MINNESOTA DEPARTMENT OF NATURAL RESOURCES

Fisheries Management Plan for Leech Lake

2016-2020

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Leech Lake Fisheries Input Group

Organization/Affiliation	Representative
City of Walker	Jed Shaw
Leech Lake Association	Pat Mortale
Leech Lake Band of Ojibwe	Steve Mortensen
Leech Lake Fishing Task Force	Larry Jacobson
Leech Lake Area Watershed Foundation	Jim Bedell
Statewide Bass Work Group	Scott Peterson
Statewide Northern Pike and Muskellunge Work Group	Greg Kvale
Statewide Walleye Work Group	Tom Neustrom
Resort owner	Tim Anderson
Resort owner	Frank Alianello
Local business owner	Chip Leer
Local business owner	Jeff Arnold
Local guide	Al Maas
Local angler	John Dainsberg
Statewide angler	Doug Strecker
Academic, Bemidji State University	Dr. Andrew Hafs

Executive Summary

Purpose

Update the 2011-2015 Leech Lake Fisheries Management Plan for another five years.

Background and Current Status

Declines in Walleye and Yellow Perch populations during the early to mid-2000s prompted the development of a 2005-2010 Fisheries Action Plan for Leech Lake (Rivers 2005a). This plan was developed with input from concerned citizens at several open house style meetings. A more formal process using a citizen based fisheries input group was used to prepare the 2011-2015 management plan (Schultz 2010). Management efforts have focused primarily on increasing Walleye abundance using conservative regulations, cormorant management, Walleye fry stocking, and increased habitat protection.

Walleye abundance improved during 2005-2007 in response to combined management actions and has remained relatively stable since. Gill net catch rates of Walleye, female spawner abundance, Walleye recruitment, and targeting angler catch rates have been at or above long-term averages and/or objective ranges for several years. Overall, the Walleye population has fully recovered. The protected slot limit on Walleye was relaxed (from 18-26 inches to 20-26inches) effective on the 2014 Walleye opener to increase angler harvest opportunity and to relieve predatory pressure on Yellow Perch.

Although the Yellow Perch population initially responded positively to the management actions employed in 2005, the population began declining by 2008. Yellow Perch abundance in the three most recent gill net catches was at or near the historical low. Similarly, recruitment has also been declining since 2007 and size-structure (abundance of fish ≥8 inches) has been below the 25th percentile two of the past three years. Elevated predation by juvenile and adult Walleye and increases in winter harvest are both suspected as primary causes of these trends. A strong negative relationship exists between Yellow Perch recruitment and total Walleye fry densities from the same year, and record Yellow Perch harvest was documented during the 2010-11 and 2014-15 winter angling seasons. Although many anglers perceive cormorant consumption of Yellow Perch as a significant influence on recruitment, consumption by cormorants has been reduced by 90% relative to 2004 levels and has been similar to pre-2000 levels for several years.

The Minnesota Department of Natural Resources (DNR) continues to work with a group of 16 stakeholders which comprise the Leech Lake Fisheries Input Group (LLFIG). This group provides diverse local and statewide perspectives and makes recommendations on Leech Lake fisheries management. The LLFIG provided input to the DNR while establishing the 2016-2020 Leech Lake Fisheries Management Plan. This plan builds upon the successes of and knowledge gained from previous plans by recommending specific goals, objectives, and management actions aimed at preserving a high-quality, species-diverse fishery on Leech Lake. New to the 2016-2020 management plan is the use of 3-year moving averages (most recent three observations) for most of the objectives. Moving averages are used to smooth the year to year variability to more closely reflect current trends. The DNR will continue to hold annual update meetings with the LLFIG and other interested stakeholders to review the previous year's information and status with regards to the management plan. A weight of evidence approach will be used annually to assess if deviations from the management plan are necessary and appropriate.

