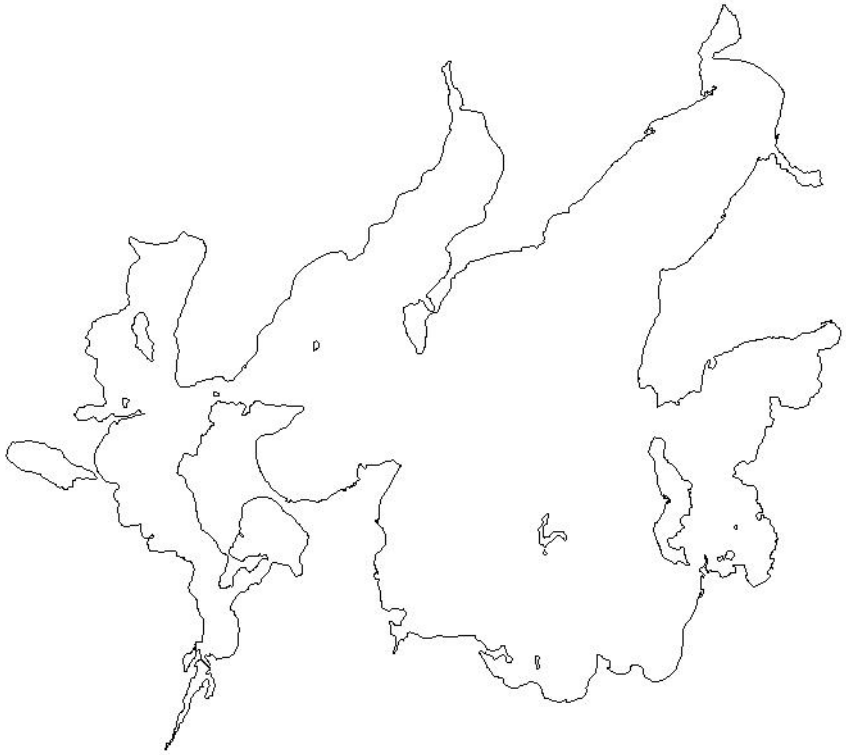
Leech Lake Management Plan

2011-2015

Doug Schultz, Large Lake Specialist
Walker Area Fisheries Office
Minnesota Department of Natural Resources
REVIEW DRAFT 6/4/2010



Executive Summary

Purpose

Update the 2005-2010 Leech Lake Management Plan.

Background & Current Status (p. 1-3)

Declines in Leech Lake percid populations and their fishery during the early 2000's prompted the 2005-2010 Leech Lake Management Plan. This plan primarily sought to improve walleye abundance and size structure through the following actions:

1) Protect mature female walleye with the current 18-26" protected slot limit and a reduced harvest limit of 4 fish;
2) Support efforts of the Leech Lake Band's Division of Resources Management (DRM) to reduce the number of double-crested cormorants on Leech Lake;
3) Estimate walleye hatch rates by stocking 5 million OTC-marked fry during 2005, 2006, and 2007 and compare estimates to those observed in the Red Lakes as evidence in support of or contrary to the hypothesis of potential reproductive issues in Leech Lake; and,
4) Continue to protect shorelands sensitive to human disturbance.

Note: The only deviation from this plan consisted of annual walleye fry stockings during 2005-2010 ranging from 7.5 to 22.5 million fry.

The special walleye harvest regulation was implemented in 2005. Hatch rates of wild walleye were determined during all stocking years and were similar to Red Lake estimates. Approximately 3,000 cormorants were removed from Leech Lake annually during 2005-2009, and nearly 5,000 feet of key shorelands on approximately 300 acres were acquired for protection near or adjacent to sensitive fish spawning and nursery areas.

Currently Leech Lake boasts one of the best multi-species fisheries in Minnesota. Above-average walleye year classes established during 2005-2008 combined with protection of older fish to produce record catch and harvest rates by walleye anglers during 2008-2009. Estimated walleye hatch rates suggest no chronic issue exists with egg to fry stage survival of wild fish, and the presence of three above-average year classes indicate juvenile walleye survival is not precluding recreational harvest. Yellow perch abundance and harvest have also increased considerably from 2004-2005 estimates. Catch and harvest rates of other species have remained within their relative historical ranges.

In August 2009 the Commissioner of the Department of Natural Resources (DNR) requested a group of 17 stakeholders with diverse local and statewide interests to work as an advisory committee. The committee was charged with providing DNR with recommendations for Leech Lake management, with particular focus on the walleye population. Most of the objectives and actions proposed and reviewed here, particularly for walleye, are products of that process.

Sportfish Population Objectives

- *Walleye:* Mature female biomass ranging from 1.5-2.0 lbs/acre (p. 4-5).
- *Walleye:* Gill net catch rate of 8.5 fish/net or higher (p. 6).
- *Walleye:* Proportion of fish sampled during annual gill net assessment that are shorter than 15 inches ranges between 45-65% (p. 7).
- *Walleye:* Year classes having a measured strength of the long-term average (50^{th} percentile) or higher produced during any 2 out of 4 consecutive years (p. 8).
- *Walleye:* Targeting angler summer harvest rate of 0.25 fish/hour (p. 9).
- *Walleye:* Natural reproduction alone can maintain a healthy, sustainable population (p. 10).
- *Yellow perch:* Maintain gill net catch rate (n/net) above the first quartile (p. 11).
- *Yellow perch:* Maintain population size structure (PSD and RSD-10) above respective first quartiles (p. 12).
- *Northern pike:* Maintain gill net catch rate (n/net) above the first quartile (p. 13).
- *Northern pike:* Maintain population size structure (PSD and RSD-28) above respective first quartiles (p. 14).

Management Actions

Assessments (p. 15-17)

- Annual assessments, including gill netting, trawling, electrofishing, seining, and water chemistry.
- Conduct creel surveys 2 of 6 years. The next scheduled surveys are 2010-2011 and 2016-2017.
- Formally review the current special walleye regulation during 2010, with any potential changes effective in spring 2011.
- Continue to improve upon age-0 predictors of potential walleye year class strength.
- Continue to support the Leech Lake Band of Ojibwe, Division of Resource Management financially and technically with double-crested cormorant control and evaluation efforts on Leech Lake.
- Complete on-going muskellunge genetic mark-recapture population estimate study as planned.

Stocking & related activities (p. 17-18)

- Stock Boy River strain walleye fry as follows: 22 million in 2011; 7.5 million in 2012; 7.5 million in 2013; 22 million in 2014; Open in 2015. "Open" includes the potential for a blank (zero fry stocked) to evaluate the capacity for natural reproduction, 7.5 million, or 22 million.
- Continue to conduct muskellunge spawn take every four years based on statewide needs to maintain genetic diversity in brood stock lakes; return 600 muskellunge fingerlings to Leech Lake during spawn take years.

Species-specific needs (p. 18)

- Consider instituting spring electrofishing assessments for largemouth bass, sunfish, and black crappie conducted on a 3-year rotation to gauge population status.

Habitat (p. 19-20)
Note: many of these initiatives will only be possible with additional resources (funding and staff)

- Continue to partner with and/or provide support to non-government organizations to identify, acquire via conservation easements, to protect shorelands, and to educate resource users on best management practices (BMPs).

- Continue to aggressively treat aquatic invasive plant species and actively work with local organizations to educate resource users on responsible aquatic invasive species prevention practices.

- Propose telemetry study to identify additional muskellunge spawning locations to guide future priorities for shoreland protection.

- Re-inventory walleye spawning habitat in Leech Lake, including use and condition.

- Monitor aquatic vegetation stands at specific locations on a more frequent (eg. annual) basis to identify potential long-term trends and influences on these trends.

Other Considerations (p. 20-22)

- DNR will hold annual meetings to update the LLAC and other interested stakeholders with the previous year's information and status with regards to the management plan.

- DNR will continue to explore management action thresholds that do not impinge on the population's potential for self-propagation.

- The LLAC recommended other sources of information, such as fishing guides, be pursued to compile additional trend information. While an annual, standardized guide diary program could be useful over the long term, the current recommendation is not to pursue such a program on a localized scale until a broader framework has been completed for all waters in the state.

- Climate effects on walleye populations will continue to be examined. However, due to the high degree of uncertainty surrounding both recruitment and climate trends, current models have limited practical applicability for guiding future management decisions at this time.

- Habitat initiatives recommended by the LLAC range from additional habitat assessments to protection and enforcement. DNR will continue with those recommendations already included under annual operating budgets. Other recommendations, particularly assessments, will only be accomplished with supplemental funding and collaboration among the many partners interested in ecosystem health and sustainability.

Leech Lake Management Plan, 2011-2015

Minnesota DNR's mission is to work with the people of Minnesota to conserve aquatic and terrestrial habitat, to manage fish and wildlife populations and habitat, to provide fisheries and wildlife related recreation, and to preserve Minnesota's outdoor heritage. Lake management plans describe management objectives and actions that support this mission. This management plan focuses on Leech Lake fish populations and habitat.

Lake Characteristics

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 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, much of which is used by spawning walleye (Wilcox 1979).

Survey History

Summer gill net surveys were infrequently completed during 1943, 1950, 1976, and 1982. Gear and locations used during these surveys were not consistent with the standardized protocols following inception of the Large Lake Program. Shoreline seining was also inconsistently used to document the presence of naturally produced young-of-year walleye.

Schupp (unpublished) identified walleye spawning locations via egg deposition during 1962 and estimated approximately 4 billion walleye eggs were deposited annually.

The first extensive walleye population survey was completed on Leech Lake from 1966-1968 by Schupp (1978) as part of a broader status update of the State's flagship walleye fisheries. The first creel survey was also conducted from 1965-1967 and estimated annual fishing pressure to be 785,905 angler-hours/year, a harvest rate of 0.183 walleye/hour, and total walleye harvest of 208,120 pounds of walleye per year (Schupp 1972).

An assessment report was completed evaluating the effect of various water level regimes on fish production in the Leech Lake (Wilcox 1979). It was recommended that water levels should be rising from April 15-May 15 to prevent exposure of walleye and northern pike eggs, or of stranding northern pike in the spawning areas.

The Large Lake Sampling Guide established sampling recommendations for Minnesota's ten largest walleye lakes (Wingate and Schupp 1984). Annual sampling accordingly began in 1983, and was noted that some of the ability to compare new information with infrequently conducted previous surveys had been lost (Gustafson 1984). Creel surveys were completed during 1984-1985, 1991-1992, 1998-1999, 2004-2005, and 2008-2009. Seining and trawling locations and techniques for sampling young-of-year

fishes were refined, and the adapted approach was reviewed by Schultz et al. (2007). Annual fall electrofishing for young-of-year walleye was initiated in 2005 and standardized in 2007.

The Leech Lake Band of Ojibwe completed a report evaluating water quality and productivity of Leech Lake (LLBO 1992). The report pointed towards the good water quality already present and recommended a series of alternatives for maintenance.

A watershed report and plan was sponsored by the Leech Lake Band of Ojibwe and the Cass, Hubbard, and Beltrami Soil and Water Conservation Districts (USDA 1993).

An aquifer survey was conducted from 1988-1991 (Lindgren 1996).

A GIS inventory was completed as part of a larger LCMR-funded study to develop GIS-based data for cooperative governmental use for long-term comprehensive management of the shoreline and water surface use of Leech Lake. The inventory was sponsored by the Tri-County Leech Lake Watershed Project (TCWP) under contract with ProWest and Associates, Inc. and the Cass County Soil and Water Conservation District (TCWP 1997).

