Fishery Survey - Diamond Lake,
Bayfield County, 2018-2019
WBIC Code – 2897100

Cris Sand (WDNR Fisheries Technician) holds a Diamond Lake walleye. Photo by: Martin Kangas

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Executive Summary

The fisheries of Diamond Lake, Bayfield County, were surveyed during 2018 and 2019, with objectives to obtain a population estimate of walleye and assess the other gamefish and panfish populations, along with sport and tribal use of these species. Sampling followed standardized Treaty Assessment protocol and included spring fyke netting, spring and fall electrofishing, and a creel survey. Results indicated adult walleye abundance (≥ 15 in and sexable fish) was 1.3 adults/acre, slightly below the average of ceded territory lakes with a stocked walleye recruitment code. The walleye size structure has been variable between survey periods but has consistently included high average lengths. The length frequency distribution of walleye indicates change over time that is likely due to fluctuations in stocking strategy and failure of several year classes. Stocking has driven walleye populations since 1986, however very low levels of natural reproduction may be present. Northern pike population and size structure has fluctuated between survey periods, despite harvest regulation changes. Northern pike average length was the highest for all survey years in 2018. Largemouth bass abundance increased rapidly and decreased slightly during the survey period, while size structure has improved. Smallmouth bass populations have decreased during the survey period. Largemouth bass relative abundance has increased 306% and smallmouth bass relative abundance has decreased 73% from 1990 to 2018. Bluegill abundances have shown downward trends, but small size structure is still present. Angling pressure during the 2018-2019 fishing season was 10.8 hr/acre of which 97% came during the open water season. Angling pressure was below the Bayfield County average of 22.2 hr/acre. Creel survey results indicated largemouth and smallmouth bass were the most targeted gamefish species (36.5% and 30.4% of directed effort, respectively) by anglers in 2018. Anglers harvested an estimated 20 walleye and tribal spearing

harvested 39 walleye. Estimated exploitation (sport angling plus tribal spearing) of walleye ≥ 15 in was 13.0% in 2018-2019.

Management recommendations include, 1) Maintaining existing walleye regulations and continue large fingerling stocking in alternate years, 2) Retain the northern pike 26 in minimum length limit with a bag limit of two fish, while continuing to monitor northern pike populations, 3) Retain current bass regulations to possibly reduce largemouth bass densities and improve smallmouth bass densities, 4) Evaluate the bluegill population during next survey year due to signs of decreased abundance, 5) Maintain and improve habitat and water quality of Diamond Lake. As well as monitor and control the spread of invasive species.

Introduction

Diamond Lake is a 341 acre drainage lake near the headwaters of Eighteen Mile Creek in Bayfield County. Diamond Lake is a low range mesotrophic lake with clear water, has private riparian ownership along the entire lake except for the public access on the southern end of the lake and is a popular recreational lake in the area. Diamond Lake has an average depth of 33 feet and a maximum depth of 83 feet. Substrate in Diamond Lake is mostly gravel with some sand and muck. It has a total alkalinity of 33 mg/l. Average summer secchi disk depth trophic state index (TSI) value for the deep hole on Diamond Lake was 40.4 (SD = 3.5, N = 113), for the time period between 1992 and 2017. Average summer chlorophyll-a and total phosphorus TSI values for the deep hole on Diamond Lake were 41.6 (SD = 4.1, N = 69) and 47.3 (SD = 2.9, N = 68) for the time period between 1994 and 2017. TSI indices are used to evaluate the trophic state or nutrient condition of lakes. Transparency and chlorophyll-a data on Diamond Lake indicate the nutrient condition was near the division line between oligotrophic and mesotrophic condition. Total phosphorus data indicated the nutrient condition was near the divison line between mesotrophic and eutrophic condition. Diamond lake is classified as a complex-two-story lake (Rypel et al. 2019).

Diamond Lake has a diverse fish community consisting of walleye *Sander vitreus*, northern pike *Esox lucius*, largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieui*, bluegill *Lepomis macrochirus*, pumpkinseed *L. gibbosus*, green sunfish *L. cyanellus*, rock bass *Ambloplites rupestris*, black crappie *Pomoxis nigromaculatus*, yellow perch *Perca flavescens*, white sucker *Catostomus commersoni*, yellow bullhead *Ameiurus natalis*, rainbow smelt *Osmerus mordax*, mottled sculpin *Cottus bairdi*, creek chub *Semotilus atromaculatus*, common shiner *Notropis cornutlus*, tadpole madtom *Noturus gyrinus*, and central mudminnow

Umbra limi. Cisco *Coregonus artedii* were also present historically but have not been sampled since 1969.

Historic management of Diamond Lake has included fishery surveys, stocking, and various length and bag regulations. Historic surveys for walleye occurred in 1990, 1996, 2003, 2006, 2009, 2012, 2015 and 2018 utilizing Wisconsin Department of Natural Resources (WDNR) standardized treaty protocols (Cichosz 2019). Walleye surveys were also conducted in 1968, 1971 and 1975 to evaluate the success of walleye stocking using a different sampling protocol, i.e. electrofishing and netting to capture walleye to determine year class strength. These historic walleye surveys did not include population estimates.

Diamond Lake has a long stocking history (Table 1). Walleye have been the only species stocked since 1969. Prior to 1969 most of the stocking involved rainbow trout and largemouth bass and to a lesser extent northern pike, smallmouth bass and brown trout. Rainbow, brown and brook trout were stocked from 1959 to 1968 in an attempt to create a two-story fishery. Survey results from 1968 found few trout and little carry over into subsequent years from stocking; at that time trout stocking was discontinued and walleye stocking was initiated (Weiher 1972). Walleye stocking began in 1969 and was intended to establish a self-sustaining fishery that might exercise biological control over an abundant but slow growing bluegill population. Prior to 1969 there had been only a remnant walleye population (Pratt 1976). Walleye stocking was discontinued in 1980 due to evidence of natural reproduction and a decline of black crappie and bluegill (Schram 1981). The first walleye population estimate occurred in 1990 and found that six walleye year classes were produced naturally after stocking had been discontinued. However, after the six naturally reproduced year classes of walleye there were 5 years with no evidence of natural reproduction and bluegill abundance had reached levels that were comparable to levels prior to walleye stocking (Kampa and Sand 1991). Kampa and Sand (1991) found this perplexing and speculated that Diamond Lake did not have habitat conditions conducive to walleye reproduction since walleye were present in the lake for many years prior to stocking even though their numbers were just detectable. However, the six year classes of naturally reproduced walleye seemed to diminish this argument. The authors also speculated that the presence of smelt in Diamond Lake might have also been a factor, suggesting that smelt could be significant predators on early life history stages of walleye. Whether environmental conditions or smelt predation acted alone or in concert in walleye declines in Diamond Lake was unknown.

Annual large fingerling walleye stocking was recommended to increase walleye abundance of a predominately stocked walleye population (Toshner 2005) which was hoped would also decrease bluegill population through predation and increase growth of bluegill. Annual large fingerling walleye stocking began in 2009 and continued until 2013. The walleye stocked during this period were marked with either a fin clip or a visible implant elastomer tag to discern survival, contributions to year class of stocked walleye and cost per recruit. Beginning in 2015, large fingerling walleye were stocked in alternate years due to changes in stocking practices made when the Wisconsin walleye initiative began.

Walleye fishing regulations have changed over time in Diamond Lake. There was no minimum length limit for walleye until 1990 when a 15 in minimum length limit was instituted statewide. In 2000, the 15 in minimum length limit remained on Diamond Lake and an additional slot limit from 20 inches to 28 inches was instituted; only one walleye over 28 inches was allowed. The slot limit was proposed because natural recruitment was low, and the population was dependent on stocking, and past survival and growth of stocked fish had been excellent (Scholl 1998). The walleye protected slot limit was shifted in 2016 from 20 inches to 24 inches. The change was made when the ceded territory walleye bag limits were changed to a 3 fish bag limit for all waters. The lack of fishing pressure from prior creel surveys and low harvest of walleye indicated that angler harvest did not have a noticeable impact on walleye populations. Making the protected slot less restrictive gave anglers an opportunity to harvest an occasional walleye.

Northern pike regulations also changed over time in Diamond Lake. There was no minimum length and a bag limit of five northern pike until 1995 when a 32-inch minimum length limit and a bag limit of one was implemented. The more restrictive northern pike regulation was implemented in an attempt to produce a higher quality northern pike fishery and encouraged by information which indicated presence of a smelt and possible cisco forage base, good growth rates and good thermal conditions for northern pike (Scholl 1994). Toshner (2005) recommended revisiting the northern pike regulation after the results of the 2006 fishery survey. Results from four surveys conducted after the 32-inch minimum regulation was implemented found only one northern pike over 32 inches. Also, anglers had expressed the desire for a more liberal regulation so that some pike harvest could occur. Creel surveys conducted after the implementation of the 32-inch minimum regulation showed little to no northern pike harvest. Considering this information, the northern pike regulation was changed to a 26-inch minimum length and daily bag limit of two fish per day in 2012.

Largemouth and smallmouth bass regulations had followed statewide general bass regulations, but this changed in 2018. Diamond lake was added to the regulation change for 15 lakes in Bayfield, Doulgas and Sawyer Counties in 2016. The change included an 18 inch minimum length for smallmouth bass and no size limit for largemouth bass with a combined bag limit of five fish of which only one could be a smallmouth bass. This regulation was proposed and was implemented to provide quality smallmouth bass angling as well as a consumptive opportunity for largemouth bass which have been increasing in abundance.

Recent management has focused on walleye stocking, regulation changes, public outreach and education and habitat protection. The objective of the 2018-2019 survey was to determine the status of the walleye population, along with sport and tribal use. More specifically, we were interested in determining population abundance, growth, size structure and harvest of walleye. We also hoped to determine some population parameters of other important gamefish and panfish in Diamond Lake.

Methods

Diamond Lake was sampled during 2018-2019 following the Wisconsin Department of Natural Resources comprehensive treaty assessment protocol (Cichosz 2019). This sampling included spring fyke netting and electrofishing to estimate walleye, bass (both largemouth and smallmouth) and northern pike abundance, fall electrofishing to estimate year class strength of walleye young-of-the-year (YOY), and a creel survey (both open water and ice). Late June fyke netting for panfish abundance last occurred in 2012. Diamond Lake is a treaty trend lake within the WDNR ceded territory monitoring framework, which designates a comprehensive survey every third year. Table 2 lists sampling methods used for individual survey years.

Walleye were captured for marking in the spring shortly after ice out with fyke nets. Each fish was measured (total length; inches and tenths) and fin-clipped. Adult (mature) walleyes were defined as all fish for which sex could be determined and all fish 15 inches or longer. Adult walleyes were given a lake-specific mark. Walleyes of unknown sex less than 15 inches in length were classified as juveniles (immature) and were marked with a different lake-specific fin clip. Marking effort was based on a goal for total marks of 10% of the anticipated spawning population estimate. To estimate adult abundance, walleyes were recaptured 1-2 days after netting. Because the interval between marking and recapture was short, electrofishing of the entire shoreline was conducted to ensure equal vulnerability of marked and unmarked walleyes to capture. All walleyes in the recapture run were measured and examined for marks. Population estimates were calculated with the Chapman modification of the Petersen Estimator using the equation:

$$N = \frac{(M+1)(C+1)}{(R+1)}$$

where N is the population estimate, M is the total number of marked fish in the lake, C is the total number of fish captured in the recapture sample, and R is the total number of marked fish captured. The Chapman Modification method is used because simple Petersen Estimates tend to overestimate population sizes when R is relatively small (Ricker 1975). Abundance and variance were estimated by the total for walleye that were ≥ 15 in and sexable. Shifts in walleye abundance over time were assessed using linear regression.