Sportfish Population Goals and Objectives

Walleye Goal: Support a self-sustaining Walleye population that balances harvest opportunity, with the opportunity to catch quality-sized fish, while meeting reproductive needs.

Walleye Objectives:

- *Abundance:* Maintain gill net catch rate (3-year moving average) of 7-10 fish/net (40^{th}-90^{th} percentiles).
- *Reproductive Potential:* Maintain mature female biomass (3-year moving average) between 1.5-2.0 pounds/acre (50^{th}-80^{th} percentiles).
- *Size Structure:* The percentage of Walleye sampled in gill nets (3-year moving average) ≥20 inches should be between 10 and 20% (50^{th}-80^{th} percentiles).
- *Recruitment:* Maintain year class strength index (3-year moving average) greater than 1.1 (25^{th} percentile).
- *Angler Catch Rate:* Maintain a targeting angler summer catch rate of 0.30 fish/hour or higher (50^{th} percentile).
- *Angler Harvest:* Sustain an annual total Walleye harvest within a target range of 130,000 and 190,000 pounds (50^{th}-80^{th} percentile).
- *Condition:* Maintain condition factor (3-year moving average) between 82 and 86 (25^{th}-75^{th} percentiles).

Yellow Perch Goal: Support a self-sustaining Yellow Perch population that provides both a stable prey base for sportfish and harvest opportunities for anglers.

Yellow Perch Objectives:

- *Abundance:* Maintain gill net catch rate (3-year moving average) of ≥16 fish/net (25^{th} percentile).
- *Size Structure:* The percentage of Yellow Perch sampled in gill nets (3-year moving average) ≥8 inches should exceed 30% (25^{th} percentile).
- *Recruitment:* Maintain gill net catch rate (3-year moving average) of age-4 Yellow Perch ≥3.2 fish/net (25^{th} percentile).
- *Angler Harvest:* The annual total Yellow Perch harvest should be less than 98,000 pounds.
- *Maturity:* Female length at 50% maturity exceeds 5.5 inches.

Northern Pike Goal: Support a self-sustaining Northern Pike population that balances harvest opportunity with catch quality.

Northern Pike Objectives:

- *Abundance:* Maintain gill net catch rate (3-year moving average) between 4.2 and 5.3 fish/net (25^{th} and 75^{th} percentiles).
- *Size Structure:* The percentage of Northern Pike sampled in gill nets (3-year moving average) ≥22 inches should exceed 30% (25^{th} percentile).
- *Recruitment:* Maintain gill net catch rate (3-year moving average) of age-3 Northern Pike between 1.0 and 1.6 (25^{th} and 75^{th} percentiles).

Management Actions

Fisheries assessments

- Conduct standardized annual assessments, including seining, trawling, electrofishing, gill netting, zooplankton, water quality and temperature monitoring.
- Conduct summer and winter creel surveys 2 of every 6 years. The next scheduled surveys are summer of 2016-2017 and 2017-2018, and the winters of 2015-2016 and 2016-2017.
- Continue to improve upon young-of-the-year predictors of potential Walleye year class strength.
- Continue to conduct lakewide Bluegill, Black Crappie, Largemouth Bass, and Smallmouth Bass spawner assessments every three years, standardizing gears, locations, and timing prior to 2018. Monitor for potential changes in size structure and catch rates. Assess the use of trap nets to sample Bluegill and Black Crappie prior to 2018. Establish Smallmouth Bass electrofishing stations prior to 2018. The next scheduled survey is in 2018.
- Insert Passive Integrated Transponder (PIT) tags in all Muskellunge adults sampled during spawn take operations and all fingerlings stocked during spawn take years on Leech Lake.
- Annually collect data from a subsample of cisco and whitefish in coordination with the Leech Lake Band of Ojibwe, Division of Resource Management commercial fishery.
- Annually collect and analyze data from a subsample of burbot registered at the Leech Lake Eelpout Festival.

