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Division of Fisheries and Wildlife

Completion Report

Large Lake Sampling Program Assessment Report for Leech Lake 2008

by

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Leech Lake
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INTRODUCTION

Minnesota's ten largest walleye lakes account for nearly 40% of the annual statewide walleye *Sander vitreus* harvest and provide significant contributions to resource-based economies on both local and statewide scales (MNDNR 1997). Prior to 1983, fisheries assessments on these lakes were infrequent and highly variable in their methods. As a result, these surveys were unreliable for assessing fishery status as well as any fishery response to management actions. Recognizing the importance of these systems and the need for robust data to effectively identify and evaluate trends in fish stocks, the Minnesota Department of Natural Resources initiated the Large Lake Program (LLP) in 1983. Goals of the LLP include annual fishery surveys using standardized methods to facilitate comparisons among years and lakes, to detect management needs and evaluate management actions, and to enhance public outreach.

Sampling guidelines for the large lakes were outlined in the Large Lake Sampling Guide (Wingate and Schupp 1984). The primary focus of the LLP and its survey methods is to promote sustainable walleye fisheries. Leech Lake is the third largest lake within state boundaries and is one of eleven lakes monitored by the LLP (MNDNR 1997).

While Leech Lake is renown among anglers as an exceptional multi-species fishery, most anglers target and harvest walleye. During the 1998-99 open water seasons, anglers averaged 1.2 million angler hours and 174,000 pounds of harvested walleye per year (Sledge, 1999, 2000). However, several consecutive years without a large walleye year class caused declines in overall walleye abundance and an unbalanced population size structure; this in turn produced historically low levels of angler effort and walleye harvest during the 2004-2005 open water seasons (Rivers 2005, 2006). These changes to the walleye fishery, as well as stress responses in the yellow perch population, coincided with expanding populations of double-crested cormorants and invasive aquatic species such as rusty crayfish and Eurasian watermilfoil. As a result, an aggressive management plan was developed and implemented to improve fishing quality and the long-term sustainability of Leech Lake. Management actions aimed at improving the walleye fishery included protecting the spawning stock of adult walleye, increasing overall abundance of walleye in Leech Lake, improving the walleye population size structure, and establishing two good walleye year classes from 2005-2010. Strategies adopted to achieve these goals included a protected slot limit to reduce exploitation of walleye brood stock, double-crested cormorant control, and stockings of marked walleye fry. The overall goal of this plan was to quickly improve the quality of walleye fishing on Leech Lake while expanding on the current knowledge of walleye recruitment dynamics and the potential effects other species might have on walleye populations.

This report primarily addresses the 2008 Leech Lake fishery assessment. The 2007 assessment of the Leech Lake fishery determined that all management goals outlined in the 2005-2010 action plan had been met or exceeded (Schultz 2008). Furthermore, preliminary statistics of a creel survey indicated extremely good fishing on Leech Lake during 2008, particularly for walleye (D. Schultz, MN DNR, unpublished data). These findings indicate substantial improvements to the walleye population and its fishery over the course of a few years. Therefore, the 2008 population assessment is also compared to the action plan goals. The completion and thorough evaluation of these efforts will refine current management strategies on Leech Lake as well as identify the needs for new ones.

STUDY AREA

Leech Lake has approximately 112,000 surface acres. In its original state, Leech Lake covered about 106,000 acres. In 1884, a dam was built on the Leech River, raising the water level about two feet and increasing the surface area to its present size (Wilcox 1979). The maximum depth of the lake is near 150 feet; however, nearly 80 percent of the lake is less than 35 feet deep.

Leech Lake is located in three glacial zones and has an irregular shape with many large and small bays. Leech Lake varies considerably from a morphological perspective. Some large bays, such as Steamboat and Boy, display highly eutrophic water characteristics whereas other large bays, such as Walker and Kabekona, have properties more congruent with oligotrophic lakes. The main portion of the lake, like most large Minnesota walleye lakes, is mesotrophic. Previous estimates of shoreline miles have varied, but using remote sensing technology, the estimate is 201 miles. Approximately 23 percent of the shoreline consists of a gravel-rubble-boulder mixture, nearly all of which is used by spawning walleye (Wilcox 1979).

The diversity of the Leech Lake shoreline and substrate, as well as its extensive littoral zone, provides excellent spawning and nursery habitats for a number of species, in particular for percids and esocids, which dominate the fish community. Walleye, northern pike *Esox lucius* and muskellunge *E. masquinongy* are the principal predators and are located throughout the lake. Although most fish species are found in every portion of the lake, the largest walleye and muskellunge concentrations exist in the mesotrophic areas. Northern pike are most common in eutrophic bays supporting large areas of dense vegetation. Yellow perch *Perca flavescens* are abundant throughout the lake and are the primary forage for walleye and northern pike. Cisco *Coregonus artedi* and lake whitefish *C. clupeaformis* are an important forage base for muskellunge and trophy northern pike (Engstrom-Heg et al. 1986) and are typically found in the mesotrophic and oligotrophic areas. Other species present in the lake include: white sucker *Catostomus commersoni*, burbot *Lota lota*, rock bass *Ambloplites ruspestris*, bowfin *Amia calva*, shorthead redhorse *Moxostoma macrolepidotum*, bullheads *Ameiurus spp.*, pumpkinseed *Lepomis gibbosus*, bluegill *L. macrochirus*, largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieui*, and black crappie *Pomoxis nigromaculatus*.

YOUNG-OF-YEAR ASSESSMENT

Introduction

The objectives of this assessment are to index the relative abundance of young-of-year (YOY) walleye and yellow perch during this time period, to index growth rate, to collect structures necessary for stocking evaluations, and to estimate potential walleye year class strength. Standardized shoreline seining has been completed on Leech Lake since 1983. Shoreline seine catch rates can be strongly influenced by several factors, including fish behavior and size. Furthermore, seining occurs relatively early in the life-history process before first-year mortality functions, such as predation and growth, have fully acted on the cohort. Consequently, seining is reserved for collecting early information on YOY growth.

Three long-term trawling stations were established in 1987. Other stations had been attempted in the past but were discontinued due to contours that were difficult to sample, abundant vegetation, or frequent snagging that would destroy the gear. Trawling is currently the best tool for estimating the potential strength of walleye cohorts (Schultz et al. 2007), although other evidence suggests that the addition of YOY catch rates in standard gillnet sets may improve on the trawl-only model. Acknowledging that the relationships between YOY walleye catch rates in various gears and ensuing year class strength remain subject to the numerous mortality processes driving recruitment variability, year class strength is not determined until some time after the first winter, fall electrofishing was added to the suite of YOY walleye assessment tools in 2005 and standardized long-term stations were established in 2007 to further index walleye year class strength. Electrofishing has proven to be a useful method for predicting walleye year class strength on some of Minnesota's other large walleye lakes and, in time, has the potential to improve on the trawl-only and trawl-gillnet methods currently employed. Electrofishing catch rates are highly dependent on water temperature, water clarity, and weather. Consequently, not all stations may be sampled during years of frequently inclement weather.

Methods

Seining

Five long-term seining stations (Figure 1) were sampled weekly from July 7 through July 30, 2008 using the parallel-to-shore method. Two hauls were made at each station using a bag seine (100-ft. long, 5-ft. deep, 0.25-in. untreated mesh). The area seined was determined by assuming the actual lakeward distance covered by the seine was 90 feet, which compensated for the bow in the seine created by water resistance during pulling. This figure was then multiplied by the distance of the pull (150 feet) and resulted in an area of 13,500 ft.^{2} (0.310 acres) per seine haul.

All fish were identified to species when possible and measured to total length (TL, mm). With exception to minnows, fish judged as young-of-year (YOY) were measured separately. When necessary, seine hauls were sub-sampled due to an extremely large number of fish captured. In these instances all fish in a volumetric sub-sample were measured, by species, and the total number obtained in the sub-sample was expanded to the total volume sampled. Age-0 walleye and age 1+ fish of other species were individually counted and measured before sub-sampling occurred. Up to 20 YOY walleye and yellow perch were collected from each haul when possible. These fish were kept for individual measurement (total length (TL), mm; weight (W), g) no later than the following day.

Trawling

Trawling was conducted at the three long-term stations (Figure 1) from August 11 through August 19, 2008 using a semi-balloon bottom trawl (25-ft. headrope, 0.25-in. mesh cod end liner). Hauls consisted of five-minute tow times at a speed of 3.5 mph for a total effort of 100 minutes of trawl time. Fish were identified, measured, and enumerated as per the methods described for shoreline seining. Up to 20 YOY walleye and yellow perch were collected per haul for individual measurement (TL, mm; W, g) no later than the following day.

Walleye year class strength is indexed by the respective relative abundance of age 1-4 walleye in gillnet catches and has traditionally been estimated using trawl catch rates of age-0 fish. However, numerous factors influence the survival of young walleye and eventually the size, or strength, of any given cohort. As a result, any measure of relative cohort strength based on the relative abundance of age-0 fish will inherently be highly variable. In spite of this, the incorporation of additional metrics, such as indices of growth or YOY walleye catch rate in experimental gillnet sets, can explain some of the additional year-to-year variability for a more precise estimate. For Leech Lake, more variability in walleye year class strength can be explained when it is predicted using both trawl and gillnet catch rates of YOY walleye (1987-2008; $F = 13.51$; $R^2 = 0.60$; $P = 0.0003$) than using trawl catch rates of YOY walleye independently (1987-2008; $F = 6.60$; $R^2 = 0.26$; $P = 0.0188$). Growth of YOY walleye, as indexed by mean TL (mm) during the 34th Julian week (mid-August), provides no substantial improvement over the trawl-gillnet based estimate.

Fall Electrofishing

Fall nighttime electrofishing targeting YOY walleye was conducted during the week of September 15, 2008 using a Coffelt pulsed-DC electrofishing boat (VVP 2E; spherical anode). Favorable weather allowed for successful sampling of all four stations this year. Sampling sites were approximately 3-5 feet deep on sand/gravel/cobble shorelines. Sampling runs consisted of 20 minutes of continuous on-time from the starting point (Figure 1). Up to 25 age-0 walleye per run were kept for individual measurement (TL, mm; W, g) and otolith removal no later than the following day; all age-1+ walleye captured were measured (TL, mm) and released.

Results

Seine

A total of 40 seine hauls captured 18 different species (Table 1). Seine catch rates of YOY walleye were highest at Fivemile Point, whereas catch rates of YOY yellow perch were highest at the Stoney Point station (Table 2). The overall catch rate of YOY walleye was 49 fish/acre and is below the 1983-2008 mean of 57.6 fish/acre (Figure 2). Conversely, the overall catch rate of YOY yellow perch was 2,013 fish/acre, well above the historical mean of 874 fish/acre (Figure 2). Seine catch rates are not used to index the relative abundance or the potential year class strength of YOY percids.

Trawl

A total of 100 minutes (20 hauls) were trawled in Leech Lake in 2008, collecting 14 different species (Table 1). By station, trawl catch rates of YOY walleye and yellow perch were highest at the Whipholt Beach station (Table 3). The overall catch rate of YOY walleye was 508 fish/hour and is well above the 1987-2008 mean of 143 fish/hour (Figure 2). Conversely, the overall catch rate of YOY yellow perch was 9,577 fish/hour and is very near the long-term average of 9,693 fish/hour (Figure 2).

This year's trawl catch rate predicts a walleye year class strength (± 95% CI) of 214 ± 96 (Table 4). However, inclusion of the YOY walleye gillnet catch rate suggests a potential year class strength of 179 ± 75. Both predictions predict a year class with above-average strength.

Electrofishing

All 12 electrofishing stations were successfully sampled during September 2008. The 2008 electrofishing catch rate of YOY walleye was 41.65 fish/hour (Table 4; Figure 2). This is only below the 2005 catch rate of 60.16 fish/hour. Electrofishing catch rates should be viewed with caution as several consecutive years of consistent sampling are required before its utility for indexing walleye year class strength can be effectively evaluated.

YOY Growth Indices

Growth of YOY percids was indexed by mean weekly length and condition during July through September. Mean length-at-week was below respective long-term averages for both species (Figure 3). For walleye, the difference was about one inch; for yellow perch, this difference was about one-quarter inch. Condition of walleye, indexed using weekly K-factors, was approximately average and varied little on a week-to-week basis. In contrast, weekly K-factors of YOY yellow perch were highly variable.

Discussion

Walleye recruitment in natural lakes is highly variable across years and is influenced by a number of physical and biological effects. High abundances of adult walleye can suppress ensuing year classes via predation (Chevalier 1973; K. Reeves, personal communication) and competition (Madenjian et al. 1996; Beard et al. 2003). Similarly, high adult abundances of other species, such as yellow perch, can exert enough predation on a walleye year class to significantly influence its outcome (Hansen et al. 1998). Spring warming rates have a strong influence on incubation times, egg survival, and food availability for newly-hatched fry (Madenjian et al. 1996; Hansen et al. 1998). Furthermore, first-winter survival of YOY walleye is size-specific and therefore strongly influenced by growth rate (Madenjian et al. 1996) and condition (Bandow and Anderson 1993) during the first summer. Therefore, the magnitude of a year class is not only determined by the number of fry that are successfully produced, but also through annual changes in the gauntlet of age-0 mortality sources and the degree each mortality source acts on a cohort during any given year.

Due to the high degree of variability in young walleye survival, estimating recruitment (ie. year class strength) based on age-0 metrics is inherently variable. For example, diversity exists among Minnesota's ten largest walleye lakes as to which YOY walleye sampling methods are the best predictor of ensuing year class strength. Fall electrofishing catch rate is the best metric on Cass, Kabetogama, Rainy, and Vermillion lakes. Conversely, trawling is the preferred method on Lake of the Woods, Leech, Mille Lacs, and Winnibigoshish lakes. Red Lake is the only lake where seining is the best tool for predicting walleye year class strength, and all three gears are used on Lake Pepin. Therefore, while nearly 20+ years of annual survey work has determined the best gear(s) for predicting walleye year class strength in each of these systems, no estimate is without error from year to year because of the dynamic mortality processes that determine recruitment.

Trawl catch rates of YOY walleye were well above average, initially suggesting a strong year class. However, growth and condition of age-0 walleye were approximately 1-inch below average during 2008, likely caused by the late spring and cool summer, which led to no age-0 walleye being sampled during the gillnet survey. As a result, size-specific first-winter mortality could play a key role in the fate of the 2008 walleye year class in spite of rather robust predictions of above average recruitment. High mortality could manifest as fish unable to meet energetic demands during winter, as suppression by preceding year classes (Kershner et al. 1999), or some combination thereof. Suppression tends to be associated with cannibalism, particularly by larger adult walleye encountering forage limitations (Chevalier 1973; K. Reeves, personal communication), or by intra-cohort competition for food sources (Li et al. 1996).

GILLNET SURVEY

Introduction

Gillnet surveys on Leech Lake have been completed annually during the first two weeks of September. Gillnets are the most effective method for assessing walleye and yellow perch populations; however, information on other species is also collected. Experimental nets (50-ft. panels of 0.75, 1.00, 1.25, 1.5, and 2.0-inch bar mesh; 250-ft. total net length) are used to reduce size-selective biases encountered when using nets of a single mesh size. Standardized methods include net design, net location, net orientation, and time of year.

Since the LLP began in 1983, four nets have been fished at fixed locations within each major bay (Wingate and Schupp 1984); the Pelican Island sets were added in 1984 for a total of 36 net sets per year. Data collected with gillnets measure trends in population metrics, such as relative abundance, spawner stock biomass, age- and size-structure, growth rates, mortality, and year class strength. Gillnet catch rates are also used to establish population management goals that can be quantitatively evaluated over time.

Methods

Standard experimental gillnet sets were lifted at 36 different locations throughout the lake from September 1 through September 12, 2008. Four sets were made in each of 9 different areas (Figure 4). For some analyses, gill net data were separated into western bays (17,927 acres) and main lake (93,914 acres) areas because differences in walleye abundance, growth, movement, and yield (Schupp 1978) between areas suggest the potential for contrasting population responses to fishing pressure and other environmental changes. Western bays sets included net stations 1-16 and main lake sets included net stations 17-36. Gill net locations in 2008 were approximately identical to locations sampled annually since 1984.

All fish captured were identified to species, measured (TL, mm), and weighed (g) with a 6.8-kg capacity digital scale. Sex and maturity data were recorded for all walleye, yellow perch, and northern pike when possible. Data were recorded separately for each of the five mesh sizes within each net. Weights and lengths were converted from metric units to English units for better comparison with historical data. Sex and maturity were assigned to fish destroyed by crayfish based on the frequency of occurrence in 25-mm length intervals within each basin using a modified version of an age-length key assignment program (Isermann and Knight 2005).

Ages were estimated using saggittal otoliths from all walleye and a single cleithrum from esocids. Otoliths were removed from a minimum random subset of 5 yellow perch per sex per mesh panel of each net. In most cases, sub-sampling for yellow perch otolith collection only occurred within the 0.75- and 1.00-inch mesh sizes. To estimate age, a per-basin maximum subsample of 10 yellow perch otoliths within 25-mm length intervals was randomly selected and aged for each sex. Age was then assigned individually to fish not aged based on observed length and sex frequencies (Isermann and Knight 2005) within 25-mm length intervals. Age assignment was basin-specific for each species because differences observed in walleye population metrics among basin types (Schupp 1978) exist to some extent for other species (Schultz 2008).

Results

Catch rates and length-frequency distributions of all species caught during the 2008 gillnet survey are summarized in Tables 5 and 6; historical gillnet catch summaries are in Table A13 and Figure A1 in the Appendix.

Walleye

A total of 326 walleye were sampled in gillnets. The 2008 gillnet catch-per-effort (CPE) of 9.06 walleye/net is below the catch rate observed during 2007 (13.1 walleye/net) but above the 1983-2008 average of 7.5 walleye/net (Figures 5 and 6). Historical gill net catch rates have ranged from 4.6 fish/set (1993) to 13.4 fish/set (1988). Of walleye captured during the 2008 gillnet survey, 75% were sampled in main lake sets. By sampling area, walleye gillnet CPE ranged from 3.25 fish/net (Kabekona Bay) to 16.75 fish/net (Pine Point) (Table 7). Biomass of mature female walleye was 1.32 pounds/acre, which is within the current management goal of 1.25-1.75 pounds/acre (Figure 7), and below the historical high observed during 2007 (2.13 pounds/acre).

Walleye from 8 to 26 inches (total length; TL) were present in the gillnet sample (Figure 8). Early indications are that the 2007 year class is above average, as predicted by the trawl-gillnet YCS model a year ago, making it the third consecutive year class of walleye to establish in Leech Lake. Observed median lengths of the 2007, 2006, and 2005 year classes were approximately 10, 14, and 18 inches TL, respectively. While the respective lengths-at-age for these year classes are ahead of the long-term average, growth was slower during 2008 than in previous years. The 2005-2007 year classes comprised 79% of the total walleye gillnet catch (Tables 8 and 9).

Walleye growth, indexed by mean length-at-age of fish caught in gillnets, was above the long-term average for all age groups (Figure 9; Tables A1-A4). Growth rates among sexes were similar until age-2 in both basins, after which females were consistently longer than males of the same age. Female walleye sampled in the main lake averaged approximately 1.0 inches longer than did females in the western bays. Similarly, males in the main lake also averaged about 1.0 inches longer than did males in the western bays. Length and age of female walleye at 50% sexual maturity was 19.2 inches and 3.5 years, respectively (Table 8). Conversely, males at 50% sexual maturity were approximately 16.0 inches long and 2.5 years old (Table 9).

A suite of biological performance indicators (BPIs), or population response metrics, were developed to monitor exploitation of Minnesota’s large lake walleye populations (Gangl and Pereira 2003). Exceedence of BPI threshold levels can be indicative of overharvest or, more precisely, increased mortality. One of the first physical signs of increased mortality is increased growth. Over the past several years, mean length at age-3, omega, and female age at 50% maturity, all three of which are either direct measures of growth or are strongly influenced by growth, have shown cause for concern (Figures 10 and 11). While the same holds true for 2008 in that these metrics still exceed their respective thresholds, omega and female age at 50% maturity are improving. Furthermore, female age diversity and female length at 50% maturity have increased, indicating that the 18-26" protected slot is having a positive effect on the population and the population is beginning to revert to a more normal state. Therefore, while the three BPIs that are most influenced by growth still exceed threshold values, nearly all BPIs are beginning to move towards the thresholds, which indicates an overall improvement to the population.

Yellow Perch

Similar to the walleye catch rate, the 2008 yellow perch gillnet catch-per-effort of 26.56 fish/net is down from 2007 observations but above the 1983-2008 average of 21.7 fish/net (Figures 5 and 6). Historically, gill net catch rates have ranged from 12.9 fish/net (2005) to 37.7 fish/net (1995). Catch rates of yellow perch in the main lake were 20.35 fish/net and 34.31 in the western bays, both above their respective averages (Table 5). By area, yellow perch gillnet catch rates ranged from 2.75 fish/net (Pelican Island) to 52.00 fish/net (Sucker Bay) (Table 7).

Lengths of yellow perch sampled with gillnets ranged from 5 to 12 inches TL (Figure 12). Of yellow perch sampled, approximately 36% were 8 inches or longer and 11% were 10 inches or longer. This is the first time since 2001 that the proportion of perch 10 inches or longer has exceeded 10%, and suggests that yellow perch fishing should continue to improve.

In general, growth of yellow perch, indexed by mean length-at-age of fish caught in gillnets, was above the long-term average for nearly all male and female age groups in both basins (Tables A5-A8). Similar to walleye, yellow perch grow slightly faster in the main lake than in the western bays. Growth rates between sexes are similar through about age-3, after which females tend to be larger than males of the same age. Length and age of female yellow perch at 50% sexual maturity were approximately 6.5 inches and 2.5 years, respectively (Table 10). Males tend to reach sexual maturity before they are effectively sampled by gillnets (Table 11). Therefore, while length at 50% maturity cannot be directly estimated for males, age at 50% maturity probably occurs at age 1.

