches and only one pike daily. This regulation facilitated an increase in both average pike size and CPUE. The regulations installed in Minnesota in 2018 have not witnessed either trend. However, the objective of the regulations, with the exception of the Southern zone, was to decrease CPUE. One possible explanation for the different outcomes is the pre-regulation CPUE. Oele et al. (2016) noted that CPUEs were low when the regulations were installed. This allowed a simultaneous increase in size structure and CPUE. However, in many Minnesota lakes, northern pike CPUE is already elevated, which could prevent shifts towards bigger fish. Angler selectivity and the time the regulation has been in place could be other factors causing the difference in outcomes.

From the research done by Bethke et al. (2021), Pierce (2010), and Oele et al. (2016), it is clear that the period of time a regulation has been in place significantly influences its success. Northern pike reach ages of 11 – 14 years, with some reaching ages of 29 years (Pierce 2010). Therefore, it takes time to witness any changes caused by fishing regulations. There are only seven years of data following the regulation change in Minnesota. Extended periods of time are required to see shifts in pike population structures as a result of regulations (Pierce 2010). In their study, Bethke et al. (2021) found trends that appeared 15 years after the regulation was installed that were not visible 10 years after the regulation. From his research, Pierce (2010) concludes that 15 years after installation is a reasonable time to evaluate the effectiveness of a pike regulation change. In their study, Oele et al. (2016) noted that a study done 13 years after the regulation was installed in Wisconsin did not distinguish clear differences that appeared 20 years after the regulation was in place. So, though no changes are detectable yet from the 2018 regulation change in Minnesota, it is young in terms of northern pike regulation. This study should be thought of as a preliminary evaluation rather than a conclusive evaluation for the 2018 pike regulation.

In conclusion, the 2018 pike regulation has been ineffective at changing pike population structure so far. However, it must be granted adequate time to ensure its impacts are properly understood. Previous studies suggest that this could be anywhere from 15 to 20 years after a regulation change. There are some factors, such as high pike CPUE and angler selectivity, that could impact the success of this regulation, but the most crucial element at the moment is time. Though similar regulations have worked to improve size structure in the past, these changes have not appeared yet for the 2018 regulation change in Minnesota. However, the primary takeaway at this point is that the regulation needs more time before its impact can be accurately evaluated.

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