

Investigational Review of the Fish Community and Walleye Management
in Crystal Lake, Bayfield County.

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By

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Executive Summary

Crystal lake is a small (111 acre), soft water lake located in southeastern Bayfield County. The lake supports a relatively simple fish community with walleye, smallmouth bass and bluegill being the most abundant sport species. Walleye density is low and sustained largely through natural reproduction. Attempts to enhance walleye abundance through stocking have been largely unsuccessful. Contribution and cost-effectiveness of stocking have been poor due to high mortality of stocked walleye fingerling. Other gamefish likely provide lesser sport fisheries. Smallmouth bass are common but size structure is poor. Minimum length limits imposed over the last decades have failed to result in appreciable numbers of legal length smallmouth bass. Northern pike populations have remained low but exhibit some trophy potential. Bluegill and yellow perch are the dominant panfish. Abundance of both species is variable, size structure is poor and neither species likely supports popular sport fisheries. Future management should focus on: 1) periodic inventories to determine the extent which naturally reproduced year-classes of walleye will sustain the fishery, 2) new harvest strategies aimed at increasing angling opportunities and improving size structure of smallmouth bass and, 3) educational initiatives aimed at instilling cost-effectiveness of preserving healthy aquatic ecosystems.

Introduction

Crystal Lake is a small (111 acre), soft water lake located in southeastern Bayfield County (Figure 1). Crystal Lake lies in the Lake Superior drainage and together with nearby Diamond Lake forms the headwaters of Eighteen Mile creek. Although periodically landlocked, Crystal Lake has an intermittent outlet that flows into Diamond Lake during periods of high water. Much of the lake's 0.6 mi² watershed is privately owned and forested. Public frontage on the lake is restricted to one state owned island and 0.33 miles of Chequamegon National Forest shoreline on the lake's far south side. In general, the area has a wealth of high quality aquatic and shoreland resources that have been increasingly targeted for development in recent decades.

Crystal lake has maximum and mean depth of 29 ft and 17 ft, respectively. Water clarity and quality are good. Average summer secchi disc readings approach 17 feet. The water is soft and infertile; alkalinity and specific conductance are 10 mg/liter and 24 umhos/cm, respectively (Self-Help Monitoring Data 1991). Chlorophyll *a* and total phosphorus levels are also low and indicative of the lake's low fertility and early mesotrophic status. Macrophyte density is low and restricted to shallow bays.

Fisheries management has primarily focused on stocking and periodic surveys. The first recorded management was a 1933 stocking of 296,000 walleye (*Sander vitreus*) fry. Subsequent stockings through the late 1950s focused on largemouth bass (*Micropterus salmoides*), but included periodic stocking of smallmouth bass (*Micropterus dolomieu*), northern pike (*Esox lucius*), and bluegill (*Lepomis macrochirus*). In addition to a self-sustaining walleye population, the first fishery investigators in 1952 found a relatively pristine lake inhabited by largemouth bass, bluegill, rock bass (*Amploplites rupestris*), green sunfish (*Lepomis cyanellus*), black crappie (*Pomoxis nigromaculatus*), and white sucker (*Catostomus commersoni*). Subsequent and more intensive surveys in 1971 and 1979 found walleye and smallmouth bass to be the dominant predators and bluegill and yellow perch (*Perca flavescens*) the dominant panfish. Although the 1971 survey found several naturally recruited walleye age classes, a relatively weak 1971 year-class

prompted walleye stocking from 1972 -1976. Walleye have been the only species stocked since 1985 (Table 1).

Recent survey efforts have focused on walleye stocking evaluations, periodic monitoring, and walleye stock assessments. A 1989 evaluation of portable floating incubation boxes containing fertilized walleye eggs found no impact on walleye year-class strength. Despite nearly a decade of concerted stocking, the first quantitative assessment of walleye stocks in 1996 found a walleye population below statewide management objectives of 3 adult walleye/acre. More recently, Crystal Lake has been part of a regional study to quantify the survival of stocked walleye fingerlings and their contribution to year-class strength.

To date, sport fisheries have been managed via statewide season, length, and bag restrictions. Public access is sufficient with a federally owned and maintained boat landing on the lake's south side.

The objective of this report was to evaluate the recent status and management of walleye and assess fish community characteristics by comparing baseline information collected in 2003 to previous survey findings.

Methods

Walleye stocks were sampled in 1996 and 2003 according to Hennessy (2002). Walleye were captured with fyke nets (4 x 6 ft frames, 0.5 in bar mesh) set in spawning areas immediately after ice out. Lead length varied and generally equaled the distance between shore and the 4-foot contour. Fyke nets in both years were set for 4 nights at water temperatures spanning 38 – 46 F. All walleye captured were sexed, measured to the nearest 0.1 in total length (TL), fin-clipped, and released. Sexually mature and non-sexable walleye ≥ 15 in (adult) received a top-caudal fin-clip. Immature walleye <15.0 in (juvenile) received a bottom-caudal fin clip. For aging purposes, the second dorsal spine was sub-sampled from 10 walleye per inch group, per sex. Other fish species collected were measured and released.

Immediately after marking a sufficient number of adult walleye, a single night of electrofishing was conducted to estimate population size. The entire shoreline was sampled utilizing a variable voltage AC boomshocker with two dippers. All walleye

collected were sexed, observed for the presence or absence of fin-clips, measured and released. Other gamefish were measured and released.

Additional sampling in 2003 followed Wisconsin's baseline lakes monitoring protocol (Simonson 2003). Mini-fyke nets (3ft. x 3 ft. frames, 0.2 in delta mesh) were set in August at randomly selected locations. One night of electrofishing (AC boomshocker, two dippers) was also conducted in September. Gamefish were collected along the entire shoreline. Panfish and non-game species were sub-sampled in two randomly selected 0.5 mile stations. All fish captured in both sampling periods were identified, measured, and released. Species not definitively identified in the field were preserved in 10 percent formalin for later identification utilizing taxonomic keys and a Leica variable power stereoscope. Fall electrofishing prior to 2003 utilized equipment and seasonal timing similar to that reported above.

Walleye spines were cross-sectioned and viewed microscopically at 100X (Margenau 1982). Growth was compared with regional means using the Fisheries and Habitat Statewide database. The microcomputer software FishCalc89 (FishCalc89 1989) was used to generate length and age distributions. Walleye abundance was estimated using the Chapman version of the Petersen formula (Ricker 1975). Abundance by length group was obtained by proportioning length frequencies obtained with fyke nets to the estimated abundance of walleye ≥ 10.0 in. Variance (of a proportion) for length groups was calculated using the following formula:

$$\text{var}(p \cdot pe) = p^2 \cdot \text{var}(pe) + pe^2 \cdot \text{var}(p) - \text{var}(p) \cdot \text{var}(pe), \text{ where}$$

var = variance

p = the proportion of fish sampled in length group

pe = population estimate for fish ≥ 10 in.

Proportional (PSD) and relative (RSD) stock densities were calculated according to 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).