Northern Pike

The 2008 gillnet catch rate of northern pike of 5.61 fish/net is down slightly from 2007 but remains above the long-term average of 4.8 fish/net (Figures 5 and 6). Northern pike gillnet catch rates have been relatively stable, ranging from 3.6 fish/net (1993) to 6.2 fish/net (1995). Consistent with long-term trends, mean catch rate during 2008 was higher in the western bays (7.19 fish/net) then in the main lake (4.35 fish/net) (Table 5), likely due to the dense vegetation frequently found in the western bays that supports a higher density of northern pike. By area, gillnet catch rates of northern pike ranged from 2.00 fish/net (Portage Bay) to 14.75 fish/net (Kabekona Bay) (Table 7). Lengths of northern pike ranged from 8 to 33 inches (Figure 13).

Growth rates of northern pike, indexed by length-at-age of fish captured in gillnets, were near the long-term averages for most age classes of males and females in both basins (Tables A9-A12). The majority of both male and female northern pike sampled had reached sexual maturity by age 2 (Tables 12 and 13). Generally, males and females have similar lengths through age 2, after which females grow faster and achieve larger sizes. Similar to walleye and yellow perch, northern pike in Leech Lake tend to grow slightly faster in the main lake than in the western bays.

Cisco (Tullibee)

The 2008 catch rate of 1.61 fish/net was below the 1983-2008 average of 5.56 fish/net (Figures 5 and 6). Gillnet catch rates of cisco have varied considerably, ranging from 0.6 fish/net (2006) to 18.5 fish/net (1987). Catch rates were slightly higher in the western bays (2.00 fish/net) than in the main lake (1.30 fish/net); the deepwater habitats in the western bays are more advantageous to cisco populations, particularly so during summer. Cisco catch rates have been in a general state of decline since the mid-1990's, and this trend is most prominent in the main lake where coldwater refuge for this species is limited during summer months. Cisco catch rates during 2008 ranged from 0.00 fish/net (Steamboat and Agency bays) to 7.75 fish/net (Kabekona Bay) (Table 7). Lengths of cisco sampled in gill nets ranged from 8 to 16 inches.

Bullheads

The collective 2008 gillnet catch rate of bullhead species was 5.7 fish/net and ranged from 0.25 fish/net (Pine and Portage Bay sets) to 23.50 fish/net (Steamboat Bay). The gill net catch rate for black bullhead (*Ictalurus melas*) was 1.14 fish/set, which is below the long-term mean catch rate of 6.34 fish/set. The catch rate of yellow bullhead (*I. natalis*) was 2.56 fish/set, which is above the historical mean of 1.51 fish/net. The catch rate of brown bullhead (*I. nebulosus*) was 1.97 fish/net, which is also above the long-term average (1.71 fish/set). Of the 204 bullhead sampled, 35% were brown bullhead, 20% were black bullhead, and 45% were yellow bullhead.

Other Species

Other species, which include bowfin, burbot, lake whitefish, muskellunge, rock bass, pumpkinseed, bluegill, largemouth and smallmouth bass, and black crappie are not effectively sampled by experimental gill nets or are present in low numbers. Gill net catch rates for most of these species were within observed ranges from 1983-2007. The only exception was white sucker, where the 2008 gillnet catch rate of 0.61 fish/net is a new historical low.

Discussion

Overall, gillnet catch rates of most species decreased slightly from 2007 but remained above respective long-term averages. The continued improvements in the walleye and yellow perch populations since 2005 are positive responses to recent management actions. The protected slot limit on walleye has successfully protected mature females in Leech Lake, thereby increasing the reproductive capacity of the population. The recruitment and fast growth of the 2005-2007 walleye year classes have been the primary cause for the increase in overall walleye abundance and numerous reports of improved fishing quality in Leech Lake. However, density is an important factor regulating growth, maturity, and recruitment (Spangler et al. 1977; Muth and Wolfert 1986; Schueller et al. 2005). As a result, walleye population metrics in Leech Lake, which are indexed by the BPIs, seem to be returning to levels more concordant with historical averages as density-dependent effects are expressing themselves with increasing abundance. Some of these, such as female age and length at 50% maturity, had already begun improving towards historical levels at the time of the 2007 assessment. Furthermore, the changes in the walleye population have led to considerable improvements to the recreational fishery, as indicated by a creel survey conducted this summer (D. Schultz, MN DNR, unpublished data).

Double-crested cormorant control efforts have reduced predatory pressures on yellow perch. While reductions in cormorant numbers have occurred with increases in perch abundance and size structure, concrete conclusions should be based on a thorough evaluation of yellow perch population dynamics.

The northern pike population is in a relatively stable status by all standards. The slight decrease in the average length of northern pike sampled during 2008 (22 inches) from 2007 observations (23 inches) was likely caused by a combination of increased fishing pressure and harvest (D. Schultz, MN DNR, unpublished data) as well as an increased frequency of younger fish during the 2008 survey and is therefore not cause for concern.

Cisco remain in a state of decline in Leech and other large lakes (e.g. Mille Lacs; T. Jones, MN DNR, personal communication) due to warmer-than-average summers occurring more frequently than they have in the past. In particular, this trend is most prominent in the shallower, more windswept main lake basin of Leech Lake where oxygen-rich coldwater habitat is limited. When unusually warm air temperatures are combined with strong winds, the entire water column is mixed and water temperatures increase markedly over a short period. In the case of coldwater species (e.g. cisco), as environmental temperatures exceed the thermal optima for proper physiological functions and are sustained at unusually high levels for extended periods (days to weeks), basic cellular processes begin to operate less efficiently. As explained more specifically by Pörtner (2001) and Pörtner and Knust (2007), oxygen demand for metabolic processes at the cellular level in fish increases exponentially with increases in temperature. At the same time, the capacity for water to retain oxygen diminishes with increasing temperature. Thermal stress occurs when aerobic metabolic demands exceed the capacity of the oxygen delivery system (ventilation and circulation). Therefore, thermal stress in fish can primarily be defined as an oxygen-limiting process, much like human aerobic performance at high altitudes. As temperatures continue to increase beyond the onset of physiological stress, or as this stress is prolonged, an oxygen deficiency can occur and eventually lead to mortality. Consequently, if the trend of increasing summer temperatures continues the cisco population in Leech Lake will be limited to the constraints of temperature-mediated mortality and could have impacts on other species, specifically the growth rates of predatory species.

FRY STOCKING

Introduction

Recruitment variability, or the variability in the size, or strength, of a year class, is influenced by a host of factors, including spawner abundance (Ricker 1975), predation (Hansen et al. 1998; Beard et al. 2003; Quist et al. 2003), spawning conditions (Hansen et al. 1998), forage abundance (Chevalier 1973), and lake morphology (Nate et al. 2001). In Minnesota's ten largest walleye lakes, strong year classes, as indexed by gillnet catch rates of 1-4 year old walleye, are defined as cohorts having a relative abundance in the upper 75th percentile of historically observed values. Strong year classes typically occur every 3 to 5 years in the large lakes. However, variable spawning and summer growing conditions can intermittently alter this frequency. Unfavorable reproductive conditions, a limited forage base, or high abundances of adult walleye can extend the time between large year classes. Fishing quality, defined by angler catch rates, closely parallels the occurrence of a strong year class. The downturn in the Leech Lake walleye fishery during the mid-2000's was a product of a prolonged period between large year classes. Proposed causes of missing year classes included double-crested cormorant predation on juvenile walleye, lower reproductive success by Leech Lake walleye in recent years, and potentially higher walleye egg mortality via rusty crayfish predation. Jarnot (2009) investigated the potential effects of rusty crayfish predation on walleye eggs and Göktepe (2008) evaluated cormorant predation on Leech Lake walleye. Therefore, the objective of this portion of the 2008 large lake work was to directly estimate walleye hatch rates in Leech Lake and to compare hatch rates observed in Leech Lake to those in other systems where similar quantitative methods have been used.

Methods

During May 2008, 22.1 million Woman Lake/Boy River walleye fry were stocked into Leech Lake. All stocked fry were marked with oxytetracycline, an antibiotic that leaves an indelible mark on fish bones that allows researchers to identify them as a stocked fish. By stocking a known number of fry, the total number of wild fry at the time of stocking was estimated using a Peterson mark-recapture equation (Logsdon 2006); this is based on the ratio of marked (stocked) to unmarked (wild) YOY walleye collected during the YOY and gillnet sampling assessments. The hatch rate of wild fry can then be estimated as a percentage of eggs carried the previous fall that hatched into fry the following spring at the time stocking occurred.

Results

A total of 511 YOY walleye were collected using shoreline seining (July), bottom trawling (August), and shoreline electrofishing (September) and examined for the presence of an OTC mark. Of the fish examined, 55% were identified as stocked fish. The 2008 wild fry hatch rate was estimated to be 0.31%, the second highest observed since walleye fry stocking began in 2005 (Table 14). The wild fry population estimate was 18.4 million and the estimated number of total fry (stocked plus wild) was 40.5 million. Fry densities per littoral acre were 317 wild fry/littoral acre (LA) and 699 total fry/LA. The 2005-2007 year classes of walleye were established with densities less than 600 total fry/LA.

Discussion

Red Lake, with its windswept gravel substrate, has historically been considered ideal habitat for a self-sustaining walleye population. The collapse of the Red Lake walleye fishery during the 1990's provided a unique opportunity to characterize walleye recruitment dynamics during the recovery period. Walleye hatch rates in Red Lake were estimated from 1999-2003 using methods similarly described for Leech Lake and have served as a description, or benchmark, of good reproduction in self-sustaining walleye populations.

The range of walleye hatch rates in Leech Lake is very similar to those observed in Red Lake and the average hatch rate in Leech Lake was actually higher than that observed in Red Lake. Thus, these data strongly suggest there is no fundamental problem with walleye reproduction in Leech Lake and should alleviate concerns that rusty crayfish are negatively impacting walleye recruitment.

Walleye fry stocking has contributed to the establishment of recent year classes in Leech Lake. However, the hypothesis that these contributions were entirely additive is not supported by the data. Total walleye fry stocked has ranged from approximately 7.5 million fry in 2005 and 2007 to 22 million fry in 2006, or roughly three times higher in 2006. While this difference has been expressed to some extent as a higher percentage of marked YOY within the 2006 and 2008 year classes, the overall gillnet catch rate of the 2006 year class at ages 1-2 has not been of similar magnitudes higher (e.g. 3 times higher than the gillnet catch rates of the 2005 and 2007 year classes). Biological limitations (i.e. carrying capacity) are likely acting on these cohorts via replacement of wild fish and increased total mortality, which in turn limits the number of fish successfully surviving through their first winter.

OTHER WORK

Water Quality

Water samples were collected at stations 1 and 5 on 21 July 2008. The Minnesota Department of Agriculture Chemistry Laboratory in St. Paul, Minnesota analyzed these samples for total phosphorus concentration, conductivity, chlorophyll a, pH, total alkalinity and total dissolved solids. Oxygen and temperature profiles were also taken at water chemistry stations 1, 2, 3, and 5.

There has been no apparent change in water quality since the inception of the Large Lake Program. In general, Walker Bay is less productive with better water clarity than the main lake (Table 15). Typically, deep water stations thermally stratify and experience dissolved oxygen depletion near the thermocline while main lake stations do not thermally stratify and maintain good dissolved oxygen concentration throughout the water column (Figure 14). A thermocline was not documented in the main lake during 2008.

Eurasian watermilfoil

A survey of Leech Lake boat harbors in 2004 found established beds of Eurasian watermilfoil (EWM) in several harbors between Stony and Rogers points and were immediately treated with aquatic herbicide (Figure 15). Every year since 2004 harbors on the west and south side of the main lake have been checked for EWM by DNR personnel and treated when necessary. Extensive searches have not discovered rooted EWM outside of harbors to date and treatments have resulted in the eradication of EWM from some areas. However, this invasive species continues to be discovered in new locations.

During summer 2007 EWM was discovered and treated in three new locations, one in Sucker Bay and two near Bear Island. Reports from lakeshore owners in conjunction with a search conducted by DNR crews completed on 5 August 2008 found EWM in 17 previously uninfested boat harbors.

Double-crested cormorant control

A total of 2,601 adult cormorants and 79 eggs were removed from Leech Lake during 2008, bringing the overall total to 9,487 birds culled since work began in 2005 (Figure 16) (LLBO 2008). Small yellow perch have been the most common component of cormorant diets (LLBO 2007). The results of the diet study, which will be used to determine the appropriate cormorant population level that Leech Lake can support without impacting fishing quality, are currently being concluded and will be made available shortly.

Rusty crayfish research

In laboratory and field experiments, rusty and native crayfishes preyed on walleye eggs at similar rates under similar conditions, indicating that both species will consume walleye eggs when they are available (Jarnot 2009). However, the authors do point out that there is no evidence explicitly implicating a strong systematic trend toward declining walleye abundance in the presence of rusty crayfish. Furthermore, walleye hatch rates on Leech Lake have exceeded those observed in Red Lake, a lake with excellent natural walleye reproduction and no rusty crayfish. Therefore, the cumulative evidence indicates that rusty crayfish are not having a detrimental effect on walleye reproduction or abundance in Leech Lake.

SUMMARY

Recent management actions and favorable environmental conditions have allowed for quick improvements in the Leech Lake yellow perch and walleye populations. Cormorant control efforts since 2005 may be at least partially responsible for the dramatic increase in the relative abundance of yellow perch in the main lake (indexed by gillnet catch rates). Good recruitment and favorable growing conditions have led to the establishment of strong walleye year classes in 2005-2007. The strength of the 2008 year class will hinge largely on winter survival and yellow perch abundance.

Growth of recent walleye year classes, indexed by length at age, is nearly a full year ahead of the long-term average and has been the product of abundant yellow perch production, an extended frequency between large year classes, and potentially longer growing seasons. This growth has greatly contributed to the rapid improvements in fishing quality that walleye anglers experienced during 2008. The current walleye regulation (protected slot limit where all walleye from 18 inches to 26 inches must be immediately returned to the water, possession limit of four fish) has also benefited fishing quality by increasing the number of older, larger walleye in the population for anglers to catch. Furthermore, preliminary results of the creel survey conducted during 2008 indicated extremely good walleye fishing on Leech Lake throughout the summer. Another survey is scheduled for summer 2009.

Regarding walleye reproduction, rusty crayfish did not predate on walleye eggs at statistically higher rates than native crayfish (Jarnot 2009). Additionally, walleye hatch rates in Leech Lake have been better than those observed in Red Lake, a lake characterized by robust walleye production and no documented invasive species. These findings suggest that there is no systemic problem with walleye reproduction in Leech Lake.

Benchmarks used to evaluate the success of the 2005-2010 action plan designed to improve the walleye population include a standing stock biomass of mature females maintained at 1.25-1.75 pounds/acre, an increase in the walleye gillnet catch rate to at least 7.4 fish/net, at least 50% of walleye sampled in experimental gillnets being shorter than 15.0 inches, and the establishment of two strong year classes of walleye between 2005-2010. As in 2007, all goals for this action plan have been met or exceeded in 2008. The estimated spawner biomass in 2008 was 1.32 pounds of walleye per acre. The gillnet catch rate in 2008 remained above the 1983-2004 average of 7.4 walleye/net. Of the 326 walleye sampled in 2008 gillnet sets, 51% were shorter than 15.0 inches; this is in spite of exceptionally the fast growth exhibited by young walleye during 2005-2007. Furthermore, strong year classes of walleye were produced during 2005, 2006, and 2007.

In addition to the dramatic improvements to the walleye and yellow perch populations, Leech Lake continues to support numerous sportfish populations that appear relatively healthy or unchanged, and remains a destination for many anglers pursuing quality multi-species angling opportunities. Northern pike abundance is above average and the size structure of the yellow perch population has increased. Anglers frequently report

catching bluegills up to 10 inches, and the relative abundance of black crappie, as indexed by gillnet catches, is also above average. Leech Lake continues to be a destination for several bass and muskellunge fishing tournaments each year.

Thus far, the aggressive monitoring and treatment of Eurasian watermilfoil (EWM) appears to have kept this invasive plant in check as discovered. Unfortunately, the plant continues to be introduced into new locations around the lake each year. Constant awareness by users and property owners alike is paramount to prevent the spread and establishment of EWM to new locations.

RECOMMENDATIONS

Leech Lake supports a diverse fish population and maintains good water quality. However, human development continues to expand throughout the area and, as more people relocate to this area and recreate on and around Leech Lake, the opportunities for further detrimental effects from human activities will continue to increase. Habitat protection measures should be taken to ensure the ecological resilience of Leech Lake is not compromised. This can be done through scrutinizing development proposals within the watershed using the environmental review process. Projects that are approved should use techniques that minimize impacts to the resource. Landowners within the watershed should be encouraged to use Best Management Practices (BMPs), especially along the lakeshore. A comprehensive list of sensitive shoreline that is prone to development should be drafted to prioritize conservation action. In addition, these landowners should be contacted and made aware of options such as conservation easements. Efforts such as these provide the best opportunities to sustain the quality resources that Leech Lake provides.

Education and communication efforts are extremely valuable in changing attitudes and perceptions about what does or does not impact ecosystem health. News releases, articles in local papers, and newsletters such as the Leech Lake Update to resorts and interested clientele are some of the avenues that should be continued and expanded.

Continued monitoring and treatment of harbors with Eurasian watermilfoil is planned for 2009. Additional educational contacts should be made to those that use the harbors, with increased effort during high use periods. Cooperation of the harbor owners is critical to successful outreach. Similar efforts are needed to prevent the introduction of other exotic species, such as zebra mussels or spiny waterflea, which have already established in other Minnesota systems.

Annual monitoring of fish populations and water quality analyses should continue. The vegetation study that began in 2002 was completed in 2005, and the information obtained will further our understanding of fish and their habitats and identify areas of concern. Muskellunge, largemouth bass, bluegill and black crappie sampling should be conducted given adequate staff time. The effects of thermal stress on cisco, specifically recruitment and mortality, should also be explored. Double-crested cormorant control efforts on Leech Lake should continue as prescribed by the management plan for this species.

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TABLES

Table 1. Catch-per-effort of all species captured in seine (fish/haul) and trawl (fish/hour) hauls, Leech Lake, 2008. Age 1+ includes all non-YOY fish captured.

Species	Age	Seine	Trawl
Bigmouth shiner	All	2.70	-
Black bullhead	All	-	-
Bluegill	0	-	-
Bluegill	1+	0.20	-
Bluntnose minnow	All	1.25	273.60
Burbot	0	-	-
Common shiner	All	-	-
Emerald shiner	All	-	-
Iowa darter	All	0.08	2.40
Johnny darter	All	2.73	15.00
Largemouth bass	0	0.85	-
Largemouth bass	1+	-	-
Logperch	All	1.70	198.60
Longnose dace	All	1.15	-
Mimic shiner	All	744.48	1,637.40
Northern pike	1+	-	0.60
Pumpkinseed	All	0.03	-
Rock bass	0	-	-
Sand shiner	All	-	0.60
Smallmouth bass	All	0.20	0.60
Spotfin shiner	All	1.10	-
Spottail shiner	All	36.78	264.60
Tadpole madtom	All	-	19.20
Trout-perch	All	0.03	13.80
Walleye	0	15.10	507.60
Walleye	1+	-	42.60
White sucker	0	0.13	0.60
White sucker	1+	-	1.20
Yellow perch	0	624.05	9,098.38
Yellow perch	1+	31.60	3,226.79

Table 2. Catch-per-effort (fish/haul) of young-of-year walleye and yellow perch at long-term seining stations, Leech Lake, 2008. A total of eight hauls were completed at each station.

Station Name	Walleye/haul	Yellow Perch/haul
Whipholt Beach	9.75	793.75
Stoney Point	33.25	1796.63
Traders Bay	5.13	158.75
Ottertail point	17.38	195.13
Fivemile Point	40.00	176.00

Table 3. Catch-per-effort (fish/hour) of young-of-year walleye and yellow perch at long-term trawling stations, Leech Lake, 2008.

Station Name	N Hauls	Walleye/hour	Yellow Perch/hour
Fivemile Point	8	315	222
Goose Island	6	212	12,658
Whipholt Beach	6	1,060	17,374

Table 4. Catch-per-effort (CPE) of young-of-year walleye in selected gears and associated year class strength (YCS) indices. Incomplete estimates of observed and predicted walleye YCS (± 95% confidence intervals) are in bold.

				Year Class Strength		
Year Class	Trawl CPE (fish/hour)	Gillnet CPE (fish/net)	Electrofishing CPE (fish/hour)	Observed	Eq. 1 Predicted	Eq. 2 Predicted
1983		0.22		111		
1984		0.36		58		
1985		0.03		155		
1986		0.08		159		
1987	49	0.11		62	80	56
1988	128	1.81		232	103	232
1989	62	0.06		48	84	55
1990	72	0.03		66	87	55
1991	58	0.47		93	82	91
1992	103	0.00		24	96	62
1993	16	0.00		9	70	36
1994	493	0.08		223	210	182
1995	183	0.51		123	119	131
1996	262	0.14		89	142	120
1997	5	0.29		181	67	59
1998	139	0.47		62	106	114
1999	348	0.56		95	167	183
2000	28	0.14		36	74	53
2001	103	0.69		80	96	124
2002	38	0.31		79	77	71
2003	27	0.08		28	73	47
2004	3	0.00		20	66	33
2005	**247**	**0.03**	**60**	**166**	**138 ± 42**	**106 ± 36**
2006	**240**	**0.69**	**35**	**248**	**136 ± 41**	**163 ± 34**
2007	**31**	**1.47**	**27**	**182**	**74 ± 37**	**173 ± 60**
2008	**508**	**0.00**	**42**		**214 ± 96**	**179 ± 75**
Mean	142.8	0.33	41	105		

Equation 1: YCS = (0.29310*trawl CPE) + 65.41317

Equation 2: YCS = (0.28968*trawl CPE) + (90.00930*gillnet CPE) + 31.81032

Table 5. Gillnet catch-per-effort (fish/net) summary by species and basin for Leech Lake, 2008.