Northern pike catch per unit effort and size structure indices (CPUE: the number of northern pike caught/net lift) were calculated from the spring netting survey. Largemouth and smallmouth bass encountered during fyke netting and subsequent electrofishing runs (adult and total walleye) were marked. For comparison purposes catch per unit effort (CPUE: the number of largemouth or smallmouth bass caught/mile of electrofishing) and size structure indices were calculated from the second electrofishing survey. Panfish catch per unit effort (CPUE: the number of panfish caught/fyke net lift and number/mile) and size structure indices were calculated from the panfish netting surveys conducted during bluegill spawning periods in June

(Table 2). Lake Class Standards catch per unit effort (CPUE) was calculated by comparing Diamond Lake CPUEs of each species to the CPUEs of the other 145 complex two-story lakes in Wisconsin (Rypel et al. 2019).

Walleye age and growth were determined from dorsal spine cross sections viewed microscopically at 100X (Margenau 1982). Walleye growth rates were compared to the average of the 18 counties in the northern district (ND). Size structure quality of species sampled was determined using the indices proportional (PSD) and relative (RSD) stock densities (Anderson and Gutreuter 1983). The PSD and RSD value for a species is the number of fish of a specified length and longer divided by the number of fish of stock length or longer, the result multiplied by 100 (Appendix Table 1). Changes in CPUE, PSD and RSD were assessed using linear regression. Changes in population size structure were determined using Kolmogorov-Smirnov tests.

An age-length key was used to estimate the abundances of age 6 and 9 walleye in the sample, assuming no natural reproduction and all fish were from stocked origin. Cost of each stocking event was calculated by multiplying the number of large fingerlings stocked by the average cost per large fingerling. Percent survival was estimated by dividing the population estimate for each age class by the total number stocked for that year and multiplying it by 100. Cost per recruit was estimated by dividing the cost of each stocking event by the estimated abundance of that year class (Olson 2015).

Creel surveys used a random stratified roving access design (Beard et al. 1997b; Rasmussen et al. 1998). The survey was stratified by month and day-type (weekend / holiday or weekday), and the creel clerk conducted interviews at random within these strata. The survey was conducted on all weekends and holidays, and a randomly chosen two or three weekdays.

Only completed-trip interview information was used in the analysis. The clerk recorded effort, catch, harvest, and targeted species from anglers completing their fishing trip. The clerk also measured harvested fish and examined them for fin-clips. Specific catch rates were assessed over time using linear regression.

Results

Total survey effort in 2018 included 22 fyke net lifts targeting spawning walleye. Three electrofishing surveys of the entire shoreline totaling 4.2 hours in spring (walleye recapture survey and bass survey) and 1.3 hours in fall (walleye recruitment survey) were conducted. In 2012, 24 fyke net lifts targeted spawning panfish.

Walleye. Adult walleye abundance (≥ 15 inches and sexable fish) was 455 (1.3 adults/acre) in 2018 for Diamond Lake. The density of adult walleye in Diamond Lake decreased significantly from 1990 to 2012 ($r^2 = 0.93$, $p = 0.001$) and showed a nonsignificant increase from 2012 to 2018 ($r^2 = 0.83$, $p = 0.27$) (Figure 1). However, overall walleye abundance from 1990 to 2018 showed a significant decrease ($r^2 = 0.67$, $p = 0.01$). Mean length for sexable walleye was high and over the eight survey years averaged 22.3 in (SD = 1.16, N = 8). Average length of sexable walleye in 2018 was 22.5 in (SD = 2.6, N = 204) (Table 3). Length of adult walleye ranged from 14.9 to 28.2 inches. Male to female ratio was 1:12. Size structure of walleyes sampled in spring fyke netting shifted significantly between every survey period (Table 4). The length frequency distribution of walleye indicates change over time that is likely due to fluctuations in stocking strategy and failure of several year classes (Figure 2). Proportional stock density (PSD) values of 92 to 100 during the sampling years supported the contention of a quality size structure of the walleye population. Similarly, RSD-20 values ranging from 33 to 96 indicated in all sampling years at least one third of mature walleye were over 20 inches in length (Table 3).

Age of adult walleye sampled during the 2018 survey ranged from 3 to 18. Male and female walleye first reached maturity at 3 and 4, respectively. Age 6 walleye accounted for 31.3% of the adult stock, followed by age 9 at 28.9% of the adult stock. Age distribution data from 1990 and 1996 indicate naturally reproduced year classes from 1980 to 1984. The survey years from 2003 to 2018 indicate natural reproduction year class failures from 1985 to 2019 suggesting the walleye population has been supported largely by stocking since 1985 (Figure 3). All walleye that were sampled in 2018 were from stocked years. Age composition of walleye sampled in fyke nets differed for all years sampled (Figure 3). Growth rates for both male and female walleye remained relatively consistent for all survey years. Male walleye growth rates were above ND averages until age 14, where growth rates then were relatively consistent with averages. Female walleye growth rates were above ND averages until age 12, were growth rates then were relatively consistent with averages (Figure 4). Walleye growth was dimorphic, female and male walleye reaching 15 inches sometime during the third and fourth growing season.

The age-at-length key showed all walleye were from stocked years. Age 6 and 9 walleye made up 60% of the estimated population. Estimated survival of age-6 walleye was 8.6% and 3.9% for age-9. Estimated cost was $12.35/age-6 and $38.91/age-9 recruit.

No age-0 walleye were found in Diamond Lake in 2019. The average age-0 walleye/mile was 1.4 (SD = 3.9, N = 25) for surveys completed from 1989 to 2019. Age-0 walleye were only found in years when small fingerlings were stocked (Table 1, Figure 5). Age-1 walleye were also collected during fall electrofishing surveys. The average age-1 walleye/mile was 0.5 (SD =

1.1, N = 25) for surveys completed from 1989 to 2019. Age-1 walleye were present only in years after a stocking event (Table 1, Figure 5).

Northern Pike. Catch per unit effort of northern pike (CPUE; the number of northern pike caught with each fyke net lift) varied throughout the survey years 1990 – 2018 and showed no significant trends ($r^2 = 0.02$, $p = 0.76$). CPUE of pike was 1.6 fish/net lift in 2018 and the average CPUE for all years was 1.6 fish/ net lift (Table 5). Lake class standards of complex two-story lakes for CPUE of northern pike scored Diamond Lake in the 63rd percentile in 2018 (Table 5). Length distributions of northern pike fluctuated significantly between some survey years from 1990 to 2018 (Table 6). Average length of northern pike during the survey years was 21.4 in (SD = 1.6, N = 8). The average length of northern pike sampled in 2018 was above the average at 23.2 in (SD = 3.7, N = 34) (Table 5). The longest northern pike sampled in 2018 was 29.9 inches. PSD and RSD-28 also indicated a fluctuating size structure for northern pike. PSD ranged from 43 to 84 and RSD-28 ranged from 5 to 23 during the survey years (Table 5). The highest PSD value for northern pike (84) came from the 2018 survey, meaning that 84% of the fish sampled were over 21 inches. Changes in PSD were not significant ($r^2 = <0.001$, $p = 0.97$). However, changes in RSD-28 showed a significant decrease between 1990 and 2018 ($r^2 = 0.55$, $p = 0.035$).

Largemouth Bass. Largemouth bass outnumbered smallmouth bass at a ratio of 8:1 in the 2018 spring electrofishing survey. Average length of largemouth bass was 13.1 in (SD = 2.5, N = 65) and was larger than the average length of 12.1 in (SD = 1.0, N = 7) for all the survey years combined (Table 7, Figure 7). The longest largemouth bass sampled in 2018 was 17.2 inches. Largemouth bass populations have been shifting toward larger fish since 2009 (Figure 7). Size structure of largemouth bass captured during spring electrofishing has varied significantly between every survey since 2003 (Table 8). Largemouth bass relative abundance was 13.0 fish/mile in 2018, the second lowest in the seven survey years and below the average of 16.0 fish/mile (SD = 6.6, N = 7) for all survey years (Figure 8). Relative abundance of largemouth bass increased significantly from 1996 to 2009 ($r^2 = 0.99$, $p = 0.002$) and has been on a slight downward nonsignificant trend from 2009 to 2018 ($r^2 = 0.68$, $p = 0.18$). Lake class standards of complex two-story lakes for CPUE (n/mile) of largemouth bass scored Diamond Lake in the 76th percentile in 2018 (Table 9). PSD ranged from 22 to 92 and RSD-15 ranged from 8 to 23 for the survey years from 1996 to 2018 (Table 7).

Smallmouth Bass. The 2018 spring electrofishing survey captured eight smallmouth bass ranging from 2.7 – 19.4 inches. The relative abundance of smallmouth bass (n/mile) decreased from 1996 – 2009, increased from 2009 – 2015 and decreased from 2015 – 2018 (Figure 8). Overall, smallmouth bass abundance has decreased significantly from 1996 to 2018 ($r^2 = 0.63$, $p = 0.03$). Smallmouth bass abundance was 1.6 fish/mile in 2018. Lake class standards of complex two-story lakes for smallmouth bass CPUE (n/mile) scored Diamond Lake in the 35th percentile for the 2018 survey year (Table 9). No further length statistics were calculated for smallmouth bass due to lower number of fish sampled during the survey years.

Bluegill. Bluegill were the most abundant panfish species sampled in Diamond Lake during the panfish fyke netting survey in 2012. Bluegill average length was 4.4 in (SD = 1.7, N= 1,194), a slight increase from 2003 (Table 10). The largest bluegill sampled in 2012 was 9.4 inches. Bluegill length frequency indicated a changing size structure (Figure 9). Length distributions of bluegill captured during panfish netting were significantly different between all survey years (Table 11). PSD and RSD-8 values were 28.2 and 2.3, the highest values for all four survey years, but still indicate a below average size structure for bluegills (Table 10).

CPUE of bluegill decreased to 50 fish/ net lift in 2012, the lowest value for the four survey years (Table 10). In 2018 the largest sample of bluegills came from spring electrofishing. Bluegills had a mean length of 3.5 in (SD = 1.2, N = 68) and total length ranged from 1.1 to 7.3 in. Recent spring netting and electrofishing surveys have showed decreasing bluegill abundances. Bluegill CPUE during spring netting and electrofishing decreased from 77 to 2 fish/net lift and 280 to 136 fish/hour from 2009 to 2018, both decreases were nonsignificant (r^2 = 0.78, p = 0.12; r^2 = 0.66, p = 0.19).

Other Panfish. Black crappie were sampled in small numbers during 2018. The largest sample of black crappie came from spring fyke netting (N = 12). Black crappies ranged in size from 3.8 to 7.8 in and had an average length of 5.0 in (SD = 1.1, N = 12). Yellow perch were sampled at the highest number during spring fyke netting (N = 69). Yellow perch had an average length of 4.8 in (SD = 0.6, N = 69) and ranged in size from 3.7 to 6.7 in. Rock bass were sampled at the highest number during spring electrofishing (N = 7). Size of rock bass ranged from 3.4 to 9.6 in. Only two pumpkinseeds were collected during the 2018 surveys, both during spring electrofishing.

Rainbow Smelt. A total of 4,280 rainbow smelt were sampled during the 2018 spring fyke netting survey, which indicated the continued presence of the invasive species. Mean length of measured smelt was 4.7 in (SD = 0.42, N = 247). Multiple year classes appear to be present in the length frequency (Figure 10).

Sport and Tribal Fishery. Anglers fished an estimated 3,684 hours (10.8 hrs/acre) during the 2018-2019 season in Diamond Lake, slightly lower than the average of 11.6 hrs/acre for Diamond Lake. Diamond Lake's projected fishing pressure was also lower than the average of 22.2 hrs/acre for Bayfield County lakes (Creel Survey Report, WDNR) and much lower than the average fishing pressure for ceded territory lakes (33.0 hrs/acre). Open water anglers accounted for 97% of all fishing effort. The directed effort, i.e. effort targeted toward a specific fish, was highest for largemouth bass (36.5%). The most sought after panfish species was bluegill, with 12.1% of the directed effort (Table 12). Fishing pressure has varied throughout the survey years, fishing pressure decreased from 1990 to 2003, increased from 2003 to 2009 and decreased from 2009 to 2018.