Results

All gears combined captured 13 fish species in 2003. Walleye and smallmouth bass were the most abundant predators, followed by largemouth bass and northern pike. Bluegill were the most abundant panfish. White Sucker and bluntnose minnow (*Pimephales notatus*) were the most common non-game fishes. With the possible exception of northern pike, species diversity appears to have changed little over time (Table 2). Northern pike were first documented during routine monitoring in 1995 and have been present in low numbers every survey since then. Species identified in previous investigations and not found recently (e.g. Iowa darter) are locally common and not considered threatened or endangered (Fago 1992). With the notable exception of rainbow smelt (*Osmerus mordax*), species diversity is similar to that of Diamond Lake. The lack of suitable oxygen and temperature regimes likely explains the apparent absence of rainbow smelt from Crystal Lake.

Walleye. Walleye abundance in Crystal lake was low. Fyke nets captured a total of 163 walleye (7.4 fish/net lift) in 1996 and 177 walleye (8.8 fish/net lift) in 2003. Estimated abundance of walleye ≥ 10 in. in 1996 and 2003 was 185 fish and 277 fish, respectively (Table 3). Estimated adult density in both years (1996 = 1.6 adults/acre, 2003 = 2.4 adults/acre) was similar to other stocked lakes in Bayfield and Douglas counties (mean = 2.2 adults/acre, N = 9, SD = 0.82; unpublished data, Brule field office) but below the objective of 3.0 adults/acre for ceded territory lakes managed for walleye (Staggs et al.1990).

Walleye size structure was generally good, but variable between 1996 and 2003 (Figure 2). Mean length of adult walleye was 15.4 in. (n = 160, SD = 2.5) in 1996 and 16.6 in. (n = 177, SD = 2.3) in 2003. Legal length walleye (≥ 15.0 in) accounted for 49.4% and 86.5% of the adult stock in 1996 and 2003, respectively (Table 4). This increase was largely attributable to a 259 % increase of walleye between 15 and 20 in long (Table 4). Abundance of large walleye (≥ 20.0 in) in both years was low, ranging from 7 (0.1 fish/acre) in 1996 to 20 (0.2 fish/acre) in 2003. RSD-20 in 1996 and 2003 was 4 and 7, respectively.

Changes in size structure appear heavily influenced by variation in cohort strength (Figure 3). Age-3 and age-4 walleye comprised 60 % of the adult stock in 1996. The

dominant age-5 and age-6 cohorts formed half the adult stock in 2003. Walleye ages 11 and older were sparse in both years accounting for fewer than 5% of all fish sampled. No relationship between stocking and adult cohort strength was detected. Strong and weak cohorts stemmed from both stocked and non-stocked years. Although the dominant age-3 and age-4 cohorts in 1996 originated from years when stocking occurred, no stocking occurred in the year that produced the dominant age-5 cohort in 2003.

Walleye growth in 1996 and 2003 was similar (Figure 4). Growth in both years was above the regional average until age-5 and slower than normal after age-7. Female and male walleye exhibited dimorphic growth, attaining legal length (15 in) sometime between their fourth and fifth growing season, respectively.

Fall shocking investigations since 1971 suggest stocking had little positive effect on year-class strength. Natural reproduction resulted in the highest catch of age-0 walleye in 1998 and some natural reproduction occurred in all non-stocked years investigated since 1971 (Table 5). Relative abundance of age-0 walleye in non-stocked years averaged 8.8 fish/mile (range 4.9 – 16.5 fish/mile) and 19.4 fish/hr (range 8.4 – 42.0 fish/hr). Relative abundance of age-0 walleye in stocked years averaged 5.0 fish/mile (range 0.4 – 11.8 fish/mile) and 12.7 fish/hr (range 1.0 – 33.3 fish/hr). Mean catch of age-0 walleye in stocked and non-stocked years were not significantly different (age-0/hr; $t = 0.94$, $df = 10$, $P = 0.37$; age-0/mile; $t = 1.54$, $df = 10$, $P = 0.16$). Results from OTC marking studies in 1999 and 2001 suggest survival and contribution of stocked fingerlings was marginal. Contribution of 5,500 stocked fingerlings to the 1999 and 2002 year-classes was 28% and 25%, respectively. Survival of the stocked fingerlings, 3 months post stocking was 0.4% (J. Kampa, WDNR, unpublished data). Estimated contribution of 5 stockings totaling 31,537 small walleye fingerling contributed 30 fish (12 %) to the adult stock (Table 6).

Spring electrofishing catches in 1971 suggest abundance of walleye prior to stocking was similar. Relative abundance of walleye ≥ 10 in was 47.3 fish/hour in 1971 compared to 40.0 fish/hour in 2003. Length distributions of spawning walleye captured electrofishing since 1971 suggest size and age structure of walleye stocks have historically been variable and subject to the influence of erratic recruitment (Figure 5).

Smallmouth bass and Largemouth bass. Smallmouth bass were the second most common predator sampled in 2003. All gears combined captured 70 smallmouth bass

ranging from 1.9 - 15.4 in. The 16 smallmouth bass (yearling and older) sampled fall electrofishing had a mean length 10.8 in (SD = 2.4) and PSD and RSD-14 of 60 and 0, respectively. Fall electrofishing surveys since 1971 suggest abundance has been variable and size structure has been poor (Figure 6). Relative abundance of smallmouth bass ranged from a low of 16.0 fish/hr in 2003 to 76.0 fish/hr in 1998 (mean = 39.3, SD = 21.4). In all years, relative abundance of legal length fish (≥ 14.0 in) was low, ranging from 0 fish/hr in seven of eight survey years to 1.0 fish/hr in 1998. Analysis of modal length distributions since 1996 suggest variable abundance is heavily influenced by individuals age 3 and younger and recruitment to older age and size classes is low (Figure 7).

Largemouth bass were the third most common predator sampled in 2003. The 48 largemouth bass (all gears combined) collected ranged from 1.6 - 17.4 in. Mean length and range of the 9 largemouth bass collected fall electrofishing was 11.9 in (SD = 1.5) and 9.3 to 13.5 in., respectively. Fall electrofishing surveys since 1971 suggest largemouth bass abundance has historically been low and are outnumbered by smallmouth bass by a ratio of nearly 6:1.

Northern Pike. A total of 19 northern pike were sampled in 1996 and 10 northern pike in 2003. Northern pike sampled in 1996 and 2003 had a mean length and range of 21.1 in (SD = 8.0) and 7.7 – 39.7 in, and 24.2 in. (SD = 5.9) and 14.8 – 37.3 in, respectively. A majority (72%) of the northern pike collected in both years were between 18 and 26 in. Relative abundance of northern pike since 1995 has remained low. Fyke nets captured fewer than 1 fish/net lift in both 1996 and 2003. No trend in abundance, either increasing or decreasing was evident. Fall electrofishing catches ranged from 2.2 fish/hour in 1995 to 6.0 fish/hour in 1996.

Other Species. Panfish sampled (all gears combined) in decreasing order of abundance in 2003 were bluegill, green sunfish, rock bass, yellow perch and black crappie. Historical surveys suggest bluegill and yellow perch have been the most common panfish species (Weiher 1971). Relative abundance of both species was variable. Fall electrofishing catches of bluegill varied nine-fold, ranging from 52 fish/hr in 1971 to 465 fish/hr in 1998 (Figure 8). Size structure historically has been poor. Proportions of bluegill ≥ 7 in ranged from 0 in four of six survey years to $< 10\%$ in 2000

and 2003 (Figure 8). Fyke netting in 1996 and 2003 suggest yellow perch are subject to dramatic fluctuations in abundance. Fyke nets captured a total of 328 yellow perch (14.9 net/lift) in 1996 and 5 yellow perch (0.2 net/lift) in 2003. Yearling yellow perch < 5.0 in in both years comprised over half (56%) the total catch.