		Western Bays			Main Lake			Overall (Whole Lake)		
			1983-2008			1983-2008			1983-2008	
Code	Species	2008	Mean	s.e.	2008	Mean	s.e.	2008	Mean	s.e.
BLB	Black bullhead	1.75	11.20	1.92	0.65	2.60	0.71	1.14	6.34	1.17
BLC	Black crappie	1.13	0.26	0.08	0.70	0.40	0.06	0.89	0.35	0.06
BLG	Bluegill	2.00	0.58	0.16	0.55	0.28	0.07	1.19	0.44	0.10
BOF	Bowfin	0.13	0.11	0.02	0.05	0.03	0.01	0.08	0.07	0.01
BRB	Brown bullhead	2.56	1.96	0.24	1.50	1.31	0.22	1.97	1.71	0.20
BUB	Burbot	0.00	0.03	0.01	0.00	0.08	0.01	0.00	0.06	0.01
HBS	Hybrid sunfish	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
LKW	Lake whitefish	0.13	0.09	0.04	0.00	0.03	0.01	0.06	0.06	0.02
LMB	Largemouth bass	0.00	0.12	0.03	0.15	0.09	0.03	0.08	0.10	0.02
MUE	Muskellunge	0.00	0.05	0.01	0.00	0.01	0.00	0.00	0.04	0.01
NOP	Northern pike	7.19	5.13	0.24	4.35	4.43	0.16	5.61	4.80	0.15
PMK	Pumpkinseed	2.00	1.05	0.15	1.05	0.56	0.11	1.47	0.78	0.10
RKB	Rock bass	5.00	3.15	0.33	0.30	0.25	0.03	2.39	1.56	0.15
SHR	Shorthead redhorse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SMB	Smallmouth bass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TME	Tiger muskellunge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TLC	Tulibee/cisco	2.00	4.99	0.97	1.30	5.78	1.04	1.61	5.56	0.85
WAE	Walleye	5.06	5.82	0.35	12.25	8.95	0.74	9.06	7.50	0.50
WTS	White sucker	0.94	1.32	0.09	0.35	1.83	0.17	0.61	1.63	0.12
YEB	Yellow bullhead	4.19	2.01	0.30	1.25	0.92	0.18	2.56	1.51	0.19
YEP	Yellow perch	34.31	24.80	1.30	20.35	19.01	1.97	26.56	21.69	1.39

Table 6. Length-frequency distribution of all species sampled in experimental gillnet sets, Leech Lake, 2008.

	Species												
										NOP			
TL (inches)	BLB	BLC	BLG	BOF	BRB	BUB	LKW	LMB	MUE	M	F	All	PMK
<4.00			4										1
4.00-4.49			4										1
4.50-4.99			4										3
5.00-5.49			3										14
5.50-5.99		1	8										10
6.00-6.49			6										9
6.50-6.99		1	2										4
7.00-7.49		2	3										5
7.50-7.99		7	5										2
8.00-8.49		3	2										3
8.50-8.99		2	1		1							1	1
9.00-9.49	1	1	1										
9.50-9.99		3						1					
10.00-10.49	6	5			7					1		1	
10.50-10-99	10	5			21			2				1	
11.00-11.49	4				19								
11.50-11.99	10	1			15							2	
12.00-12.99	9				4							1	
13.00-13.99		1			3								
14.00-14.99	1				1					3	3	6	
15.00-15.99										5	3	8	
16.00-16.99										4		4	
17.00-17.99							1			5	2	7	
18.00-18.99							1			13	4	17	
19.00-19.99										11	5	16	
20.00-20.99										15	5	20	
21.00-21.99										9	6	15	
22.00-22.99										14	9	23	
23.00-23.99				1						3	9	12	
24.00-24.99				2						2	11	13	
25.00-25.99											10	10	
26.00-26.99											8	8	
27.00-27.99											10	10	
28.00-28.99											7	7	
29.00-29.99											6	6	
30.00-30.99											7	7	
31.00-31.99										1	2	3	
32.00-32.99											1	1	
33.00-33.99											3	3	
34.00-34.99													
35.00-35.99													
≥ 36.00													
Total	41	32	43	3	71	0	2	3	0	86	111	202	53

Table 6 continued. Length-frequency distribution of all species sampled in experimental gillnet sets, Leech Lake, 2008.

	Species												
						WAE					YEP		
TL (inches)	RKB	SHR	SMB	TME	TLC	M	F	All	WTS	YEB	M	F	All
<4.00													
4.00-4.49	3												
4.50-4.99													
5.00-5.49	7									3	9	5	14
5.50-5.99	10										96	89	185
6.00-6.49	1								1	1	81	112	193
6.50-6.99	3									3	38	44	82
7.00-7.49	5										18	35	53
7.50-7.99	14									3	20	67	87
8.00-8.49	13				1					3	14	67	81
8.50-8.99	6				11	1		1	1	3	5	47	52
9.00-9.49	4				4		2	2		4	7	60	67
9.50-9.99	10					5	5	10	2	5	2	32	34
10.00-10.49	7				8	13	6	19	1	15	3	38	41
10.50-10-99	2				18	17	11	28	1	16		40	40
11.00-11.49	1				3	7	5	12	2	15		14	14
11.50-11.99					1	4	5	9	1	6	1	9	10
12.00-12.99					4	11	4	15	3	11		3	3
13.00-13.99						11	15	26	1	4			
14.00-14.99					2	15	29	44	1				
15.00-15.99					5	10	27	37					
16.00-16.99					1	7	6	13	2				
17.00-17.99						5	13	18	6				
18.00-18.99						10	13	23					
19.00-19.99						10	11	21					
20.00-20.99						7	4	11					
21.00-21.99						8	4	12					
22.00-22.99						4	1	5					
23.00-23.99							8	8					
24.00-24.99						1	3	4					
25.00-25.99							6	6					
26.00-26.99							2	2					
27.00-27.99													
28.00-28.99													
29.00-29.99													
30.00-30.99													
31.00-31.99													
32.00-32.99													
33.00-33.99													
34.00-34.99													
35.00-35.99													
≥36.00													
Total	86	0	0	0	58	146	180	326	22	92	294	662	956

Table 7. Mean (± s.e.) gillnet catch-per-effort (fish/net) by sampling area for selected species, Leech Lake, 2008.

	Walleye/net		Yellow perch/net	
Station	Number	Pounds	Number	Pounds
Kabekona Bay	3.25 (1.11)	8.34 (2.42)	29.50 (8.63)	6.02 (2.86)
Steamboat Bay	5.00 (1.78)	9.39 (5.01)	43.50 (16.26)	9.83 (5.67)
Walker Bay	7.75 (1.55)	10.12 (2.79)	44.50 (21.58)	11.39 (8.32)
Agency Bay	4.25 (1.44)	3.59 (0.88)	19.75 (4.42)	3.41 (1.64)
Sucker Bay	7.50 (3.62)	12.84 (7.10)	52.00 (24.50)	10.54 (4.14)
Pine Point	16.75 (5.57)	18.25 (5.08)	8.50 (3.80)	1.75 (0.77)
Portage Bay	16.00 (3.85)	27.20 (5.58)	13.25 (5.54)	2.39 (0.75)
Pelican Island	14.25 (2.87)	18.83 (3.82)	2.75 (1.49)	0.56 (0.28)
Bear Island	6.75 (2.93)	6.52 (2.42)	25.25 (12.68)	6.92 (3.72)
Mean	9.06 (1.22)	12.91 (1.76)	26.56 (4.81)	6.02 (1.37)

	Northern pike/net		Tullibee/net	
Station	Number	Pounds	Number	Pounds
Kabekona Bay	14.75 (5.82)	39.06 (19.21)	7.75 (3.88)	4.09 (1.71)
Steamboat Bay	6.50 (0.87)	16.92 (3.64)	0.00 (0.00)	0.00 (0.00)
Walker Bay	4.50 (1.55)	14.36 (6.82)	0.25 (0.25)	0.74 (-)
Agency Bay	7.80 (3.40)	8.66 (3.84)	0.00 (0.00)	0.00 (0.00)
Sucker Bay	9.50 (4.03)	32.15 (5.42)	0.75 (0.75)	4.61 (-)
Pine Point	2.75 (0.85)	7.51 (2.19)	3.50 (3.18)	5.72 (5.47)
Portage Bay	2.00 (0.58)	4.77 (1.52)	1.00 (0.41)	0.32 (0.08)
Pelican Island	2.25 (0.85)	10.35 (1.64)	0.50 (0.50)	0.38 (-)
Bear Island	5.25 (2.66)	10.00 (3.38)	0.75 (0.48)	0.33 (0.13)
Mean	5.61 (1.02)	15.56 (2.97)	1.61 (0.64)	2.39 (0.95)

Table 8. Age length-frequency distribution of immature and mature (bold) female walleye captured in experimental gillnets, Leech Lake, 2008.

	Age																			
Length Group	0		1		2		3		4		5		6		7		8+		Total	
< 4.0																			0	**0**
4.0-4.9																			0	**0**
5.0-5.9																			0	**0**
6.0-6.9																			0	**0**
7.0-7.9																			0	**0**
8.0-8.9																			0	**0**
9.0-9.9			7																7	**0**
10.0-10.9			16		1														17	**0**
11.0-11.9			7		3														10	**0**
12.0-12.9					4														4	**0**
13.0-13.9					15														15	**0**
14.0-14.9					29														29	**0**
15.0-15.9					24	**1**	2												26	**1**
16.0-16.9							6												6	**0**
17.0-17.9							10	**3**											10	**3**
18.0-18.9							11	**2**											11	**2**
19.0-19.9							4	**3**	1	**2**				**1**					5	**6**
20.0-20.9										**1**		**2**		**1**					0	**4**
21.0-21.9												**1**		**1**		**1**		**1**	0	**4**
22.0-22.9																**1**			0	**1**
23.0-23.9																		**8**	0	**8**
24.0-24.9																		**3**	0	**3**
25.0-25.9																		**6**	0	**6**
26.0-26.9																		**2**	0	**2**
27.0-27.9																			0	**0**
28.0-28.9																			0	**0**
29.0-29.9																			0	**0**
> 30.0																			0	**0**
Total	0	**0**	30	**0**	76	**1**	33	**8**	1	**3**	0	**3**	0	**3**	0	**2**	0	**20**	140	**40**

Table 9. Age length-frequency distribution of immature and mature (bold) male walleye captured in experimental gillnets, Leech Lake, 2008.

	Age																			
Length Group	0		1		2		3		4		5		6		7		8+		Total	
< 4.0																			0	**0**
4.0-4.9																			0	**0**
5.0-5.9																			0	**0**
6.0-6.9																			0	**0**
7.0-7.9																			0	**0**
8.0-8.9			1																1	**0**
9.0-9.9			5																5	**0**
10.0-10.9			29		1														30	**0**
11.0-11.9			8		3														11	**0**
12.0-12.9			1		10														11	**0**
13.0-13.9					11														11	**0**
14.0-14.9					14	**1**													14	**1**
15.0-15.9					5	**3**		**2**											5	**5**
16.0-16.9						**1**		**6**											0	**7**
17.0-17.9								**4**						**1**					0	**5**
18.0-18.9								**5**				**2**		**1**		**1**		**1**	0	**10**
19.0-19.9														**3**		**1**		**6**	0	**10**
20.0-20.9												**1**		**2**		**3**		**1**	0	**7**
21.0-21.9														**2**				**6**	0	**8**
22.0-22.9																		**4**	0	**4**
23.0-23.9																		**1**	0	**1**
24.0-24.9																			0	**0**
25.0-25.9																			0	**0**
26.0-26.9																			0	**0**
27.0-27.9																			0	**0**
28.0-28.9																			0	**0**
29.0-29.9																			0	**0**
> 30.0																			0	**0**
Total	0	**0**	44	**0**	44	**5**	0	**17**	0	**0**	0	**3**	0	**9**	0	**5**	0	**19**	88	**58**

Table 10. Age length-frequency distribution of immature and mature (bold) female yellow perch captured in experimental gillnets, Leech Lake, 2008.

	Age																			
Length Group	0		1		2		3		4		5		6		7		8+		Total	
<4.00																			0	**0**
4.00-4.49																			0	**0**
4.50-4.99																			0	**0**
5.00-5.49					1	**1**	1		2										4	**1**
5.50-5.99			3	**1**	43	**4**	22	**6**	8	**2**									76	**13**
6.00-6.49			2		19	**2**	41	**23**	12	**9**	2	**2**							76	**36**
6.50-6.99			1	**1**	1	**2**	8	**14**	2	**8**	4	**3**							16	**28**
7.00-7.49							3	**12**	1	**10**	1	**8**							5	**30**
7.50-7.99								**27**		**16**	2	**18**		**4**					2	**65**
8.00-8.49								**14**	1	**11**		**31**		**8**		**2**			1	**66**
8.50-8.99								**8**		**14**		**15**		**7**		**3**			0	**47**
9.00-9.49								**4**		**12**		**11**	2	**28**		**3**			2	**58**
9.50-9.99										**6**		**9**		**16**		**1**			0	**32**
10.00-10.49										**1**		**15**		**13**		**9**			0	**38**
10.50-10-99										**2**		**9**		**20**		**9**			0	**40**
11.00-11.49												**6**		**3**		**5**			0	**14**
11.50-11.99														**2**	1	**5**		**1**	1	**8**
12.00-12.99														**1**		**2**			0	**3**
13.00-13.99																			0	**0**
14.00-14.99																			0	**0**
> 14.99																			0	**0**
Total	0	**0**	6	**2**	64	**9**	75	**108**	26	**91**	9	**127**	2	**102**	1	**39**	0	**1**	183	**479**

Table 11 Age length-frequency distribution of immature and mature (bold) male yellow perch captured in experimental gillnets, Leech Lake, 2008.

	Age									
Length Group	0	1	2	3	4	5	6	7	8+	Total
<4.00										0 **0**
4.00-4.49										0 **0**
4.50-4.99										0 **0**
5.00-5.49		**1**	**4**	**4**						0 **9**
5.50-5.99		**9**	**44**	**23**	**20**					0 **96**
6.00-6.49		**3**	**29**	**17**	**26**	**6**				0 **81**
6.50-6.99			**11**	**9**	**17**	**1**				0 **38**
7.00-7.49			**1**	**11**	**4**	**2**				0 **18**
7.50-7.99			**2**	**4**	**5**	**9**				0 **20**
8.00-8.49				**2**	**3**	**4**	**4**	**1**		0 **14**
8.50-8.99					**1**	**2**	**1**	**1**		0 **5**
9.00-9.49				**1**		**6**				0 **7**
9.50-9.99							**1**	**1**		0 **2**
10.00-10.49						**1**	**1**		**1**	0 **3**
10.50-10-99										0 **0**
11.00-11.49								**1**		0 **1**
11.50-11.99										0 **0**
12.00-12.99										0 **0**
13.00-13.99										0 **0**
14.00-14.99										0 **0**
> 14.99										0 **0**
Total	0 **0**	0 **13**	0 **91**	0 **71**	0 **76**	0 **31**	0 **7**	0 **4**	0 **1**	0 **294**

Table 12. Age length-frequency distribution of immature and mature (bold) female northern pike captured in experimental gillnets, Leech Lake, 2008.

	Age									
Length Group	0	1	2	3	4	5	6	7	8+	Total
< 4.0										0 **0**
4.0-4.9										0 **0**
5.0-5.9										0 **0**
6.0-6.9										0 **0**
7.0-7.9										0 **0**
8.0-8.9	1									1 **0**
9.0-9.9										0 **0**
10.0-10.9										0 **0**
11.0-11.9										0 **0**
12.0-12.9										0 **0**
13.0-13.9										0 **0**
14.0-14.9		1 **1**	1							2 **1**
15.0-15.9		1 **2**								1 **2**
16.0-16.9										0 **0**
17.0-17.9			**2**							0 **2**
18.0-18.9		**2**	**1**	**1**						0 **4**
19.0-19.9			**1**	**2**	**2**					0 **5**
20.0-20.9		**1**	**2**	**2**						0 **5**
21.0-21.9			**3**	**2**	**1**					0 **6**
22.0-22.9			**2**	**6**		**1**				0 **9**
23.0-23.9				**6**	**2**	**1**				0 **9**
24.0-24.9				**3**	**3**	**4**	**1**			0 **11**
25.0-25.9				**1**	**4**	**5**				0 **10**
26.0-26.9				**1**	**5**	**1**	**1**			0 **8**
27.0-27.9					**4**	**2**	**2**	**2**		0 **10**
28.0-28.9					**2**	**3**	**2**	**2**		0 **9**
29.0-29.9							**4**		**2**	0 **6**
30.0-30.9						**1**	**4**	**2**		0 **7**
31.0-31.9							**2**			0 **2**
32.0-32.9								**1**		0 **1**
33.0-33.9									**3**	0 **3**
34.0-34.9										0 **0**
35.0-35.9										0 **0**
> 36.0										0 **0**
Total	1 **0**	2 **6**	1 **11**	0 **24**	0 **23**	0 **18**	0 **16**	0 **7**	0 **5**	4 **110**

One 11-inch and one 12-inch age-1 assigned female, unknown maturity due to crayfish damage

Table 13. Age length-frequency distribution of immature and mature (bold) male northern pike captured in experimental gillnets, Leech Lake, 2008.

	Age																			
Length Group	0		1		2		3		4		5		6		7		8+		Total	
< 4.0																			0	**0**
4.0-4.9																			0	**0**
5.0-5.9																			0	**0**
6.0-6.9																			0	**0**
7.0-7.9																			0	**0**
8.0-8.9																			0	**0**
9.0-9.9																			0	**0**
10.0-10.9			1																1	**0**
11.0-11.9																			0	**0**
12.0-12.9																			0	**0**
13.0-13.9																			0	**0**
14.0-14.9				**2**		**1**													0	**3**
15.0-15.9			1	**3**		**1**													1	**4**
16.0-16.9				**2**		**2**													0	**4**
17.0-17.9						**1**		**4**											0	**5**
18.0-18.9				**1**		**8**		**3**		**1**									0	**13**
19.0-19.9						**5**		**3**		**2**		**1**							0	**11**
20.0-20.9						**4**		**7**		**2**		**2**							0	**15**
21.0-21.9								**1**		**4**		**4**							0	**9**
22.0-22.9								**7**		**2**		**4**		**1**					0	**14**
23.0-23.9										**1**				**1**					0	**2**
24.0-24.9											1	**1**							1	**1**
25.0-25.9																			0	**0**
26.0-26.9																			0	**0**
27.0-27.9																			0	**0**
28.0-28.9																			0	**0**
29.0-29.9																			0	**0**
30.0-30.9																			0	**0**
31.0-31.9																**1**			0	**1**
32.0-32.9																			0	**0**
33.0-33.9																			0	**0**
34.0-34.9																			0	**0**
35.0-35.9																			0	**0**
> 36.0																			0	**0**
Total	0	**0**	2	**8**	0	**22**	0	**25**	0	**12**	1	**12**	0	**2**	0	**1**	0	**0**	3	**82**

One 10-inch and one 11-inch age-1 assigned male, unknown maturity due to crayfish damage

Table 14. Summary of walleye fry stocking for Red Lake, 1999-2003 and Leech Lake, 2005-2008. SSB refers to spawner stock biomass estimated from gillnet catches of mature female walleye the previous fall.

					Fry per littoral acre		
Lake	Year	SSB (lbs/A)	Hatch Rate (%)	YOY Marked (%)	Wild	Stocked	Total
Red	1999	0.17	0.60	86	86	521	607
	2001	1.31	0.16	70	174	400	574
	2003	0.76	0.02	97	11	414	425
	Mean	0.74	0.26		90	445	535
Leech	2005	1.91	0.22	39	203	130	334
	2006	1.04	0.12	86	61	380	440
	2007	1.67	0.54	23	432	129	561
	2008	2.13	0.31	55	317	382	699
	Mean	1.69	0.30		253	255	509

*Estimated as 25,000 eggs per pound of mature female

Table 15. Mean chlorophyll-a (Chlor-a), total phosphorous (Total P), pH, alkalinity, total dissolved solids (TDS), Secchi depth, and mean calculated trophic state index (TSI) by basin, Leech Lake, 1984-2008.