Walleye were the third most targeted gamefish by sport anglers in Diamond Lake during the 2018-2019 fishing season. The directed effort toward walleye was 8.5 % in 2018-2019, the lowest for all eight survey years (Table 12). An estimated 32 walleye were caught during the open water and ice season in 2018-2019, of which an estimated 19 fish were harvested during open water season and one harvested during the ice season (Figure 11). Sport angling accounted for 34% of the combined total harvest (sport angling plus tribal spearing). Sport angling exploitation represented 4.4% of the adult stock. Tribal harvest accounted for 39 walleye in 2018 (Hmielewski 2019). Size of walleye harvested ranged from 15.2 to 28.2 in. Tribal harvest represented 66% of the combined total harvest (sport angling plus tribal spearing) and 8.6% of the total adult stock. The mean length of tribally harvested walleye was 21.4 in (SD = 3.7, N = 39). Male and female walleye represented 20% and 44% of the total tribal harvest, respectively, the other 36% were of unknown sex. Total walleye exploitation (sport and tribal) has gone up and down throughout the survey years and was at 12.9% in 2018.

The most sought after gamefish species by anglers was largemouth bass with 36.5% of the directed effort. The directed effort for largemouth bass increased from 1990 to 2006, remained relative consistent from 2006 to 2015 and increased in 2018 (Table 12). In the 2018-

2019 fishing season an estimated 2,809 largemouth bass were caught. An estimated 210 largemouth bass were harvested in 2018, the highest value for all gamefish species (Figure 11).

Smallmouth bass was the second most sought after gamefish in 2018 on Diamond Lake with 30.4% of directed effort. An estimated 667 smallmouth were caught, and no recorded harvest occurred (Figure 11). Directed effort for smallmouth bass has varied throughout the survey years, 2018 had the highest directed effort for smallmouth for all survey years (Table 12).

Northern pike were the fourth most sought after gamefish in 2018-2019 on Diamond Lake with 7.7% of directed effort. Estimated catch of northern pike was 413 with a recorded harvest of 4 fish. Directed effort for northern pike remained relatively consistent from 1990 to 2015 but decreased to 7.7% in 2018 (Table 12).

Anglers pursuing panfish fished an estimated 1,159 hours and accounted for 16.9% of the total directed angling effort for the 2018-2019 open water and winter seasons combined. An estimated 2,330 bluegills were caught in the 2018-2019 fishing season, of which 603 were estimated to be harvested (Figure 12). Directed effort toward bluegill has remained relatively consistent throughout all survey years (Table 12). The catch rate of anglers specifically targeting bluegill has shown a nonsignificant decrease from 1990 to 2018 ($r^2 = 0.47$, $p = 0.06$). Estimated catch of black crappie was 166 with 61 fish being harvested in 2018 – 2019 (Figure 12). In 2018-2019 an estimated 82 yellow perch were caught with no estimated harvest. Rock bass were estimated to be the second most caught and harvested panfish species with 171 being caught and 72 harvested, despite no directed effort toward the species (Figure 12). Pumpkinseeds were a minor component of the panfish fishery.

Discussion

Diamond Lake has supported and continues to support a diverse fish community and popular sport fishery. Natural reproduction supports all species in Diamond Lake, except for walleye which is supported by stocking. Harvest regulations aimed at protecting adult walleye have been successful. Northern pike harvest management has shown mixed results. The recent changes in harvest regulations for bass are too recent to show any major results.

Results from the 2018-2019 survey suggest that the regulation change for walleye (minimum length limit of 15 inches, protected slot length limit of 20 to 24 inches and a bag limit of three with only one over 24 inches) still has been successful in protecting adult walleye. Average length of adult walleye in 2018 was 22.5 in (SD = 2.6, N = 204), with PSD and RSD values of 100 and 88, showing the regulations can still maintain the excellent size structure of walleye in Diamond Lake. The harvest of walleye by anglers was down in 2018, most likely due to the lowest fishing pressure for walleye in the eight survey years. The decrease in harvest also may show that the new walleye regulations implemented in 2016 still protect the adult walleye stock. The creel survey data needs to be compared with caution due to the observation that small sample size (few interviews) may lead to large variance and poor confidence interval coverage for harvest rate estimates (Newman et al. 1997). Walleye densities decreased significantly from 1990 to 2012 and have increased nonsignificantly from 2012 to 2018 (1.3 adult walleye/acre) but are still slightly below the ceded territory stocked lake recruitment code average from 1990-2018 of 1.6 adult walleye/acre (SD = 1.5, N = 257). Also, below objectives of 3.0 adults/acre for ceded territory lakes managed for walleye (Staggs et al. 1990). Walleye recruitment has also changed dramatically during the survey years. Percent distribution by ages for 1996 displays the missing year classes that are from years where no stocking occurred. The success of stocking small fingerling walleye also decreased during the survey years and can be seen in the percent distribution by age for 2012 and 2015. No natural recruitment of walleye and minimal success of small fingerling stocking of walleye could be attributed to the significant decrease in walleye abundance from 1990 to 2012. Large walleye fingerlings have been stocked since 2007 and have shown stronger recruitment, this can be seen in the percent distribution by age for 2018 and in the age-1 abundances from Figure 5. The success of large fingerling walleye stocking could be related to the slight increase in adult walleye abundance. The reason for the decrease in success of small fingerlings in unknow but research done by Kampa and Hatzenbeler (2009), showed that large fingerlings produce more consistent year classes. Stocking has driven the walleye population since 1986 but very low numbers of natural reproduction may still be present. The cost per age 6 and 9 recruit was estimated at $12.35 and $38.91 per walleye, respectively. Sand (2012) found that age-5 recruits from the 2007 stocking in Diamond Lake costed an estimated $88.29 per fish. In Middle McKenzie Lake, Burnett County, Wisconsin it was found that age 4 and 6 walleye were estimated to cost $40.71 and $23.56, respectively (Roberts 2019). Compared to the previous stocking evaluation the age 6 and 9 recruits were very successful and comparable to other stocked walleye lakes. However, that is not the case for all stocked year classes as these were the two most successful. The average cost for an age 3-9 walleye in Diamond Lake was $70.28 (SD = 48.43, N = 6). Diamond lake's walleye population is driven by one or two very successful stocking events.

The success of the northern pike regulation (minimum length limit of 26 inches and a bag limit of 2 fish per day) is hard to evaluate. Fishing pressure for northern pike was the lowest it has ever been and the lowest for all gamefish species. Estimated catch and harvest of pike was also down. Northern pike sampled in 2018 had an average length of 23.2 in (SD = 3.7, N = 34) and a PSD value of 84, both were the highest for all survey years, indicating size structure may be increasing. Also, a PSD value of 84 for Diamond Lake is higher than the average of 30 that is reported for small northern Wisconsin lakes (Margenau et al. 1998). However, there was a significant decrease in RSD-28 values from 1990 to 2018, showing the proportion of larger fish has declined significantly over the survey period. The more restrictive regulation (minimum length limit of 32 inches and a bag limit of 1 fish per day) showed no signs of improving northern pike size structure and relative abundance fluctuated. Spring fyke netting in 2018 sampled six northern pike over 26 inches. Northern pike regulations with a minimum size limit of 26 inches and bag limit of two have been shown not to have a significant difference in average and max size when compared to regulations with no size limit and a bag limit of five fish (Oele et al. 2016). Predicting how this regulation will change Diamond Lake northern pike populations is difficult, as there are other factors that have been shown to influence northern pike. Water clarity (Secchi depth) and northern pike density have been shown to be negatively affect northern pike size structure (Margenau et al. 1998; Oele et al. 2016). Diamond Lake has clear water, so this could be a factor limiting northern pike growth in the lake. Density of northern pike in Diamond Lake is relatively low at 1.6 northern pike/net lift, meaning this shouldn't be a limiting factor in size structure but it could be. Future surveys will give more results on how the regulation change in 2012 has affected the size structure of northern pike in Diamond Lake.

Largemouth bass abundance increased significantly from 1996 to 2009 and decreased nonsignificantly from 2009 to 2018. Overall largemouth bass abundance increased by 306% from 1996 to 2018. The average length of largemouth bass sampled during spring electrofishing was 13.1 in (SD = 2.5, N = 65), the highest for all survey years. Smallmouth bass abundance decreased from 1996 to 2009 and fluctuated from 2009 to 2018 with an overall significant decline. Smallmouth bass abundance in 2018 was down 73% when compared to 1996. Historical surveys on Diamond Lake indicated smallmouth outnumbering largemouth bass (Pratt 1976; Weiher 1972). Smallmouth bass also outnumbered largemouth bass at a ratio of 2:1 in 1996 surveys. However, surveys in 2009 and 2018 showed largemouth bass outnumbering smallmouth bass at ratios of 28:1 and 8:1, respectively. Showing that largemouth bass are now the dominant bass species but not as dominant as they once were. Largemouth bass and smallmouth bass were the first and second most sought after fish by anglers with 36.5 and 30.4 percent of the angler directed effect, respectively. Regulation change in 2018 implemented a no size limit for largemouth bass and an 18-inch size limit for smallmouth bass, with a catch and release season (for smallmouth bass) and a combined bag of five bass, of which only one can be a smallmouth bass. The angler catch and harvest of gamefish shows that the estimated catch of largemouth bass was down compared to the previous three survey years but it had the highest estimated harvest for all survey years. The estimated catch of smallmouth bass in 2018 was similar to all the survey years and an estimated zero smallmouth bass were harvested. Creel survey data from 2018 shows the new regulations could have an impact on the largemouth bass and smallmouth bass populations, but it is too early to make any conclusions. Largemouth bass populations could be having an impact on walleye populations in Diamond Lake. Studies have shown that largemouth bass and walleye have overlapping diets and compete for the same food sources throughout multiple life stages (Kelling et al. 2016; Fayram et al. 2005). Direct competition between largemouth bass and walleye for prey most likely isn't limiting walleye abundance due to the availability of forage fish like smelt and bluegill. Stocked walleye survival has been negatively associated with largemouth bass abundance, due to predation of juvenile walleye (Fayram et al. 2005). However, Kelling et al. (2016), stated largemouth bass predation is probably not a limit factor of walleye abundance. Overall, a decrease in largemouth bass abundance could benefit smallmouth and walleye populations.

Bluegill was the most abundant and most popular panfish species among anglers in Diamond Lake. Length at age data from previous panfish surveys on Diamond Lake indicate slow growth (Toshner 2005). Aging structures from the two most recent panfish netting surveys hasn't be analyzed. Diamond lake has historically had high abundances of small bluegills, but recent surveys show decreasing bluegill abundances. From 2009 to 2018 bluegill CPUE has decreased for spring netting and electrofishing, possibly showing a decrease in overall abundance. Angler catch rates of bluegills are also on a downward trend. The decreasing bluegill abundance in Diamond Lake could be leading to faster growth. Weiner and Hanneman (1982) found a negative correlation between bluegill growth and density for six Wisconsin lakes. Bluegill growth was also found to be density dependent in research done by Tomcko and Pierce (2005). In Minnesota lakes it was found that secchi depth and maximum depth were negatively correlated with bluegill length at ages I-VI (Tomcko and Pierce 2001). Diamond lake is slightly oligotrophic with a max depth of 83 feet, which could be associated with the slow bluegill growth. Diamond Lake's bluegill population could also be influenced by angler exploitation (Coble 1988). In 2018, creel surveys estimated that 2,330 bluegills were caught and 603 were harvested (Figure 12). Anglers in 2018 tended to harvest the larger bluegills, the average length of harvested bluegills was 7.5 in (SD = 0.4, N = 27). Harvesting the larger bluegill in the population forces more smaller bluegills to reproduce, slowing their growth, and ultimately shrinking the size structure of the population (Beard et al. 1997a). Removal of the larger breeder bluegills could be what is stunting the Diamond Lake bluegill population. Rebuilding quality bluegill size structure is a long-term process and can take years to reach desired results (Beard and Essington 2000). Decreasing angler harvest of large bluegill may be a useful tool for increasing bluegill size structure. Increasing the predator base could also be a solution to reducing the density of bluegill and improving growth. Positive correlation between bluegill growth and walleye CPE in northern Wisconsin lakes has been recorded (Snow and Staggs 1994). Predation of bluegills by walleye has been documented in simple communities (Beard 1982; Schneider 1997; Schnieder and Breck 1997). Adult walleyes are capable of preying on bluegills as large as 5 inches (Schneider and Breck 1997). Increasing walleye abundance may also be a tool to increase bluegill growth. The last panfish survey was conducted in 2012 and the CPUE was 50 fish/net lift, the lowest out of the four surveys and CPUE of bluegill has decreased for other surveys. It is possible that the bluegill abundance has decreased, and growth has increased but that will not be known until another panfish survey has been completed and aging structures have been analyzed.