Similar to previous investigations, white sucker and bluntnose minnow were the most common non-game species sampled in 2003. Fyke nets captured 417 (19.0 fish/net lift) white suckers in 1996 and 123 (6.2 fish/net lift) in 2003. Bluntnose minnow have been collected in 7 of 9 surveys since 1951. These species along with the periodicity of large year-classes of yellow perch are likely the majority of the forage base.

Discussion

Crystal Lake supports a relatively simple fish community typical of small, infertile, soft water lakes in the Lake Superior basin. Although low density, the lake supports a viable walleye fishery that appears largely sustained by natural reproduction. Attempts to bolster walleye abundance through small fingerling stockings have resulted in marginal effectiveness. High post stocking mortality appears to be limiting contribution and resulting in poor cost-effectiveness of this program.

Smallmouth bass are the other major gamefish in Crystal Lake, outnumbering largemouth bass nearly 6 to 1. Minimum length limits enacted in 1990 (12 inch) and 1998 (14 inch) on both species have failed to produce any significant number of legal-length individuals. Although biases inherent to fall electrofishing may underestimate size structure and no growth information is available, length data suggests recruitment of smallmouth bass to older length and age classes is low, possibly due to the synergistic effect of slow growth and high natural mortality (Serns 1978).

Abundance of northern pike has remained low since their first recorded presence in 1995. Although four investigations prior to 1995 failed to collect northern pike, the species is native to the Lake Superior basin and has inhabited interconnected Diamond Lake since at least 1959 (Weiher 1971). No trend in northern pike abundance could be detected and production may be limited by the lack of available spawning habitat. Given the lake's low trophic state, simple fish assemblage, and limited forage base, increased abundance of northern pike could have significant impacts on the balance of the fish

community. Yellow perch and white sucker for instance, declined by more than 70% following northern pike expansions in two central Minnesota lakes (Anderson and Schupp 1986; Wesloh and Olson 1962).

Abundance of panfish populations in Crystal Lake appears variable. Bluegill have historically been the most common panfish species. Reasons for the species less than desirable size structure remain uncertain. Density of major piscivores (walleye and northern pike) is low and predation on bluegill may be buffered by availability of more preferred diets of white sucker and yellow perch. Although low vegetative cover appears conducive to high predator efficiency, the lake's low productivity may not be capable of sustaining predator densities necessary to achieve desirable bluegill growth and size structure (Snow 1968). Certainly, the failure of walleye stocking to achieve any significant increase in walleye abundance is suggestive that existing predators may be in equilibrium with carrying capacity. Yellow perch and rock bass are likely the lake's only native panfish species (Becker 1983). Bluegill, green sunfish, and black crappie are not known to be endemic to the Lake Superior basin and their presence is likely the result of wide spread fish introductions in the early 1900s (Becker 1983). It seems plausible therefore, that Crystal Lake lacks physical, biological and chemical characteristics necessary to support stable populations of non-native centrarchid panfish. It may also be plausible that these species represent nothing more than a diversion of energy from endemic species to those more adaptable to regional climatic and environmental conditions.

Summary and Management Recommendations:

1. Manage Crystal Lake primarily for walleye, smallmouth bass and yellow perch with secondary emphasis on largemouth bass and bluegill. Due to the lakes lack of suitable habitat and low forage abundance no active management of northern pike is recommended. Specific management objectives are as follows:
 - a. Walleye: maintain a spring spawning population density (fish \geq 10 in) of 3 adult walleye/acre and PSD of 40%. These levels should provide a viable

sport fishery as well as supply sufficient predation to reduce/enhance the bluegill population.

- b. Smallmouth bass: maintain a fall electrofishing CPE near 60 fish per hour and improve the PSD to greater than 40%.
 - c. Bluegill: maintain a fall electrofishing CPE below 300 fish per hour and improve the PSD to greater than 40%.
2. While the walleye population was below management objectives of 3 adults/acre, the trend has been toward increased abundance (1.6/acre in 1996 to 2.4/acre in 2003). Walleye stocking success has been marginal and not cost-effective. Although low, natural reproduction was evident in all non-stocked years and historical information suggests the population will sustain itself at similar abundance levels. Recent studies suggest walleye stocking may contribute to reduced natural reproduction (Chilcote 2003; Nickelson 2003). It's plausible therefore, that discontinuation of supplemental stocking could result in stronger natural year-classes which alone may be sufficient in achieving management goals for walleye. As such, it is recommended stocking be discontinued and fall electrofishing inventories be conducted biennially to further assess strength and variability of naturally recruited walleye year-classes. To ensure adherence to the above objectives, the status of adults stocks should be investigated every three years as part of routine monitoring on adjacent Diamond Lake. As appropriate, alter management strategies to react to any major changes to the fishery.
3. Explore alternative harvest regulations for smallmouth bass and largemouth bass. Although some improvement in size structure has occurred with the implementation of more restrictive length limits in the 1990s, the current regulation of a 14-in minimum and 5 daily bag has failed to produce any substantial increase in numbers of legal-length bass. Due to suspected slow growth, the regulation's ineffectiveness may be due to the synergistic effect of concentrating harvest on the few large fish present. As such, harvest restrictions of no minimum length and a daily bag limit of 2

fish (only one of which could be greater than 14 in) is recommended. This would allow some harvest of the more numerous medium-size bass and offer greater protection to less-abundant and ecologically-important large fish.

4. Maintain the wild nature of the remaining undeveloped shoreline by discouraging further development and by following the guidelines for riparian management zones as described in "Wisconsin's Forestry Best Management Practices for Water Quality" (PUB-FR-093 95).
5. Work with shoreland residents and Bayfield County Zoning to create an "adopt a lake" management plan incorporating all phases of water resource and shoreland management. The plan should 1) develop strategies for identifying, protecting and enhancing sensitive aquatic and shoreland habitats; 2) implement self help water quality monitoring and provide mechanisms for control of satellite exotic infestations; and 3) provide an educational and interactive forum for environmentally sensitive shoreland living.

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Table 1. Walleye stocking history of Crystal Lake, Bayfield County, 1972 - 2003.

| Year | Small Fingerling | Large Fingerling | Total |
|-------------------|---------------------|---------------------|--------|
| 1972 | 4,560 | | 4,560 |
| 1973 | 6,160 | | 6,160 |
| 1974 | 6,160 | | 6,160 |
| 1976 | 5,600 | | 5,600 |
| 1985 ¹ | | 1,600 | 1,600 |
| 1986 | 5,500 | | 5,500 |
| 1989 | 5,521 | | 5,521 |
| 1992 ² | 8,500 | 400 | 8,900 |
| 1993 | | 2,027 | 2,027 |
| 1995 | 6,216 | | 6,216 |
| 1996 ² | | 847 | 847 |
| 1997 | 5,550 | | 5,550 |
| 1999 | 5,550 | | 5,550 |
| 2001 | 5,550 | | 5,550 |
| 2003 | 5,550 | | 5,550 |
| Total | 47,937 | 4,874 | 52,811 |

¹ Cooperative stocking purchased by Pioneer Sportsman Club and Crystal Lake Property Owners Association.