A number of invasive species have been identified in Leech Lake in recent years. These species and first record of presence include: rusty crayfish (Helgen 1990); heterosporosis (unknown); curly-leaf pondweed (unknown); Eurasian watermilfoil (Rivers 2005a); purple loosestrife (unknown), and banded mystery snail (2006; G. Montz, MN DNR, unpublished data). Currently invasive plant species are not widely distributed in Leech Lake. Other aquatic invasive species are increasing in prevalence throughout Minnesota and pose a likely risk to Leech Lake.

Past Fisheries Management

Walleye stocking history is summarized in Attachment A.

Fish population assessments have been completed annually since 1983 as per Wingate and Schupp (1984). In 1984, the number of gill net locations were expanded from 32 to 36. While gillnetting methods have remained fixed, young-of-year sampling techniques and/or locations have been modified to improve utility while minimizing gear destruction and/or negative effects on habitat, particularly vegetation.

A compendium atlas was compiled in 1997 to summarize past management on the Large Lakes and to set target, or threshold, harvest levels based on empirical yield models and past harvest history (MN DNR 1997); harvest estimates that regularly exceeded targets could be indicative of overharvest. The following target harvests (pounds) were established for Leech Lake: walleye – 209,000; northern pike – 163,000; yellow perch – 98,000; cisco and whitefish – 130,000; and, other species – 52,000. In most cases harvest has been below prescribed targets, with the only exception being yellow perch harvest during 1998 (113,444 lbs) and 1999 (150,666 lbs).

Following the walleye population collapse of the Red Lakes, Gangl and Pereira (2003) developed biological performance indicators (BPIs) designed to detect walleye population stress responses to overharvest.

Several consecutive years without a strong walleye year class in Leech Lake (1998-2004) combined with relatively high walleye harvest during the late 1990's (approximately 145,000 lbs/year) led to declines in overall walleye abundance and unbalanced size structure of walleye and yellow perch populations. Consequently, this led to historically low levels of angler effort and walleye and yellow perch harvest during the 2004-2005 angling seasons (Rivers 2005b, 2006). These changes to the walleye and yellow perch fisheries coincided with expanding populations of historically native double-crested cormorants and invasive rusty crayfish. As a result, an aggressive management plan was developed and implemented to

improve fishing quality and the long-term sustainability of Leech Lake. Management objectives 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. Management actions adopted to achieve objectives included restricting harvest of walleye brood stock (18-26" PSL; possession of 4, one over 26" allowed in possession), federal approval for and implementation of lethal double-crested cormorant control (approximately 3,000 birds culled annually from 2005-2009), and stockings of OTC-marked walleye fry (originally proposed at 5 million fry for three consecutive years was expanded to 7.5 to 22 million fry/year; Attachment A). 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 may have on sportfish populations. The 2005-2010 Management Plan is summarized in Attachment B. No management objectives or actions were directed at the yellow perch population or populations of other species.

Social considerations

With the current 2005-2010 management plan expiring and fishing quality on Leech Lake significantly improved, particularly for walleye, the Minnesota Department of Natural Resources (DNR) needed to update the Leech Lake management plan. DNR recognizes the economic base supported by Leech Lake and the role fishing quality in Leech Lake has on the local quality of life, the need for improved communication and cooperation between the agency and its stakeholders, and the need for an adaptive management framework that provides context for framing biological and social questions and goals with stakeholder involvement. Adaptive management promotes flexible decision making that can be adjusted over time as outcomes from management actions and other events become better understood (ie. learning by doing).

The DNR requested a group of 17 stakeholders with diverse local and statewide interests to work as an advisory committee to make recommendations on Leech Lake fish population management, with particular focus on the walleye population. The committee built upon the success of the previous plan by recommending to the DNR specific goals and/or actions aimed at preserving a quality fishery on Leech Lake. The four key areas of focus included walleye fry stocking, special walleye regulations, double-crested cormorant management, and habitat protection. The specific charge for the Leech Lake Advisory Committee (LLAC) as indicated in the August 2009 letter of invitation to committee members was:

> "… to develop and recommend, as appropriate, a management framework that identifies objectives, management actions, thresholds, models, and monitoring plans for each of these four key areas. DNR seeks recommendations pertaining to the biological and social aspects related to Leech Lake and will consider the committee's recommendations and other public input when approving a 2011 – 2015 plan for Leech Lake."

This proposed management plan primarily represents recommendations from the LLAC (LLAC 2010) that DNR has considered moving forward under the 2011-2015 Leech Lake Management Plan.

Sportfish Population Objectives

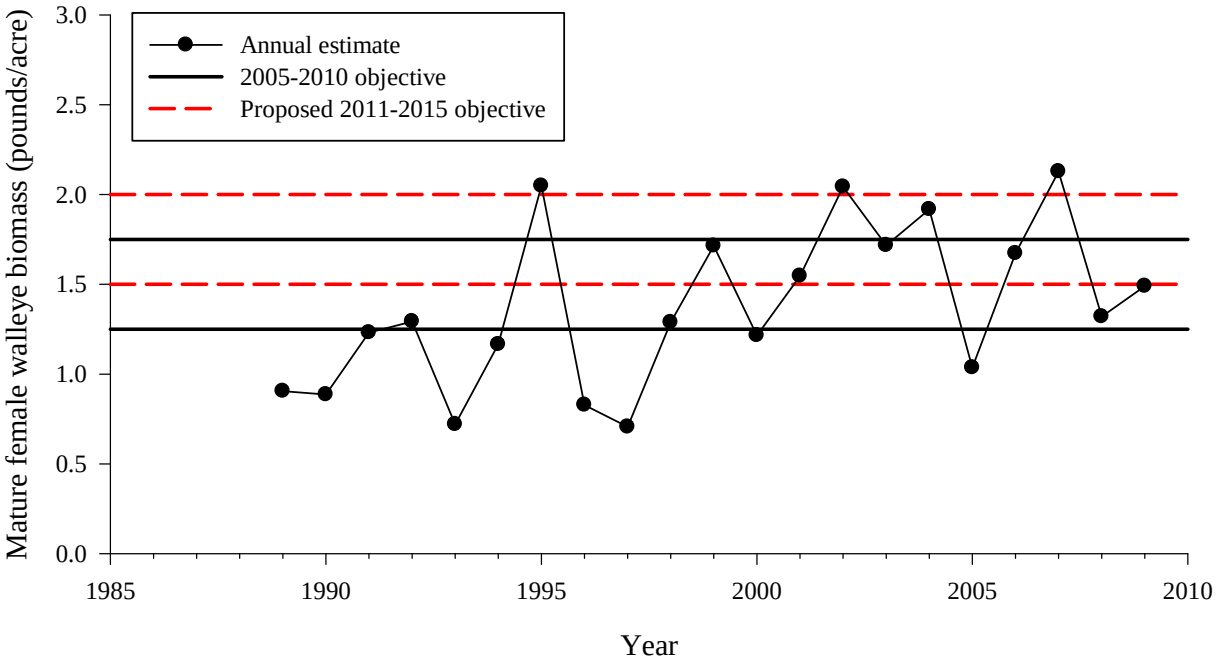
Outlining population objectives is important because they are measurable parameters that can be useful for evaluating actions, the results of which can be applied to future decision-making processes. Placing proposed objectives within their proper historical context and relative to 2005-2010 objectives is necessary for an unbiased and realistic expectation of what is sustainable as well as evaluating and building upon results of previous work. For example, a walleye gill net catch rate of 20 walleye/net in Leech Lake is neither realistic nor sustainable as the walleye gill net catch rate has never exceeded 13.4 walleye/net and has exceeded 8.5 walleye/net only 25% of years sampled during 1983-2009. The LLAC did recognize the importance of consistency over the next five years to the adaptive management framework and that some objectives outlined within this management plan may not be sustainable over the long-term. Thus, failure to meet a particular objective during 2011-2015 will not prompt deviation from operational plans described in this document. Instead, management actions will proceed as outlined and changes will be discussed and considered for implementation when this management plan is revised to reflect goals, objectives, and actions for 2016 and beyond, further building upon the outcomes of this and previous efforts.

Walleye. *Mature female biomass ranging from 1.5-2.0 lbs/acre.*

Maintaining an adequate standing stock of mature females (ie. spawners) is essential for consistent natural reproduction in any fish population, the magnitude of which during any given year is often determined by other uncontrollable factors, such as weather and growing conditions, forage availability, density-dependence, and others. The previous management objective of 1.25-1.75 pounds/acre (below) contributed to the production of two strong year classes and three more average year classes (25^{th}-75^{th} percentile) during 2005-2009. Furthermore, one of the goals of stocking marked fry during 2005-2010 was to determine the optimum range for spawner density. While estimated hatch rates have been similar to those observed in Red Lake and estimated wild fry densities have averaged 279 fry/LA, varying the target range for spawner density over a series of consecutive years lends statistical power to this assessment. Maintaining spawner biomass between 1.5-2.0 lbs/acre would produce projected fry densities between 250-350 fry/LA using the average observed hatch rate of 0.36%.

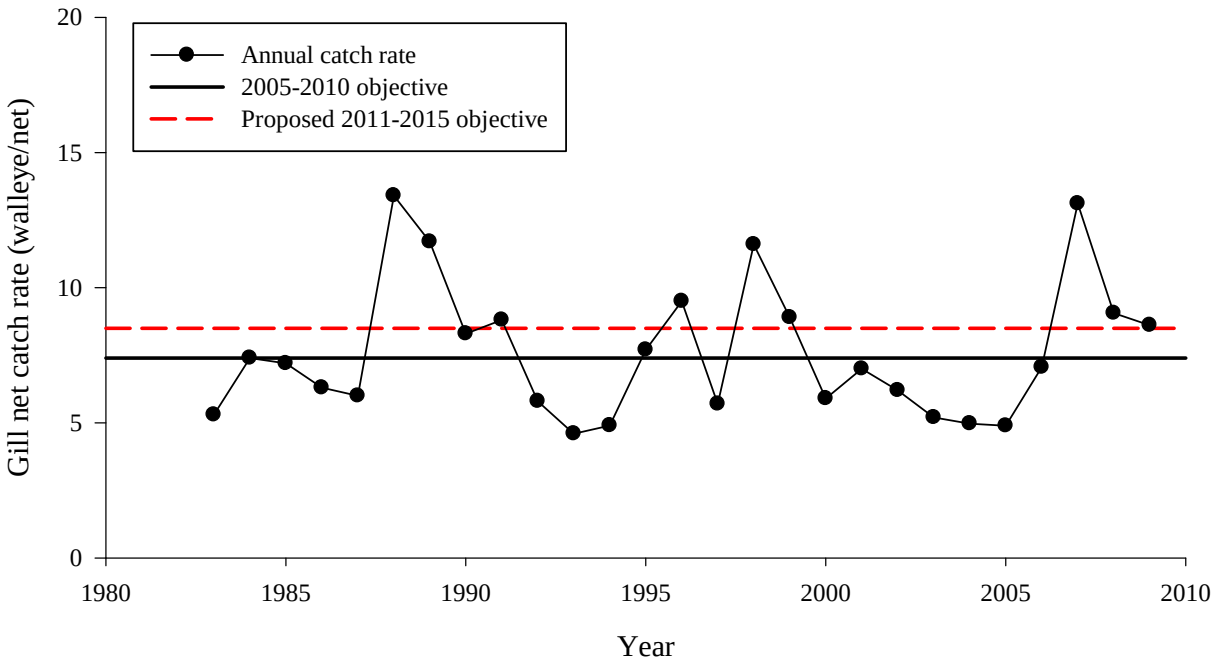
Spawner density is influenced by the presence or absence of large year classes (e.g. the 2005 year class of walleye is beginning to reach maturity and thus spawner density may increase in the near-term), the growth and maturity rates of those year classes, and angler harvest. Recruitment patterns, growth rates and maturity rates all exhibit density-dependent responses. For example, as walleye abundance, or density, increases over a series of years so does the competition among individuals for space and resources such as food and habitat (Kershner et al. 1999); this typically results in slower growth and maturity rates and lower recruitment of young fish to the adult population (Muth and Wolfert 1986; Schueller et al. 2005). Conversely, as density decreases and competition among individuals is reduced resources become more available; growth and maturity rates tend to increase as does the overall recruitment pattern given appropriate environmental conditions during specific years (Hansen et al. 1998; Schupp 2002). Walleye harvest regulations may therefore need to be modified from the existing 18-26" protected slot limit to maintain the proposed objective over the following five years. Furthermore, walleye harvest regulations will likely require periodic adjustment in response to the ebb and flow of density-dependent mechanisms and management objectives. Regulation adjustment(s) over time should be used cautiously to avoid compulsive response(s) to short-term dynamics common to and frequent in walleye populations, as over-reactive modifications could be detrimental to population balance and, in particular, the fishery it supports.