	Main Lake								Western Bays							
Year	Station	Chlor-a (ppb)	Total P (ppm)	pH	Alkalinity (ppm)	TDS (ppm)	Secchi (ft.)	Mean TSI	Station	Chlor-a (ppb)	Total P (ppm)	pH	Alkalinity (ppm)	TDS (ppm)	Secchi (ft.)	Mean TSI
1984		4.0	0.022		133	169				4.0	0.011		132	147		
1985																
1986	7	3.0	0.011	8.51	134	158	4.7		1	3.0	0.006	8.61	135	160	9.3	
1987	7	3.0	0.014	8.35	131	154	3.9		1	4.0	0.014	8.50	147	153	8.2	
1988	5	3.0	0.031	7.85	133	169	7.7		1	3.0	0.017	8.00	46	377	7.9	
1989	5	3.0	0.017	7.85	132	172	7.6		1	3.0	0.008	8.54	128	176	9.8	
1990	3	3.0	0.015	8.61	130	168	7.3		1	3.0	0.015	8.40	130	164	12.2	
1991	5	1.0	0.020	8.49	127	180	7.7		1	1.0	<0.005	8.60	126	172	7.9	
1992	5	2.0	0.016	8.44	139	178	11.4		1	3.0	0.010	8.54	139	168	13.2	
1993	5	6.4	0.013	8.58	140	156	8.5		1	4.9	0.014	8.62	128	180	13.0	
1994	5	5.5	0.023	8.58	138	170	6.0		1	2.9	0.016	8.66	140	168	8.0	
1995	7	11.9	0.018	8.57	136	192	8.9		1	6.5	0.012	8.70	136	180	11.5	
1996	7	3.1	0.055	8.50	133	176	8.9		1	2.4	0.020	8.73	136	224	10.6	
1997	7	3.1	0.041	8.54	132	172	9.9		1	4.4	0.044	8.64	133	192	13.6	
1998	3	6.5	0.028	8.64	131	152			1	4.2	0.029	8.66	133	172		
1999	5	5.1	0.028	8.56	129	172	7.5	49	1	3.8	0.025	8.62	135	180	13.0	45
2000	3	4.2	0.028	8.46	139	180	6.0	49	6	2.4	0.019	8.62	138	176	17.2	41
2001	3	5.6	0.033	8.73	125	170	7.0	49	6	4.0	0.016	8.76	126	168	11.0	43
2002	3	5.4	0.020	8.66	133	164	6.5	49	6	4.1	0.020	8.75	136	176	11.0	44
2003	3	7.2	0.020	8.42	139	160	6.5	50	6	4.1	0.010	8.64	140	160	11.0	44
2004	3	3.4	0.013	8.50	143	176	9.0	44	6	2.4	0.010	8.69	146	176	13.1	40
2005	3	4.4	0.016	8.62	143	172	5.0	50	6	3.7	0.016	8.57	141	176	8.5	45
2006	3	8.4	0.016	8.51	140	148	6.0	51	6	4.2	0.010	8.51	135	144	10.0	44
2007	3	8.9	0.019	8.46	144	168	8.2	48	6	3.6	0.011	8.61	143	168	10.5	42
2008	5	3.4	0.013	0.85	146	172	6.5	39	1	5.2	0.012	8.50	148	168	10.5	38
Mean		4.8	0.022	8.47	135	169	7.3	49		3.5	0.016	8.59	132	181	11.0	43

FIGURES

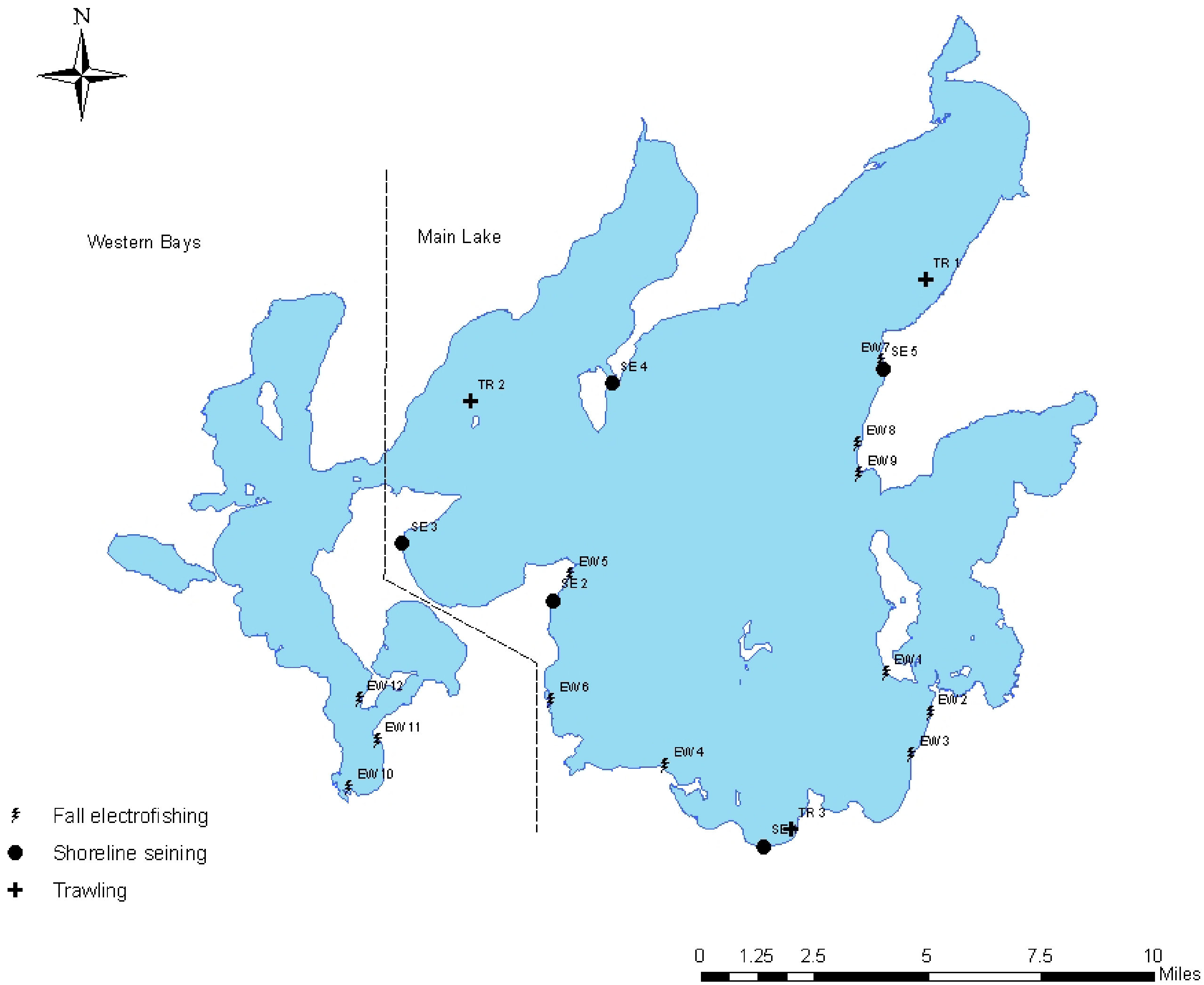

Figure 1. Long-term sampling stations targeting young-of-year percids in Leech Lake.

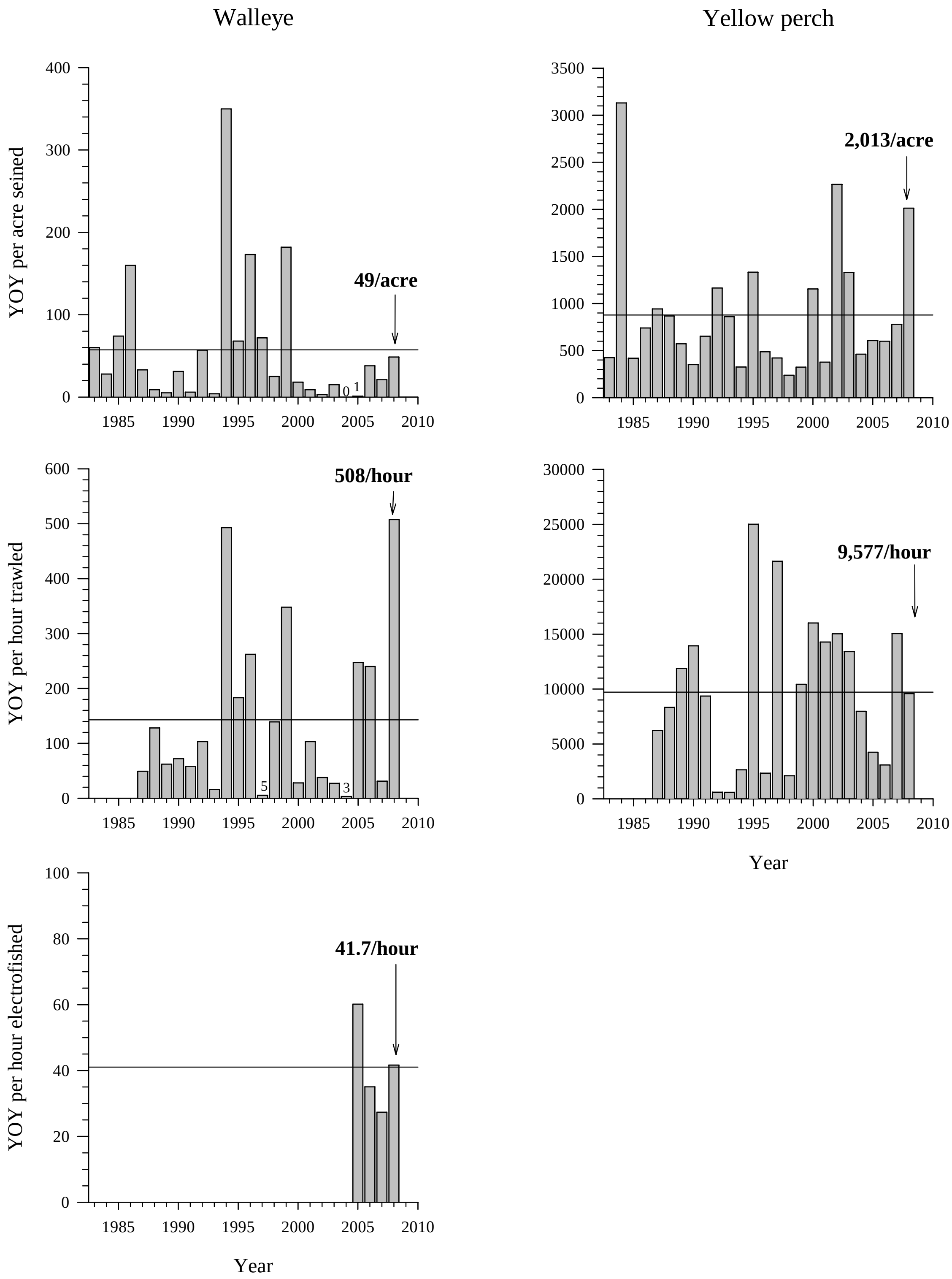

Figure 2. Catch-per-effort (bars) and historical averages (lines) of young-of-year (YOY) walleye (left column) and yellow perch (right column) at long-term sampling stations, Leech Lake, 1983-2008.

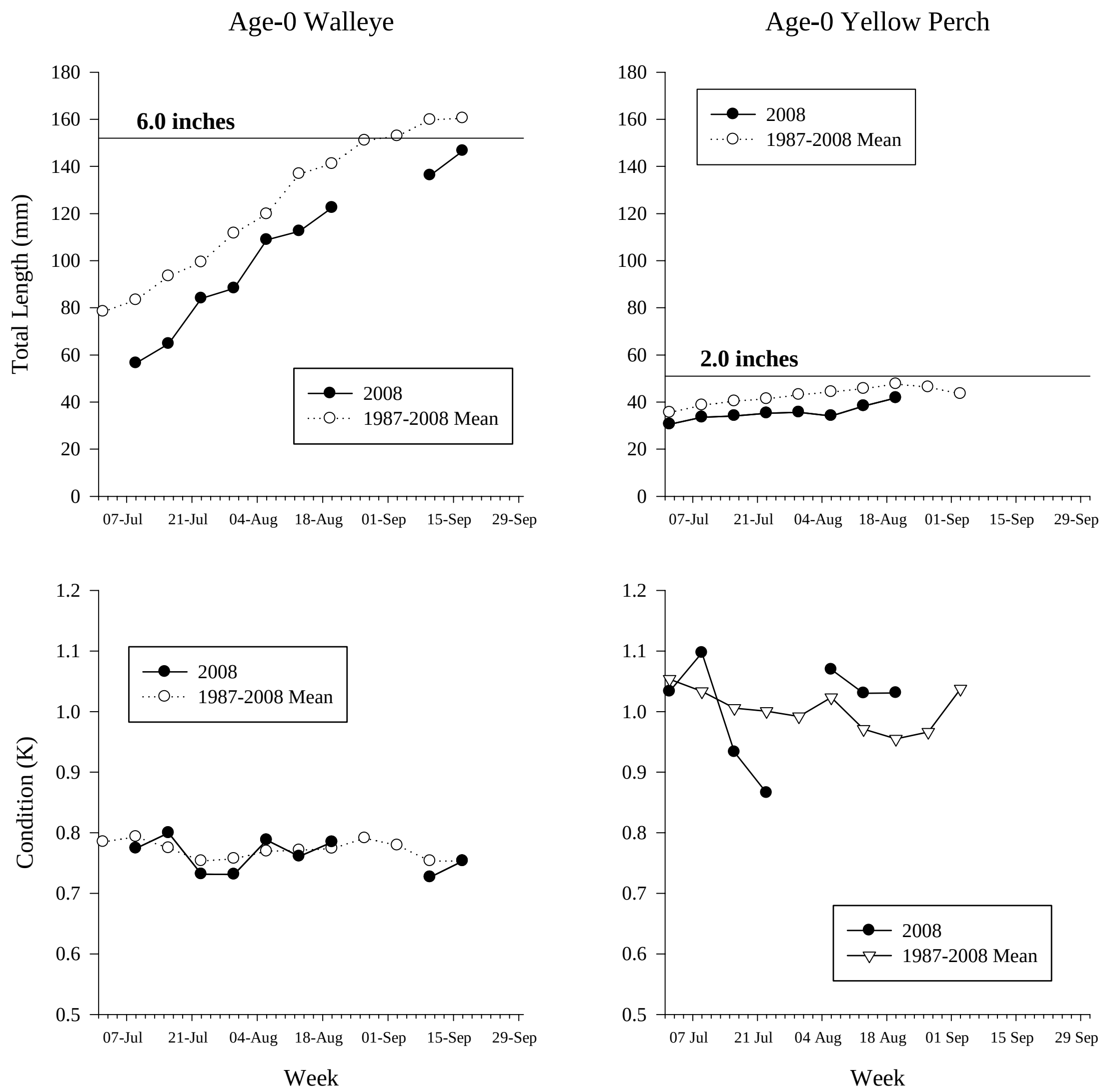

Figure 3. Mean weekly growth (top row) and condition (bottom row) of age-0 walleye (left column) and yellow perch (right column) captured in Leech Lake during the annual young-of-year assessment, 2008.

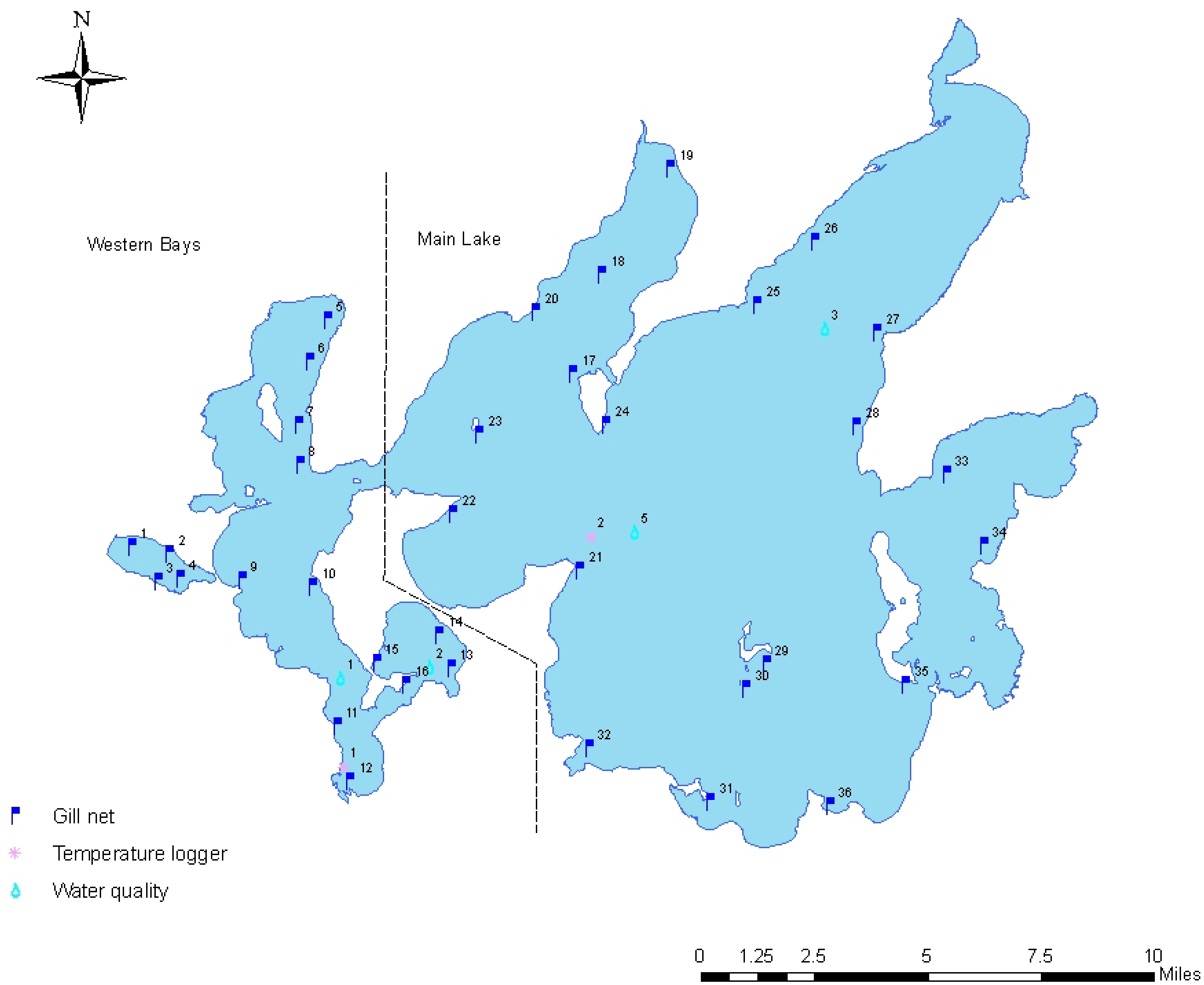

Figure 4. Gillnet (flags), temperature loggers (dots) and water quality (droplets) sampling locations on Leech Lake.

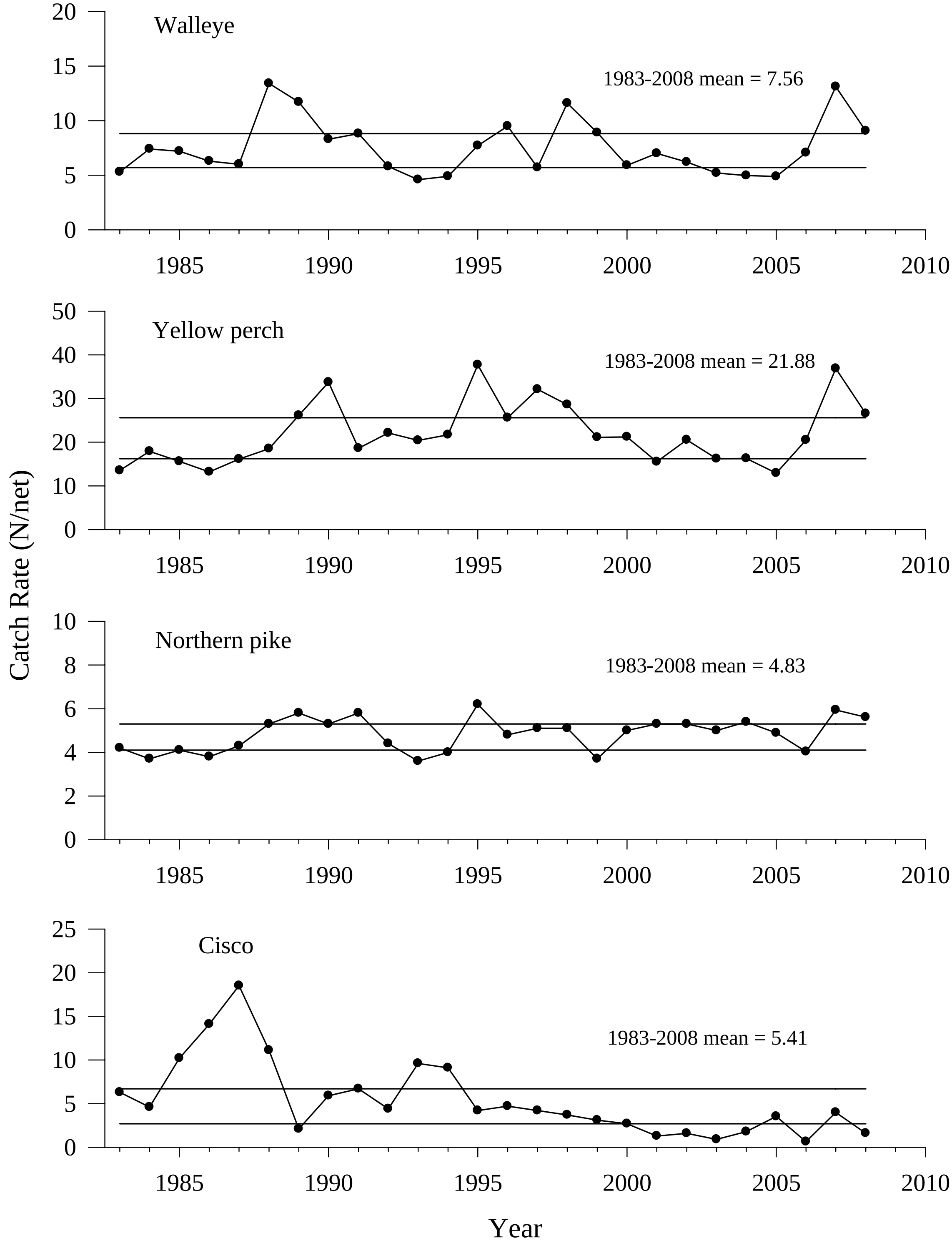

Figure 5. Gillnet catch rates (fish/net) of selected species in Leech Lake, 1983-2008. Horizontal lines represent respective upper (3rd) and lower (1st) quartiles.