Stocking & related activities

- Stock 7.5 million Boy River Strain Walleye fry (OTC marked) if the 3-year moving average (year class strength index values) falls below the 25th percentile.
- Stock sufficient numbers (low density) of Walleye fry (Boy River strain) to estimate wild fry production when mature female density falls below 1.25 or exceeds 2.75 pounds/acre. The purpose of this stocking is to expand on the existing range of total fry density observations. Information gained from these stocking events will increase understanding of the relationship between total fry density and recruitment. Stocking should not occur if Walleye condition and Yellow Perch abundance remain low.
- Conduct Muskellunge spawn take operations every four years in Miller's Bay to maintain genetic diversity in statewide brood stock lakes. Return 600 Muskellunge fingerlings to Leech Lake during spawn take years. The next scheduled spawn take is 2017.

Regulations

- The existing Walleye regulation (20-26 inch protected slot limit, possession limit of 4, one over 26 inches allowed in possession) will be continued. Adjustments to the existing 20-26 inch protected slot limit will be considered if mature female biomass continues to exceed the objective range of 1.5-2.0 pounds/acre and other key population metrics indicate signs of an unbalanced Walleye population. The DNR will review the status of key population metrics with the Leech Lake Fisheries Input Group annually.
- The existing bag limits of 50 Cisco (Tullibee) and 25 Lake Whitefish within the Leech Lake Indian Reservation will be continued. Daily and Possession limits are the same.
- The Leech Lake Fisheries Input Group requested DNR consider and evaluate bag limit reductions on panfish species to maintain the existing size quality of the populations.
- If changes to statewide regulations occur, implement regulations consistent with statewide recommendations and evaluate angler and fish population responses through standardized creel and gill net surveys.

Habitat

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

- Continue to partner with and/or provide support to government and non-government organizations to acquire via fee title or conservation easement key shore land areas within the Leech Lake watershed with the intent to protect key habitats and to implement best management practices (BMPs) where appropriate.
- Explore options for inventorying nearshore aquatic habitat in Leech Lake, including use and condition.
- Explore options for performing an inventory of aquatic vegetation stands to identify potential long-term trends in species composition, abundance, and distribution.
- Explore options for performing a telemetry study to identify additional Muskellunge spawning locations to guide future priorities for shoreland protection.
- Coordinate with DNR Ecological and Water Resources staff and Cass County Environmental Services to assist with aquatic invasive species prevention, education, and management efforts by DNR Ecological and Water Resources Division and other agencies.

Other Considerations

- Continue to provide financial and technical support to the Leech Lake Band of Ojibwe, Division of Resource Management for Double-Crested Cormorant control and evaluation efforts on Leech Lake.
- Continue to monitor potential effects of climate change on Walleye populations, specifically the length and intensity of the growing season (i.e. growing degree days).
- Evaluate the potential of collecting additional data from annual Muskellunge tournaments.
- Explore options for determining Largemouth Bass re-redistribution needs following tournaments if the number of tournaments increases to pre-2014 levels.
- DNR will hold annual meetings to update the LLFIG and other interested stakeholders to share the previous year's information and track status with regards to the management plan.

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Fisheries Management Plan for Leech Lake, 2016-2020

Minnesota Department of Natural Resources Mission Statement

The mission of the Minnesota Department of Natural Resources (DNR) is to work with citizens to conserve and manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for commercial uses of natural resources in a way that creates a sustainable quality of life.

Purpose

Management plans describe goals, objectives, and actions that support the DNR mission statement. The purpose of this plan is to guide fisheries management on Leech Lake. It is written for use by both the DNR and citizens that are interested in the management of the fishery resource. This plan is based on a fish community approach to fisheries management and highlights why this approach is important. This plan is designed to guide effective and efficient allocation of staff and fiscal resources to protect the fish community and provide for its sustained use. The goals, objectives, and actions identified in this plan will focus the work of the DNR over the next five years. Although this plan contains clearly defined goals, objectives, and actions, it is written to be flexible and deviations can occur based on changes to the fishery or the citizens that utilize it. Citizen participation is major component in the development of this plan and will continue to be critical throughout its life. The success of the plan will ultimately be determined by its benefits to the resource and users.