The full effects of harvest regulations on key walleye population attributes, such as abundance, recruitment, growth, and mortality, are still under investigation. Therefore, it is essential that future discussions on and proposals for regulation change(s) encompass appropriate timelines to accurately describe the effects on population characteristics as they occur. This will not only allow fishery managers to further understand the influences varying harvest regulations can have on population functions, but eventually allow regulations to be more prescriptive than experimental in nature based on observed trends and desired outcomes.



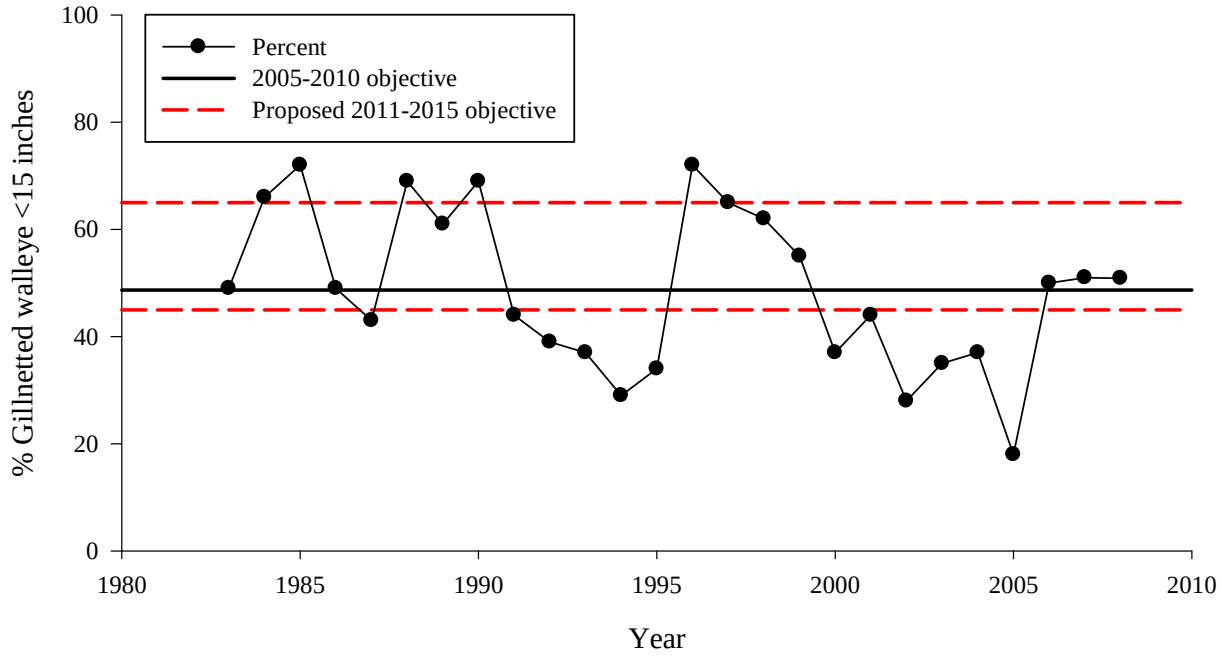
Walleye. *Gill net catch rate of 8.5 fish/net or higher.*

Walleye gill net catch rates have ranged from 4.61 fish/net (1993) to 13.39 fish/net (1988); peaks in the gill net time series have typically been attributed to a large number of age-0 fish being caught relative to other years (1988 and 2007 in particular). Thus, gill net catch rates are strongly influenced by recruitment variability, or the variability in the frequency and magnitude of a cohort of fish produced and entering the population, the growth rate of a particular cohort (gill net capture efficiency is related to the size of fish), and the scope of harvest regulations. The comparable objective under the previous plan was a gill net catch rate of 7.4 walleye/net or higher, the long-term average at the time (below). The LLAC proposed a gill net catch rate of 8.5 walleye/net (75th percentile) or higher; the current 1983-2009 average is 7.6 walleye/net. The ability to meet this new objective consistently for the duration of this management plan is expected to be influenced by recruitment variability, changes in growth rates, and harvest regulations. As this objective represents the 75th percentile it may not be sustainable. For example, the production of a single poor year class (strength below the 25th percentile) could reduce the gill net catch rate below the 8.5 fish/net objective as the cohort reaches age-1 and age-2 in respective gillnet surveys and before fish produced during ensuing years are large enough to be effectively captured, thus making a significant contribution to the sample. This would not represent a recruitment issue or prompt concern as it simply reflects the influence recruitment variability can and does have on differing measures of fish populations.



Walleye. *Proportion of walleye during annual gill net assessment that are shorter than 15 inches ranges between 45-65%.*

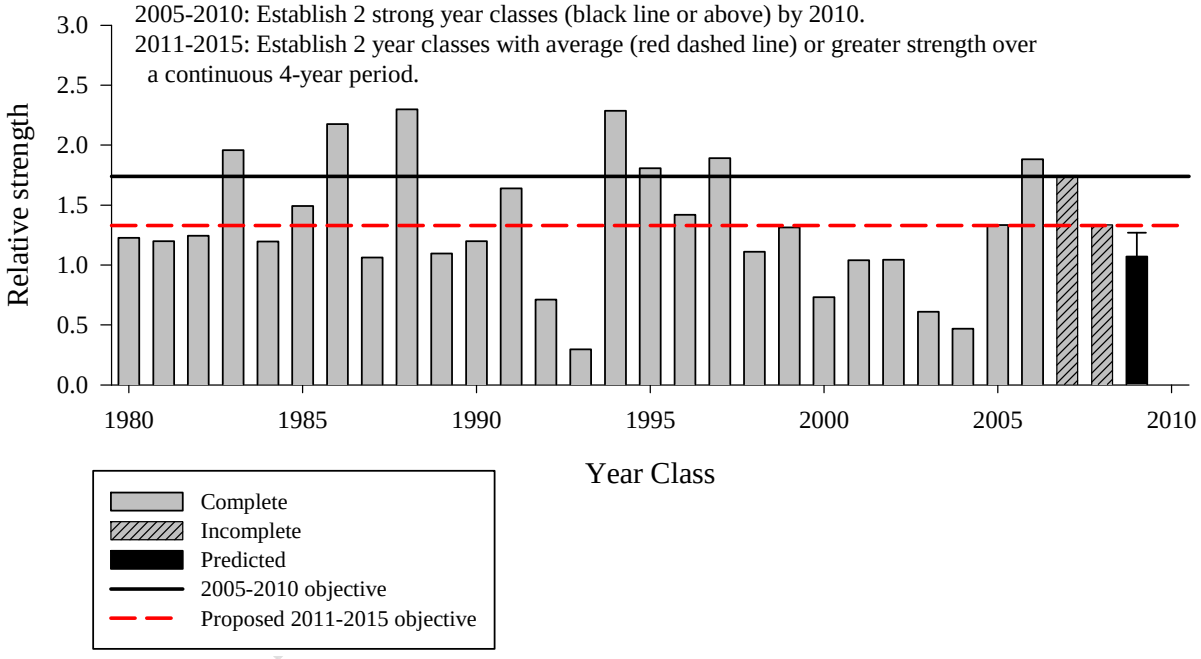
The comparable objective under the 2005-2010 management plan was 50% of walleye sampled during the gill net survey would be shorter than 15 inches (below). The purpose of this objective was to assertively identify a quantity of smaller fish entering the population that would be available for angler harvest,. Due to the fast growth rates exhibited by the 2005-2007 year classes, this objective was modestly met during most years as cohorts produced tended to reach 15 inches by age-2 instead of the typical age-3. Taking the effects of growth and recruitment variability under consideration, the LLAC proposed that this metric be allowed to range between 45-65% over the next five years. As with gill net catch rates, the feasibility of meeting this objective consistently over the next five years will be strongly tied to recruitment patterns and growth rates of young fish. However, harvest regulation could also play a key role as it could significantly increase the relative abundance of fish larger than 15 inches, thereby driving this metric down without a concomitant decrease in actual production of smaller fish.



Walleye. *Year classes having a measured strength of the long-term average (50th percentile) or higher produced 2 of 4 consecutive years.*

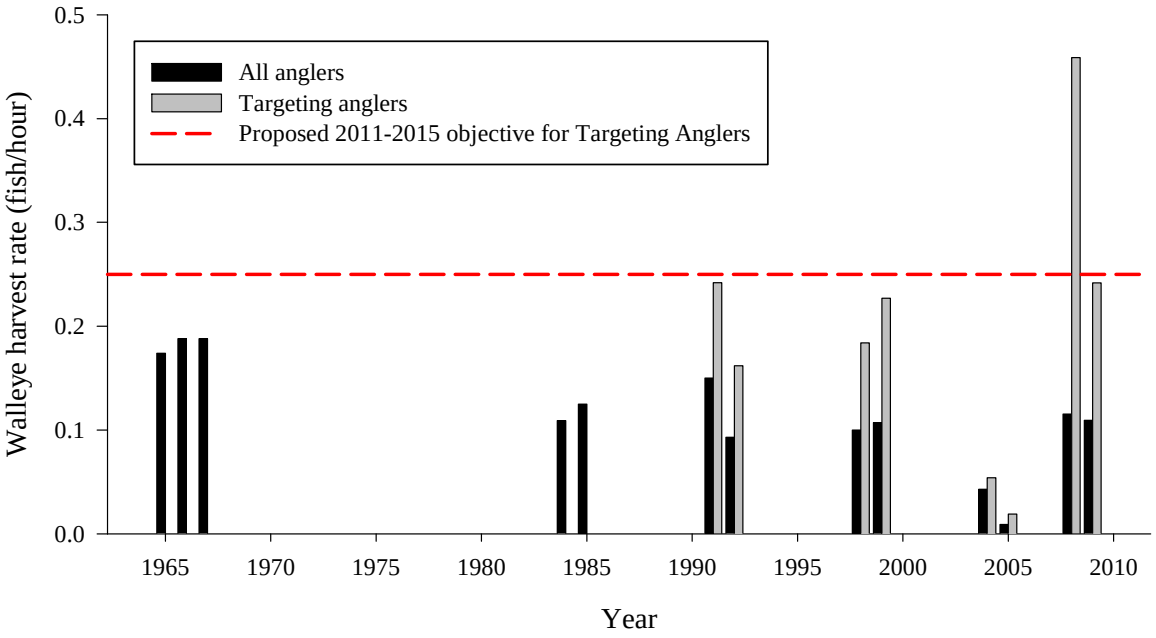
NOTE: The index of walleye year class strength presented below is the Pereira index corrected for size-specific catchability. A statistical review contrasting the Pereira and Schupp indices is presented in Attachment C.