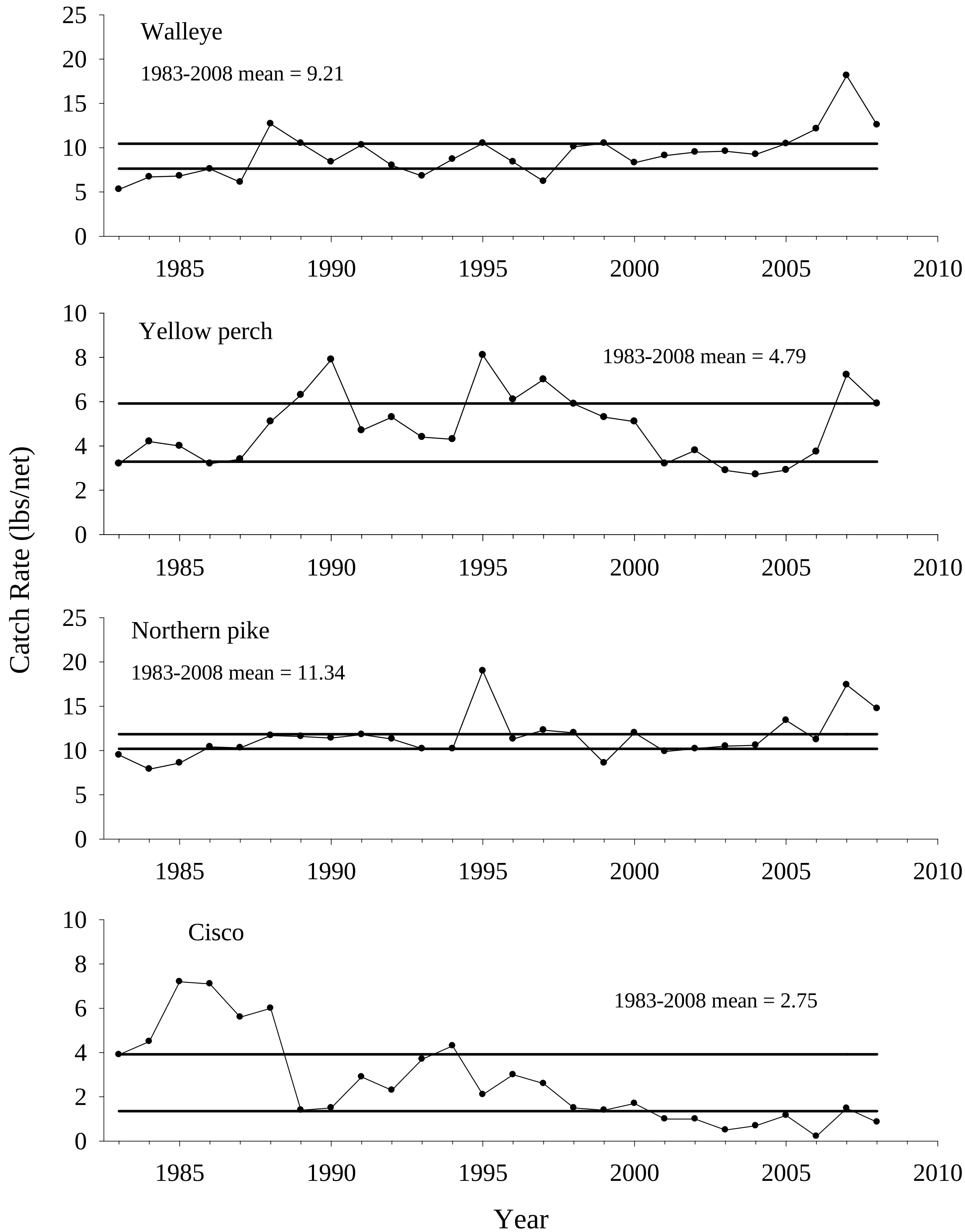

Figure 6. Gillnet catch rates (lbs/net) of selected species in Leech Lake, 1983-2007. Horizontal lines represent the respective upper (3rd) and lower (1st) quartiles.

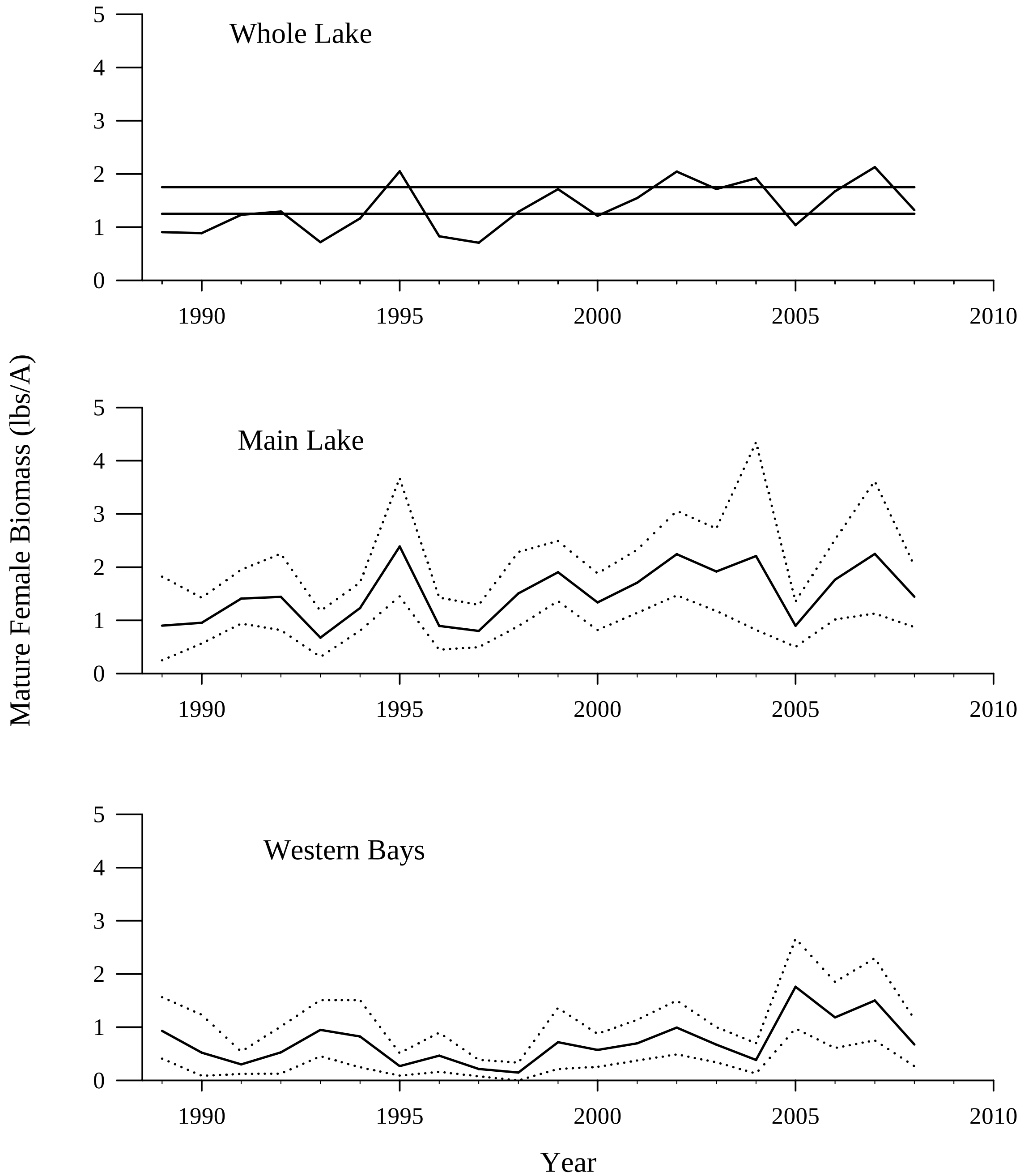

Figure 7. Estimated biomass (lbs/acre) of mature female walleye in Leech Lake, 1989-2008. Horizontal lines on the whole lake estimate (top) depict the current management goal of 1.50-1.75 lbs/acre. Dashed lines on the main lake (center) and western bays (bottom) estimates represent the 95% confidence intervals.

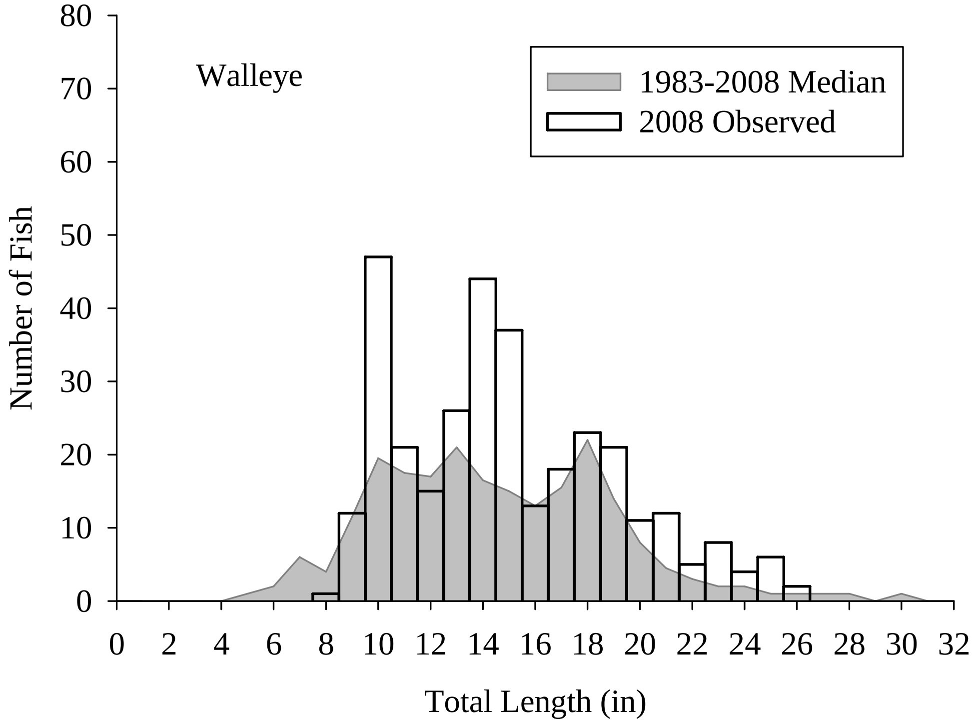

Figure 8. Length-frequency distribution of Leech Lake walleye sampled with experimental gillnets, 2008.

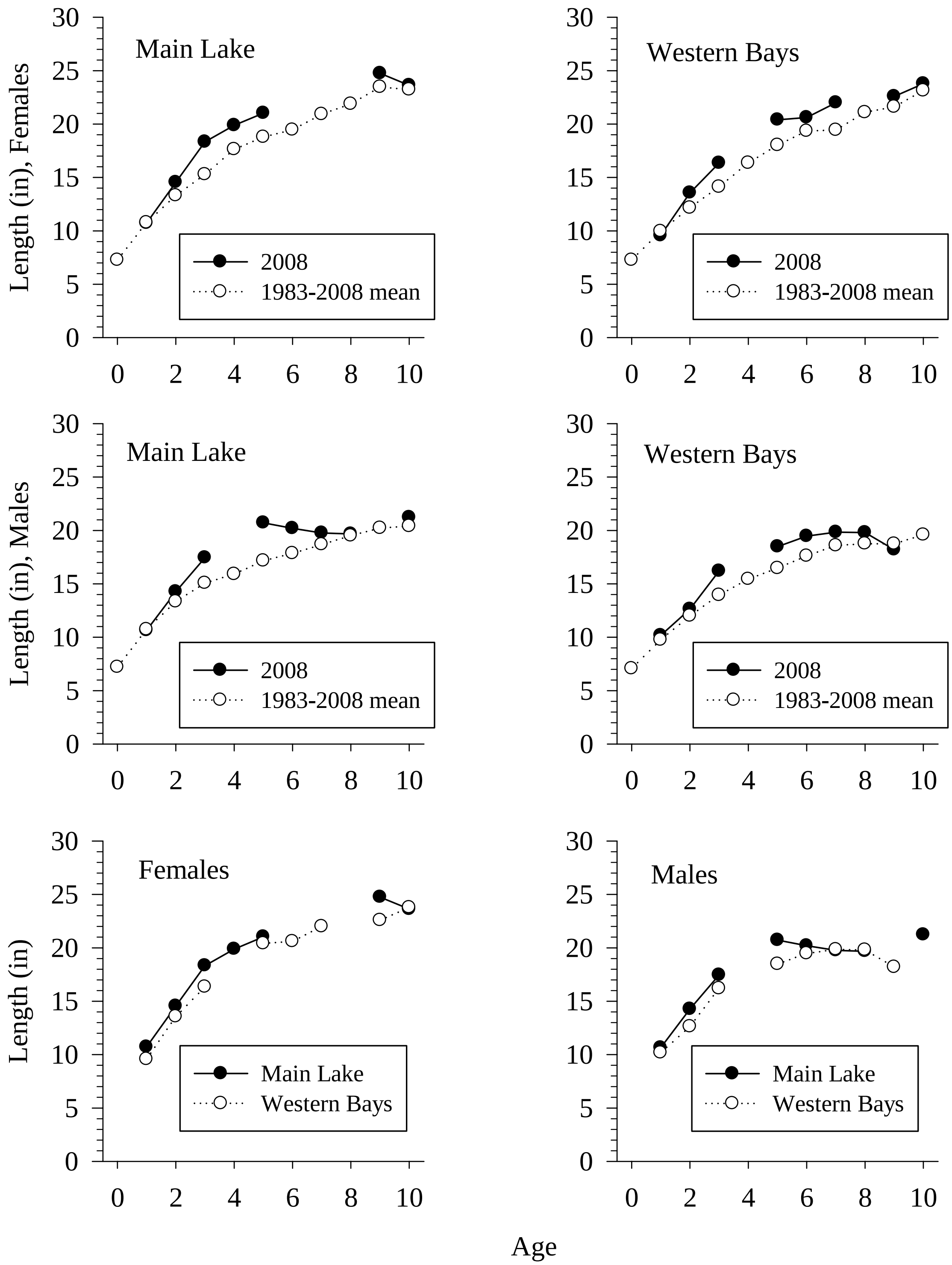

Figure 9. Mean length-at-age of walleye captured in experimental gillnet sets, 2008.

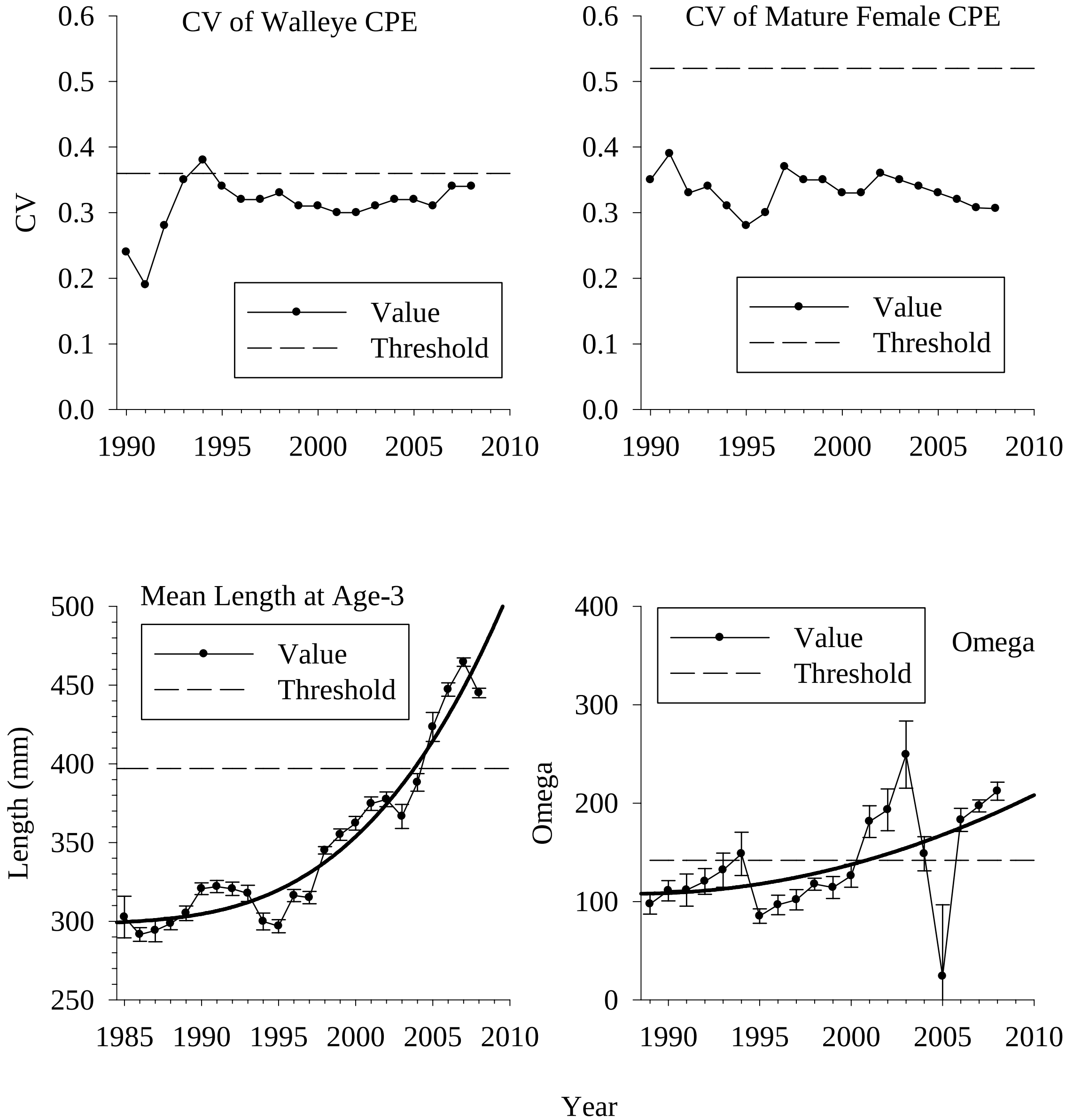

Figure 10. Coefficient of variation (CV) in gillnet catch-per-effort (CPE) of all walleye (top left panel) and mature female walleye (top right panel), mean length of all age-3 walleye sampled in experimental gillnets (bottom left panel), and omega values (bottom right panel) for the Leech Lake walleye population. Values above the respective thresholds (dashed lines) indicate population stress responses; error bars are standard error of the mean.

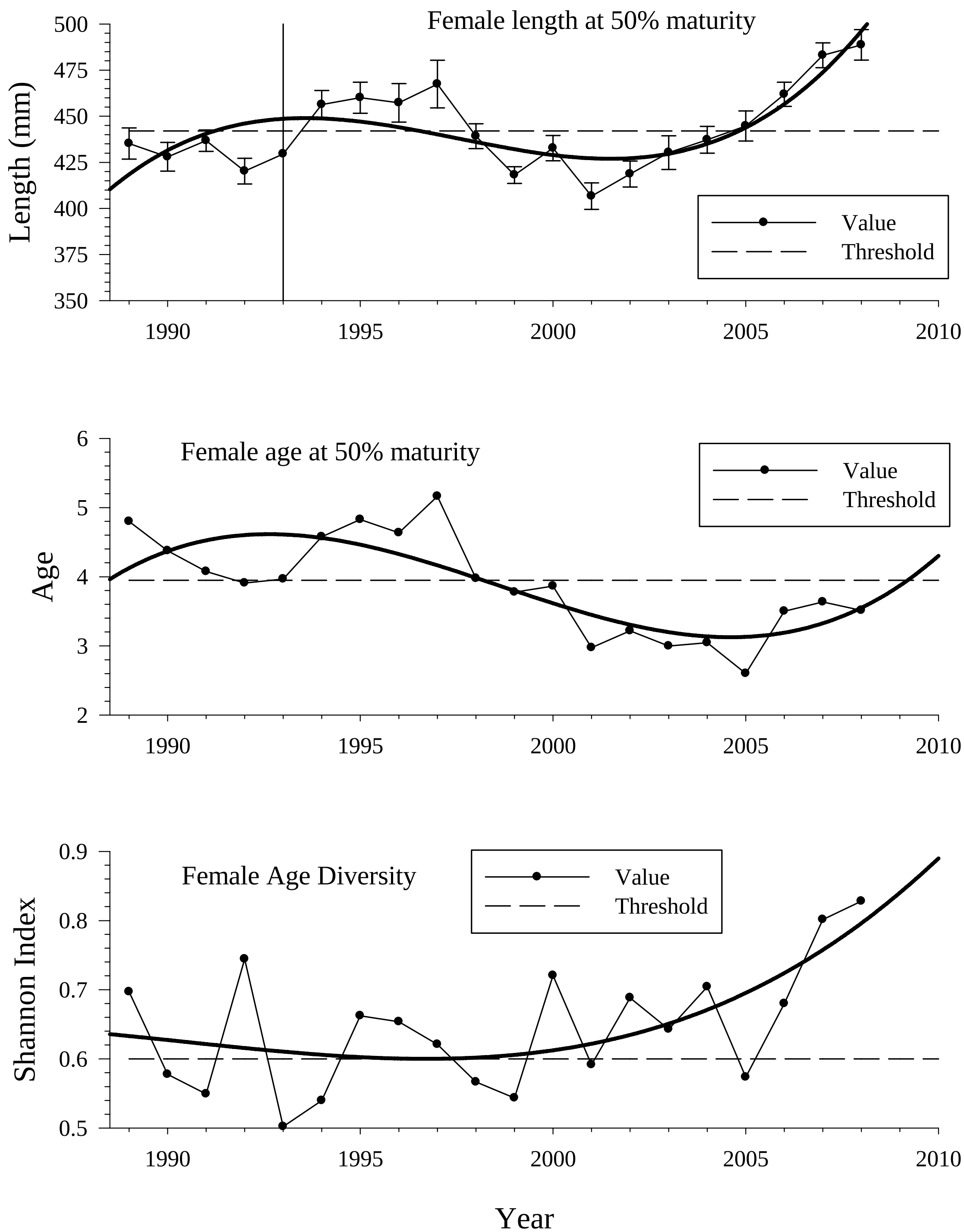

Figure 11. Mean length of female walleye at 50% maturity (top), estimated age of female walleye at 50% maturity (middle), and age diversity of female walleye sampled in experimental gillnets (bottom) from the Leech Lake walleye population. Values below the respective thresholds (dashed line) indicate a population stress response; error bars are standard error of the mean.