² Includes cooperative stockings of small and large fingerling by Fish For The Future.

Table 2. Species assemblage of the fish community in Crystal Lake, Bayfield County, 1951 - 2003.

| Common Name | Scientific Name | Survey Year | | | | | | | | |
|------------------|--------------------------------|-------------|------|------|------|------|------|------|------|------|
| | | 1951 | 1971 | 1979 | 1992 | 1995 | 1996 | 1998 | 2000 | 2003 |
| Walleye | <i>Sander vitreus</i> | X | X | X | X | X | X | X | X | X |
| Smallmouth bass | <i>M. dolomieu</i> | | X | X | X | X | X | X | X | X |
| Largemouth Bass | <i>Micropterus salmoides</i> | X | X | X | X | X | X | X | X | X |
| Northern Pike | <i>Esox lucius</i> | | | | | X | X | X | X | X |
| Bluegill | <i>Lepomis macrochirus</i> | X | X | X | X | X | X | X | X | X |
| Yellow Perch | <i>Perca flavescens</i> | | X | X | X | X | X | | X | X |
| Rock bass | <i>Amploplites rupestris</i> | X | X | X | X | X | X | X | X | X |
| Green Sunfish | <i>L. cyanellus</i> | X | X | X | X | X | | X | X | X |
| Black Crappie | <i>Pomoxis nigromaculatus</i> | X | X | X | X | | X | | | X |
| White sucker | <i>Catostomus commersoni</i> | X | X | X | X | X | X | X | | X |
| Bluntnose Minnow | <i>Pimephales notatus</i> | | X | X | X | X | | X | X | X |
| Johnny Darter | <i>Etheostoma nigrum</i> | | | X | X | X | | | X | X |
| Iowa Darter | <i>E. exile</i> | | | X | X | | | X | X | |
| Common Shiner | <i>Luxilus cornutis</i> | | X | X | | | | | | |
| Golden Shiner | <i>Notemigonus crysoleucas</i> | | X | | | | | | | |
| Tadpole Madtom | <i>Noturus gyrinus</i> | | | X | | | | X | X | X |

Table 3. Walleye abundance and density estimates, coefficient of variation (C.V.) and 90% confidence intervals (C.I.) for Crystal Lake, Bayfield County. Adult estimates include all sexable fish and unknown sex fish ≥ 15.0 inches.

| Year | Size | Abundance | C. V. | 90% C.I. | No/Acre | |
|------|----------------|-----------|-------|----------|---------|-----|
| 1996 | ≥ 10.0 in | 185 | 0.07 | 164 | 207 | 1.7 |
| 2003 | ≥ 10.0 in | 277 | 0.10 | 231 | 324 | 2.5 |
| 1996 | Adult | 178 | 0.07 | 158 | 199 | 1.6 |
| 2003 | Adult | 267 | 0.10 | 222 | 311 | 2.4 |

Table 4. Estimated walleye abundance by size, Crystal Lake, Bayfield County, 1996 and 2003. Coefficient of variation of estimated abundance in parenthesis.

| Length Interval (in) | 1996 | | | 2003 | | |
|-------------------------|---------|------------------------|--------------------|---------|------------------------|--------------------|
| | Percent | Estimated Abundance | Catch/ Net Lift | Percent | Estimated Abundance | Catch/ Net Lift |
| 10.0 - 14.9 | 52.5 | 97 (0.10) | 3.8 | 17.0 | 47 (0.19) | 1.5 |
| 15.0 - 19.9 | 43.8 | 81 (0.11) | 3.2 | 75.7 | 210 (0.11) | 6.7 |
| 20.0 - 24.9 | 3.7 | 7 (0.41) | 0.3 | 7.3 | 20 (0.28) | 0.7 |
| 25.0+ | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 |
| Total | 100.0 | 185 (0.07) | 7.3 | 100.0 | 277 (0.10) | 8.9 |

Table 5. Electrofishing relative abundance of age-0 walleye in stocked and non-stocked years, Crystal Lake, Bayfield County, 1971 - 2003.

| Year | Number Stocked | Non-stocked | | Stocked | |
|------|-------------------|-------------|-------------|-----------|-------------|
| | | #/Mile | #/ Hour | #/Mile | #/ Hour |
| 1971 | 0 | 5.5 | 8.4 | | |
| 1986 | 5,500 | | | | 5.3 |
| 1989 | 5,521 | | | 0.4 | 1.0 |
| 1992 | 8,900 | | | 5.1 | 16.3 |
| 1995 | 6,216 | | | 11.8 | 33.3 |
| 1996 | 0 | 10.6 | 19.3 | | |
| 1998 | 0 | 16.5 | 42.0 | | |
| 1999 | 5,500 | | | 2.8 | 5.3 |
| 2000 | 0 | 4.9 | 11.9 | | |
| 2001 | 5,500 | | | 3.1 | 6.7 |
| 2002 | 0 | 6.7 | 15.5 | | |
| 2003 | 5,500 | | | 8.3 | 21.0 |
| Mean | | 8.9 (4.8) | 19.4 (13.3) | 5.0 (3.9) | 12.7 (11.5) |