Lake Characteristics

Leech Lake has approximately 112,000 surface acres. In its original state the 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 has approximately 58,000 littoral acres (≤15 feet).

Leech Lake is located in three glacial zones and has an irregular shape with many large and small bays. The lake varies considerably from a morphological perspective. Some large bays, such as Steamboat, Boy, and Headquarters, display eutrophic water characteristics (high in productivity) whereas other large bays, such as Walker, Kabekona, and Agency have properties more congruent with oligotrophic lakes (low in productivity). The main portion of the lake (including Sucker, Portage, and Traders bays), is mesotrophic (moderate in productivity). Shoreline length based on remote sensing technology is 201 miles. Approximately 23% of the shoreline consists of a windswept gravel-rubble-boulder mixture, nearly all of which is suitable Walleye spawning habitat (Wilcox 1979), and numerous off-shore gravel-rock-boulder reefs are also available.

The diversity of the shoreline and substrate, as well as its extensive littoral zone, provides excellent spawning and nursery habitats for a number of species. Walleye *Sander vitreus*, Northern Pike *Esox lucius* and Muskellunge *E. masquinongy* are the principal predators and are common throughout the lake. Although most fish species are found in every portion of the lake, Walleye and Muskellunge abundances are highest in the mesotrophic areas. Northern Pike are most prominent in vegetated eutrophic bays. Yellow Perch *Perca flavescens* are abundant throughout the lake and are the primary forage for most predators. Cisco *Coregonus artedi* and Lake Whitefish *C. clupeaformis* are an important forage species for larger predators and are typically found in the mesotrophic and oligotrophic areas. Juvenile Cisco also comprise larger proportions of predator diets when large year classes are present. Other species present in the lake include: White Sucker *Catostomus commersoni*, Burbot *Lota lota*, Rock Bass *Ambloplites rupestris*, Bowfin *Amia calva*, Shorthead Redhorse *Moxostoma macrolepidotum*, Bullheads *Ameiurus spp.*, Pumpkinseed *Lepomis gibbosus*, Bluegill *L. macrochirus*, Largemouth Bass *Micropterus salmoides*, Smallmouth Bass *M. dolomieu*, and Black Crappie *Pomoxis nigromaculatus*.

Survey History

DNR:

Prior to the inception of the large lake program in 1983, unstandardized gill netting, seining, trawling, and creel survey assessments were infrequently conducted by the DNR. Gill net assessments were completed during 1943, 1944, 1950, 1976, and 1982. Seining assessments were completed from 1965-1968, 1970-1982. Trawling assessments were completed from 1965-1968, and in 1976. Summer creel surveys were conducted in 1965, 1966, and 1967, while a winter creel survey was conducted in 1965-66. Gear and locations used during these surveys were not consistent with the standardized protocols established with the inception of the Large Lake Program in 1983 (Wingate and Schupp 1984).

Annual Large Lake Program surveys initiated in 1983 included seining in mid-July and gill netting in mid-September; additional gears targeting specific species and age classes have been added over the past 32 years. Currently annual surveys include water quality in mid-July (1986-present), trawling in mid-August (1987-present), hourly water temperature loggers (2006-present), electrofishing in mid-September (2007-present), and monthly zooplankton sampling (2012-present). Summer creel surveys have been conducted in 1984-1985, 1991-1992, 1998-1999, 2004-2005, 2008-2011, and 2014, and winter creel surveys were conducted in 1984-85, 1990-91, 1991-92, 2004-05, 2005-06, 2010-11, and 2014-15. Spring bluegill, black crappie, largemouth bass, and smallmouth bass assessments were initiated in 2012 and are conducted every three years.

1965-68: 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).