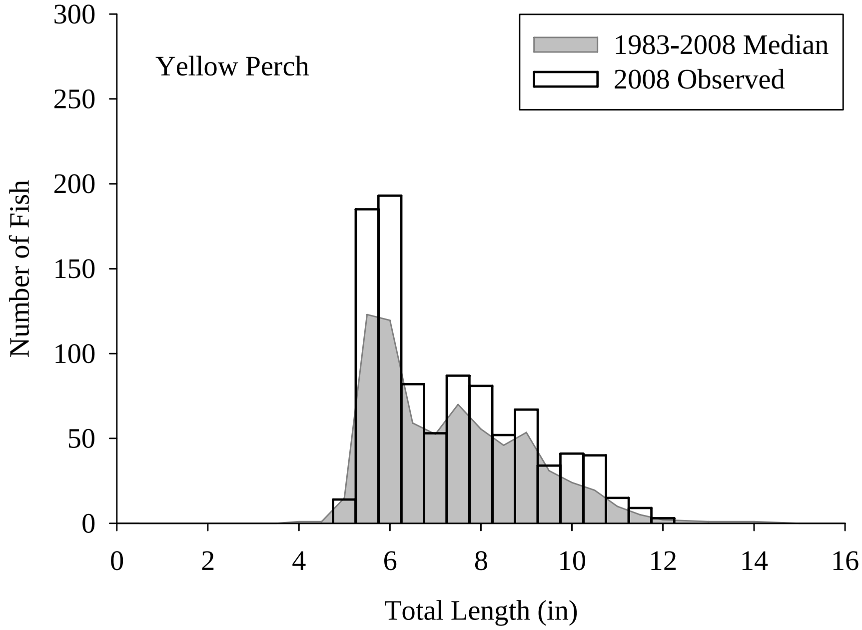

Figure 12. Length-frequency distribution of yellow perch sampled with experimental gillnets in Leech Lake, 2008.

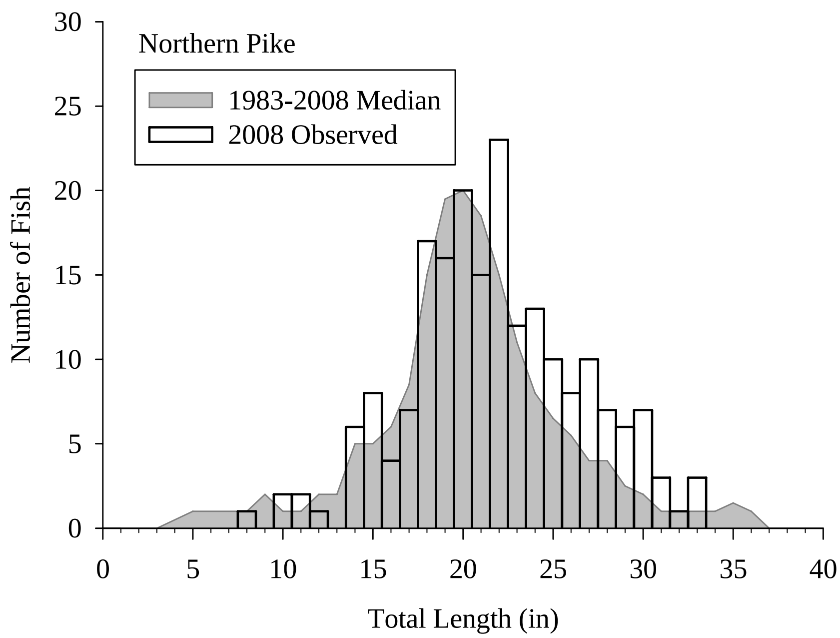

Figure 13. Length-frequency distribution of northern pike sampled with experimental gillnets in Leech Lake, 2008.

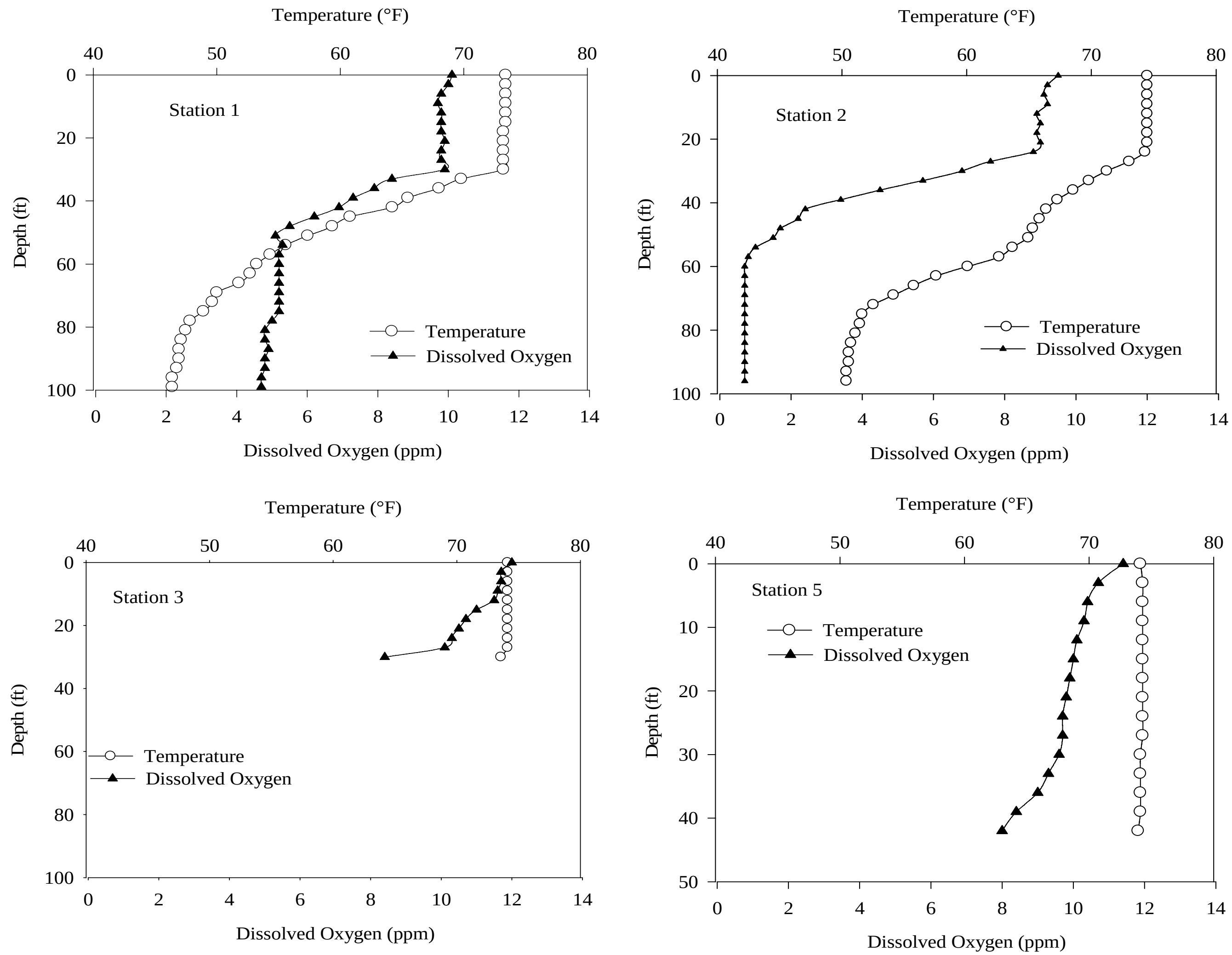

Figure 14. Temperature and oxygen profiles in Walker Bay (stations 1 and 2) and the main basin (stations 3 and 5) of Leech Lake, 10 August 2008.

Figure 15. Leech Lake boat harbors where Eurasian watermilfoil has been identified and chemically treated during 2008.

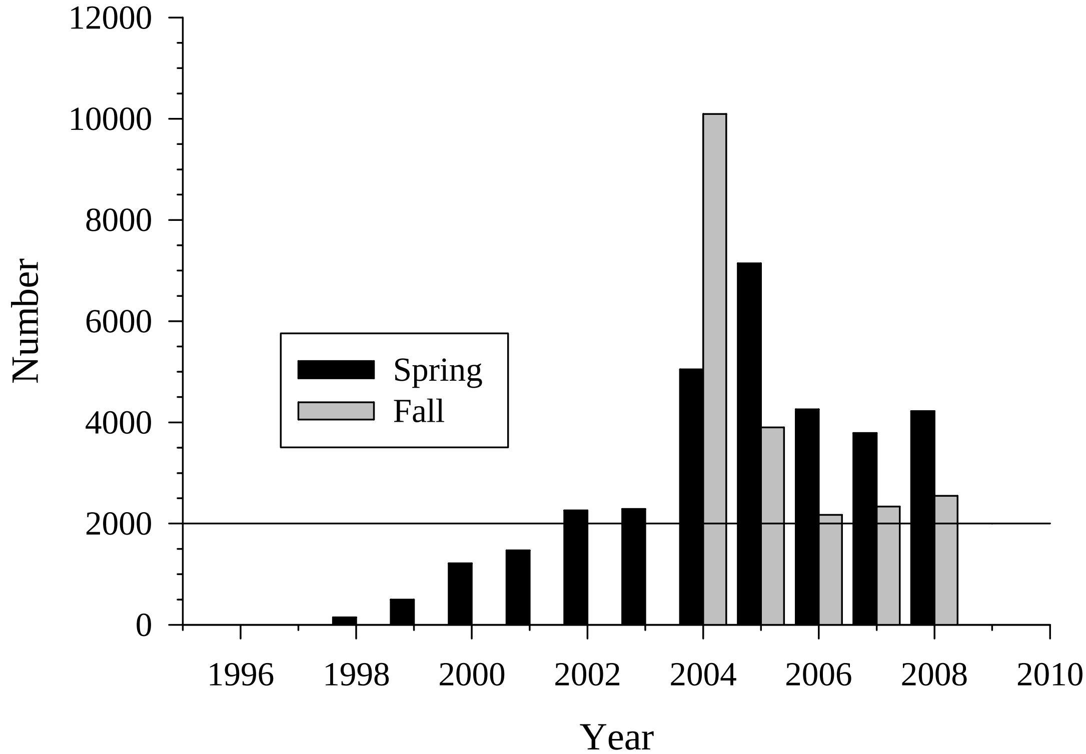

Figure 16. Spring and fall double-crested cormorant numbers on Leech Lake. The line depicts the current fall population goal of 2,000 birds ([500 nesting pairs x 2 adults] + 2 offspring/nest). Adapted from LLBO (2008).

APPENDIX

Table A1. Mean length-at-age data of female walleye captured with experimental gillnets in the main lake basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980				12.93	17.30	16.83	19.30		22.60		
1981			11.20		14.15	16.31	18.73		21.73	23.70	
1982		8.80		14.43	14.85	17.26	21.95	22.50	22.80		
1983		10.77	10.31	12.90	14.94	19.29	19.73	23.00		22.40	22.80
1984	6.60	10.00	11.03	13.15	17.23	18.52	18.93	21.04			
1985		9.58	11.07	13.74	16.14	18.31	19.88	20.00	20.80		23.78
1986		9.28	11.46	14.04	16.94	19.21	20.75	20.72	21.20	23.94	24.20
1987			13.40	13.77	16.97	20.01	20.20	21.55	21.95	25.60	24.30
1988	7.43	10.20	12.39	15.40	17.98	18.65	20.08	20.86	22.15	23.77	24.55
1989		10.28	13.18	14.46	18.80	19.95	19.31	22.40			
1990		11.06	13.68	15.47	17.51	19.47	20.80	21.85	22.70	23.10	24.50
1991		11.02	13.05	15.98	17.69	19.44	20.85	20.05	23.90	24.90	20.30
1992		9.85	12.32	15.00	18.27	19.70	19.65				
1993		9.30	13.35	15.45	16.60	18.03	16.50				
1994		10.34	12.45	14.76	17.64	19.33	19.70	21.17	20.65	21.53	24.06
1995	7.30	9.62	12.82	15.59	17.52	19.24	20.30	20.45	22.02	23.82	
1996		10.40	13.11	15.41	18.25	19.31	19.50	23.20			24.25
1997	6.60	10.27	13.81	16.63	18.53	19.23	21.10	21.46	23.20	23.27	23.85
1998	6.95	10.88	14.63	16.72	18.38	19.17	22.11		23.61		23.62
1999	6.94	10.48	14.35	17.27	19.54	18.96	20.29	23.26	23.74	24.74	
2000	7.15	10.99	13.87	18.25	19.51	20.21		23.17			
2001	7.62	11.87	16.35	18.17	19.91	21.16	22.95				
2002		12.55	14.31	18.95	20.27	21.48					
2003	7.10	10.91	14.17	19.57	21.50	21.02					
2004		11.53	14.37	18.54	19.87						
2005		12.37	16.16	18.33							
2006	7.06	12.02	14.54								
2007	7.58	10.71									
2008											
Mean	7.12	10.60	13.25	15.80	17.85	19.17	20.12	21.67	22.36	23.71	23.65

Table A2. Mean length-at-age data of male walleye captured with experimental gillnets in the main lake basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980				13.60	14.57	15.13	17.16	18.90	18.50		
1981			10.87		15.20	16.29	17.43		18.80	18.10	
1982		10.20	11.30	13.65	14.58	15.79	17.82	18.68			
1983		11.00	10.95	13.43	14.72	17.77	18.53	18.96	19.10	20.60	19.55
1984	7.05	9.07	11.36	13.30	15.50	16.15	17.80		17.80		
1985		9.48	11.80	13.63	15.21	17.05	18.20	18.10		20.85	
1986		9.34	11.70	14.85	16.13	17.33	16.90	18.68	18.10	20.20	19.88
1987		10.50	12.93	14.19	17.04		18.13	18.88	18.58	21.20	
1988	7.16	10.29	12.42	15.43	16.30	17.41	18.38	18.52	19.10	20.50	20.33
1989		9.85	12.84	14.70	16.15	18.08	19.50	19.95		19.30	
1990		10.78	14.02	14.73	16.43	17.39	17.70	18.50		20.80	
1991		10.95	12.52	14.96	15.89	17.10	19.53		21.40	20.90	
1992		9.73	13.50	16.00	16.40	19.00	18.50				
1993		10.10			14.80	16.90	20.90			19.40	
1994	6.80	10.04	12.18	14.68	15.87	17.82	17.87	18.72		20.15	20.33
1995	7.57	9.56	12.65	15.06	16.40	17.84	18.24	19.60	19.00	20.37	20.75
1996	6.60	9.86	13.29	15.16	16.08	18.09	18.33	20.00		20.04	20.35
1997	6.94	10.32	13.73	15.93	17.29	18.56	19.13	19.54	20.32	21.29	20.66
1998	7.24	10.98	14.58	16.11	17.93	17.40	19.43	19.29	20.28	20.59	21.22
1999	6.90	10.83	13.64	16.63	18.25	19.00	19.66	20.44	21.09		
2000	7.05	11.34	14.60	17.35	18.54	19.51	19.92		19.69		
2001	7.18	11.71	15.59	16.52	18.74	19.00	19.78	19.75			
2002		12.50	15.07	17.24	18.84	19.88	20.19				
2003		12.03	14.65	17.24	18.15	20.71					
2004		11.61	16.69	18.31							
2005	6.58	12.32	15.74	17.45							
2006	7.23	12.01	14.26								
2007	7.34	10.63									
2008											
Mean	7.05	10.66	13.32	15.42	16.46	17.79	18.65	19.16	19.37	20.29	20.38

Table A3. Mean length-at-age data of female walleye captured with experimental gillnets in the western bays basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980				14.12	14.20	17.40	15.95	17.85		19.40	
1981			11.12	13.15	13.17	17.46	20.70	19.80	19.80		
1982		9.73	11.23	12.97	15.03	17.04	18.63	19.63	23.00		
1983		9.94	12.53	12.95		19.09	19.88		21.47		
1984			11.37	12.40	15.63	16.14	19.00	22.10	22.10		
1985		7.50	13.10	13.30	13.71	18.00	20.06				22.10
1986		9.36	10.93	13.43	16.28	18.79	20.02	21.05	22.36	21.20	21.10
1987		9.70	11.93	13.57	17.18	18.45	19.10	21.53			
1988	7.03	9.56	12.39	15.08	17.45	18.87	20.41	20.40	21.37	22.80	
1989		10.00	13.11	14.10	18.50	18.50		20.55			19.10
1990		9.91	12.11	13.78	15.65	16.50	19.40		22.40		
1991		10.12	10.67	13.18	13.75	18.88	19.30		19.20	20.50	
1992			11.08	12.90	15.40	18.20	19.60	18.70			
1993				14.30	17.10	16.20	16.60				
1994		8.76	11.30	13.47	16.30	17.90	18.87	19.25	18.95	19.00	
1995	6.50	8.45	11.22	14.23	14.90	18.16	17.50	18.83	23.70	24.49	21.38
1996		9.57	12.66	14.09	15.30	17.15	18.30		25.12		22.52
1997		9.99	12.68	14.85	16.55	17.68	19.00		19.55	21.34	24.20
1998	7.23	9.94	12.44	14.30	16.63	19.80	18.70		22.28	24.76	23.77
1999	6.30	9.31	11.93	14.82	17.34	19.29	19.89	22.87	24.46	22.58	
2000		9.80	12.40	14.20	17.70	19.07	20.59	21.67			
2001		10.81	14.19	15.65	18.73	20.10	21.27	21.99			
2002		10.31	12.88	16.17	18.55	20.26	20.60				
2003		10.61	13.87	17.24	19.44	20.39					
2004		10.71	14.09	17.03							
2005		11.55	14.67	16.34							
2006		10.71	13.55								
2007	7.01	9.57									
2008											
Mean	6.81	9.82	12.38	14.29	16.28	18.31	19.24	20.44	21.84	21.79	22.02

Table A4. Mean length-at-age data of male walleye captured with experimental gillnets in the western bays basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980				13.86	15.00	15.38	16.83		19.10		
1981			11.52	13.17	14.80	15.50	16.00	18.45	18.30	20.15	19.95
1982		9.57	11.90	13.00	14.46	16.34	17.47	17.15	18.43	19.73	19.15
1983		10.23	11.20	12.97	14.30	16.73	17.03	18.57	19.13		20.90
1984		8.40	10.55	12.65	14.80	15.48	17.80	18.68	18.50		
1985		7.90	11.10	13.65	13.73	16.20	17.14	18.05		18.38	20.10
1986		8.84	11.12	12.90	15.30	17.03	18.06	18.22	18.80	16.80	19.60
1987		10.08	12.08	13.74	15.33	16.30		18.60			
1988		9.84	12.16	14.46	16.77	17.98	18.42	19.30	18.13		19.40
1989		9.64	12.38	16.05	16.05	16.77		19.30		18.85	
1990		10.05	13.72	13.13	14.50	18.80	16.30				
1991		9.29	11.26	13.48	15.04	16.13	17.50				
1992		7.80	10.60	11.50	14.30		18.40				
1993		10.10	11.25	12.80	14.90	16.65					
1994		8.57	11.19	13.40	14.95	16.20	18.10	19.20		19.40	19.50
1995		8.58	11.11	13.76	16.50	15.60	18.50		18.30		18.98
1996		8.96	11.22	13.40	15.60	18.90		19.10	18.80	18.50	19.69
1997		9.51	11.96	14.92	16.54	18.35		19.04	19.61	19.84	21.56
1998	6.90	10.02	12.43	15.07		16.37	18.76	19.85	18.54	20.59	
1999	5.50	9.95	12.02	15.47		16.97	19.25		19.51	18.19	
2000		9.95	12.80	15.10	16.38		17.87		19.80		
2001	6.70	10.26	13.15	14.51	17.48	17.78	19.10	19.84			
2002		10.13	12.87	15.81	16.82	18.43	19.46				
2003	6.60	10.15	14.33	16.18	18.50	18.48					
2004		10.13	14.00								
2005		10.81	14.28	16.19							
2006	6.75	11.15	12.62								
2007	7.52	10.17									
2008											
Mean	6.66	9.62	12.11	14.05	15.55	16.93	17.89	18.81	18.84	19.04	19.88

Table A5. Mean length-at-age data of female yellow perch captured with experimental gillnets in the main lake basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980							10.27	9.31	11.95	10.50	
1981						8.89	9.27	10.97	9.80	11.07	11.30
1982					7.81	7.19	10.78	9.89	10.64	12.27	11.40
1983				6.67	6.80	9.40	8.61	9.99	11.13	10.84	13.20
1984				5.66	8.03	7.71	8.66	10.06	10.53	11.05	11.50
1985				7.12	6.74	8.52	9.68	9.98	9.79	10.15	10.37
1986			5.93	6.03	7.51	8.82	9.67	9.65	8.97	10.45	10.62
1987				6.42	7.42	8.04	9.03	8.68	9.85	10.14	9.90
1988				5.91	7.26	7.75	8.30	9.18	10.26	10.30	12.50
1989				5.45	6.51	7.19	8.07	8.94	9.61	10.80	11.93
1990				6.00	6.62	7.51	7.90	9.18	10.28	10.90	11.18
1991			5.60	5.60	5.62	6.81	7.85	9.78	10.70	11.28	11.30
1992				6.15		16.27	8.96	10.90	10.90		
1993				6.15	7.18	7.96	9.76	9.88	10.50		
1994				5.96	7.36	8.76	9.49	9.74	12.60		
1995				6.26	7.61	8.39	9.62	10.75		11.93	
1996				6.04	7.55	8.87		11.90			
1997				6.08	7.44		9.05	11.30	10.39		
1998			5.60	6.23		8.74	10.33	11.34			
1999			5.60		8.62	8.57	9.91				
2000				6.74	7.13	9.42	9.47	10.41			
2001			5.76	6.80	8.69	10.45	10.66	9.70			
2002			5.54	7.00	9.33	10.43	10.20				
2003			5.95	8.22	8.62	9.33					
2004			6.32	7.33	8.40						
2005		5.39	6.39	7.56							
2006			5.93								
2007		5.76									
2008											
Mean		5.58	5.86	6.43	7.54	8.86	9.34	10.07	10.49	10.90	11.38