The effect of rainbow smelt on the fishery in Diamond Lake is not clearly understood. Rainbow smelt were first sampled in Diamond Lake in 1967. Yellow perch may be one species smelt are impacting in Diamond Lake. In Crystal Lake, Vilas County, Wisconsin yellow perch recruitment declined after the exotic rainbow smelt increased in abundance. Competition between age-0 perch and smelt may reduce the likelihood of strong year-classes of yellow perch when year classes of rainbow smelt occur (Hrabik et al. 2001). In addition, rainbow smelt may have influenced the downfall of cisco in Diamond Lake. The last known sampling of cisco was in 1969 shortly after rainbow smelt were first sampled. Rainbow smelt have had similar negative interactions with cisco/herring in other waters (Meyers et al. 2009; Olynyk et al. 2017). The literature suggests that smelt can have significant impacts on growth rates of walleye and zooplankton communities. Rainbow smelt were introduced into the Horsetooth Reservoir, Colorado to increase prey availability for walleye in 1983. Within six years of smelt being introduced walleye growth improved by 50% and zooplankton levels were reduced from 40-80 organisms/L to less than 1.0 organism/L, and a switch occurred in zooplankton species composition (Johnson and Goettl 1999). Rainbow smelt contribute to high growth rates of walleye and are available forage year-round (Fincel et al. 2014). Rainbow smelt may also be impacting the natural reproduction of walleye in Diamond Lake. In a study done on Wisconsin lakes, the presence of smelt was shown to reduce the density of young of the year walleye when compared to lakes without the presence of smelt (Mercado-Silva et al. 2007). The impacts of rainbow smelt on Diamond Lake are still largely unknown.

Summary and Management Recommendations

1. Walleye abundance in Diamond Lake is slightly below the average abundance for lakes with a stocked recruitment code in the ceded territory. Current walleye regulations seem to be protecting adult fish and should be kept due to the lake's dependence on stocking. Stocking of large fingerling walleye should continue in alternate years. Another stocking evaluation could be done based on the next survey year to continue to estimate the price per stocked cohort.
2. Northern pike regulations (minimum length limit of 26 inches and a bag limit of 2 fish per day) should be kept in place. Average length of northern pike was the highest for all survey years in 2018 but the impacts of the regulation should be monitored in future surveys. It is important to try and maintain a northern pike population in Diamond lake to possibly help control the bluegill and smelt populations.

3. Largemouth bass abundance decreased slightly in 2018. The new bass regulations put into place in 2018 should be kept in place to possibly reduce largemouth bass abundance and increase smallmouth bass abundance. The reduction of largemouth bass could also possibly improve walleye stocking success.
4. Bluegill have recently shown signs of decreasing in abundance but have shown slow growth in the past. Panfish netting should be done during the next survey year to evaluate the bluegill populations. Aging data from future and the previous two panfish surveys should also be read to monitor changes in growth. Regulation change for bluegill should only be looked at if the panfish netting survey and aging data both exhibit poor size structure and slow growth.
5. Efforts to maintain and improve habitat and water quality should be encouraged. Invasive species should also be monitored and controlled. Currently, three invasive species are found in Diamond Lake: Rainbow smelt, banded mystery snail and chinese mystery snail.

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Table 1. Stocking history for Diamond Lake, Bayfield County, Wisconsin.

Year	Species	Number Stocked	Age/Size
1933	Walleye	225,508	Fry
	Largemouth Bass	255	Fingerling
1934	Walleye	85,512	Fry
1935	Largemouth Bass	880	Fingerling
1939	Largemouth Bass	600	Fingerling
1940	Largemouth Bass	1,000	Fingerling
1944	Largemouth Bass	2,020	Fingerling
1945	Largemouth Bass	3,000	Fingerling
1946	Largemouth Bass	1,200	Fingerling
1947	Largemouth Bass	550	Fingerling
1949	Largemouth Bass	1,000	Fingerling
1950	Largemouth Bass	3,000	Fingerling
	Northern Pike	100,000	Fry
1951	Northern Pike	49,000	Fry
1952	Largemouth Bass	6,000	Fingerling
	Northern Pike	71,000	Fry
1955	Smallmouth Bass	3,500	Fingerling
1959	Rainbow Trout	10,000	Yearling
	Rainbow Trout	2,650	Fingerling
1960	Rainbow Trout	4,028	Yearling
	Rainbow Trout	5,000	Fingerling
	Brook Trout	450	Adults
1961	Rainbow Trout	6,500	Yearling
1962	Rainbow Trout	1,500	Yearling
	Brown Trout	2,500	Yearling
1963	Rainbow Trout	3,500	Yearling
1964	Rainbow Trout	1,500	Yearling
1965	Rainbow Trout	1,500	Yearling
1966	Rainbow Trout	1,500	Yearling
1967	Rainbow Trout	3,000	Yearling
1968	Rainbow Trout	1,500	Yearling
1969	Walleye	26,800	Small fingerling
1970	Walleye	5,600	Small fingerling
1971	Walleye	5,600	Small fingerling
1972	Walleye	8,000	Small fingerling
1973	Walleye	16,590	Small fingerling
1975	Walleye	18,075	Small fingerling
1976	Walleye	18,000	Small fingerling
1977	Walleye	48,040	Small fingerling
1978	Walleye	32,076	Small fingerling
1979	Walleye	32,584	Small fingerling
1991	Walleye	3,000	Small fingerling
1992	Walleye	25,575	Small fingerling
1994	Walleye	17,787	Small fingerling
1994	Walleye	3,500	Large fingerling
1996	Walleye	17,050	Small fingerling
1998	Walleye	17,050	Small fingerling
2000	Walleye	17,050	Small fingerling
2002	Walleye	17,050	Small fingerling
2004	Walleye	17,061	Small fingerling
2006	Walleye	7,544	Small fingerling
2007	Walleye	6,820	Large fingerling
2009	Walleye	3,410	Large fingerling
2010	Walleye	1,650	Large fingerling
2011	Walleye	1,536	Large fingerling
2012	Walleye	1,705	Large fingerling
2013	Walleye	1,705	Large fingerling
2015	Walleye	1,608	Large fingerling
2017	Walleye	1,611	Large fingerling
2019	Walleye	1,612	Large fingerling

Table 2. Comprehensive fishery survey history, Diamond Lake, Bayfield County, Wisconsin.

	Year							
Survey Type	1990	1996	2003	2006	2009	2012	2015	2018
Walleye Population Estimate	X	X	X	X	X	X	X	X
Spring Electrofishing - Bass		X	X	X	X	X	X	X
Panfish Netting	X	X	X			X		
Creel Survey	X	X	X	X	X	X	X	X
Fall Electrofishing - Age 0 walleye	X	X	X	X	X	X	X	X

Table 3. Walleye length statistics, Diamond Lake, Bayfield County, Wisconsin.

Year	Avg. Length (SD)	N	PSD	RSD 20
1990	21.4 (2.2)	201	100%	33%
1996	22.7 (4.3)	227	92%	75%
2003	20.7 (2.8)	275	100%	56%
2006	23.1 (3.0)	133	100%	84%
2009	24.4 (2.9)	92	100%	96%
2012	21.4 (3.1)	126	100%	64%
2015	22.4 (2.4)	149	100%	90%
2018	22.5 (2.6)	204	100%	88%

Table 4. Kolmogorov-Smirnov test results for walleye length distribution comparisons from Diamond Lake, Bayfield County, Wisconsin.

Comparison	D - Statistic	P- value
90 vs 96	0.3907	< 0.00001
96 vs 03	0.3711	< 0.00001
03 vs 06	0.3596	< 0.00001
06 vs 09	0.2447	0.00297
09 vs 12	0.5744	< 0.00001
12 vs 15	0.3779	< 0.00001
15 vs 18	0.1785	0.00825

Table 5. Northern pike length statistics, Diamond Lake, Bayfield County, Wisconsin.

Year	Avg. Length (SD)	N	PSD	RSD 28	CPUE	Lake Class Standards – CPUE
1990	22.8 (2.7)	30	73%	23%	0.9	42%
1996	22.5 (4.9)	72	65%	21%	1.8	70%
2003	19.5 (4.8)	100	43%	4%	3	85%
2006	21.3 (4.6)	115	66%	6%	1.8	70%
2009	22.2 (5.1)	68	77%	11%	2.4	79%
2012	20.5 (5.8)	46	64%	5%	0.5	24%
2015	18.9 (6.2)	37	45%	8%	0.7	33%
2018	23.2 (3.7)	34	84%	9%	1.6	63%

Table 6. Kolmogorov-Smirnov test results for northern pike length distribution comparisons from Diamond Lake, Bayfield County, Wisconsin.

Comparison	D - Statistic	P-value
1996 vs 2003	0.3013	0.00106
2003 vs 2006	0.2667	0.00093
2015 vs 2018	0.4893	0.00065

Table 7. Largemouth bass length statistics, Diamond Lake, Bayfield County, Wisconsin.

Year	Avg. Length (SD)	N	PSD	RSD 15
2003	11.9 (3.4)	69	65%	23%
2006	12.4 (2.1)	95	65%	8%
2009	10.2 (2.6)	111	22%	11%
2012	12.0 (2.2)	98	61%	9%
2015	12.7 (2.1)	105	68%	11%
2018	13.1 (2.5)	65	92%	17%

Table 8. Kolmogorov-Smirnov test results for largemouth bass length distribution comparisons from Diamond Lake, Bayfield County, Wisconsin.

Comparison	D - Statistic	P- value
03 vs 06	0.2346	0.02454
06 vs 09	0.6245	< 0.00001
09 vs 12	0.5359	< 0.00001
12 vs 15	0.2476	0.00399
15 vs 18	0.2271	0.03180

Table 9. Largemouth and smallmouth bass Lake Class Standards – CPUE (n/mile) rankings, Diamond Lake, Bayfield County, Wisconsin.

	Largemouth Bass	Smallmouth Bass
Year	Lake Class Standards - CPUE	
1996	49%	69%
2003	76%	63%
2006	81%	63%
2009	84%	19%
2012	82%	40%
2015	83%	52%
2018	76%	35%

Table 10. Bluegill length statistics, Diamond Lake, Bayfield County, Wisconsin.

Year	Avg. Length (SD)	N	PSD	RSD 8	CPUE
1990	4.5 (1.1)	951	10.3%	0.0%	78
1996	5.2 (1.0)	2342	24.9%	0.3%	130
2003	4.1 (1.0)	2087	7.8%	0.7%	139
2012	4.4 (1.7)	1194	28.2%	2.3%	50

Table 11. Kolmogorov-Smirnov test results for bluegill length distribution comparisons from Diamond Lake, Bayfield County, Wisconsin.

Comparison	D - Statistic	P- value
90 vs 96	1	< 0.00001
96 vs 03	1	< 0.00001
03 vs 12	1	< 0.00001

Table 12. Angler directed effort (%) for creel survey from Diamond Lake, Bayfield County, Wisconsin.