1979-80: A Muskellunge telemetry study was conducted to identify spawning areas, seasonal distribution, and movement throughout 1979 and 1980 (Strand 1986). Six spawning locations were determined lakewide through the tracking of 14 females. Spawning sites were characterized as being approximately 3-6 feet deep with *Chara* spp. as the dominant vegetation type.

2002-2005: The first lakewide survey of aquatic vegetation distribution and assemblage (Perleberg and Loso 2010).

2005-2010: Double-crested cormorant studies assessed cormorant diets (Göktepe 2008; Hundt 2009; Göktepe et al. 2012) and estimated cormorant population size, associated fish consumption, and trends in fish population metrics in response to culling efforts (Schultz et al. 2013).

2007: A critical review of young-of-the-year Walleye sampling (Schultz et al. 2007). Concluded Walleye year class strength was most accurately predicted using mid-August bottom trawling data, when compared to mid-July seining data. However, mid-September electrofishing data may serve as an additional tool to predict Walleye year class strength.

2012: Compared genetic variation in Leech Lake and Woman Lake Walleye populations (Miller 2012). No declines in genetic diversity in Leech Lake were detected between the pre-stocking (pre-2005) and stocking (2005-present) time periods. Additionally, no signs of increased relatedness or inbreeding depression were observed and no increases in genetic diversity are needed.

2012: Compared variation in juvenile Walleye growth rates in Leech Lake (Ward et al. 2012). Growth rates for both age-0 and age-1 Walleye for both stocked and naturally produced year classes were compared and no statistically meaningful differences were observed. Growth was negatively associated with higher fry densities and positively associated with longer and warmer growing seasons.

Other Management Agencies:
1978-79: The Army Corps of Engineers completed an assessment evaluating nearshore habitat and 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 limit the accessibility to or potentially strand Northern Pike in spawning areas.

1988-91: A hydrology and groundwater quality study was conducted from 1988-1991 (Lindgren 1996).

1992: The Leech Lake Band of Ojibwe completed a report evaluating water quality and productivity of Leech Lake (LLBO 1992). The report indicated good water quality was present and recommended alternatives for maintenance.

1993: Leech Lake River Basin Study Report: 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).

1997: A Water Quality Assessment of the Leech Lake Watershed: A watershed report sponsored by the Leech Lake Division of Resource Management and the Minnesota Chippewa Tribe (LLDRM 1997).

2010-Present: Watershed Restoration and Protection (WRAP) strategies outlined under the guidance of MN Pollution Control Agency (unpublished).

Invasive Species:
A number of invasive species have been identified in Leech Lake. These species and first record of presence include: rusty crayfish (Helgen 1990); heterosporosis (unknown); curly-leaf pondweed (unknown); Eurasian watermilfoil (Rivers 2005b); purple loosestrife (unknown), and banded mystery snail (2006; G. Montz, DNR, unpublished data).

Recent Fisheries Trends and Status

Walleye is currently the only species of sportfish in Leech Lake with special regulations (20-26 inch protected slot limit, possession limit of 4, one of which can be over 26"). Reduced daily and possession limits on Cisco and Lake Whitefish are in place on all waters within the Leech Lake Indian Reservation, which includes most of Leech Lake. Statewide regulations apply to all other species.

Walleye:
Walleye abundance in the mid-2000s was low relative to the historical time series. Relatively high angler pressure and harvest in the late 1990s and into the 2000s (Sledge 1999, 2000) combined with increasing cormorant abundance and predation during 2000-2004 to produce five of the weakest seven Walleye year classes observed since 1983 (Schultz et al. 2013). Starting in 2005, conservative regulations, cormorant management, Walleye fry stocking, and increased habitat protection were implemented concurrently to improve the Walleye population.