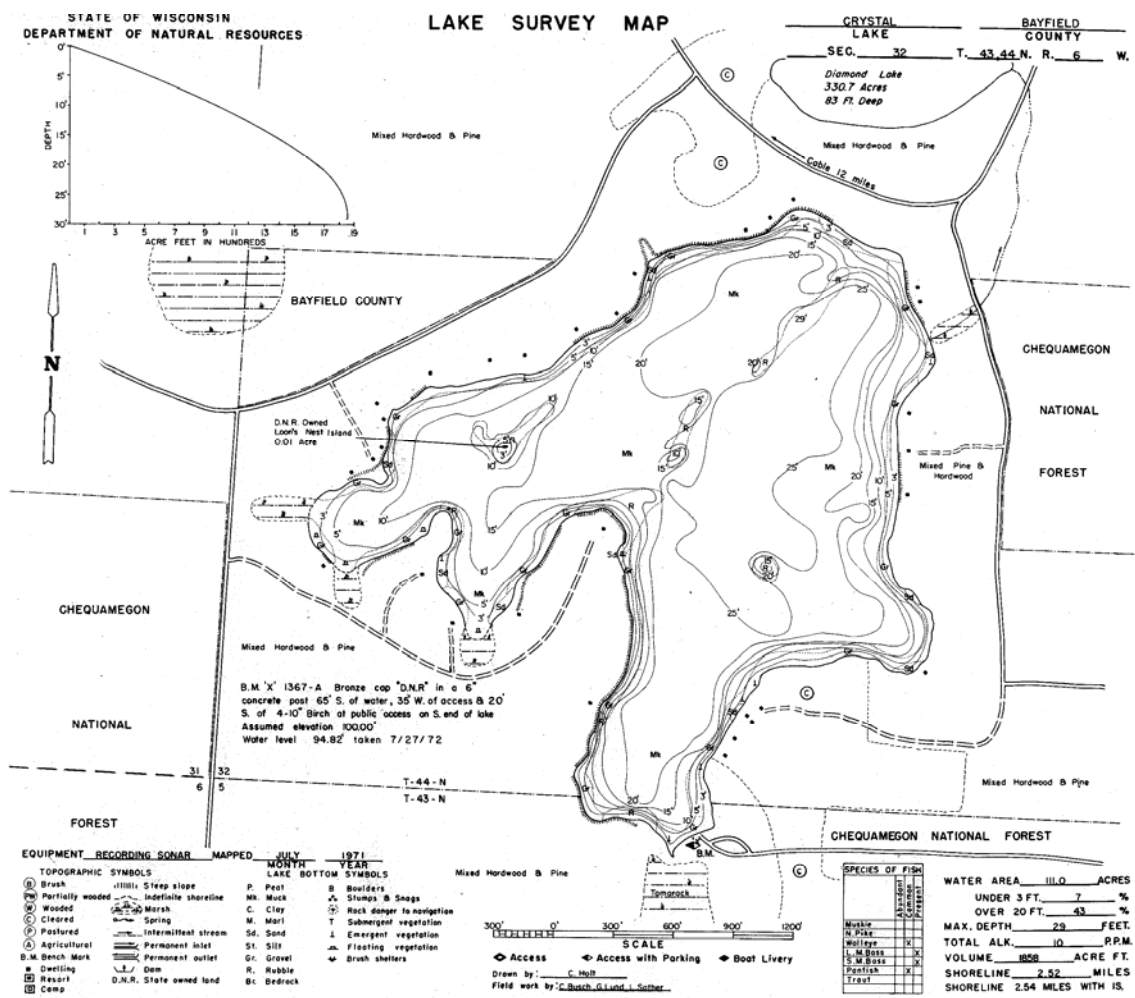


Figure 1. Crystal Lake map, Bayfield County, Wisconsin.

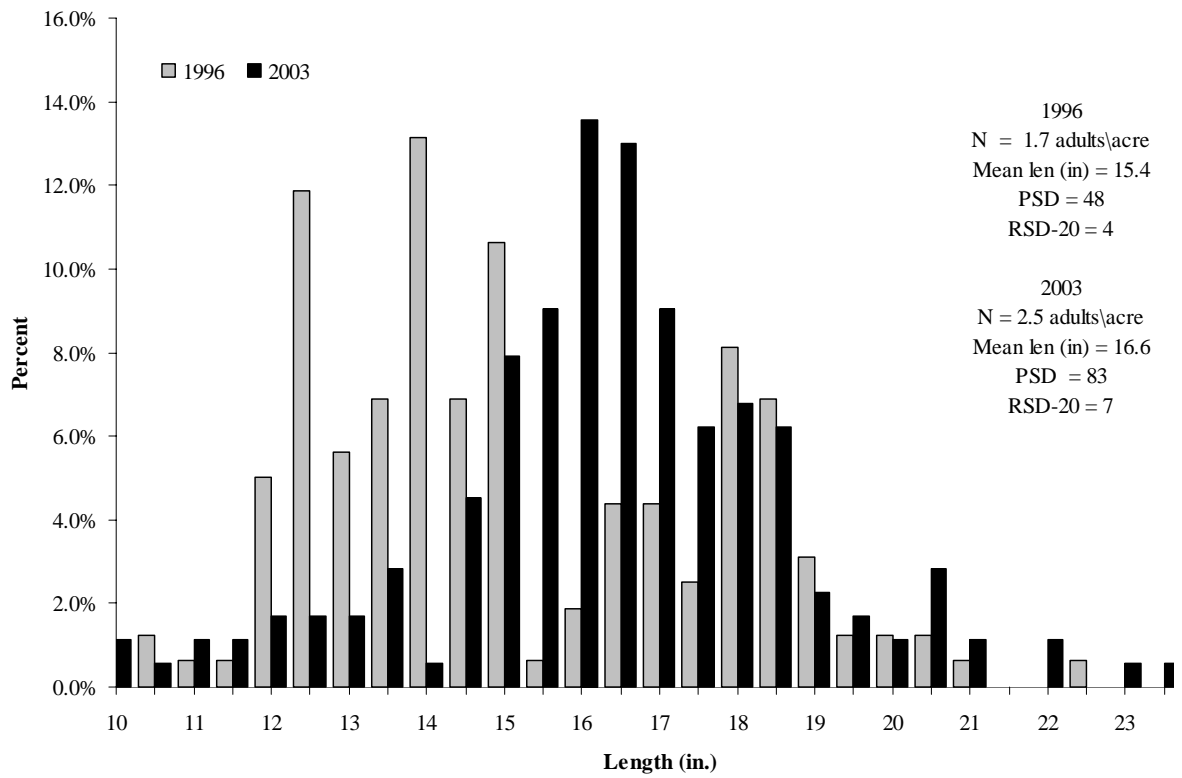


Figure 2. Walleye length frequency comparison, 1996 and 2003, Crystal Lake, Bayfield County, Wisconsin.