	Year							
Species	1990	1996	2003	2006	2009	2012	2015	2018
Walleye	36.6%	42.3%	25.2%	15.2%	11.0%	21.6%	20.1%	8.5%
Northern Pike	18.2%	18.3%	15.0%	19.0%	14.6%	12.5%	16.9%	7.7%
Largemouth Bass	0.0%	3.8%	21.3%	25.5%	23.5%	25.0%	25.2%	36.5%
Smallmouth Bass	30.3%	18.8%	12.9%	19.7%	23.8%	20.8%	21.3%	30.4%
Bluegill	10.6%	12.6%	12.4%	13.0%	12.9%	11.9%	7.4%	12.0%
Black Crappie	2.1%	1.0%	10.5%	4.6%	7.3%	5.5%	6.5%	4.5%
Yellow Perch	2.1%	2.0%	0.0%	2.2%	3.9%	1.3%	2.6%	0.4%
Pumpkinseed	0.0%	0.2%	0.0%	0.2%	1.2%	0.5%	0.0%	0.0%
Rock Bass	0.0%	1.2%	0.0%	0.6%	1.7%	1.0%	0.0%	0.0%

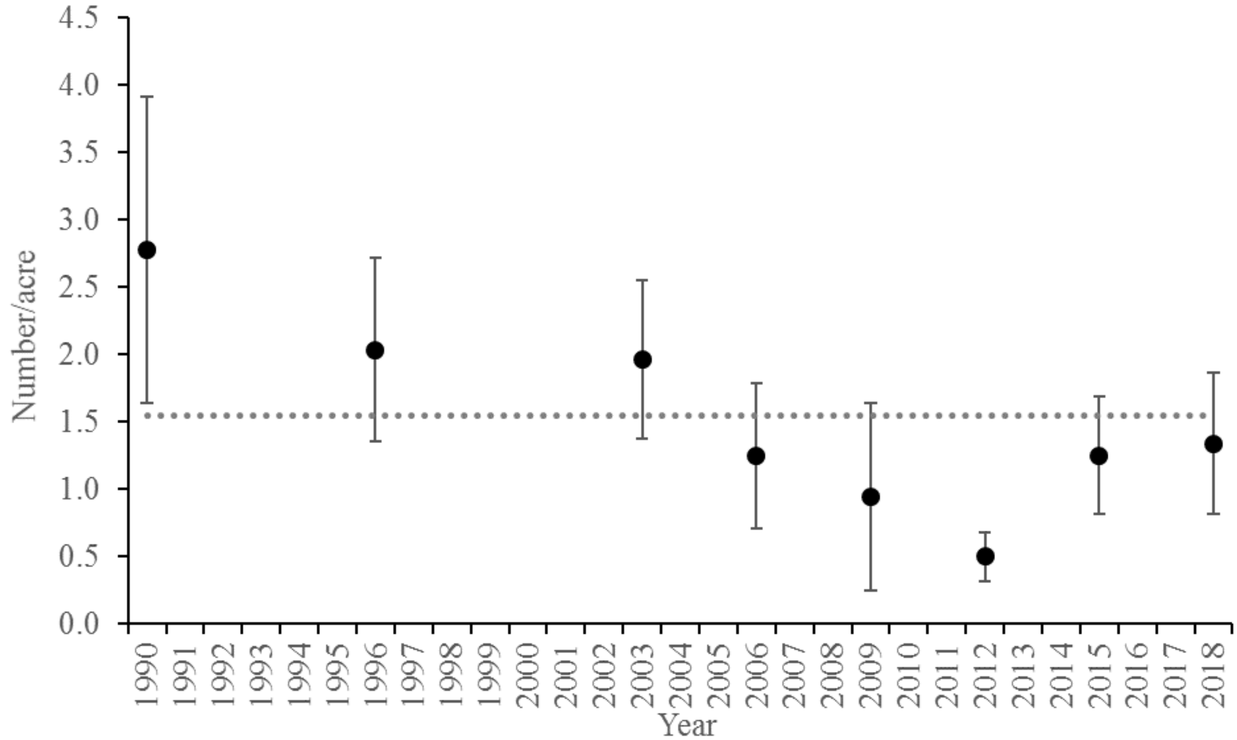


Figure 1. Number of adult walleye ≥ 15 in and sexable (number/acre ± 95% confidence intervals) by year in Diamond Lake, Bayfield County, Wisconsin. Horizontal dashed line represents the average number of walleye per acre for ceded territory lakes with a stocked recruitment code from 1990-2018.

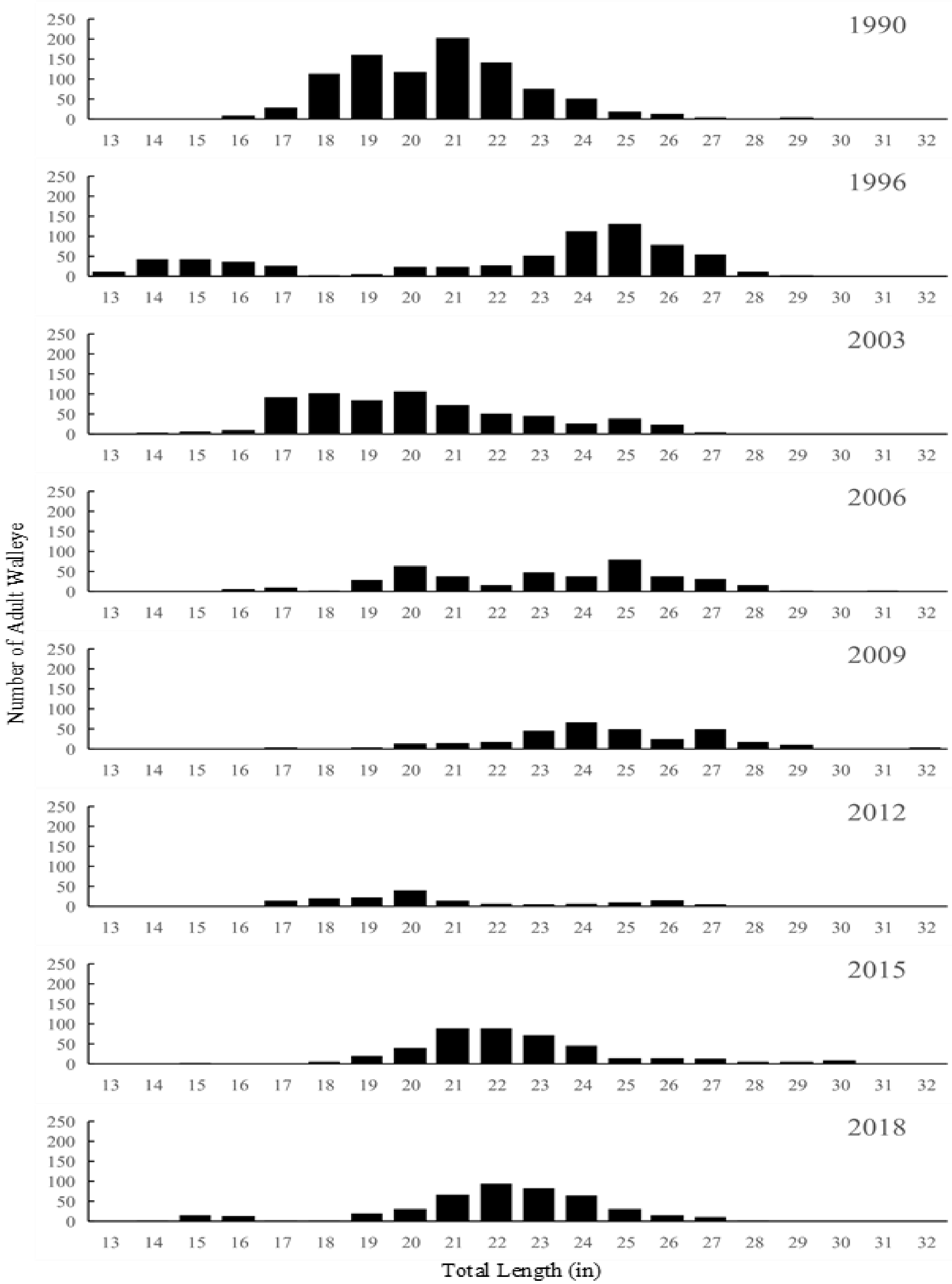


Figure 2. Estimated adult walleye abundance by length interval in Diamond Lake, Bayfield County, Wisconsin.

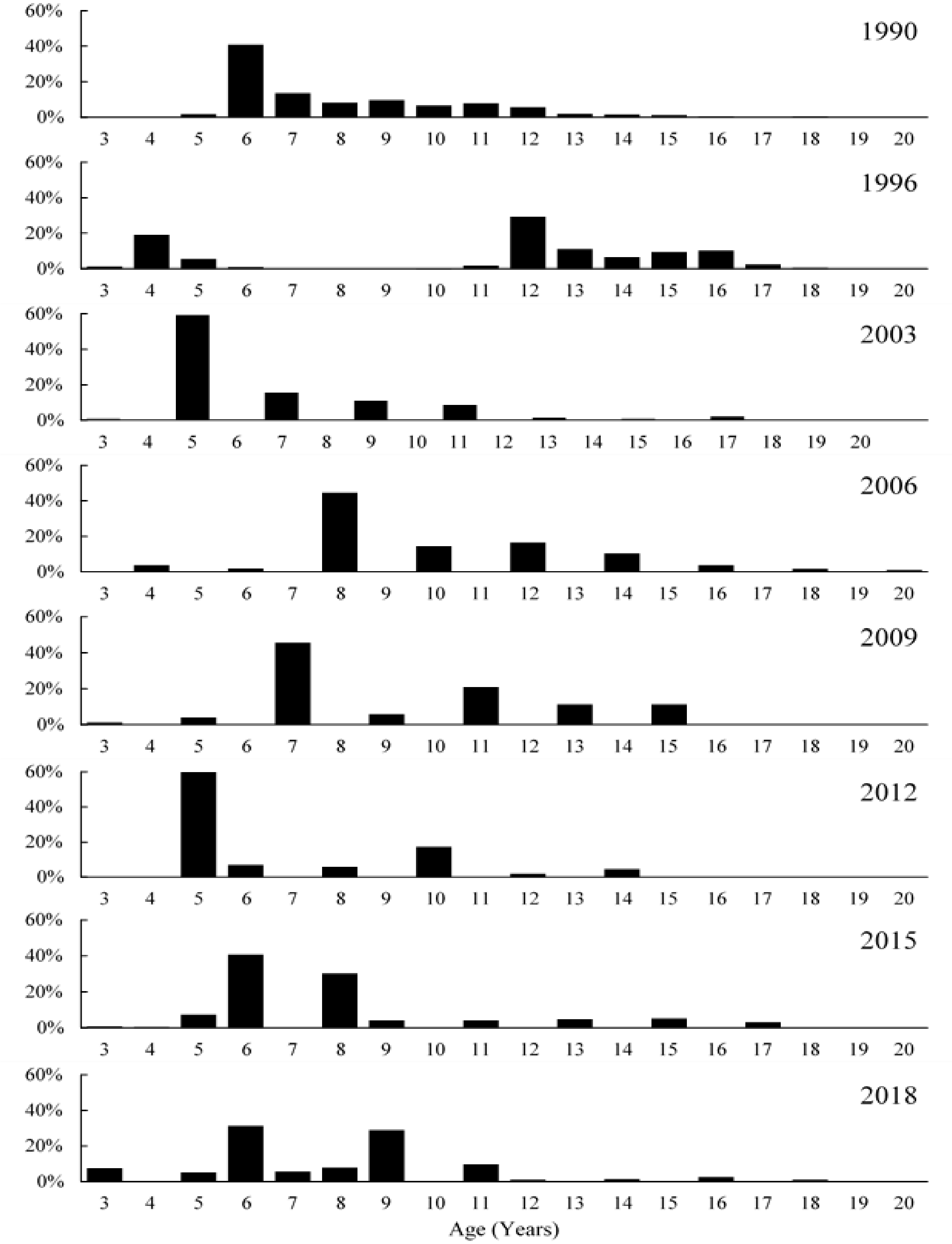


Figure 3. Percentage distribution by age of walleye in Diamond Lake, Bayfield County, Wisconsin.