Several consecutive years without a strong walleye year class (above 75th percentile; black line) from 1998-2004 and only one of which met the long-term average (50th percentile) led to record low walleye angling success and fishing pressure on Leech Lake (Rivers 2005b, 2006). The goal of the 2005-2010 management plan was to quickly improve walleye fishing; one objective towards that goal was to establish two strong year classes within that five-year period. Strong year classes were produced during 2006 and 2007, and average year classes were produced during 2005 and 2008. With fishing significantly improved, the LLAC-proposed objective for maintaining quality walleye fishing on Leech Lake is to have above average (50th percentile) year classes produced during 2 out of 4 continuous years. This would rely on the age-0 predicted year class strength index (YCS) during any given sample year, the incomplete measures of respective age-1 and age-2 cohorts within the same year, and the fixed index of age-3 fish during the same year. For example, this objective for the 2010 sampling season would be measured as the predicted age-0 YCS produced during 2010 and the estimated strengths via gill net sampling of the 2009 (age-1), 2008 (age-2), and 2007 (age-3) year classes. With the presence of potentially five average (25th – 75th percentile) or stronger year classes already established within the system, suppression of some ensuing year classes by older cohorts would not be surprising and thus may play a key role in meeting this objective over the next five years and its potential application beyond this plan.



Walleye. *Targeting angler summer harvest rate of 0.25 fish/hour.*

While this objective was not outlined under the 2005-2010 management plan, it does represent significant importance as it is a measure of fish returned to the angler. Harvest rates of targeting walleye anglers were selected by the LLAC because 1) fish are measured by creel clerks, thus avoiding recall and/or prestige biases associated with catch rates, and 2) Targeting Angler statistics are a more precise measure of fishing quality for a particular species than All Angler statistics, which include fishing effort and catch of anglers specifically targeting other species (eg. muskellunge, largemouth bass, etc.). Averaged across Leech Lake summer creel surveys completed since 1991, only 50% of interviewed angling parties specifically target walleye (D. Schultz, unpublished data). The LLAC proposed a targeted walleye harvest rate by summer anglers of 0.25 walleye/hour as an objective for this management plan. This objective is aggressive as it is considerably higher than the pre-regulation 1991-1999 average of 0.20 walleye/hour. Generally, protected slot limits tend to reduce the harvest rate but increase the catch rate within walleye fisheries. Special walleye harvest regulations that will assist with meeting other objectives, such as maintaining spawner biomass between 1.5-2.0 lbs/acre, could be antagonistic to and likely carry priority over meeting this objective.

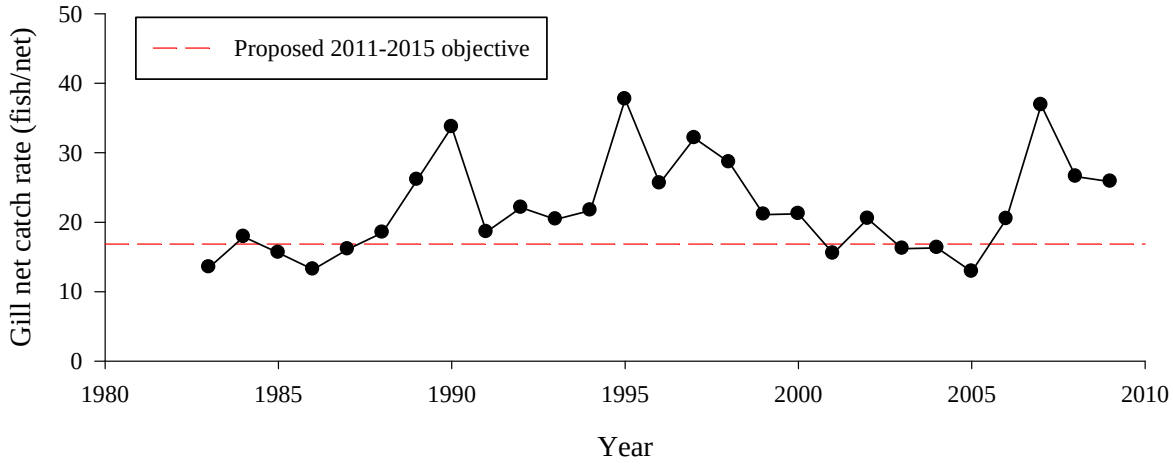


Walleye. *Natural reproduction alone can maintain a healthy, sustainable population.*

Oxytetracycline (OTC)-marked walleye fry were stocked under the 2005-2010 management plan. The use of marked fry facilitated estimation of wild fry densities and hatch success. The estimated walleye hatch rates during 2005-2009 were very similar to those estimated in Red Lake, a system without invasive rusty crayfish and characterized as having robust natural walleye reproduction, thus suggesting no chronic issue with egg-to-fry survival (Schultz 2010a). With potentially five average or stronger year classes produced during 2005-2009, two of which were strong, concerns surrounding juvenile walleye survival have also been addressed. While all indications suggest the Leech Lake walleye population has the capacity to be self-sustaining; testing this hypothesis with full certainty requires stocking blanks (zero walleye stocked) and observing the outcome since there was significant fry stocking during 2005-2010. The LLAC unanimously agreed that a healthy, self-sustaining walleye population is an important management objective. Correctly characterizing natural reproduction and ultimately crafting criteria that use stocking to the best benefit of the population and the economic base it supports is necessary for proper long-term management. Therefore, evaluating the capacity of natural reproduction during 2015 and beyond should be a high priority.

Yellow perch. *Maintain gill net catch rate (fish/net) above the first quartile.*

Yellow perch gill net catch rates have ranged from 12.9 (2005) to 37.7 (1995) fish/net; similar to other populations, much of this variability can be attributed to fluctuations in recruitment. The precipitous decline in perch catch rates from 1997-2005 occurred concomitantly with marked increases in the local double-crested cormorant colony. Studies revealed that cormorants fed primarily within the main lake basin of Leech Lake and that yellow perch were their principal prey (D. Schultz, MN DNR & S. Mortensen, LLBO DRM, unpublished data). Based on the historical time series (below), the population objective of the first quartile (16.8 fish/net) represents a threshold where cormorant predation is suspected to have negatively impacted the perch population. Basin-specific trends will continue to be monitored.



Yellow perch. *Maintain gill net PSD and RSD-10 above respective first quartiles.*

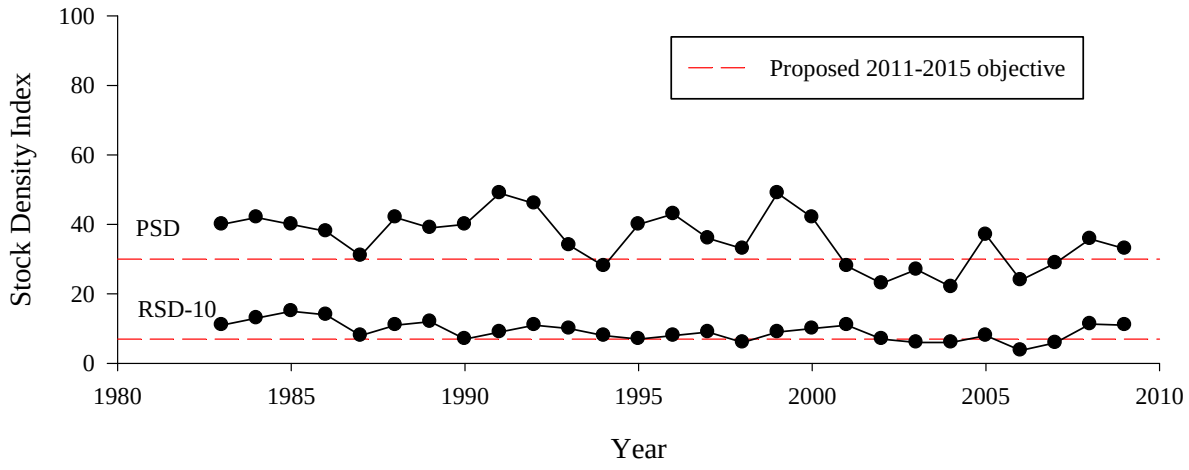
Proportional Stock Density (PSD; Anderson 1976) and Relative Stock Density (RSD; Gabelhouse 1984) indices are a length-categorization system developed by fisheries biologists to easily assess the size structure of fish populations. Simply stated, it represents the proportion of fish in the sample longer than a specific length. The minimum size used for calculating the indices typically corresponds to the approximate size at which fish become fully susceptible to the sampling gear. As with most fisheries techniques, these metrics will vary with recruitment patterns as unusually large (or small) cohorts grow into the minimum lengths for these indices and are eventually lost to either natural or harvest mortality. Yellow perch PSD during any given sample year is calculated as:

$$PSD = \frac{N \geq 8.0"}{N \geq 5.0"}$$

where N = the total number of fish in the gill net sample longer than or equal to the specified length. Similarly, RSD-10 is calculated as:

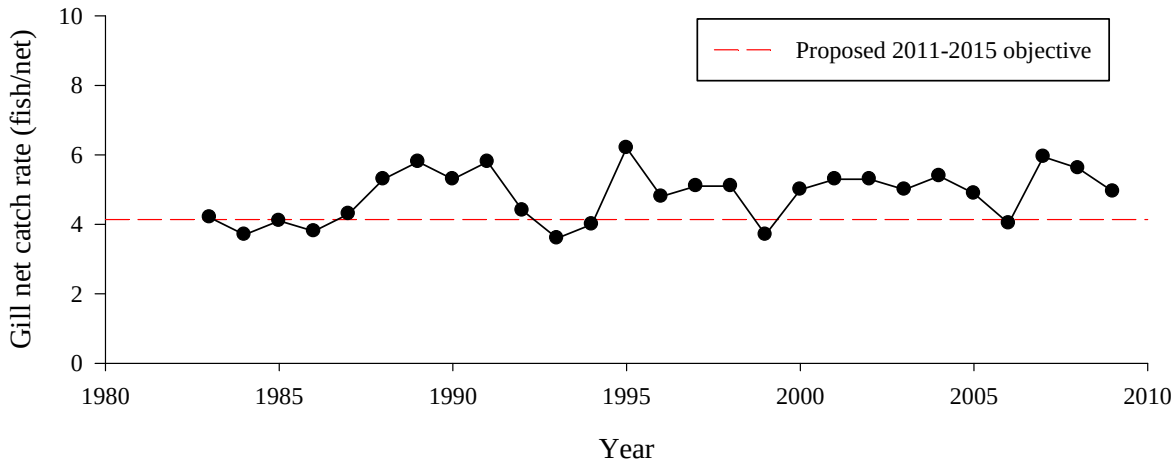
$$RSD-10 = \frac{N \geq 10.0"}{N \geq 5.0"}$$

Analogous to the proposed gill net catch rate objective, the proposed PSD and RSD-10 objectives (below) represent an approximate level where cormorant predation is suspected to have negatively impacted the yellow perch population. This seems intuitively more pronounced when using PSD; among perch sizes available, cormorant electivity is highest for 9" yellow perch (Coleman 2009). Conversely, RSD-10 is an important metric for gauging the proportion of larger perch available to the recreational fishery.