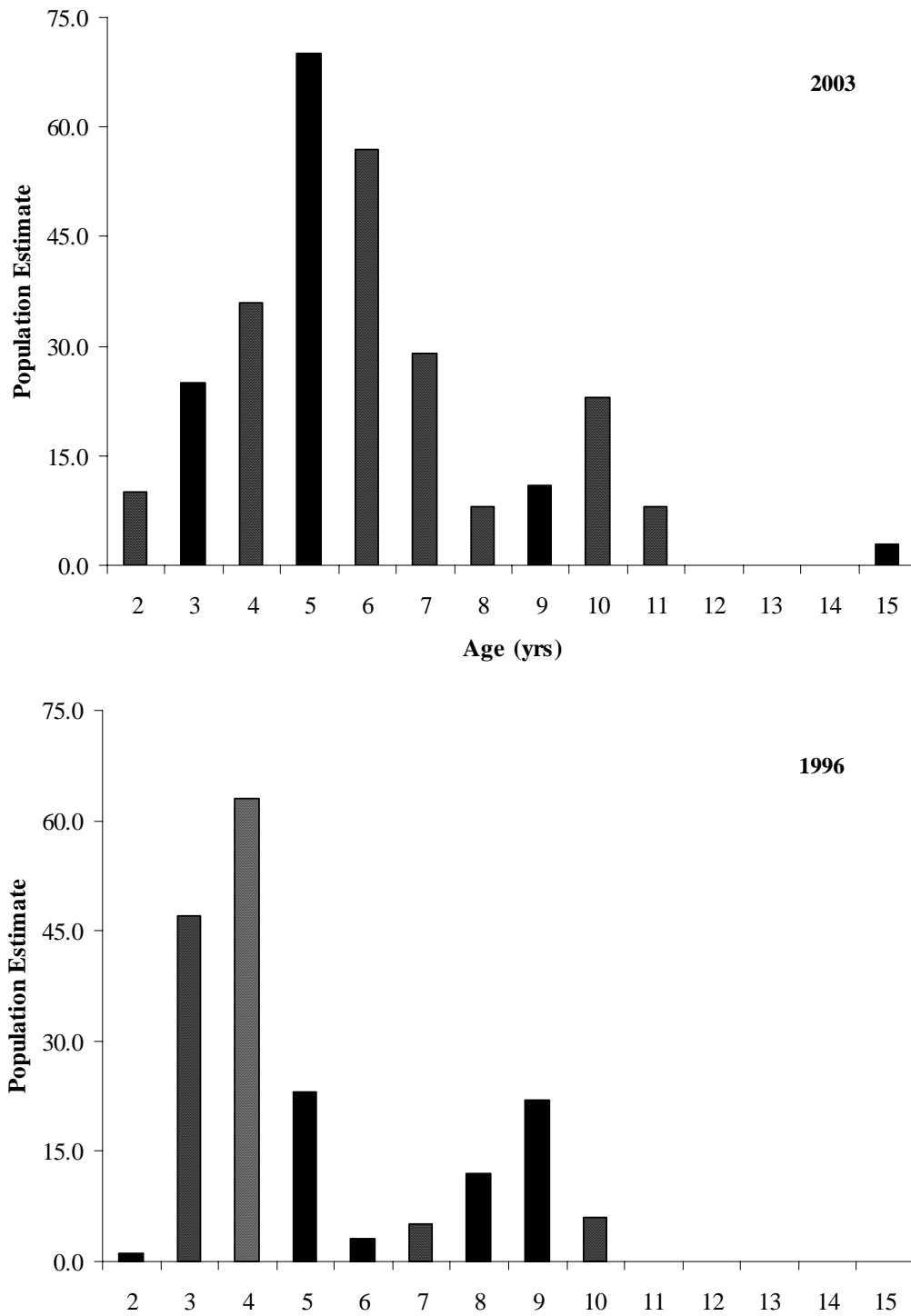


Figure 3. Walleye population age distribution, Crystal Lake, Bayfield County, 1996 and 2003. Diagonal bars represent age-classes stemming from years when stocking occurred.

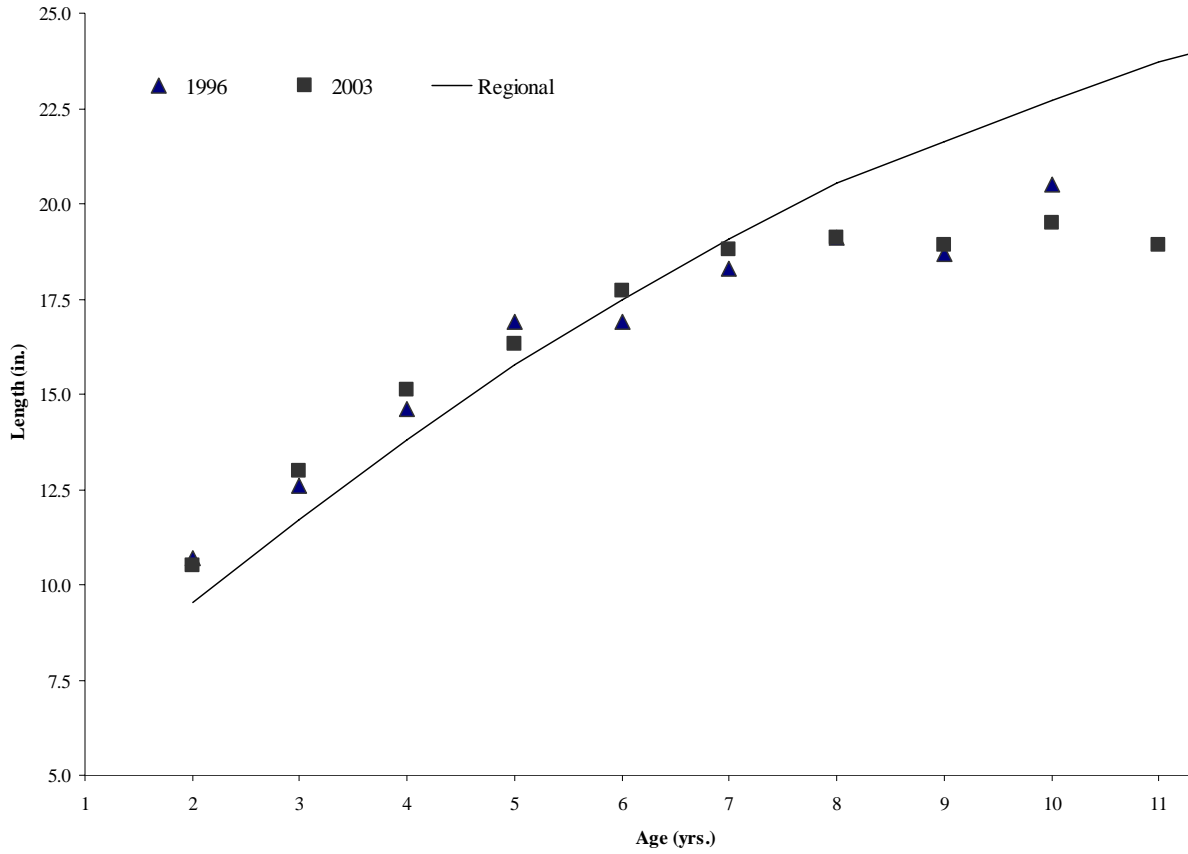


Figure 4. Age at length of walleye, 1996 and 2003, Crystal Lake, Bayfield County, Wisconsin, and mean length-at-age for walleye in the 18-county WDNR northern region.