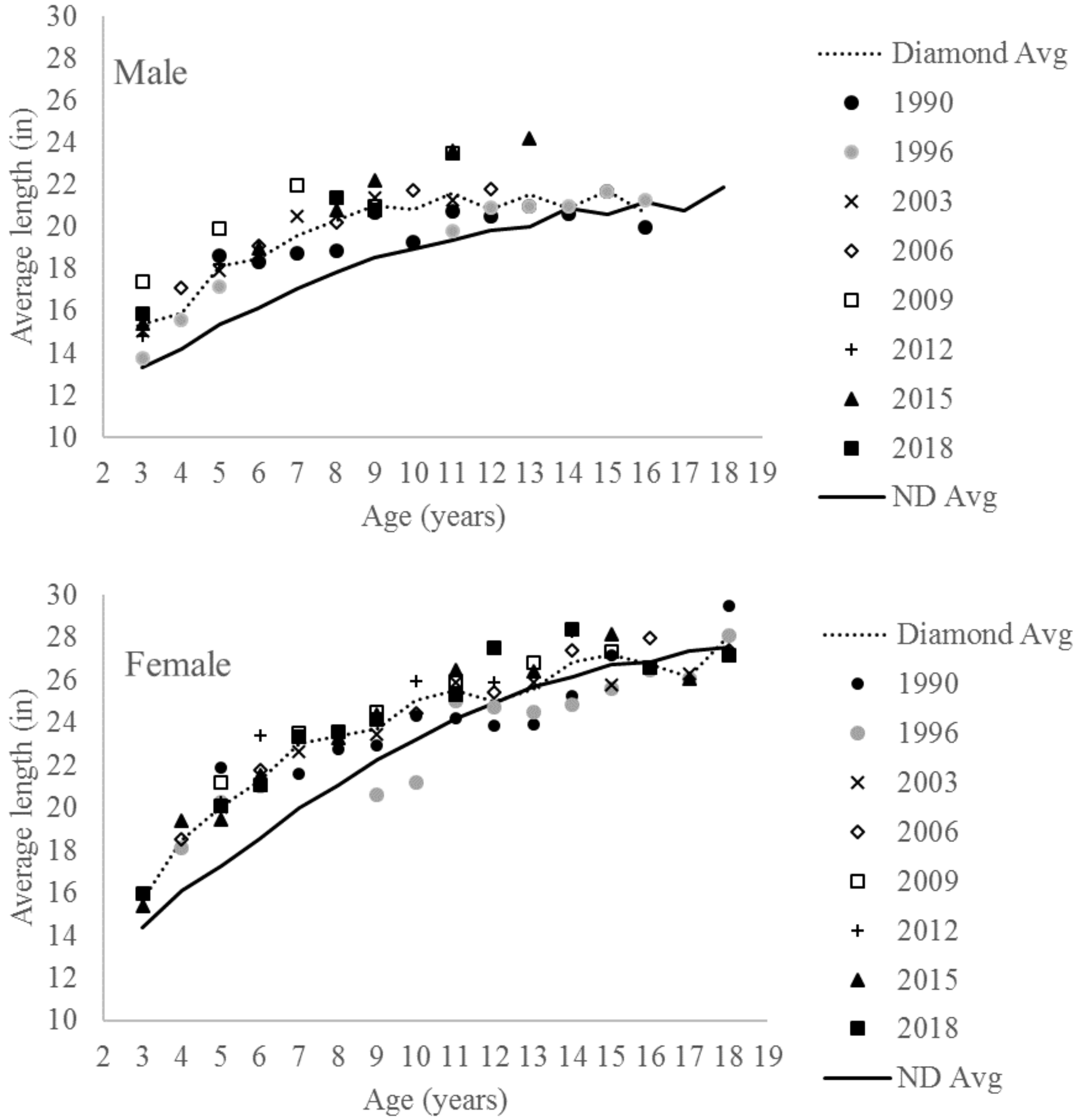


Figure 4. Age at length of male and female walleye in Diamond Lake, Bayfield County, Wisconsin.

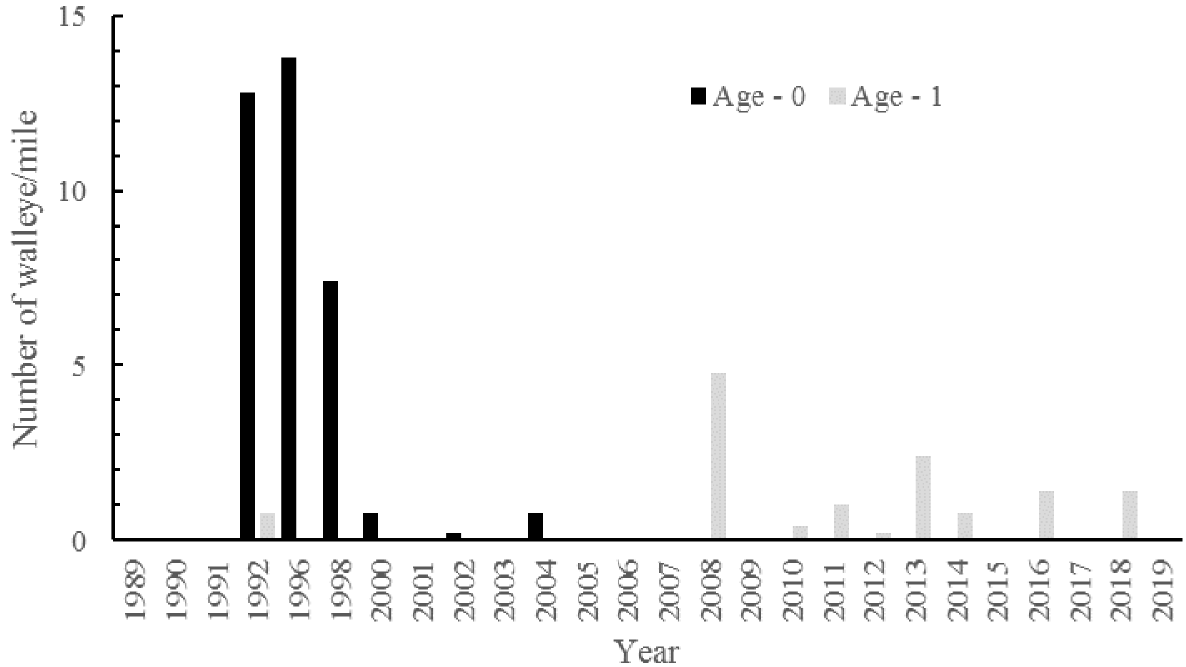


Figure 5. Relative abundance of age-0 (black) and age-1 (gray) walleye determined by fall electrofishing. Diamond Lake, Bayfield County, Wisconsin. No survey in 2009.

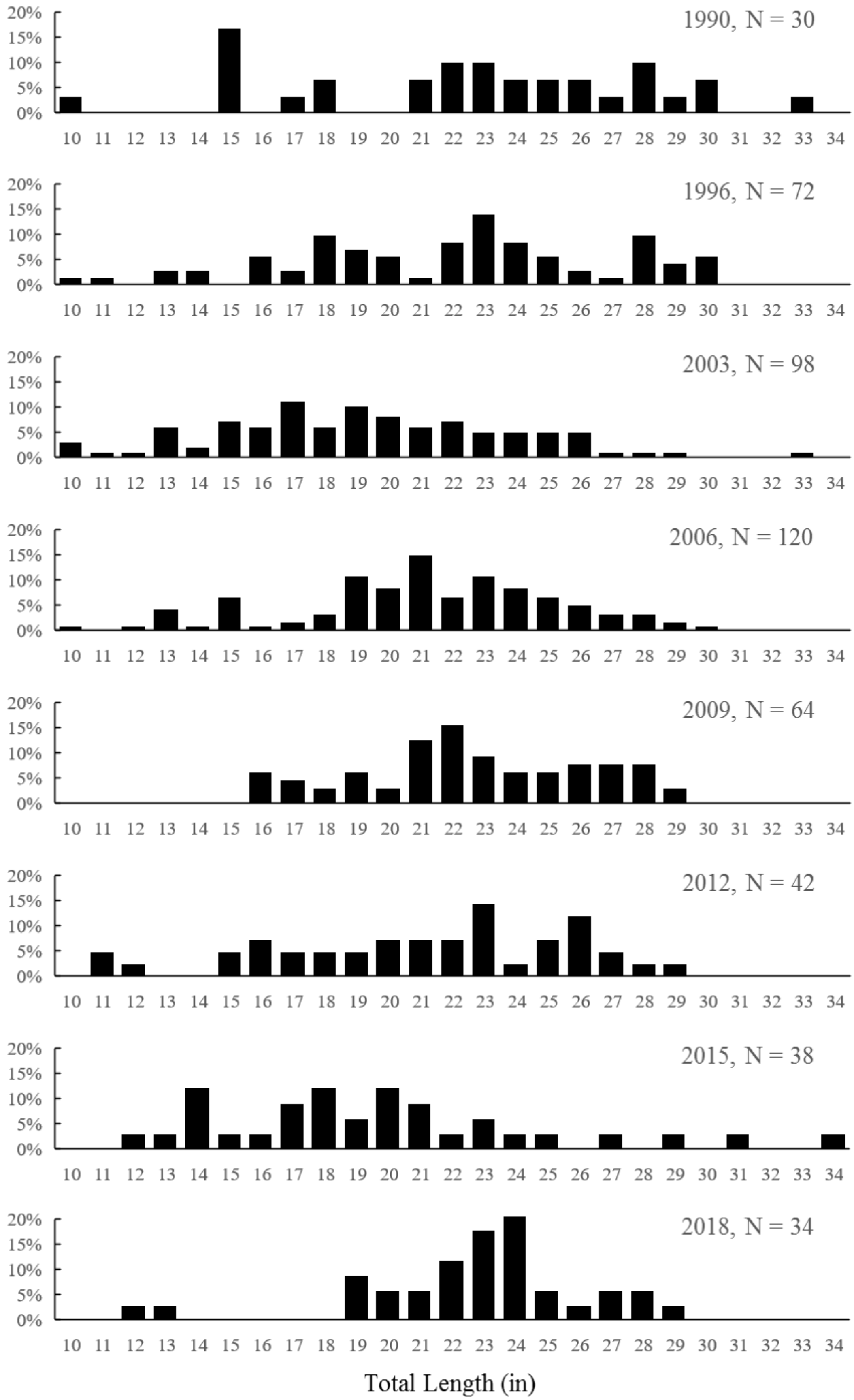


Figure 6. Percent length frequency of northern pike in Diamond Lake, Bayfield County, Wisconsin.