Table A6. Mean length-at-age data of male yellow perch captured with experimental gillnets in the main lake basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980							8.90	7.70			
1981						8.96	7.48	10.27	9.30	10.80	9.60
1982					7.02	7.03	9.42	8.97	10.05		9.80
1983				6.10	5.96	8.88	8.85	9.10	9.67	9.65	10.70
1984			6.70	5.64	8.43	7.53	8.76	9.14	8.03	9.80	9.70
1985			5.40	7.02	6.73	7.84	8.25	8.66	9.85	10.13	
1986			5.84	5.87	7.29	8.07	8.24	7.83	8.35	9.45	9.15
1987		5.47		6.19	6.73	8.00	8.13	8.36	8.80	8.20	8.80
1988			5.00	5.37	6.25	7.20	7.44	8.64	8.70	9.04	11.00
1989				5.52	6.27	7.00	7.67	7.92	7.60	9.13	
1990				6.07	6.33	7.17	7.43	8.65	8.60		
1991				5.60	7.20	7.27		8.40	9.50		
1992				5.63	6.50		8.00	8.85	10.10		
1993			5.70	5.98	7.05	7.54	8.92	9.18	9.90		
1994			5.65	5.74	6.60	7.98	8.21	9.70			
1995				6.01	6.58	8.00	11.05				
1996				5.83	7.24	7.94		10.90			
1997				6.02	7.20						
1998			5.47	6.05		8.88					
1999			5.27		8.30	7.83					
2000				6.37	5.73	7.09					
2001			5.30	5.94	7.60						
2002			5.64	6.25	6.85	7.08	9.25				
2003			5.95	7.02	8.04	9.20					
2004			6.02	6.44	6.79						
2005		5.25	6.01	6.90							
2006			6.06								
2007		5.81									
2008											
Mean		5.51	5.72	6.07	6.94	7.82	8.50	8.89	9.11	9.53	9.82

Table A7. Mean length-at-age data of female yellow perch captured with experimental gillnets in the western bays basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980							10.49	9.80	11.13	9.80	11.25
1981						9.35	8.80	10.95	10.38	11.43	10.95
1982					6.97	8.12	10.18	9.21	11.70	9.80	10.70
1983				6.41	6.61	9.19	8.25	10.93	10.90	10.53	10.00
1984				5.70	7.95	7.63	8.85	10.50	9.98	10.50	10.12
1985				7.21	6.67	8.65	9.34	9.49	9.86	9.50	9.35
1986			5.80	5.96	7.27	7.71	9.11	9.54	9.48	9.68	8.73
1987				6.74	7.51	7.79	8.83	9.20	9.42	9.67	11.00
1988				6.30	6.62	7.62	7.88	8.72	9.30	9.80	11.29
1989				6.30	6.55	6.89	7.20	7.45	10.10	10.44	
1990				5.62	6.05	7.28	7.45	9.70	10.13	10.80	10.87
1991				5.70	6.18	7.06	7.25	9.41	11.11	11.14	
1992				5.95	6.16	7.33	8.60	10.90	10.68	9.80	11.30
1993				5.55	6.10	8.02	9.38	9.96	10.27	11.00	10.00
1994				6.02	6.71	8.61	9.14	10.06	10.40	11.15	
1995				6.02	7.27	8.37	10.14	9.98		11.54	
1996				5.90	7.21	8.05	8.13	10.58	10.16		
1997				6.11	7.01	8.27	9.98	9.78	11.56		
1998			5.60	5.87	6.83	8.65	9.74	10.65		11.61	
1999			5.30	5.86	7.43	8.37	9.97	10.14	11.77	11.89	
2000				6.10	7.45	8..8	10.66				
2001			5.67	6.20	8.02	9.72	9.38	10.84			
2002			5.14	7.25	8.34	8.40	9.34				
2003			6.28	7.01	7.61	8.23					
2004			6.02	6.54	6.99						
2005			6.11	6.51							
2006			5.81								
2007		6.34									
2008											
Mean			5.75	6.21	7.02	8.15	9.05	9.89	10.46	10.56	10.46

Table A8. Mean length-at-age data of male yellow perch captured with experimental gillnets in the western bays basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980							10.80	7.76		10.28	10.60
1981						8.73	7.77	10.40	9.97	9.60	10.60
1982					6.66	7.20	9.50	8.94	10.33		10.75
1983				6.40	6.19	8.97	7.79	9.59		9.37	
1984				5.83	7.67	7.21	8.34	9.10	8.83	10.10	9.73
1985				7.08	6.26	8.37	8.10	8.60	8.60	9.00	10.10
1986			5.70	5.76	6.90	6.78	7.72	7.55		9.10	9.13
1987				6.00	6.40	6.96	8.00	8.10	9.50	8.10	9.83
1988				5.83	6.17	7.02	7.39	8.87	8.10	8.73	10.00
1989				5.67	6.08	6.87	7.74	7.60	8.23	9.48	10.25
1990				5.42	6.34	7.28	7.67	7.55	8.78	10.65	
1991			5.20	5.65	6.50	7.80	8.05	8.18	9.13	11.00	
1992			5.40	5.90	6.15	6.66	7.75	9.56	10.10	10.30	
1993				6.14		7.10	8.50	9.25			
1994			5.70	5.67	6.74	7.30	8.19	9.95		10.30	9.02
1995				5.92	7.02	7.93	9.10			9.69	
1996				6.02	6.70	7.70		10.00	8.98	10.77	
1997			5.30	5.77	6.80		9.12	9.77	10.47		
1998			5.30	6.65		7.92	9.40	8.88			
1999			5.50		8.08	8.70	9.87			10.43	
2000				6.36	7.11	9.35		8.95			
2001			5.73	5.84	6.90		7.74	9.40			
2002				6.29	8.23	6.63	8.70				
2003			6.30	6.28	6.82	7.73					
2004			5.89	6.51	6.41						
2005			5.55	3.15							
2006			6.32								
2007											
2008											
Mean			5.66	5.91	6.77	7.63	8.44	8.90	9.25	9.81	10.00

Table A9. Mean length-at-age data of female northern pike captured with experimental gillnets in the main lake basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980							22.02	26.55		29.80	
1981						24.15	27.58	30.70	28.00	32.50	
1982					23.04	26.61	29.48	27.20	29.40		
1983				19.08	23.93	28.20	29.40	31.50	28.70		
1984			16.13	21.59	23.86	22.10	33.90		33.80	33.40	
1985		18.20	21.25	22.08	23.00	22.00	27.37	28.15	30.45		28.60
1986		15.50	20.74	22.44	21.23	27.13	29.70		29.70	29.10	
1987		18.20	19.71	21.06	26.46	24.46	27.45		34.45	34.70	27.80
1988		15.35	20.24	22.15	24.09	25.62	27.09	29.28	27.80	34.50	
1989		17.80	21.13	22.61	23.87	25.32	29.63	32.50	32.40		
1990		13.10	20.85	22.40	25.08	25.03	26.95	26.70	33.65		
1991		16.77	21.87	22.99	24.91	27.48	29.00				
1992		16.79	22.42	21.78	23.36	26.93		33.00			
1993		17.27	20.38	21.79	26.73	27.72	31.10				
1994		17.43	20.91	22.54	24.64	30.15	32.05				
1995	10.10	15.91	19.90	22.11	24.98	27.70		29.20			
1996		16.10	20.35	22.25	25.64		25.50	24.60			
1997		18.08	19.44	22.08	24.07	27.20	25.43			30.47	
1998		15.73	19.98	21.59	23.48	23.78	29.57	36.16			
1999		18.35	19.08	21.81	23.86	25.43	30.14	25.20			
2000		15.30	21.18	22.47	23.37	25.26	25.94				
2001		16.43	20.54	22.12	22.62	26.57	26.70	32.17			
2002		16.90	22.52	23.98	25.94	28.07	28.99				
2003		18.31	21.46	23.79	25.85	26.72					
2004		16.57	21.98	25.02	26.65						
2005		17.31	20.49	24.53							
2006		17.17	20.39								
2007		17.32									
2008	8.50										
Mean	9.30	16.78	20.56	22.36	24.38	26.07	28.33	29.49	30.84	32.07	28.20

Table A10. Mean length-at-age data of male northern pike captured with experimental gillnets in the main lake basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980							21.55	21.85			
1981						22.04	22.60	26.80	23.90	29.35	21.70
1982					21.83	20.18	25.00	25.10		22.40	21.20
1983				19.47	20.68	21.79	22.90	23.90	20.90	23.40	
1984			15.10	19.90	21.93	22.54	21.40	22.90			
1985			15.40	21.10	21.80	20.40	23.83			21.40	
1986		15.00	18.55	20.33	20.50	20.00	21.60	23.06		22.67	
1987		15.03	18.25	18.44	21.47	21.74	22.80	20.00	21.60	17.07	
1988		12.90	17.65	20.04	20.23	22.14	22.63	23.80	24.20	20.80	
1989		15.70		20.24	20.59	20.83	22.68	22.58			
1990		17.80	18.90	21.60	21.10	22.37	20.80	26.20		31.40	
1991		16.20	19.68	19.68	21.05	18.65	21.35				
1992		17.00	18.55	20.48	21.50	20.86					
1993		15.78	16.78	20.20	20.63	21.25					
1994	9.25	17.10	17.83	19.40	22.45	22.90					
1995	10.00	13.95	17.90	20.35	21.33	23.70					
1996		15.83	18.68	20.11	22.38	21.10		21.35			
1997	9.00	15.47	17.96	20.37	22.40	21.40	22.55				
1998	9.60	15.20	18.09	20.54	21.12	21.51	22.64				
1999		14.90	18.19	20.28	21.49	21.77	24.09				
2000	12.00	16.20	19.40	20.47	20.97	23.19		22.36			
2001	9.63	14.05	17.58	20.39	21.65	24.02	23.46				
2002			19.45	20.42	22.62	23.98	23.11				
2003		16.73	17.83	21.36	22.80	22.13					
2004	9.41	14.84	19.66	21.59	21.50						
2005		17.24	20.98	21.33							
2006			18.84								
2007		15.90									
2008											
Mean	9.84	15.64	18.24	20.35	21.48	21.76	22.65	23.32	22.65	23.56	21.45

Table A11. Mean length-at-age data of female northern pike captured with experimental gillnets in the western bays basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980							28.00				
1981						22.73	26.68	29.07	27.00		
1982					21.24	20.90	26.60	29.44			
1983				19.33	24.93	27.78	23.40	30.00	35.60		
1984			15.78	19.23	25.40	22.80	28.30	31.80		33.90	28.05
1985			18.71	22.45	23.51	26.35	30.70	31.48	28.85		
1986		15.70	18.25	20.86	23.48	28.60	30.80	29.10	23.90	18.10	35.70
1987		16.26	18.71	22.06	23.15	25.75	32.50	27.06	31.53	27.80	
1988		15.43	18.76	21.37	26.58	25.18	25.45	30.05	28.70	33.40	
1989		16.50	19.05	22.15	24.80	27.90	32.40	17.20	30.34		
1990		15.15	18.62	22.14	24.20	25.00	24.65	33.40			
1991		15.95	17.05	21.77	25.21	25.48	27.08	32.40	29.00		
1992		14.93	20.10	20.74	23.38	24.63	29.93		35.70		
1993		14.90	20.12	21.57	25.29	26.10	30.90	32.07	31.03		
1994	9.40	16.65	19.17	21.56	23.92		30.00	35.40		34.60	
1995		15.23	20.13	20.30	27.55	26.83	27.28		30.20		
1996		14.19	18.08	21.93	26.98	23.90	29.20	30.64			
1997	10.55	14.71	17.68	21.31	23.20	24.59	24.47	27.95	32.80		
1998	8.50	13.57	18.93	20.12	22.56	23.00	26.78	34.49	30.85	35.08	
1999		14.72	17.75	21.09	22.91	26.27	26.62	27.24		29.17	
2000		15.14	17.50	20.17	22.13	26.88	29.46	30.38	32.44		
2001		13.47	18.42	20.96	23.91	25.62	30.15	28.84			
2002		15.21	19.38	21.91	24.26	27.28	29.36				
2003	9.70	14.33	18.73	21.94	24.24	25.76					
2004		17.76	19.30	22.78	24.63						
2005		15.75	19.47	22.03							
2006	10.45	14.89	19.54								
2007		13.27									
2008											
Mean	9.72	15.17	18.66	21.29	24.24	25.42	28.29	29.89	30.57	30.29	31.88

Table A12. Mean length-at-age data of male northern pike captured with experimental gillnets in the western bays basin, Leech Lake.

	Age										
YC	0	1	2	3	4	5	6	7	8	9	10
1980							21.37	23.60			
1981						19.50	24.20				23.10
1982					19.95	20.43	24.80		21.20		26.70
1983				17.95	20.84	23.43		21.00			
1984			16.96	17.25	21.39	24.55	22.70	23.70	28.20	25.17	
1985			16.82	19.65	20.89	21.50	22.47	18.00			24.30
1986		13.95	17.24	19.71	19.20	18.70		27.70	20.70	26.75	24.70
1987		15.02	17.39	19.36	20.58	20.80	22.20		21.65		
1988		14.26	17.32	18.29	20.10	21.07	19.95	23.77		22.90	
1989		15.44	17.62	21.09	20.18	22.30	22.58	21.10			
1990		16.25	18.36	19.97	18.70	22.00	21.50				
1991		15.70	17.25	19.50	19.60	20.17	23.65	27.80			
1992		13.80	18.30	18.50	20.98						
1993		14.36	17.49	21.03	21.08	23.88					
1994		14.90	17.11	19.93	20.80	25.00					
1995	8.80	14.07	16.16	19.30	18.30	24.87			25.20		
1996		12.83	17.48	20.45	21.16	24.00					
1997	9.30	13.93	17.58	19.64	19.89	20.70	22.73	20.71			
1998			17.08	18.88	20.70	21.10	20.75				
1999		14.36	17.82	19.57	20.37	21.71	11.54			23.27	
2000	10.00	14.60	18.06	18.98	21.61	22.56					
2001		12.96	16.75	18.76	20.38	24.71	22.64	31.54			
2002		14.17	17.11	18.53	21.26	21.94					
2003		13.69	18.74	21.34	22.09	21.51					
2004		14.86	17.79	20.10	20.76						
2005		15.10	17.10	19.57							
2006	9.90	15.59	17.97								
2007		11.99									
2008											
Mean	9.50	14.37	17.46	19.45	20.47	22.11	21.65	23.89	23.39	24.52	24.70

Table A13. Gillnet catch-per-effort (fish/net) by species for Leech Lake, 1983-2008.

	Year											
Species	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Black bullhead	11.25	9.72	13.75	7.97	11.19	15.06	21.33	11.56	16.53	9.80	4.33	3.92
Black crappie	0.13	0.50	0.17	0.33	0.31	0.36	0.28	0.28	0.53	0.20	0.17	0.19
Bluegill	0.00	0.06	0.00	0.22	0.06	0.08	0.64	0.33	0.14	0.40	0.33	0.19
Bowfin	0.03	0.03	0.06	0.03	0.08	0.19	0.03	0.03	0.00	0.10	0.03	0.03
Brown bullhead	2.50	1.08	0.58	0.75	1.06	0.94	1.83	0.92	3.14	1.50	1.69	2.17
Burbot	0.09	0.08	0.11	0.17	0.03	0.08	0.08	0.00	0.08	0.10	0.08	0.08
Hybrid sunfish	0.03	0.00	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Lake whitefish	0.16	0.19	0.00	0.00	0.06	0.19	0.00	0.00	0.36	0.00	0.00	0.06
Largemouth bass	0.09	0.00	0.00	0.00	0.14	0.08	0.44	0.03	0.14	0.00	0.03	0.00
Muskellunge	0.03	0.03	0.00	0.00	0.00	0.00	0.25	0.08	0.00	0.00	0.06	0.00
Northern pike	4.19	3.72	4.08	3.78	4.25	5.31	5.83	5.33	5.81	4.40	3.58	4.03
Pumpkinseed	0.09	0.25	0.28	0.22	0.33	0.69	1.11	1.61	1.00	1.10	0.47	0.44
Rock bass	0.50	1.31	2.11	1.06	0.39	0.86	2.25	2.67	2.11	1.10	2.06	1.17
Shorthead redhorse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Smallmouth bass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tiger muskellunge	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Tullibee/cisco	6.31	4.56	10.19	14.06	18.47	11.08	2.11	5.94	6.67	4.40	9.64	9.14
Walleye	5.25	7.42	7.22	6.28	6.03	13.39	11.72	8.33	8.81	5.80	4.61	4.89
White sucker	1.31	1.78	1.78	1.06	2.36	2.56	2.06	2.14	1.75	2.00	1.64	1.86
Yellow bullhead	1.09	0.42	1.36	1.03	1.25	2.17	1.94	0.94	3.36	1.40	1.69	2.69
Yellow perch	13.50	17.94	15.61	13.19	16.06	18.47	26.08	33.67	18.64	22.10	20.39	21.67
Total fish/set	46.55	49.09	57.30	50.15	62.13	71.54	78.01	73.86	69.07	54.40	50.80	52.56
Total sets	32	36	36	36	36	36	36	36	36	36	36	36

Table A13 continued. Gillnet catch-per-effort (fish/net) by species for Leech Lake, 1983-2008.

	Year											
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Black bullhead	0.88	0.67	1.49	2.50	1.75	0.54	0.69	1.22	1.25	4.25	3.50	1.44
Black crappie	0.12	0.14	0.11	0.17	0.31	0.20	0.36	0.31	0.56	0.25	0.39	0.64
Bluegill	0.09	0.08	0.14	0.17	0.11	0.57	0.64	1.00	0.50	0.78	2.08	1.14
Bowfin	0.00	0.03	0.03	0.06	0.33	0.17	0.06	0.11	0.03	0.11	0.00	0.00
Brown bullhead	0.91	0.58	0.66	1.28	3.25	2.09	2.08	0.86	0.94	1.61	4.11	2.00
Burbot	0.06	0.00	0.03	0.06	0.06	0.03	0.08	0.06	0.00	0.00	0.03	0.03
Hybrid sunfish	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lake whitefish	0.15	0.06	0.11	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Largemouth bass	0.03	0.08	0.03	0.22	0.08	0.03	0.06	0.31	0.25	0.11	0.03	0.08
Muskellunge	0.06	0.03	0.11	0.06	0.03	0.06	0.00	0.00	0.00	0.00	0.03	0.03
Northern pike	6.17	4.83	5.14	5.08	3.69	4.97	5.28	5.28	4.97	5.39	4.89	4.03
Pumpkinseed	0.24	0.47	1.09	0.72	0.39	0.43	1.11	1.08	1.61	0.81	2.06	0.64
Rock bass	2.71	2.89	2.03	2.25	1.83	0.89	1.86	1.22	1.28	2.00	0.58	0.47
Shorthead redhorse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Smallmouth bass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Tiger muskellunge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tullibee/cisco	4.18	4.72	4.23	3.67	3.14	2.66	1.28	1.58	0.92	1.78	3.53	0.64
Walleye	7.74	9.50	5.69	11.64	8.92	5.91	7.03	6.19	5.17	4.97	4.89	7.06
White sucker	3.12	1.97	1.20	1.97	1.17	0.94	1.17	1.28	1.42	0.83	0.86	1.89
Yellow bullhead	0.41	0.33	0.91	0.83	0.86	0.37	0.53	1.61	1.28	2.72	2.56	1.69
Yellow perch	37.66	25.64	32.11	28.58	21.06	21.17	15.53	20.50	16.17	16.28	12.89	20.47
Total fish/set	64.56	52.02	55.11	59.26	47.01	41.06	37.73	42.64	36.33	41.91	42.43	42.25
Total sets	35	36	35	36	36	35	36	36	36	36	36	36

Table A13 continued. Gillnet catch-per-effort (fish/net) by species for Leech Lake, 1983-2008.