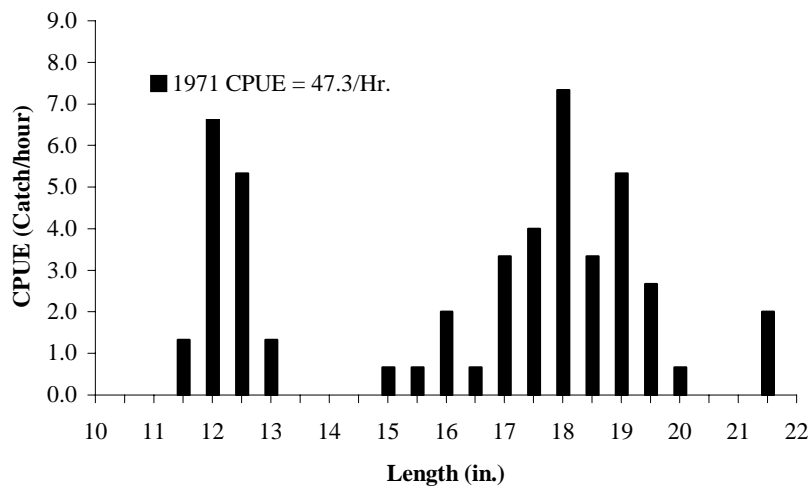
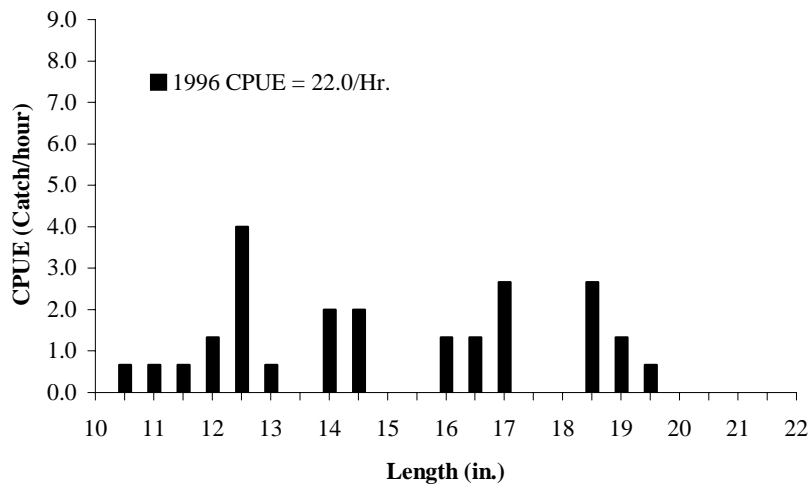
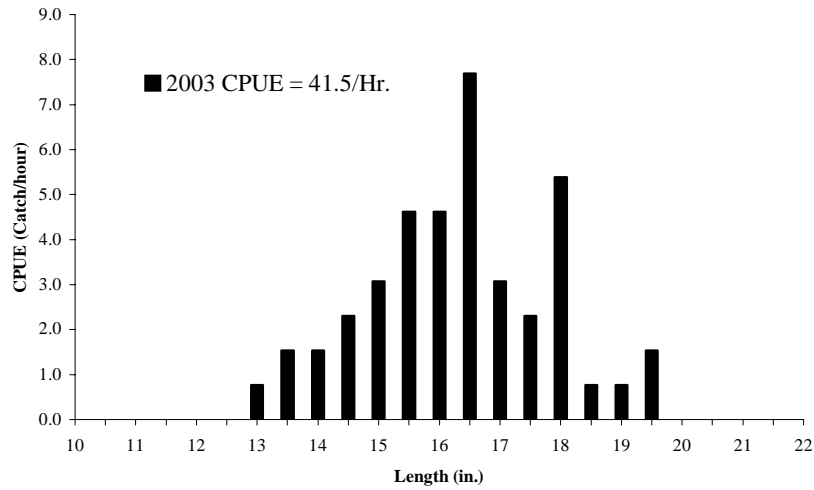


Figure 5. Relative abundance by length of walleye sampled during spring electrofishing, Crystal Lake, Bayfield County, 1971, 1996 and 2003.

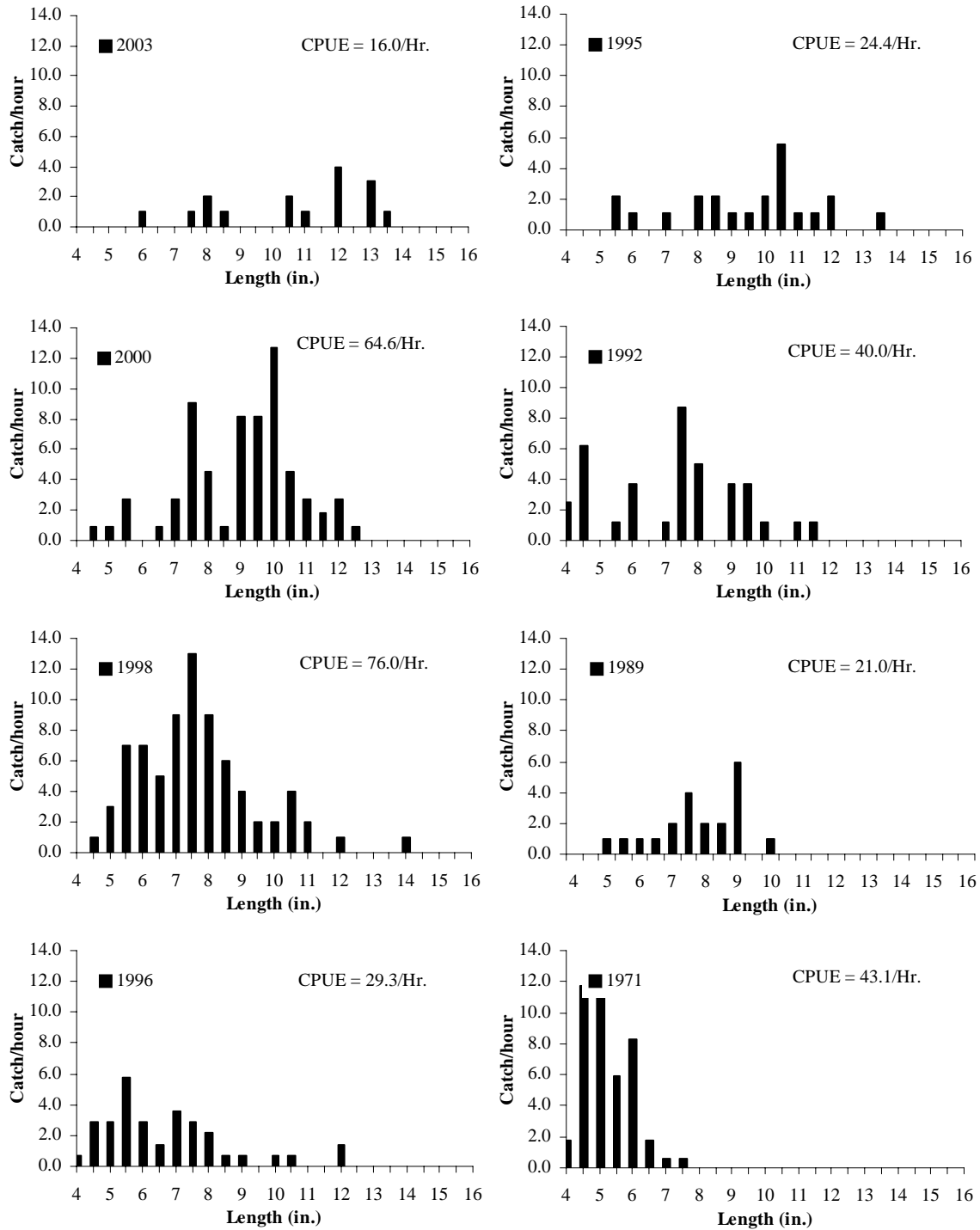


Figure 6. Relative abundance by length of smallmouth bass sampled fall electrofishing, Crystal Lake, Bayfield County, 1971 - 2003.