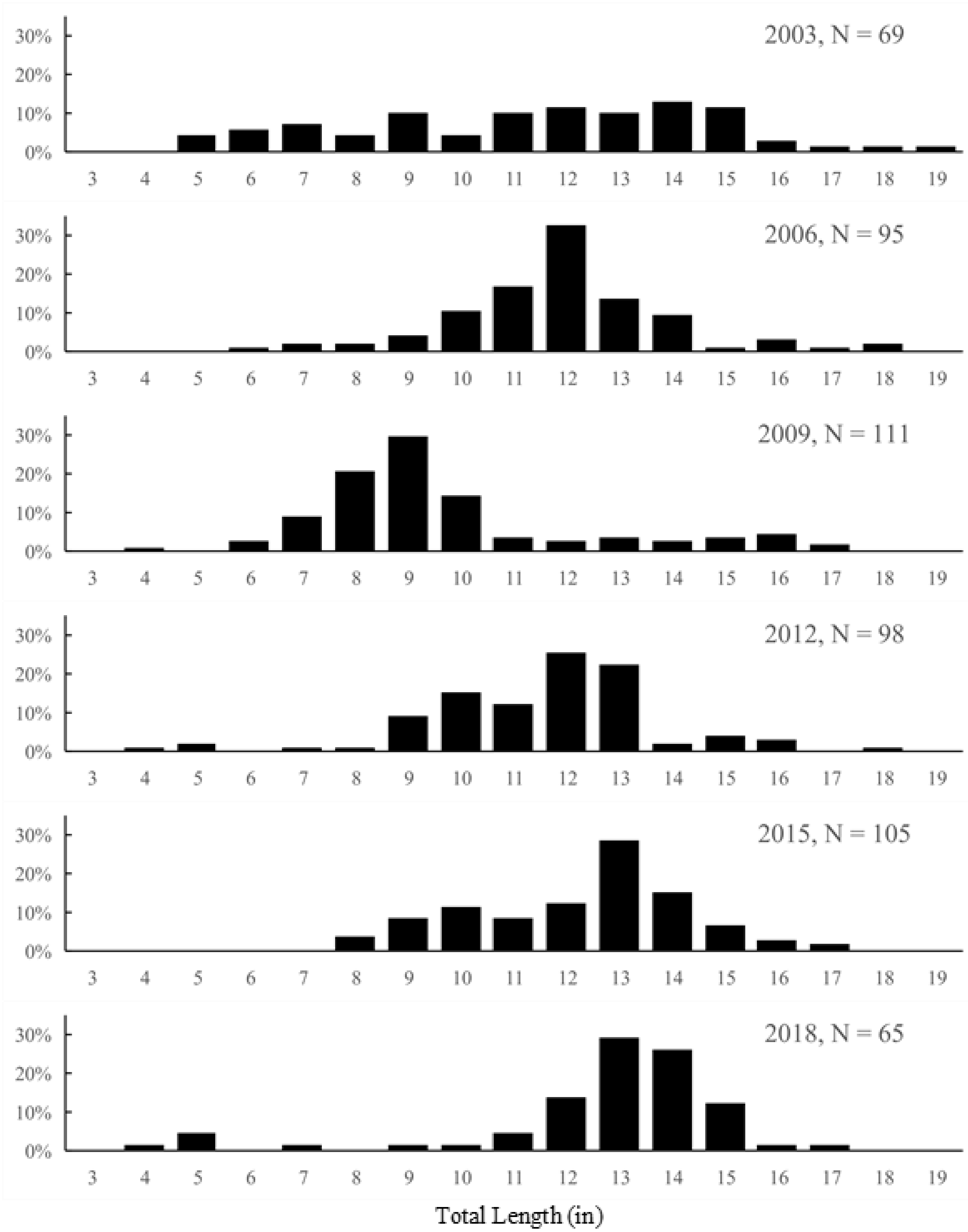


Figure 7. Percent length frequency of largemouth bass in Diamond Lake, Bayfield County, Wisconsin.

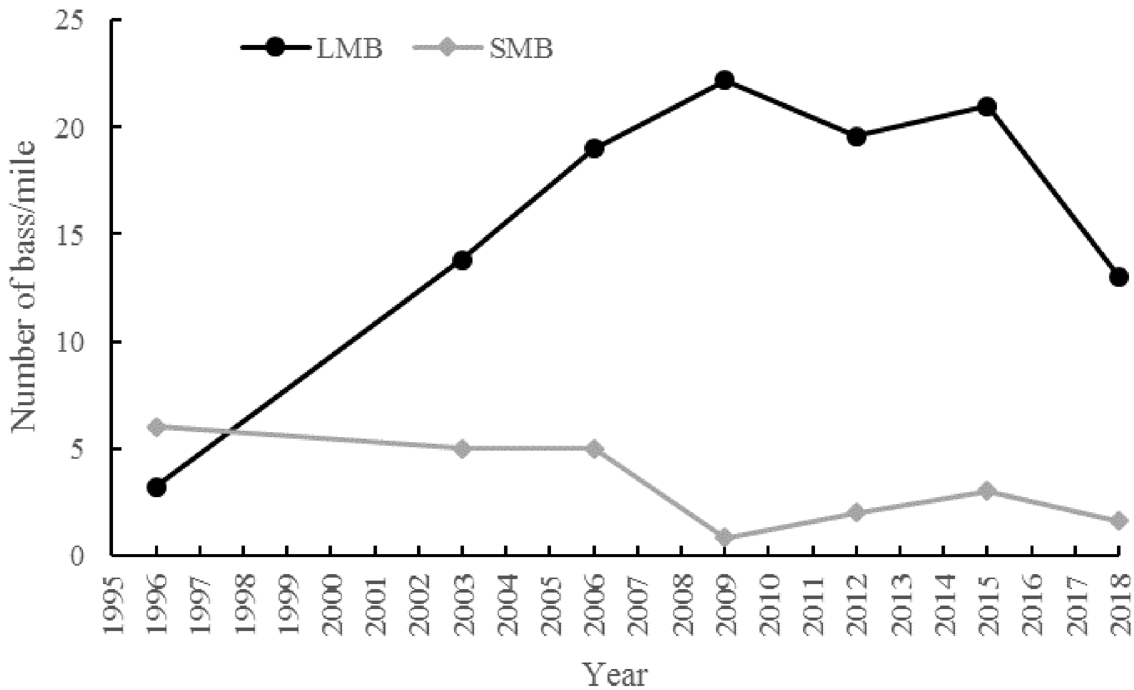


Figure 8. Relative abundance of bass (number/mile) collected during spring electrofishing surveys in Diamond Lake, Bayfield County, Wisconsin.

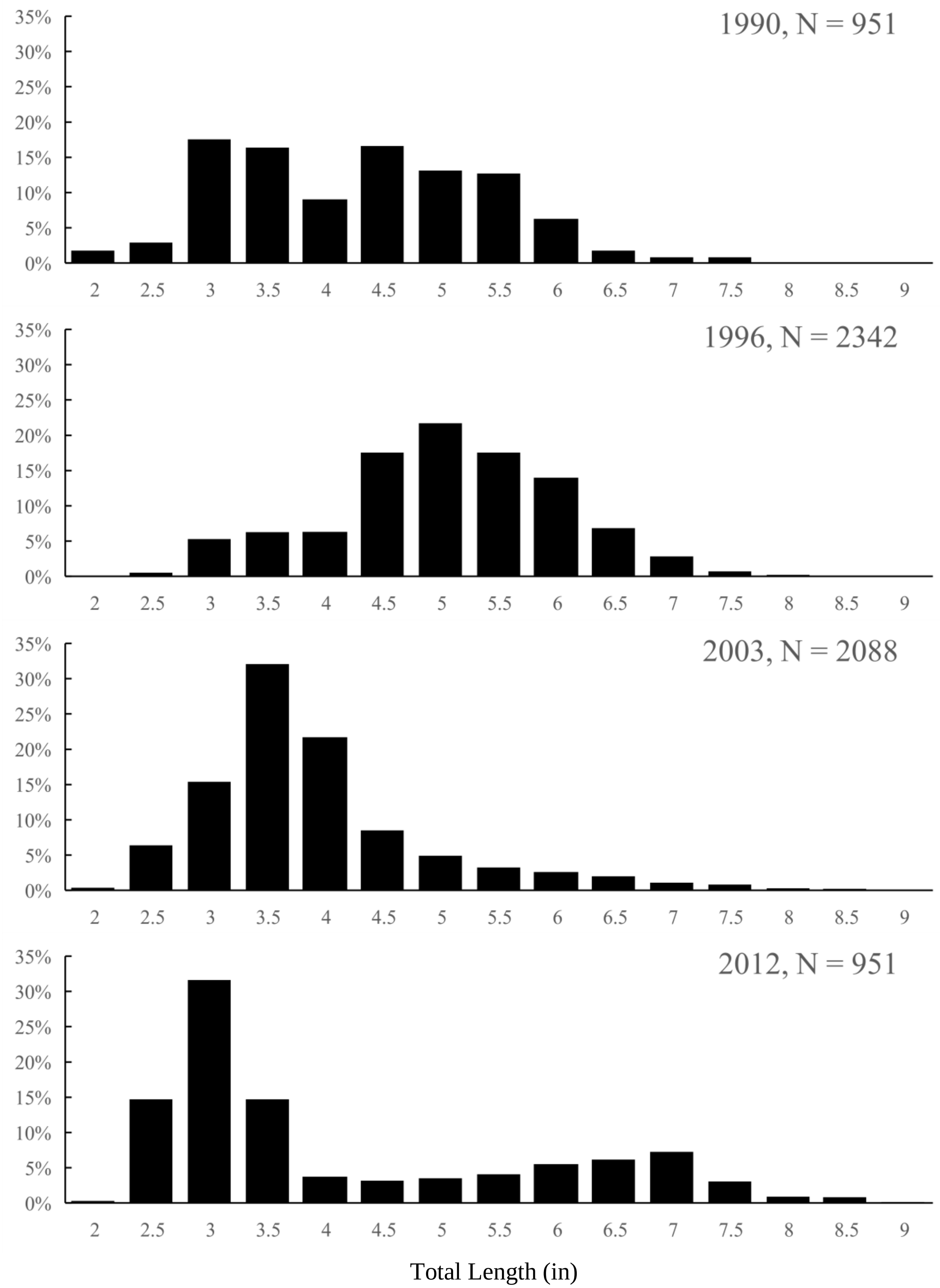


Figure 9. Percent length frequency bluegill in Diamond Lake, Bayfield County, Wisconsin.

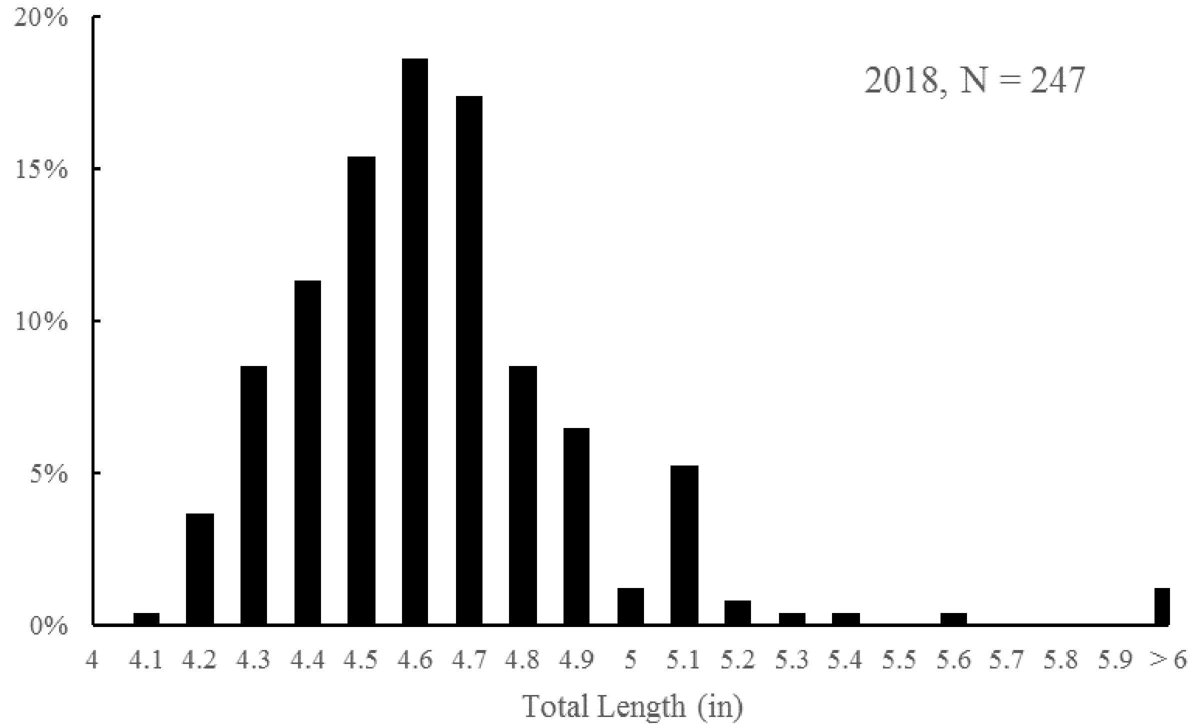


Figure 10. Length frequency percentage of rainbow smelt in Diamond Lake, Bayfield County, Wisconsin.