	Year						Quartiles	
Species	2007	2008	Min	Max	Median	Mean	First	Third
Black bullhead	1.89	1.14	0.54	21.33	3.92	6.34	1.44	11.19
Black crappie	1.72	0.89	0.06	1.72	0.28	0.35	0.17	0.36
Bluegill	1.14	1.19	0.00	2.08	0.22	0.44	0.09	0.64
Bowfin	0.11	0.08	0.00	0.33	0.03	0.07	0.03	0.10
Brown bullhead	4.25	1.97	0.20	4.25	1.50	1.71	0.92	2.09
Burbot	0.06	0.00	0.00	0.17	0.06	0.06	0.03	0.08
Hybrid sunfish	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Lake whitefish	0.00	0.06	0.00	0.36	0.00	0.06	0.00	0.06
Largemouth bass	0.22	0.08	0.00	0.44	0.08	0.10	0.03	0.14
Muskellunge	0.03	0.00	0.00	0.25	0.03	0.04	0.00	0.06
Northern pike	5.94	5.61	0.15	6.17	4.97	4.80	4.08	5.31
Pumpkinseed	1.33	1.47	0.09	2.06	0.69	0.78	0.39	1.10
Rock bass	1.33	2.39	0.15	2.89	1.33	1.56	1.06	2.11
Shorthead redhorse	0.03	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Smallmouth bass	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Tiger muskellunge	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Tullibee/cisco	4.00	1.61	0.64	18.47	4.23	5.56	2.66	6.67
Walleye	13.11	9.06	0.50	13.39	7.03	7.50	5.69	8.81
White sucker	0.72	0.61	0.12	3.12	1.75	1.63	1.17	1.97
Yellow bullhead	4.22	2.56	0.19	4.22	1.28	1.51	0.86	1.94
Yellow perch	36.86	26.56	1.39	37.66	20.47	21.69	16.17	25.64
Total fish/set	76.97	55.28	36.33	78.01	52.02	54.19	42.64	62.13
Total sets	36	36						

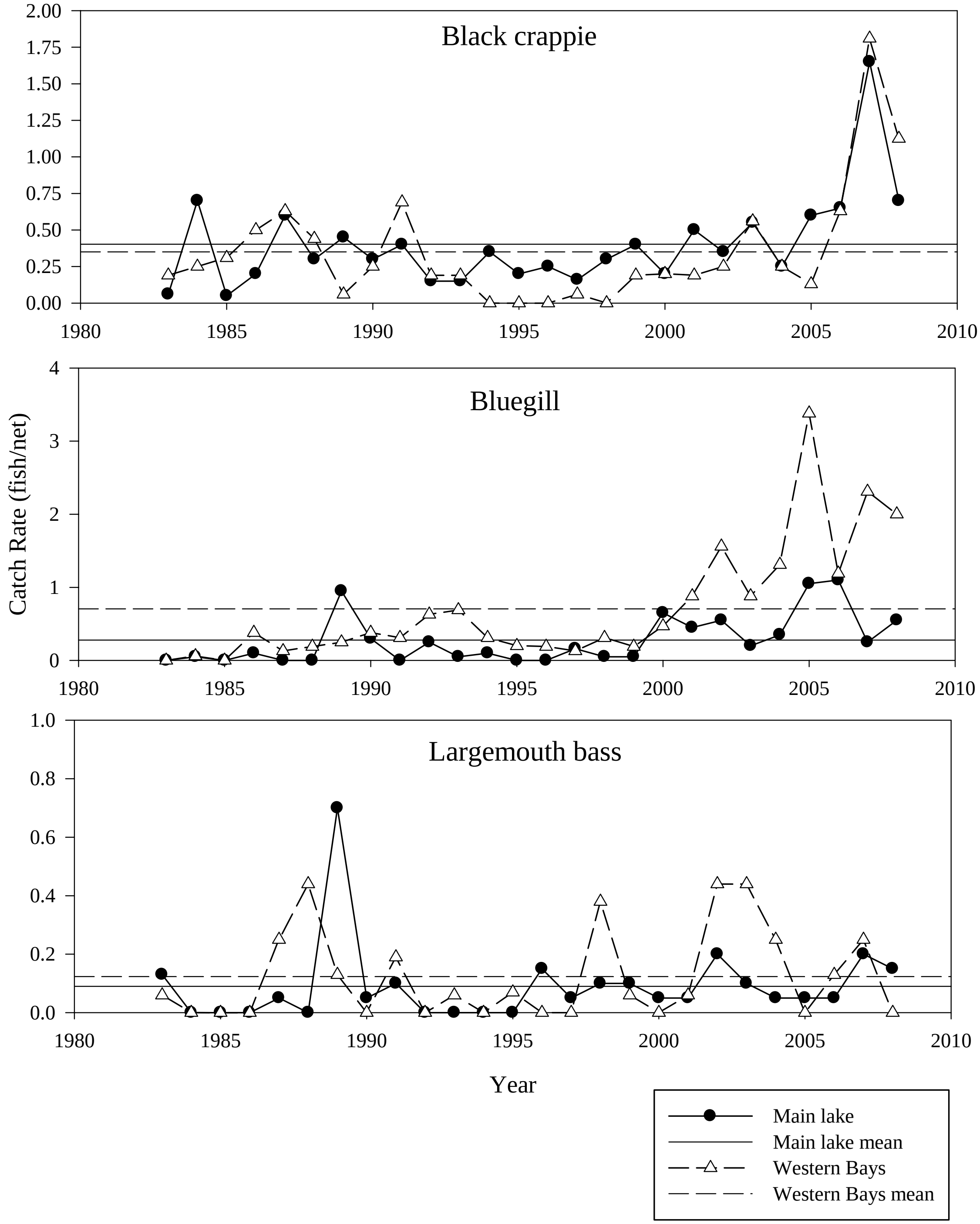

Figure A1. Gillnet catch rates (fish/net) of selected species in Leech Lake, 1983-2008.

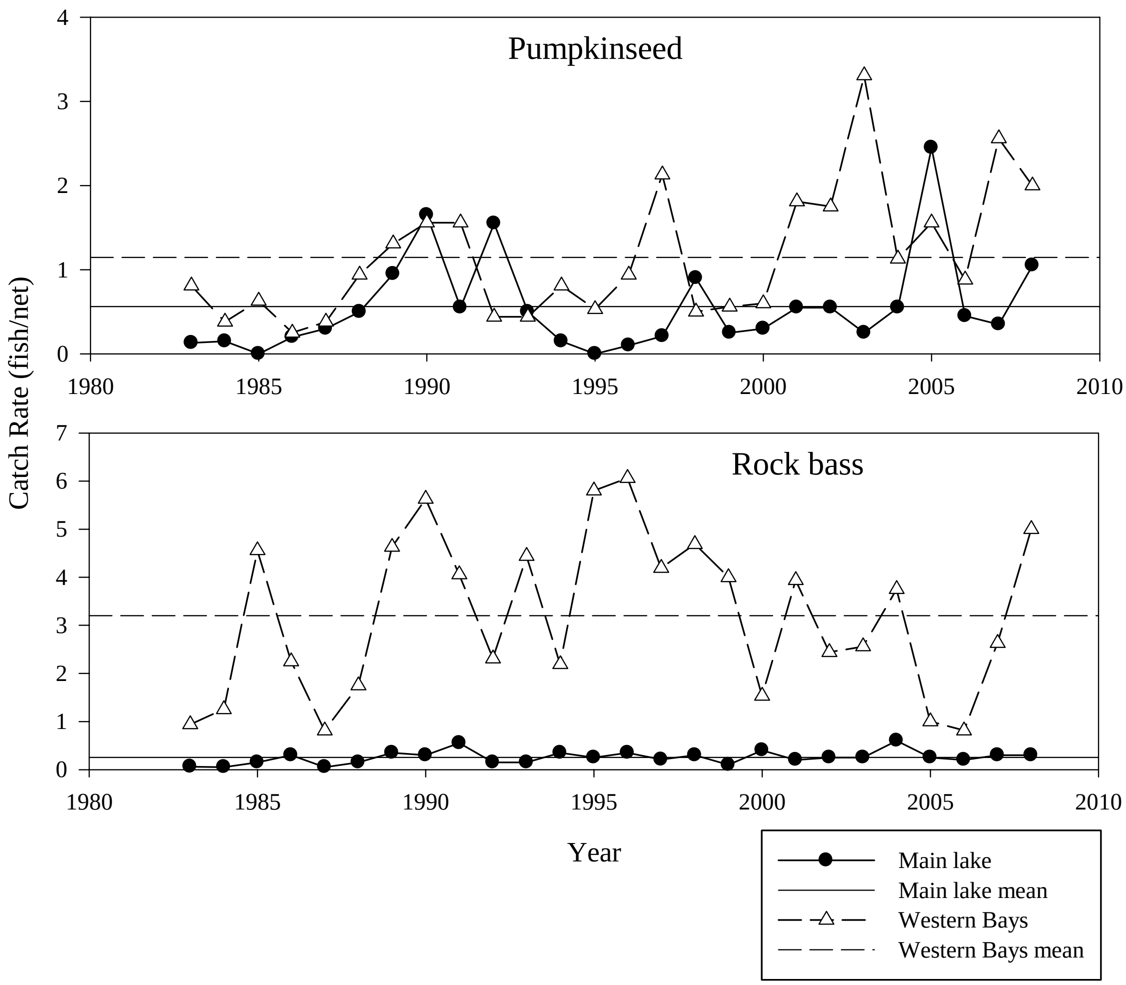

Figure A1, continued. Gillnet catch rates (fish/net) of selected species in Leech Lake, 1983-2008.

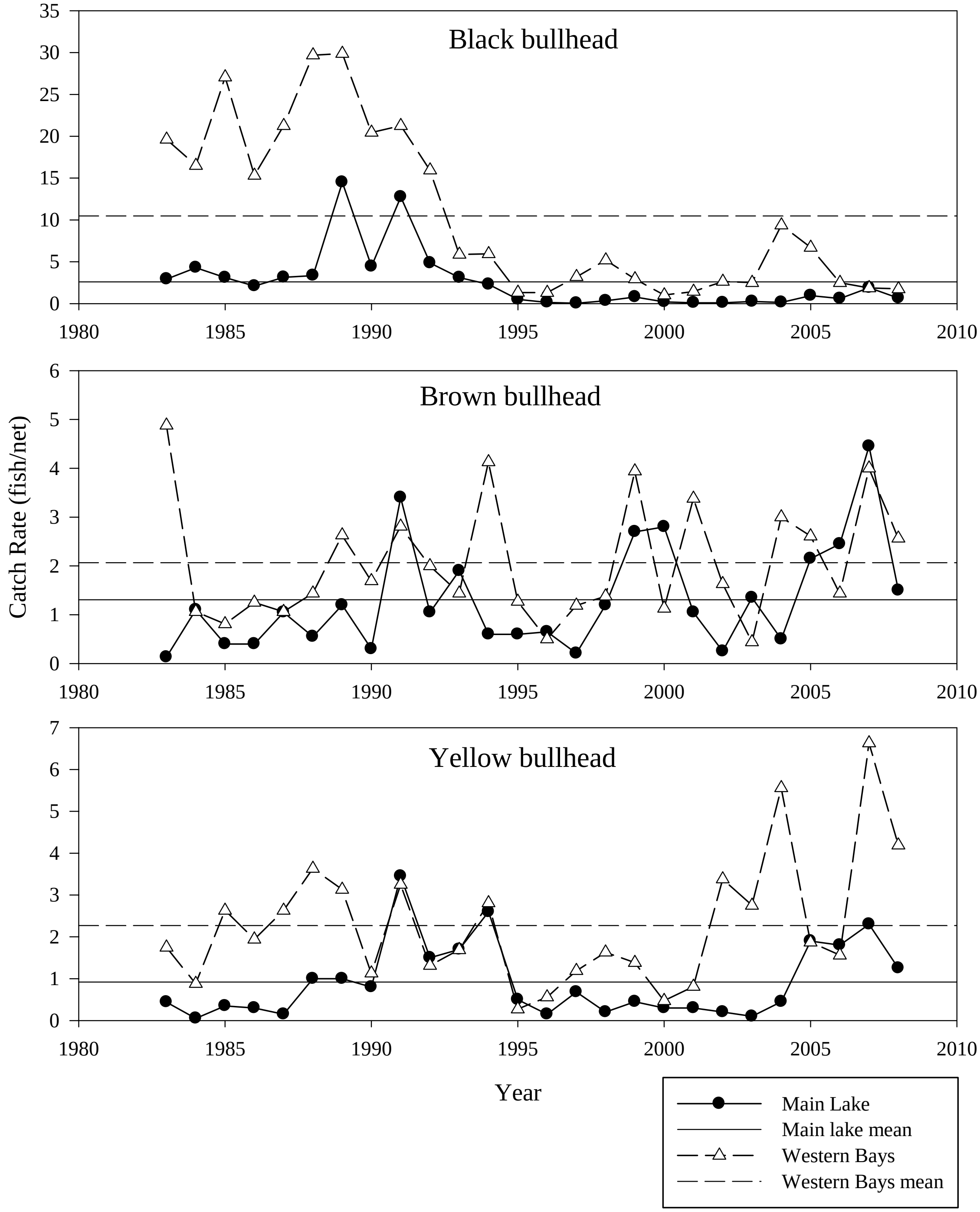

Figure A1, continued. Gillnet catch rates (fish/net) of selected species in Leech Lake, 1983-2008.

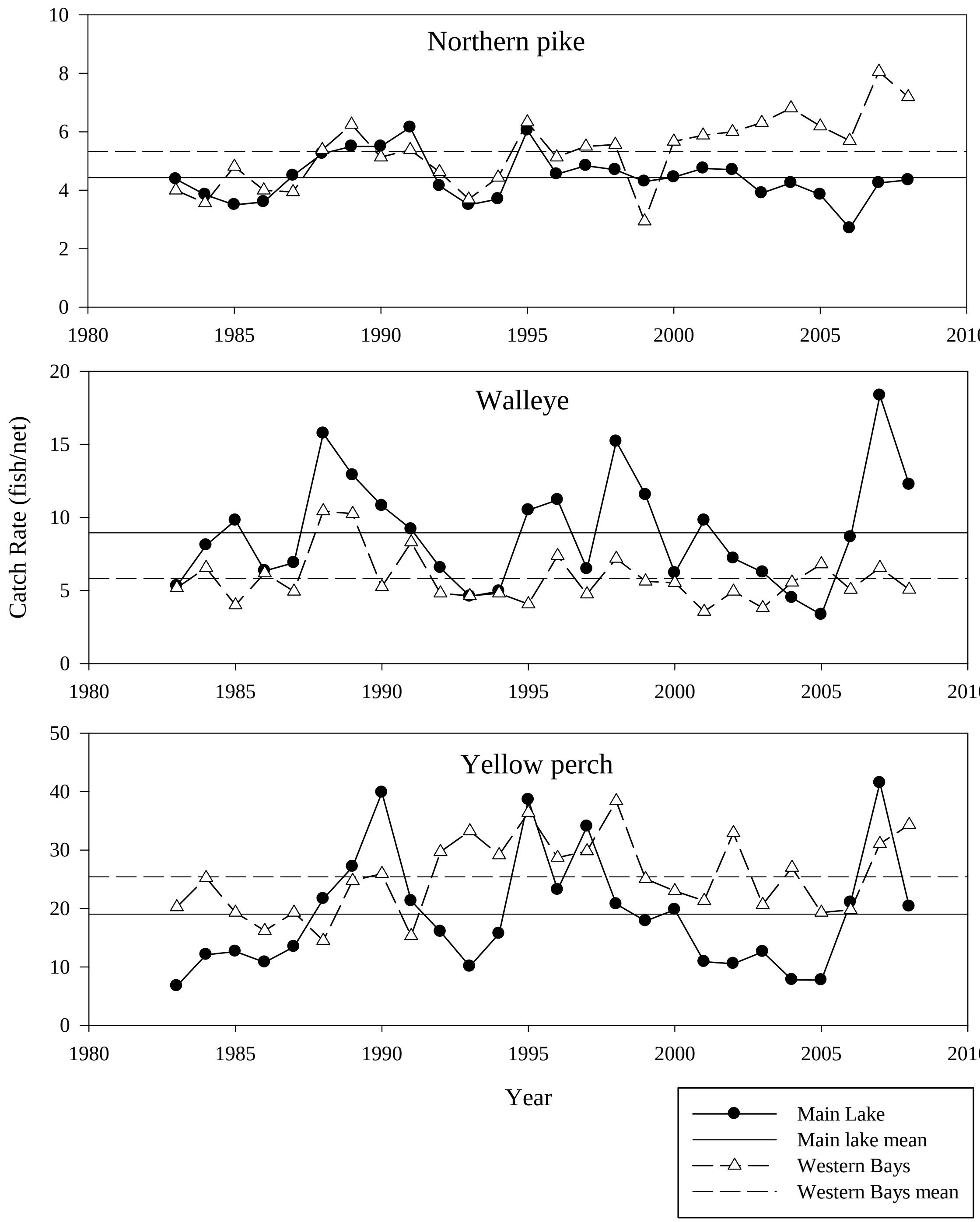

Figure A1, continued. Gillnet catch rates (fish/net) of selected species in Leech Lake, 1983-2008.

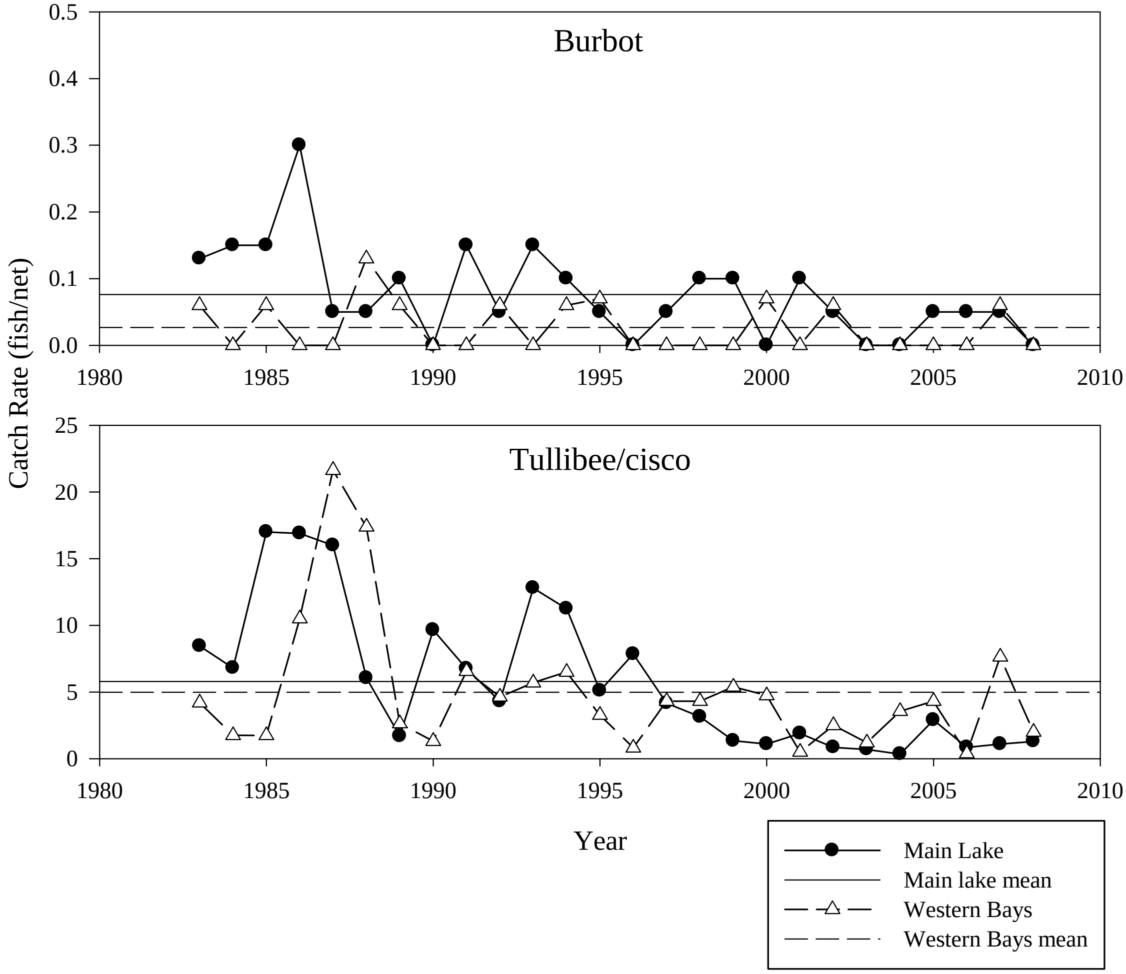

Figure A1, continued. Gillnet catch rates (fish/net) of selected species in Leech Lake, 1983-2008.

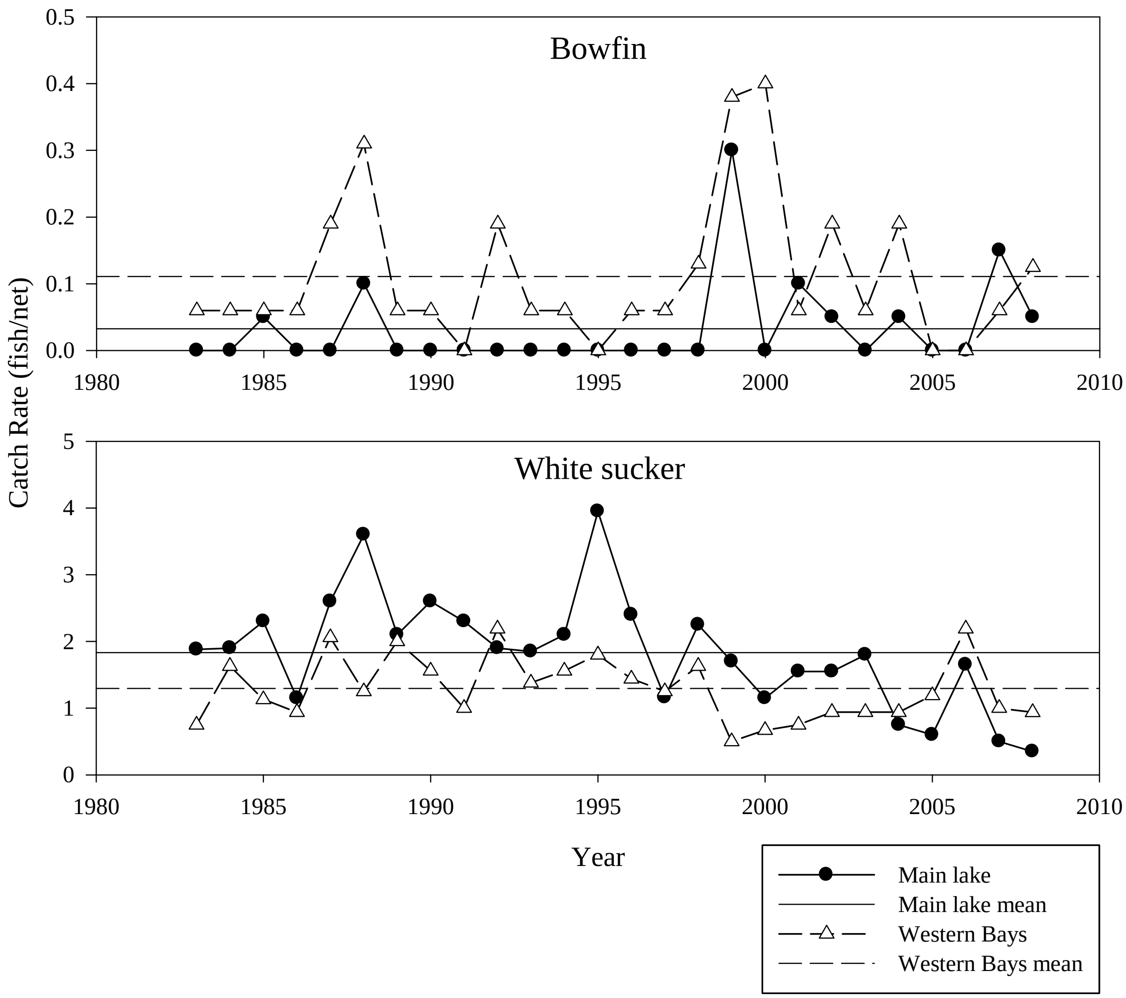

Figure A1, continued. Gillnet catch rates (fish/net) of selected species in Leech Lake, 1983-2008.