Northern pike. *Maintain gill net catch rate (fish/net) above the first quartile.*

Gill net catch rates have varied little since 1983, ranging from 3.6 (1993) to 6.2 (1995) fish/net, and thus indicating a stable northern pike population. With the northern pike population showing no signs of distress, this objective is proposed as a lower threshold that, when reached and sustained during consecutive years, could indicate the need for alternative management action(s). Other metrics, such as growth rate, maturity rate, and harvest statistics, are also important tools for identifying key population trends and their potential causes, and will continue to be monitored.



Northern pike. *Maintain gill net PSD and RSD-28 above respective first quartiles.*

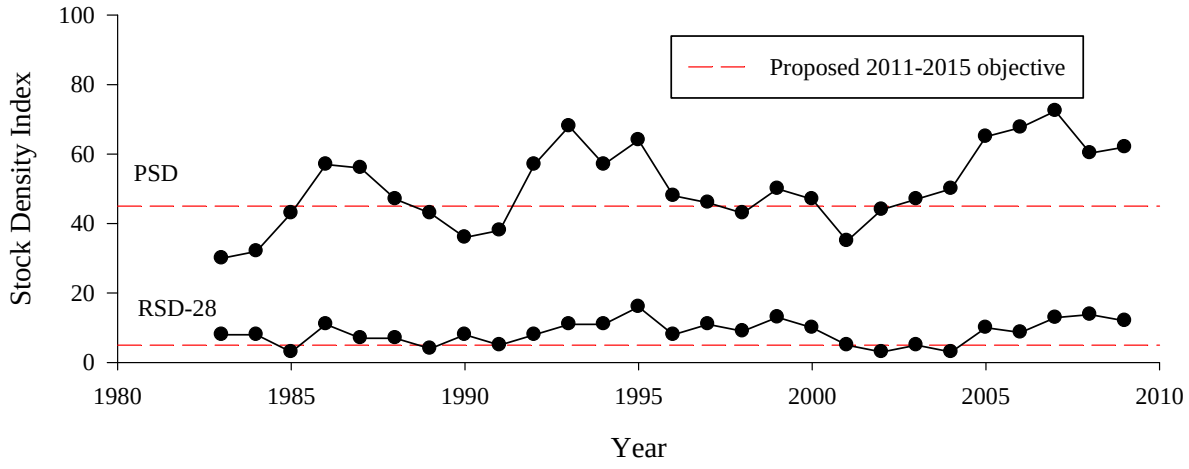
Proportional Stock Density (PSD; Anderson 1976) and Relative Stock Density (RSD; Gabelhouse 1984) indices are a length-categorization system developed by fisheries biologists to quickly assess the size structure of fish populations. Simply stated, it represents the proportion of fish in the sample longer than a specific length. The minimum size used for calculating the indices typically corresponds to the approximate size at which fish become fully susceptible to the sampling gear. As with most fisheries techniques, these metrics will vary with recruitment patterns as unusually large (or small) cohorts grow into the minimum lengths for these indices and are eventually lost to either natural or harvest mortality. Northern pike PSD during any given sample year is calculated as:

$$PSD = \frac{N \geq 21.0''}{N \geq 14.0''}$$

where N = the total number of fish in the gill net sample longer than or equal to the specified length. Similarly, RSD-28 is calculated as:

$$RSD - 28 = \frac{N \geq 28.0''}{N \geq 14.0''}$$

Similar to the gill net catch rate, neither of these metrics indicate need for concern at this time, and the proposed objectives will therefore be used as benchmarks for considering alternative management action(s). Both metrics have increased since 2005 (below), indicating a relative increase in the proportion of larger fish in the population over the last five years. The observed changes in both metrics over time, particularly RSD-28 during the early 2000's, cannot be attributed to cormorant predation; esocids comprised 1% of total cormorant diets by weight during 2005-2007 (D. Schultz, MN DNR, unpublished data). More likely, changes in RSD-28 reflect a concurrent combination of recruitment variability and changes in annual harvest by anglers.



Management Actions

Assessments

Annual Large Lake surveys

Wingate and Schupp (1984) first outlined sampling strategies for Minnesota's large walleye lakes in 1984. Sampling strategies have been adapted on a lake-specific basis to address particular needs or challenges when sampling fish populations. Fish population assessments on Leech Lake have been conducted in an annual, standardized framework since 1983. Methods include seining, trawling, and electrofishing for young-of-year fish from July - September and gill netting of older fish during September. Water quality samples are collected at two locations during late July of each year. Leech Lake will continue to be surveyed in this manner during 2011-2015.

Creel surveys

The recreational fishery is surveyed 2 of 6 consecutive years. Survey methods have been adapted as the fishery dynamics have changed, particularly with resorts and launch services (Rivers 2005b). The next scheduled creel surveys on Leech Lake are 2010-2011 and 2016-2017.

Walleye regulation review

DNR will complete a preliminary evaluation of potential walleye regulations using models developed by Dave Staples, DNR Fisheries Biometrician. Pending this evaluation, potential regulation options will be included as questions during the 2010 summer creel survey to solicit additional angler input, as well as public input during fall 2010. If any of the potential regulation options fail to meet the aforementioned walleye population objectives outlined by the LLAC during the preliminary evaluation, the regulation option will be discontinued from the remaining regulation process. LLAC membership suggested that matching the walleye regulation on Leech and Winnibigoshish lakes for 2011-2015 would be desirable if supported by the analysis and the public input process.

Leech Lake will be posted with signs during summer 2010 informing the public that a regulation review process has begun with public input to be scheduled for fall 2010. Any proposed regulation changes would likely start in spring 2011.

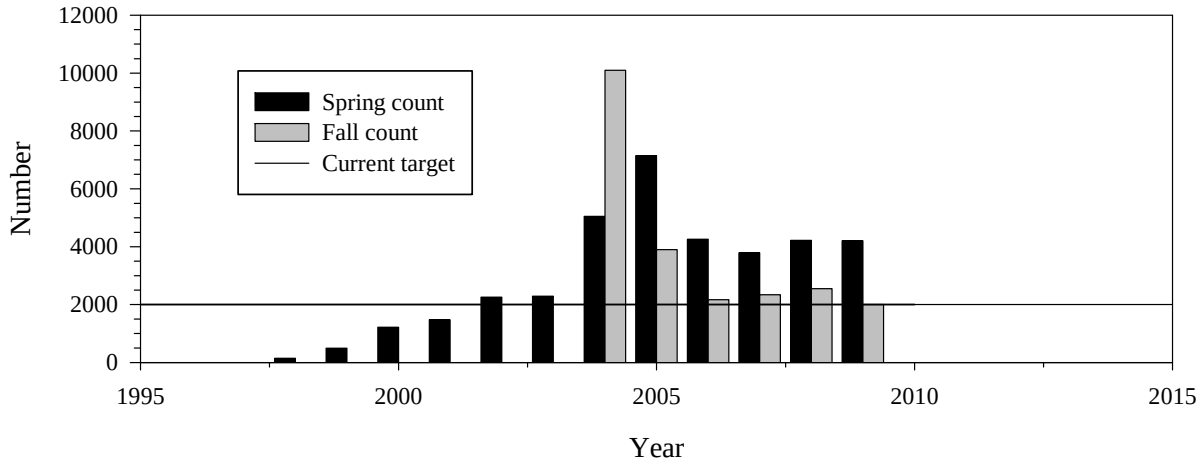
Predictors of walleye year class strength

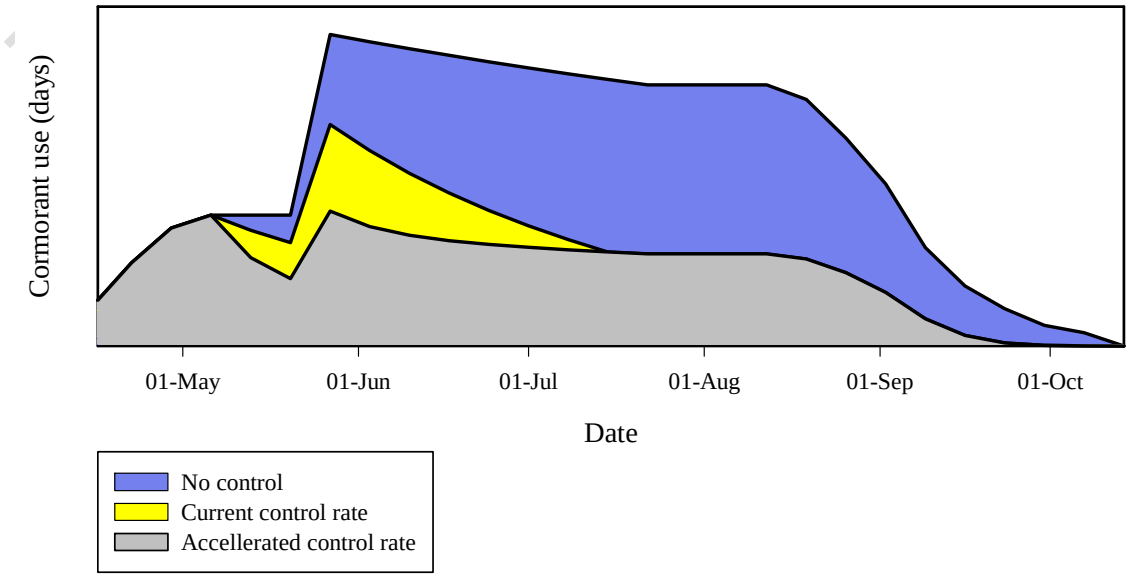
Currently trawl and gill net catch rates of young-of-year walleye are used to forecast year class strength. The multivariate method has greater precision over the trawl-only prediction model (Schultz 2010a), though both are subject to the high uncertainty surrounding young-of-year catch rates and first-year

survival. These methods will continue to be refined as additional years are sampled and as new techniques, such as fall electrofishing, can be evaluated for potential application.

Double-crested cormorant control & evaluation

The LLAC and the DNR both recognize the Leech Lake Band of Ojibwe, Division of Resource Management (DRM) jurisdiction over double-crested cormorant control policy on tribal lands and waters. During 2005-2009, approximately 3,000 cormorants were removed from Leech Lake annually under DRM supervision and the population has been maintained near the 2,000 bird fall target (below). Preliminary evaluation suggests recent control efforts have reduced cormorant use of Leech Lake by nearly 60%. These assessments also indicate that an accelerated control rate (removing majority of birds over a shorter duration; bottom figure) has the potential to further reduce cormorant use of Leech Lake by an additional 15-20% while operating under the existing federal Public Resource Depredation Order. Therefore, the DNR will continue to support DRM's efforts to secure funding sources for cormorant control, including pursuit of funding for accelerated control, and assist with continuing evaluations of potential cormorant impacts on Leech Lake sportfish populations as requested by DRM.