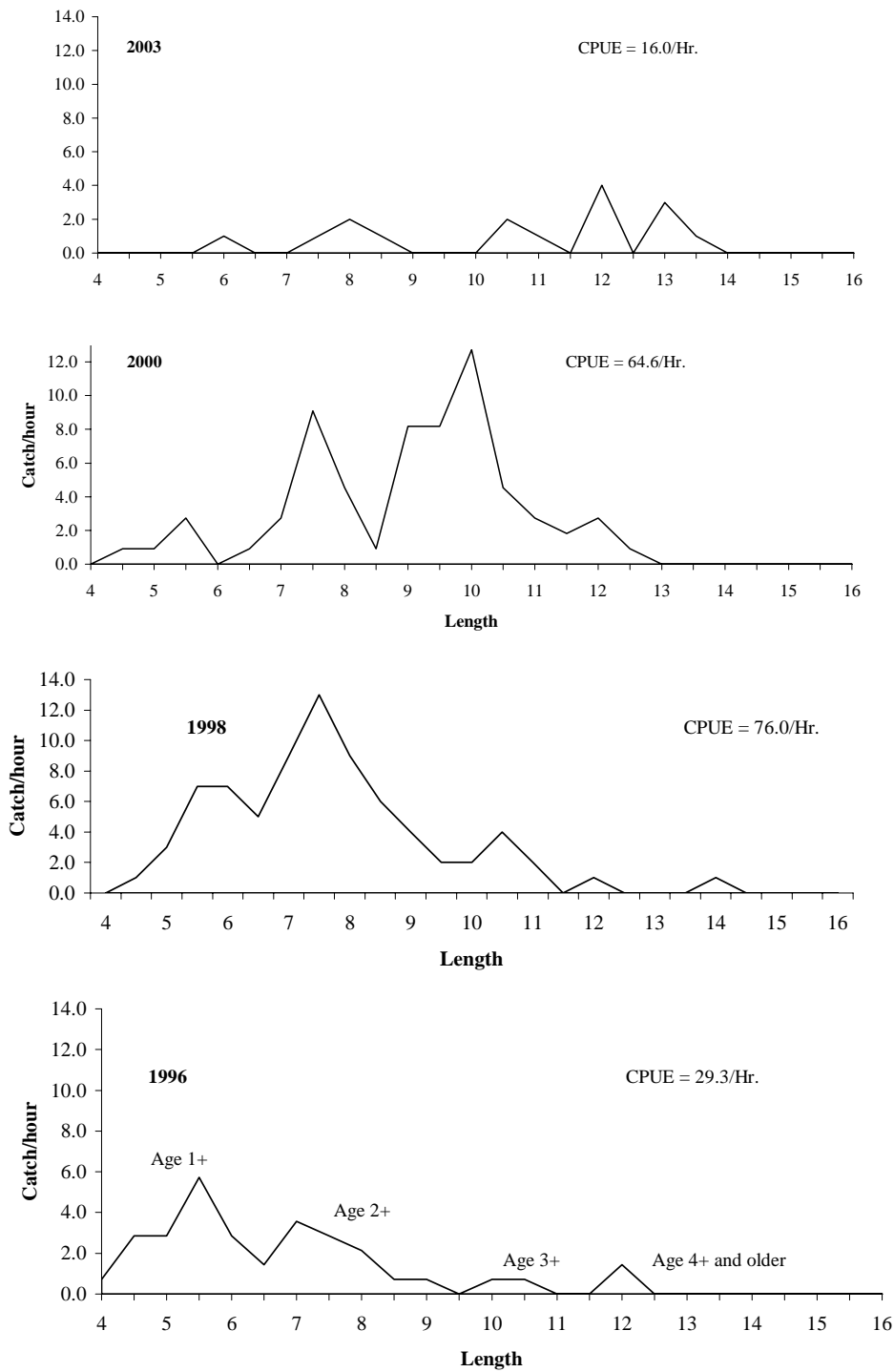


Figure 7. Modal length distributions of smallmouth bass sampled fall electrofishing, Crystal Lake, Bayfield County, 1996 - 2003.

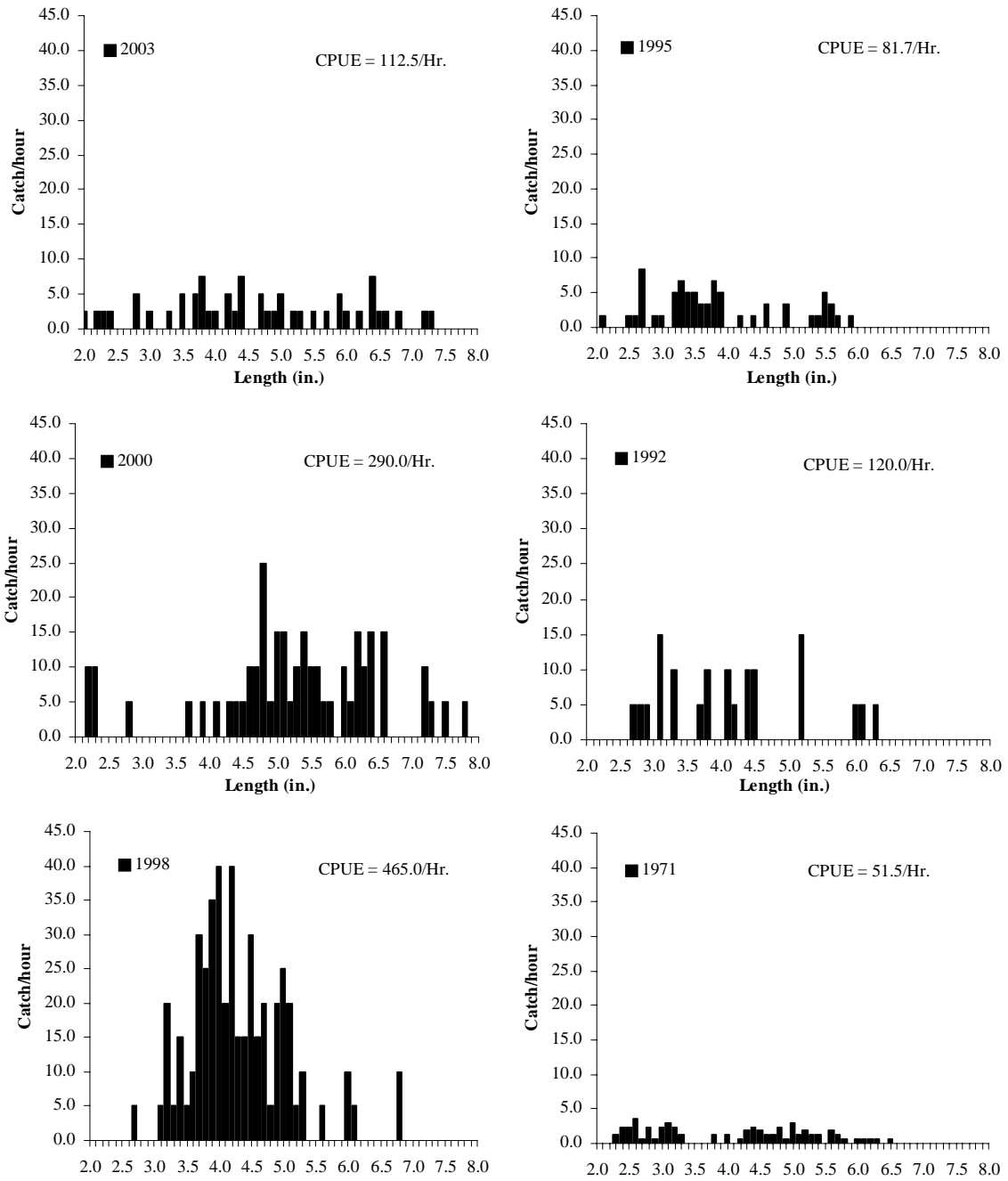


Figure 8. Relative abundance by length of bluegill sampled fall electrofishing, Crystal Lake, Bayfield County, 1971 - 2003.

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 |