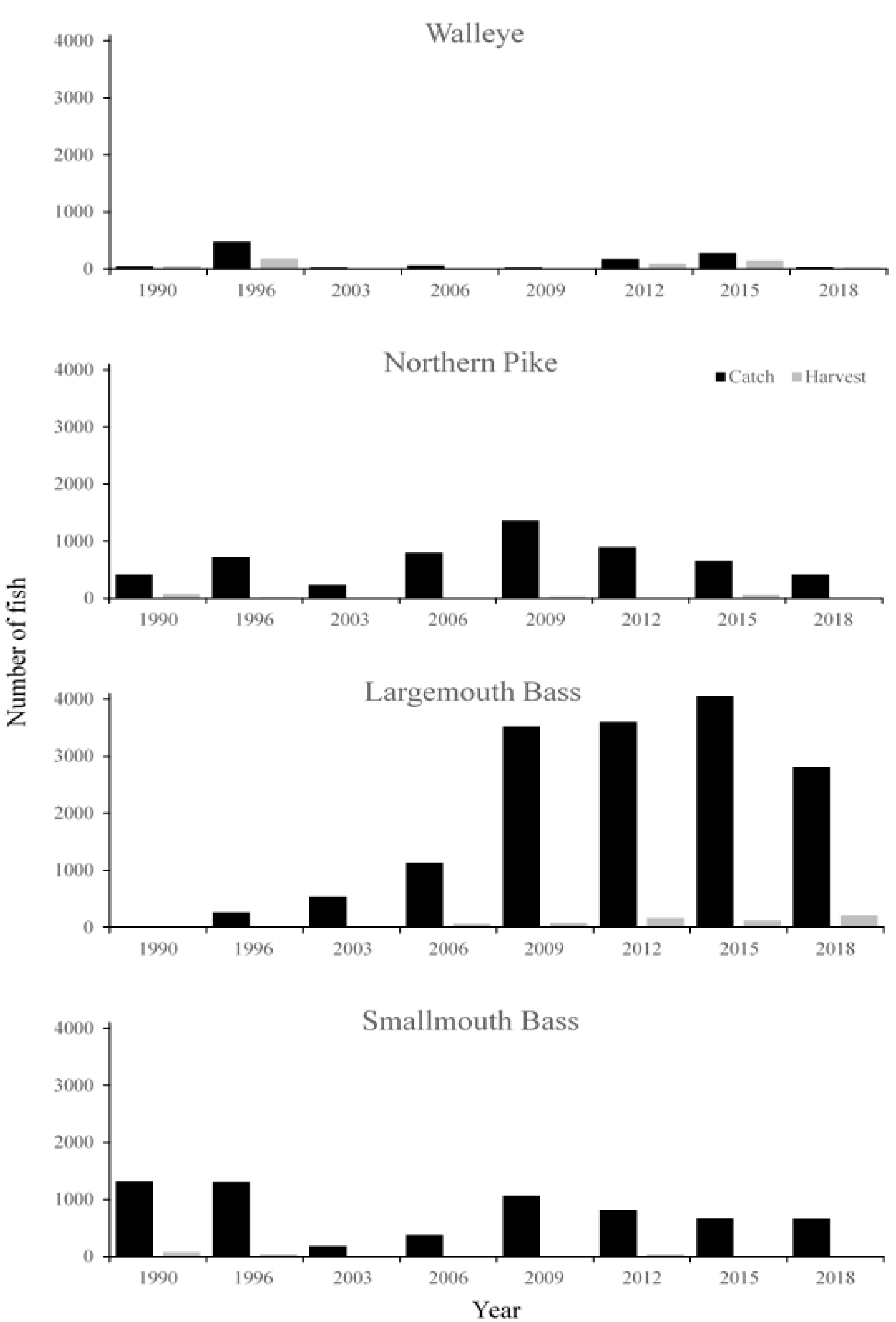


Figure 11. Angler catch and harvest of gamefish, Diamond Lake, Bayfield County, Wisconsin.

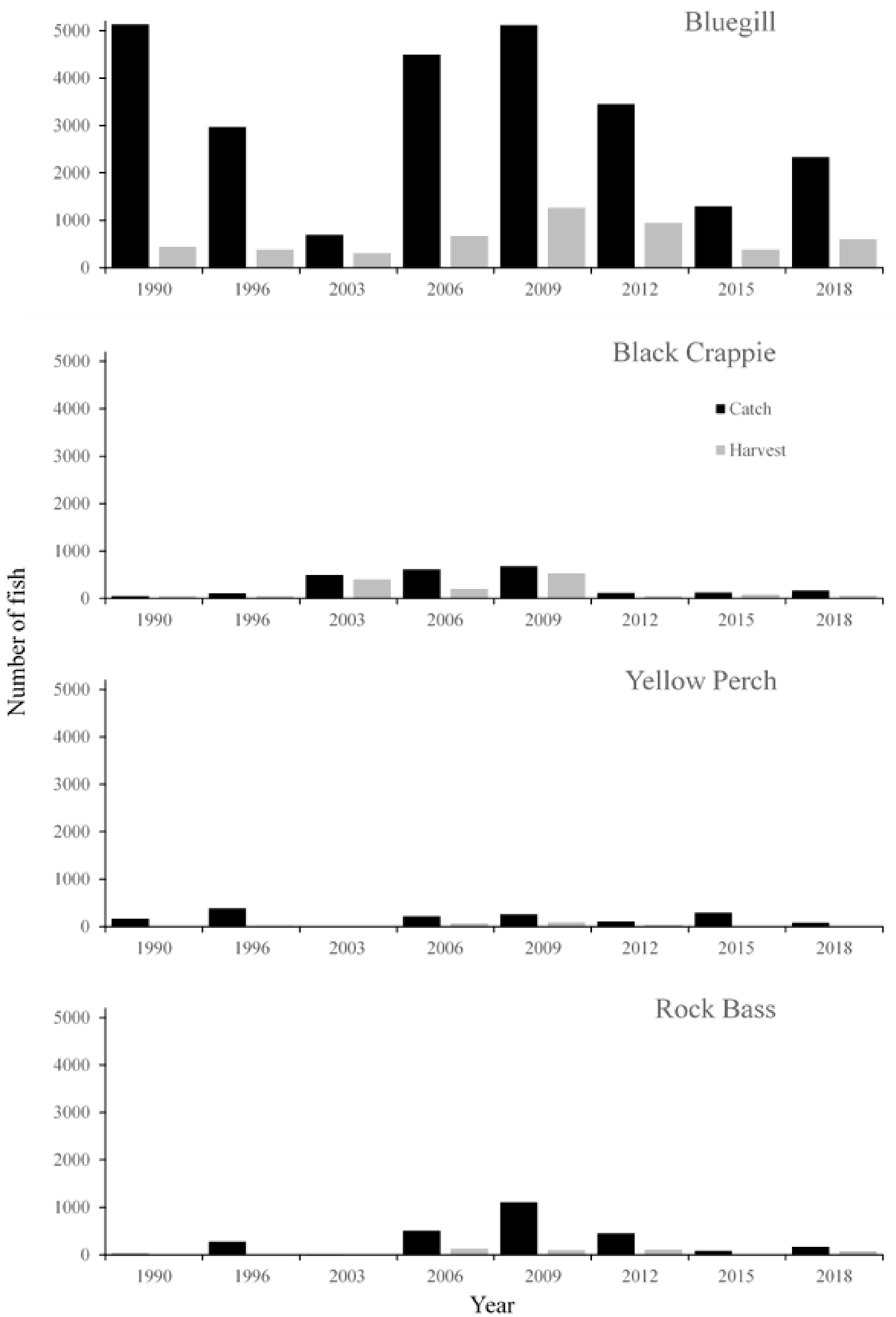
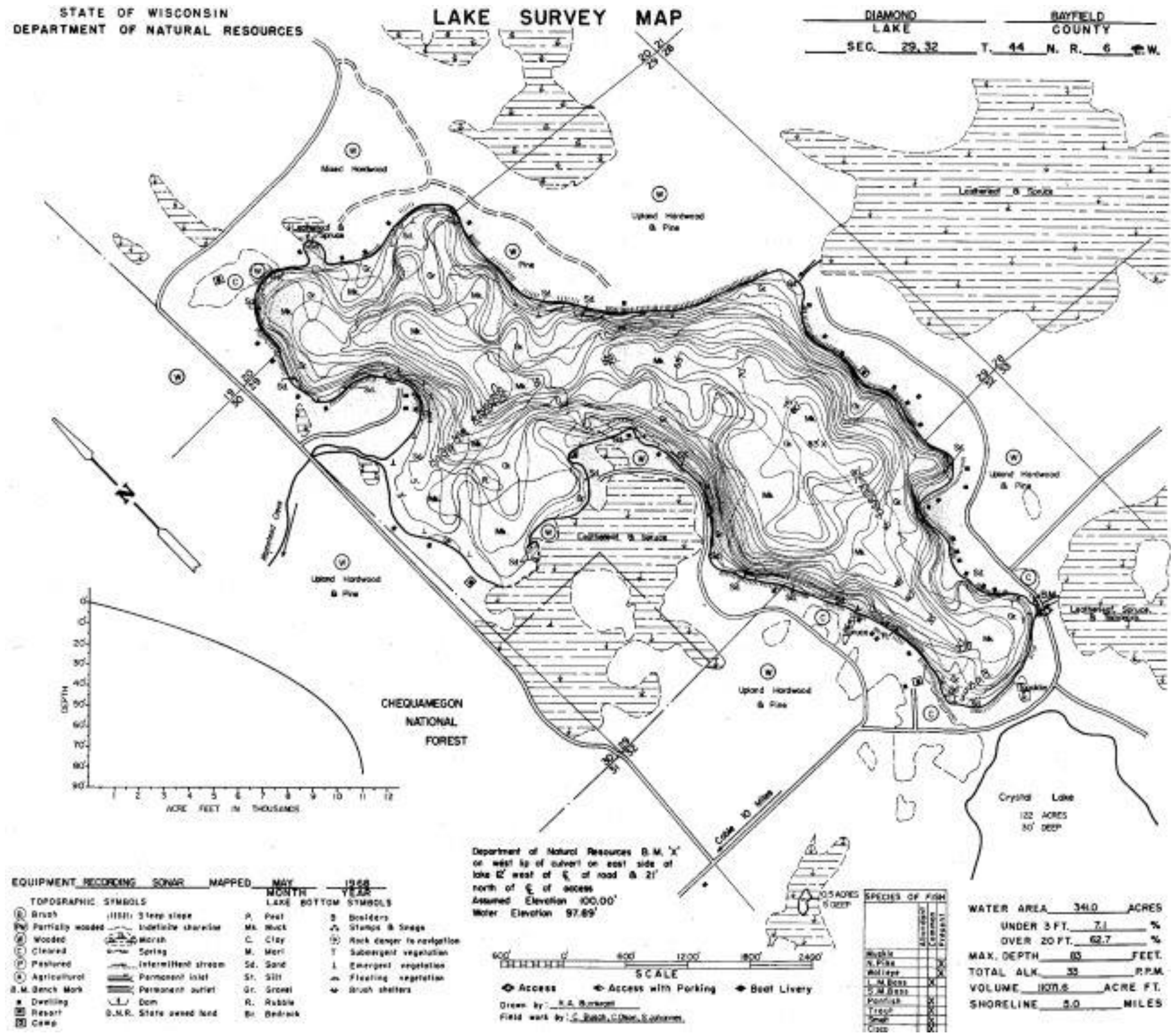


Figure 12. Angler catch and harvest of panfish, Diamond Lake, Bayfield County, Wisconsin.

Appendix

Appendix Table 1. Proportional and relative stock density values.

Species	Stock Size (in)	Quality Size (in)	Preferred Size (in)
Black Crappie	5	8	10
Bluegill	3	6	8
Largemouth Bass	8	12	15
Northern Pike	14	21	28
Pumpkinseed	3	6	8
Rock Bass	4	7	9
Smallmouth Bass	7	11	14
Walleye	10	15	20
Yellow Perch	5	8	10



Appendix Figure 1. Lake Map, Diamond Lake, Bayfield County, Wisconsin.