Muskellunge assessment

Traditional muskellunge assessments using large trap nets to capture fish are not feasible on Leech Lake due to the off-shore orientation of principle spawning habitat; few fish are captured despite immense amounts of sampling effort. In 2009 the Walker Area Fisheries office initiated a research study to determine if population estimates muskellunge could be made using genetic markers (ie. DNA fingerprints) in lieu of traditional tagging methods. This study entails using scale samples collected by the local fisheries office and muskellunge anglers fishing Leech Lake during the 2009-2010 seasons as the marking and recapture events to obtain a Peterson population estimate. This study should be completed as planned and its usefulness evaluated for future endeavors.

Stocking & related activities

Walleye Fry Stocking

Minnesota DNR recognizes stocking as a valuable management tool when used appropriately, but has not found it necessary for long-term maintenance of walleye populations in large lakes. The exception involves a policy of returning a percentage of fry back to the parent waters when the DNR conducts spawntake operations (eg. Vermillion and Winnibigoshish lakes).

The 2005-2010 walleye plan originally proposed low level stockings (5.0 million) of Boy River strain OTC-marked walleye fry with the intent of quantifying wild walleye hatch rates and recruitment. Walleye stocking was elevated to much higher levels when the legislature directed the DNR to stock 22.5 million walleye fry in 2009 and 2010.

DNR will follow the walleye stocking recommendations of the LLAC during the next five years. Leech Lake presently has an adequate density of mature female walleye to produce cohorts of fish necessary for maintaining fishing quality at historical levels. During the LLAC process, DNR proposed a stocking regime that included consecutive blanks (ie. 2 years stocked, 2 years not stocked) to determine the full extent of natural reproduction and eventual recruitment to the population. The LLAC did not reach consensus on a walleye stocking strategy; however, there was majority support for a stocking regime that included annual stocking (see table). As part of the ultimate goal of achieving a self-sustaining walleye population in Leech Lake, the health and reproductive viability of the population will be monitored in a comprehensive manner over the next five years. This will include estimating wild fry production rate using OTC marking and also relative survival from the fry stage to juvenile fish before they reach harvestable sizes (e.g. ages 1-3), with comparisons to other, similar large lakes throughout the State. The level of stocking in 2015 will therefore be determined based on this comprehensive performance evaluation and current status of the walleye population.

Year	Amount of OTC-marked fry (millions)
2010	22.5 - legislated
2011	22.0
2012	7.5
2013	7.5
2014	22.0
2015	Open - Options include 0 (blank), 7.5, or 22.0

All walleye fry will originate from the Boy River (Cass County) and be marked with OTC prior to stocking. This genetic stocking strategy is based on evaluation and recommendations from Dr. Loren Miller, a geneticist from the University of Minnesota, which determined that the Boy River strain is the most similar and thus preferable given the large quantities of fry programmed during 2011-2014 (Miller 2007). Other recommended strategies for reducing the risk for adverse population impacts at the genetic level include stocking early life stages (fry instead of fingerlings), stocking fewer fish, stocking less often, and not stocking from multiple sources (e.g. other strains). Since the ultimate goal from the LLAC is to have a self-sustaining walleye population on Leech Lake, DNR will be following these genetic recommendations.

Muskellunge Stocking

Muskellunge spawn take operations will be conducted every four years based on statewide needs to maintain genetic diversity in traditional brood stock lakes. During spawn take years 600 muskellunge fingerlings will be returned to Leech Lake under the traditional DNR put-back policy on systems with spawn take operations.

Species-specific needs

Spring electofishing surveys should be developed and implemented to gauge the status of Leech Lake's largemouth bass, sunfish, and black crappie populations. Annual sampling is not feasible due to current constraints on staff and budget. However, sampling every 2-3 years depending on other annual workloads on Leech Lake (eg. muskellunge spawn take) and other waters managed by the Walker Area Fisheries office (eg. Boy River walleye spawn take operation, other Centrarchid surveys) may be possible, particularly if funding permits hiring of one additional permanent full-time or permanent seasonal position.

Habitat

Note: many of these initiatives will only be possible with additional resources (funding and staff).

Habitat protection

Some habitat management actions will require additional funding, or will only be possible when specific opportunities present themselves; some management is traditional and ongoing. DNR Fisheries will make recommendations or support actions with other non-government organizations and/or government agencies as appropriate to protect the aquatic resource.

DNR will cooperate and partner with non-governmental organizations to identify and acquire critical shoreland habitat through fee title and conservation easements. Five Mile Point and Miller's Bay (Whipholt) have been identified as high priority areas for acquisition because they are muskellunge spawning areas and potentially sensitive to anthropogenic disturbance. Prioritizing additional areas for acquisition can be accomplished using findings from the Cass County Sensitive Shorelands project and other habitat-oriented evaulations.

Aquatic Invasive Species (AIS) management & education

Management, control, and prevention of AIS were important activities for the LLAC. Management of AIS is primarily the responsibility of DNR Division of Ecological Resources. DNR will continue to aggressively treat invasive aquatic plants in harbors to reduce the likelihood of species being spread from Leech Lake to other waters in the area. DNR will work with local stakeholders and organizations to increase signage and education regarding AIS prevention. DNR Fisheries will notify and coordinate with AIS watercraft inspectors to increase inspections prior to major fishing tournaments and request an increased enforcement presence at tournaments. Mandatory inspection for invasive species on all watercraft participating in fishing tournaments will continue to be a condition reflected in fishing tournament permit language.

Education, outreach and training for guides, resorts, law enforcement, and industry (i.e. dock and marina vendors) regarding AIS prevention will remain a priority for DNR.

Muskellunge telemetry

Radio-telemetry completed by Strand (1986) led to the identification and physical description of six different muskellunge spawning locations in Leech Lake. Due to their importance to a nationally recognized muskellunge fishery and their susceptibility to human disturbance, these locations have been a focus for continued habitat protection on Leech Lake. Two of the locations became muskellunge egg collection locations and were paramount to MN DNR moving exclusively to using Leech Lake strain (aka. Mississippi strain) muskellunge for statewide introduction and management purposes because of their trophy potential.

Miller's Bay on the south end of Leech Lake was long suspected to be a muskellunge spawning site but not identified by Strand (1986) or documented otherwise. DNR reconnaissance netting in 2003 verified the reports with the collection of mature individuals, and the spawn take operation conducted on a four-year rotation was moved to Miller's Bay in 2005. Miller's Bay is a broad, shallow bay where incubating muskellunge eggs are extremely susceptible to disturbance, destruction, or being covered by re-suspended sediments from passing boats. Consequently, this location has been particularly important for ongoing habitat protection efforts.

The identification of Miller's Bay post hoc Strand's (1986) efforts highlights the potential for other sensitive spawning locations that have not been identified. Thus, additional telemetry work contracted through a local university could provide further insight into muskellunge needs on Leech Lake and future allocation of habitat protection funds. Outside funding sources, such as Muskies Inc., should be sought to complete this work.

Aquatic vegetation monitoring

DNR Fisheries will work with local stakeholders and Division of Ecological Resources to outline a long-term monitoring strategy for specific vegetation beds using the point-intercept method.

Other Considerations

Annual stakeholder meetings

As per LLAC request, annual update meetings will be conducted during February. The purpose of these meetings during 2011-2015 will be to share current data and information with the LLAC and other interested stakeholders. Management objectives and actions delineated in this document are intended to provide the framework for management for the next five years. Most management objectives and actions outlined here are directed at animal populations. Consequently, time is required for these populations to express via metrics, such as recruitment, growth, and maturity rates, the effects any management actions may be having. While adaptive management relies upon "learning by doing", appropriate timelines are needed to ensure the outcomes of management actions can be accurately assessed and that useful lessons are indeed garnered from the approach for application to future decision-making processes.

Development and evaluation of potential management triggers

Throughout the LLAC process there was interest in the development and use of management thresholds, or triggers, that initiate a management response. Similar examples include the Biological Performance Indicators (BPIs) developed by Gangl and Pereira (2003) for detecting a population response to overharvest, annual Mille Lacs Lake walleye harvest allocations among state and tribal entities based on availability (R. Bruesewitz, MN DNR, personal communication), and the current Red Lakes walleye

management plan which bases allowable harvest and harvest regulations around maintaining a range of pre-determined spawner biomass density (G. Barnard, MN DNR, personal communication). In all three examples the management threshold is harvest-oriented and the likely management action is to restrict harvest (or expand in some cases) via special regulations to prevent overexploitation or to stay within defined harvest allocations.

Management thresholds for the purpose of prescribing management actions in response to other issues, such as recruitment variability, are far more complex. Recruitment patterns are influenced at differing levels by a multitude of factors during any given year (e.g. weather patterns, growing season length, forage availability, density, suppression by previously established year classes, predation by other species, and others) and thus are highly variable and highly unpredictable in all fish populations. The LLAC specifically outlined a natural, self-sustaining walleye population as an important objective. Using the time series available, management threshold(s) that do not impinge on the population's potential for self-propagation should be considered for potential implementation in 2016.

Guide diaries

The LLAC recommended that other sources of information, specifically guide diaries, be pursued for long-term trend purposes. The primary statistical concerns that require review before implementing such a method long-term include data integrity (eg. recall and/or prestige biases) and participation. For example, Sullivan (2003) reported walleye anglers exponentially exaggerated their catches relative to test angling as overall catch rates within the fishery declined. The current recommendation is not to pursue the use of guide diaries until a program specific to fishing guides that includes a standardized framework for data collection on all waters is implemented on a statewide basis.

Climate effects on walleye populations

Climate effects on walleye populations, particularly recruitment patterns, will continue to be evaluated on a statewide basis (D. Pereira, MN DNR, unpublished data). While these models have been useful for understanding the larger drivers of walleye recruitment dynamics within (Hansen et al. 1998) and among (D. Pereira, MN DNR, unpublished data) systems, these models currently do not forecast potential year class strengths with practical accuracy because of the compounded inherent uncertainties surrounding first-year survival of fish and year-to-year climate trends.

Habitat Initiatives

The LLAC outlined a number of habitat initiatives for DNR to pursue over the course of the following five years (LLAC 2010). Some of these recommendations are enveloped under annual DNR operating responsibilities and associated budgets. In other instances, staff and funding limitations necessitate that much of this work will only be accomplished with supplemental funding and collaboration among the many partners interested in a healthy ecosystem (p. 22).

	Lead Agency/Partners	Relative Priority (1 = high, 2 = moderate, 3 = low)	Funding
Habitat Related Recommendations			
1. Continue to evaluate vegetation status	FAW[1], WER[2];	3	DNR base funding Volunteers
2. Inventory and evaluate spawning areas	FAW Research Unit, partners	3	External funding
3. Include agencies with authority on water level management in annual meeting	FAW, COE[3]	2	Agency base funding
4. Continue environmental review	WER, FAW, COE, Cass County	1	Agency base funding
5. Protect vegetation beds including wild rice	WER, Cass County	1	Agency base funding
6. Enforce shoreland rules, vegetation removal, and invasive species	DOE[4], WER	1	DNR base funding
7. Acquire important shoreland	FAW, Leech Lake Watershed Foundation, Leech Lake Association, partners	1	External funding
8. Continue shoreland development rulemaking	WER	1	DNR base funding
9. Continue invasive species prevention and treatment	WER, partners	1	DNR base funding
10. Continue state and local rulemaking regulating docks	WER	1	DNR base funding
11. Enhance watercraft inspection with new seasonal positions and trained volunteers	WER, partners	1	DNR base funding External funding
12. Enhance tournament watercraft inspections, enforcement and education	WER, partners	1	DNR base funding
13. Conduct invasive species and vegetation management education and outreach for guides, resorts, law enforcement, and industries	WER, partners	1	DNR base funding

[1] DNR Division of Fish and Wildlife
[2] DNR, Division of Waters and Ecological Resources
[3] Corp of Army Engineers
[4] DNR, Division of Enforcement

Literature Cited

Anderson, R.O. 1976. Management of small warm water impoundments. Fisheries 1:5-7, 26-28.

Coleman, J.T.H. 2009. Diving behavior, predator-prey dynamics, and management efficacy of double-crested cormorants in New York state. PhD Dissertation, Cornell University, Ithaca, NY.

Gabelhouse, D.W., Jr. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Gangl, R.S. and D.L. Pereira. 2003. Biological performance indicators for evaluating exploitation of Minnesota's large-lake walleye fisheries. North American Journal of Fisheries Management 23:1303-1311.

Gustafson, S. 1984. Large lake sampling program assessment report for Leech Lake, 1983. Completion Report, F-29-R-2, Study 2. Minnesota Department of Natural Resources, St. Paul, MN.

Hansen, M.J., M.A. Bozek, J.R. Newby, S.P. Newman, and M.D. Staggs. 1998. Factors affecting recruitment of walleyes in Escanaba Lake, Wisconsin, 1958-1996. North American Journal of Fisheries Management 18:764-774.

Helgen, J. 1990. The distribution of crayfish in Minnesota. Section of Fisheries Investigational Report 405. Minnesota Department of Natural Resources, St. Paul, MN.

Kershner, M.W., D.M. Schael, R.L. Knight, R.A. Stein, and E.A. Marschall. 1999. Modeling sources of variation for growth and predatory demand of Lake Erie walleye, 1986-1995. Canadian Journal of Fisheries and Aquatic Sciences 56:527-538.

Lindgren, R. 1996. Hydrology and ground-water quality of glacial-drift aquifers, Leech Lake Indian Reservation, north-central Minnesota. U.S. Geological Survey Water-Resources Investigations report 95-4077.

LLAC (Leech Lake Advisory Committee). 2010. Leech Lake Advisory Committee report to the Minnesota Department of Natural Resources. Minnesota Department of Natural Resources, Section of Fisheries, St. Paul, MN.

LLBO (Leech Lake Band of Ojibwe). 1992. A water quality assessment of the productivity of Leech Lake. The Minnesota Chippewa Tribe Water Research Lab & the Cass County Soil Conservation Service.

Logsdon, D. 2006. Contribution of fry stocking to the recovery of the walleye population in the Red Lakes. Section of Fisheries Investigational Report 535. Minnesota Department of Natural Resources, St. Paul, MN.

Miller, L. 2007. Leech Lake walleye genetics. Progress Report. Minnesota Department of Natural Resources, St. Paul, MN.

MN DNR (Minnesota Department of Natural Resources). 1997. Potential, target, and current yields for Minnesota's large walleye lakes. Section of Fisheries, Special Publication 151. Minnesota Department of Natural Resources, St. Paul, MN.

Muth, K.M. and D.R. Wolfert. 1986. Changes in growth and maturity of walleyes associated with stock rehabilitation in western Lake Erie, 1964-1983. North American Journal of Fisheries Management 6:168-175.

Rivers, P. 2005a. Large lake sampling program assessment report for Leech Lake, 2004. Completion Report, F-29-R-24, Study 2. Minnesota Department of Natural Resources, St. Paul, MN.

Rivers, P. 2005b. Leech Lake summer and winter creel surveys, May 15 to September 30, 2004. Completion Report, Study 4, Job 714. Minnesota Department of Natural Resources, St. Paul, MN.

Rivers, P. 2006. Leech Lake summer and winter creel surveys, May 14 to September 30, 2005. Minnesota Department of Natural resources, Section of Fisheries, Completion Report, Study 4, Job 678.

Schueller, A.M., M.J. Hansen, S.P. Newman, and C.J. Edwards. 2005. Density dependence of walleye maturity and fecundity in Big Crooked Lake, Wisconsin, 1997-2003. North American Journal of Fisheries Management 25:841-847.

Schultz, D., P. Rivers, D. Staples, and D. Pereira. 2007. A critical review of the young-of-year walleye assessment program on Leech Lake, Minnesota. Minnesota Department of Natural Resources, Walker Area Fisheries Office, Walker, MN.

Schultz, D. 2010a. Large Lake sampling program assessment report for Leech Lake, 2009. Minnesota Department of Natural Resources, Section of Fisheries, Completion Report, F-29-R-29, Study 2.

Schultz, D. 2010b. Summer creel survey report for Leech Lake, 2009. Minnesota Department of Natural Resources, section of Fisheries, Completion Report, F-29-R-29, Study 4, Job 835.

Schupp, D.H. 1972. The walleye fishery of Leech Lake, Minnesota. Section of Fisheries Investigational Report 317. Minnesota Department of Natural Resources, St. Paul, MN.

Schupp, D.H. 1978. Walleye abundance, growth, movement, and yield in disparate environments within a Minnesota lake. American Fisheries Society Special Publication 11:58-65.

Schupp, D.H. 2002. What does Mt. Pinatubo have to do with walleyes? North American Journal of Fisheries Management 22:1014-1020.

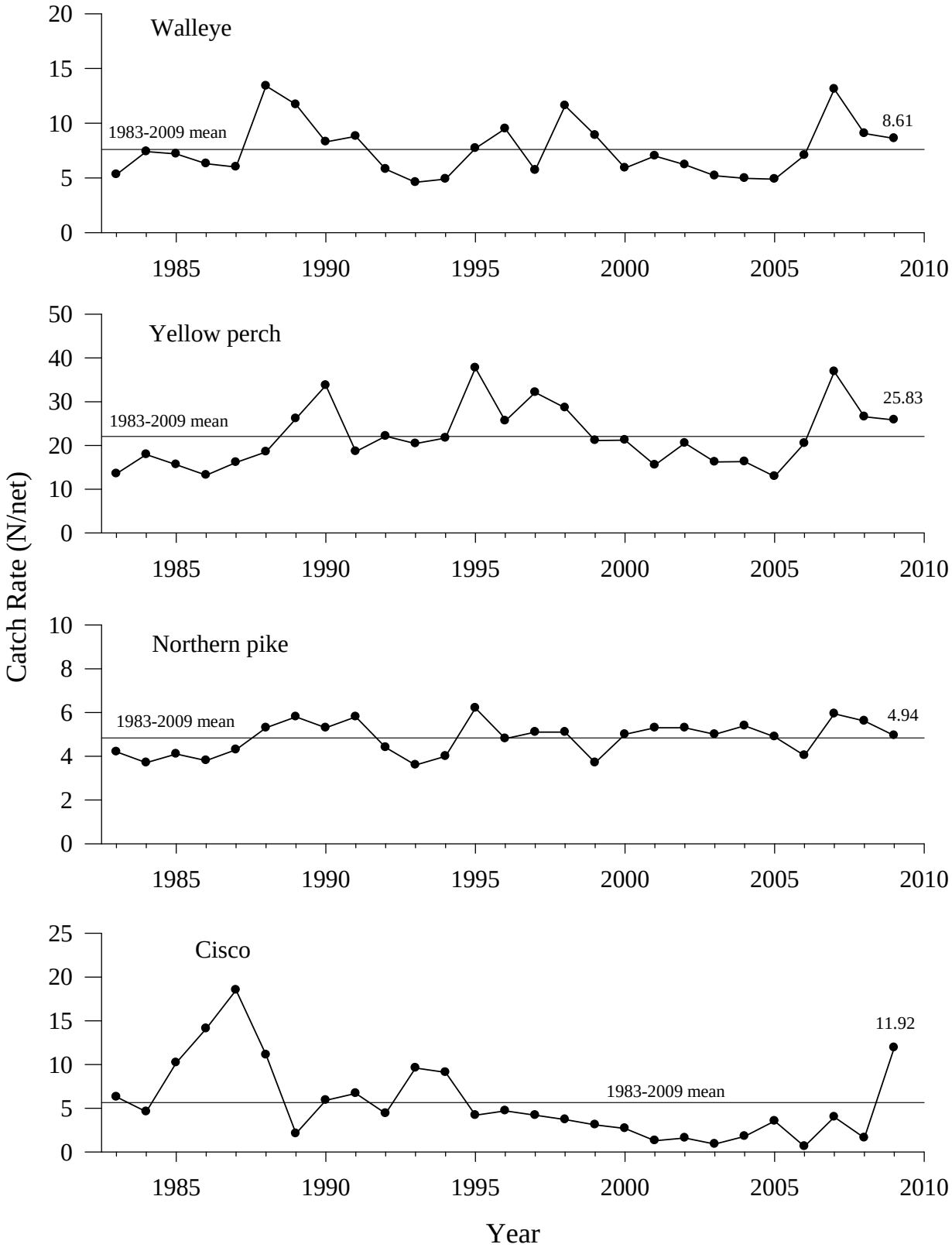
Sullivan, M.G. 2003. Exaggeration of walleye catches by Alberta anglers. North American Journal of Fisheries Management 23:573-580.

USDA (U.S. Department of Agriculture). 1993. Leech Lake river basin study report. U.S. Department of Agriculture.

Wilcox, D. 1979. The effect of various water level regimes on fish production in the Leech Lake reservoir, Cass County, Minnesota. Minnesota Department of Natural Resources, St. Paul, MN.

Wingate, P.J. and D. Schupp. 1984. Large lake sampling guide. Section of Fisheries Special Publication 140. Minnesota Department of Natural Resources, St. Paul, MN.

Appendix 1. Gill net catch rates (fish/net) of selected species in Leech Lake, 1983-2009 (Schultz 2010a).



Appendix 2. Estimated total angling pressure and total catch statistics for the summer open water creel season on Leech Lake, Minnesota, 1965-2009 (Schultz 2010b)

	Year						
	1965	1966	1967	1984	1985	1991	1992
				Angling Pressure			
Angler Trips	221,220	217,185	201,093	182,530	352,646	306,585	246,198
Angler Hours	858,960	862,346	785,905	697,267	1,290,339	1,195,683	935,553
-Walleye Tourn.							
-Total hours							
				Number of Harvested Fish			
Northern pike	60,943	52,336	48,108	40,109	79,144	42,376	26,610
Muskellunge	139	151	236	20	372	81	32
Largemouth bass	-	-	-	1,023	1,166	1,024	1,466
Yellow perch	150,599	145,510	13,359	143,756	229,660	176,646	216,323
Walleye (Legal)	149,917	162,091	147,822	76,170	161,193	179,898	86,877
-Illegal[1]							
-Released[2]							
-Total kill	149,917	162,091	147,822	76,170	161,193	179,898	86,877
				Pounds of Harvested Fish			
Northern pike	155,800	138,666	125,081	73,609	148,562	96,655	65,526
Yellow perch	78,050	77,813	70,805	54,236	87,033	58,412	83,777
Walleye (Legal)	199,012	224,310	201,038	95,625	163,537	186,882	119,076
-Illegal[1]							
-Released[2]							
-Total kill	199,012	224,310	201,038	95,625	163,537	186,882	119,076
				Harvest per Angler Hour (all anglers)			
Northern pike	0.071	0.061	0.061	0.058	0.061	0.035	0.028
Muskellunge	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Largemouth bass	-	-	-	0.001	0.001	0.001	0.002
Yellow perch	0.175	0.169	0.170	0.206	0.178	0.148	0.231
Walleye	0.174	0.188	0.188	0.109	0.125	0.150	0.093
				Harvest per Angler Hour (targeting anglers)			
Northern pike						0.159	0.110
Muskellunge						0.001	<0.001
Largemouth bass						0.013	0.079
Yellow perch						1.870	2.184
Walleye						0.242	0.162

[a]18-26" protected slot limit

[1]Walleye protected by length limit

[2]Estimated post-release hooking mortality (Reeves and Bruesewitz 2007)

Appendix 2, continued. Estimated total angling pressure and total catch statistics for the summer open water creel season on Leech Lake, Minnesota, 1965-2009 (Schultz 2010b).

	Year						1965-2009
	1998	1999	2004	2005[a]	2008[a]	2009[a]	Mean
				Angling Pressure			
Angler Trips	316,930	295,976	192,407	119,114	152,044	179,118	229,465
Angler Hours	1,274,985	1,193,941	682,346	430,003	585,371	779,163	891,339
-Walleye Tourn.						15,545	15,545
-Total hours						794,708	
				Number of Harvested Fish			
Northern pike	50,255	47,749	23,638	13,967	16,908	10,890	39,464
Muskellunge	-	-	38	119	-	-	91
Largemouth bass	2,649	2,349	3,807	3,105	2,412	1,243	1,557
Yellow perch	391,367	439,768	51,355	84,783	136,096	126,476	177,361
Walleye	141,577	149,717	29,022	3,940	64,969	81,242	110,341
-Protected[1]				No est.	2,533	4,660	-
-Released[2]			708	171	3,424	9,947	3,563
-Total kill	141,577	149,717	29,730	4,111	70,926	95,849	111,991
				Pounds of Harvested Fish			
Northern pike	122,684	127,013	62,659	37,654	54,820	33,588	95,563
Yellow perch	113,444	150,666	21,175	34,485	59,149	54,733	72,598
Walleye	159,393	189,028	68,355	6,348	72,959	86,428	136,307
-Protected[1]				No est.	8,451	10,334	-
-Released[2]			973	533	5,585	27,002	8,523
-Total kill	159,393	189,028	69,328	6,881	86,995	123,764	140,375
				Harvest per Angler Hour (all anglers)			
Northern pike	0.044	0.045	0.035	0.033	0.029	0.014	0.044
Muskellunge	-	-	<0.001	<0.001	-	-	-
Largemouth bass	0.002	0.002	0.006	0.007	0.004	0.002	0.002
Yellow perch	0.347	0.408	0.075	0.197	0.233	0.162	0.208
Walleye	0.100	0.107	0.043	0.009	0.115	0.110	0.116
				Harvest per Angler Hour (targeting anglers)			
Northern pike	0.128	0.122	0.082	0.074	0.339	0.197	0.151
Muskellunge	-	-	-	0.001	-	-	<0.001
Largemouth bass	0.040	0.009	0.054	0.070	0.237	0.059	0.070
Yellow perch	2.156	2.283	0.479	0.442	2.730	2.020	1.771
Walleye	0.184	0.227	0.054	0.019	0.459	0.242	0.199

[a]18-26" protected slot limit

[1]Walleye protected by length limit

[2]Estimated post-release hooking mortality (Reeves and Bruesewitz 2007)

Attachment A. Leech Lake walleye stocking history.

Year	Fry	Fryling	Fingerling	Yearling	Adult
1922-1945	171,038,212	-	-	-	890
1946	-	-	-	-	50
1947	NONE				
1948	-	-	87,583	-	-
1949	-	-	123,854	-	-
1950	-	-	26,530	-	-
1951	-	-	-	197	54,050
1952	-	-	62,564	-	-
1953	-	-	10,500	-	23,691
1954	-	-	173,483	-	585
1955	-	-	25,064	-	145
1956	-	-	9,625	-	6
1957	-	-	5,576	-	666
1958	-	-	-	-	12
1959	-	-	10,472	-	-
1960-1961	NONE				
1962	-	-	15,439	1,101	653
1963	-	-	10,396	6	-
1964	-	-	23,148	-	-
1965	-	-	34,380	-	-
1966	-	-	11,815	-	-
1967	-	-	44,863	-	-
1968	-	-	7,387	-	-
1969	-	-	140	5	-
1970	-	-	31,603	-	22
1971	NONE				
1972	-	-	2,660	-	120
1973	-	-	18,554	10	1
1974	-	-	2,505	-	50
1975	-	-	26,560	-	-
1976-1979	NONE				
1980	-	-	49,650	-	-
1981	-	-	5,300	-	-
1982	-	-	34,067	-	270
1983	2,000,000	-	-	818	-
1984	400,000	-	12,250	-	-
1985	100,000	-	7,150	110	4
1986	2,500,000	-	1,790	-	-
1987	-	-	112	-	-
1988-2004	NONE				
2005	7,562,115	-	-	-	-
2006	22,032,452	206,084	-	-	-
2007	7,523,670	-	-	-	-
2008	22,166,808	-	-	-	-
2009	22,669,368	-	-	-	-

Attachment B. Comparison of 2005-2010 and 2011-2015 Leech Lake management plan objectives for walleye.

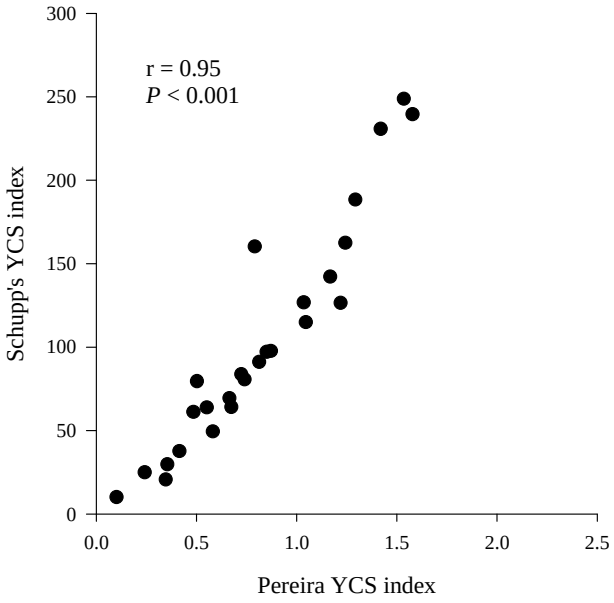
	Leech Lake Plan 2005 – 2010	LLAC Recommendations for 2011 – 2015 Plan
Objectives		
Spawner biomass	1.25 – 1.75 lbs/acre	**1.5 – 2.0 lbs/acre**
Gillnet catch rate	At least 7.4 WAE/net	**> 8.5 WAE/net**
Gillnet size distribution	50% gillnetted WAE < 15"	**45 – 65% ≤ 15"**
Year class strength	Two strong year classes by 2009	**Average (50th percentile) or stronger year classes produced 2 out of 4 years.**
Age 1	Age 1 trawl catch rate 45 fish/hour	*Declined as a population objective.*
Creel census	*Not used.*	**Targeted summer WAE harvest rate: 0.25 WAE/hour**
Natural reproduction	*Not used.*	**Natural reproduction alone can maintain a healthy, sustainable WAE population**

Attachment C. Statistical comparison of the Schupp and Pereira year class strength indices with application for Leech Lake walleye management.

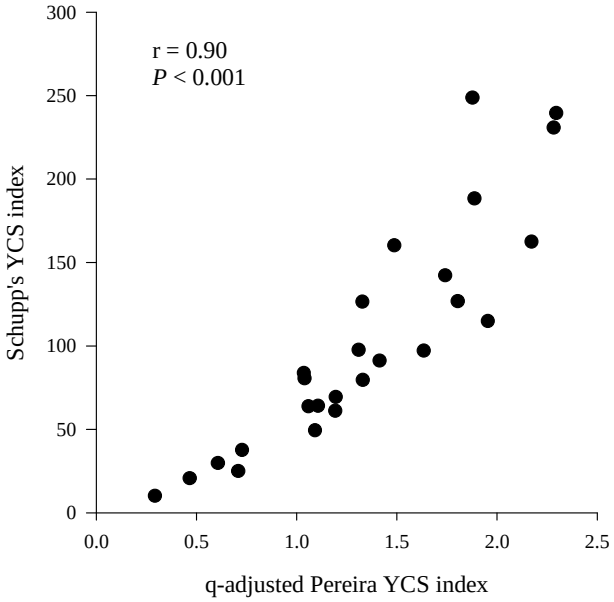
David Staples, Fisheries Biometrician, MN DNR, Forest Lake, MN.
Doug Schultz, Large Lake Specialist, MN DNR, Walker, MN.

The 1987-2008 gill net data were used to compare year class strength indices on Leech Lake (Schultz 2010). All stastistical analyses were completed using the Statistical Analysis Software (SAS, v. 9.2).

Schupp's (unpublished) walleye year class strength (YCS) index on Leech Lake is calculated using total gill net catch of age 1-4 walleye for a cohort; age-specific catch rates can be substituted for total catch when the sampling effort is unequal among years. Schupp's YCS index has been a useful measure of year class strength that describes a cohort's abundance (as measured by CPUE) relative to the average cohort abundance in the lake; however, it does not provide measures of uncertainty for YCS estimates, so statistical comparisons of cohort strengths are limited.



Pereira's YCS index calculates the least-squares mean around ages 1-3 gill net catch rates of a cohort using standard linear models. This method is more straightforward, provides confidence intervals around YCS estimates, and has become the basis for recruitment assessment models on Minnesota's large walleye lakes. There are concerns, however, over whether the two methods perform similarly when estimating YCS. Pearson correlation coefficients were determined to describe the relationship between the Schupp index and the two Pereira indices (right), and showed a very strong correlation (r = 0.95) between YCS estimates from the 2 methods.



Gear selectivity can bias estimates of recruitment (Jackson and Noble 1995), and the size-selectivity of gill nets used to index recruitment of walleye cohorts in Minnesota lakes has been described by Anderson (1998). Differing growth rates among walleye year classes influences their relative representation in gill net catches, thus potentially biasing the recruitment index for the cohort. Standardizing gill net catch rates by Anderson's (1998) catchability coefficient (q) reduces the effects differing growth rates may on walleye CPUE and resulting YCS measures. In light of the fast growth experienced by recent walleye cohorts, specifically those produced during 2005-2007, a q-adjusted Pereira index was tested to account for the influence differing growth patterns among cohorts can have on recruitment index determination. This would prevent a poor cohort from appearing to have a strong YCS when, in reality, its CPUE was only high because fast growth made them more susceptible to capture in the gill nets, and vice versa. Despite

using different input data than the Schupp's YCS index, which does not correct for net size-selectivity, the *q*-adjusted Pereira index is still highly correlated with the Schupp index ($r = 0.90$), with estimates from the two methods mainly diverging at higher YCS levels (see figure).

In conclusion, the *q*-adjusted Pereira index gives a very similar portrayal of YCS as the Schupp index, allows statistical comparisons of YCS among cohorts, and corrects for biases resulting from size-selectivity in gill net catches. This is an improvement over current practice, and future year class strengths on Leech Lake will be measured using the *q*-corrected Pereira index until more refined approaches can be developed.

Literature Cited

Anderson, C.S. 1998. Partitioning total size selectivity of gill nets for walleye into encounter, contact, and retention components. Canadian Journal of Fisheries and Aquatic Sciences 55:1854-1863.

Jackson, J.R. and R.L. Noble. 1995. Selectivity of sampling methods for juvenile largemouth bass in assessments of recruitment processes. North American Journal of Fisheries Management 15:408-418.