Walleye abundance improved rapidly in response to combined management actions and has remained relatively stable since 2007. Gill net catch rates have exceeded the long-term average during 2007-2014, female spawner abundance has been within or above the management objective range since 2010, average or stronger year classes were produced during 2010-2014, and targeting angler catch rates have been at or above the long-term average since 2008. Overall, the Walleye population has fully recovered. Mature female density exceeded the management objective range for several years prompting the relaxation of the protected slot limit from 18-26 inches to 20- 26 inches in 2014 to allow for increased angler harvest.

Yellow Perch:
Increased predation by double-crested cormorants resulted in low abundances of Yellow Perch during the early to mid-2000s (Schultz et al. 2013). Yellow Perch gill net catch rates were below the 25th percentile in 2005 when cormorant culling commenced, and by 2007 catch rates exceeded the 75th percentile. This rapid change was attributed to predation relief in conjunction with fast growth and high survival rates of Yellow Perch. However, as Walleye abundance continued to increase at both the juvenile and adult levels, predation pressure on Yellow Perch by Walleye also increased and indices of Yellow Perch abundance again declined. Yellow perch are the primary prey species for Walleye and most other predatory sportfish in the lake.

Yellow Perch gill net catch rates have had a decreasing trend since 2007 as the Walleye population recovered and active Walleye management activities continued through 2014. Yellow Perch gill net catch rates have fallen below the 25th percentile the past three years (2012-2014) and reached a historic low in 2013. The abundance of age-4 Yellow Perch recruiting to the fishery has also had a declining trend since 2007 while the percentage of Yellow Perch in gill nets ≥8 inches has been below the 25th percentile two of the past three years (2012-2014). Elevated predation by juvenile and adult Walleye and increases in total harvest of Yellow Perch by winter anglers are both suspected as primary causes of the most recent decline. A strong negative relationship exists between Yellow Perch recruitment and total Walleye fry density estimates from the same year class (Appendix B, Figure 4), and record Yellow Perch harvest was documented during the 2010-11 and 2014-15 winter angling seasons (Schultz and Vondra 2011, Stevens and Ward 2015). Due to record harvest of Yellow Perch the past two winter creel surveys, additional surveys will be conducted in both the winters of 2015-16 and 2016-17 to continue to monitor and evaluate harvest. Although some perceive cormorant consumption of Yellow Perch continues to have a significant influence on Yellow Perch recruitment, consumption by cormorants has been reduced by 90% relative to 2004 levels and are similar to pre-2000 levels (Schultz et al. 2013).

Northern Pike:
All metrics indicate the population is stable and low to moderate in abundance. The lakewide abundance continues to remain stable, with an average gill net catch rate of 4.7 fish/net over the past five years (1983-2014 average = 4.8 fish/net). The gill net catch rate of age-3 fish/net has remained between the 25th and 75th percentiles five of the past five years, indicating stable lakewide abundance of smaller individuals surviving to catchable sizes (i.e. stable recruitment). Additionally, the percentage of Northern Pike sampled in gill nets ≥22 inches has exceeded 30% for ten years in a row, indicating a stable abundance of mid-size and larger fish.

Other Sportfish Species:
Limited long-term data is available to review trends and status for other sportfish species, such as Black Crappie, Bluegill, Muskellunge, and Largemouth and Smallmouth Bass; these data sets are currently building.

Social considerations

The DNR recognizes the economic base supported by Leech Lake and the role fishing quality in Leech Lake has on the local quality of life. Communication and cooperation between the DNR and stakeholders, and the need for an adaptive management framework that provides context for framing biological and social questions and goals with stakeholder involvement is critically important. Adaptive management promotes flexible decision making that can be adjusted over time as outcomes from management actions and other events become better understood (i.e. learning by doing).

The DNR requested 16 stakeholders with diverse local and statewide interests provide input to the DNR on proposed management goals, objectives, and actions as the Leech Lake Fisheries Management Plan was updated for 2016-2020. The Leech Lake Fisheries Input Group (LLFIG) was formed in February 2015 and is represented by eight organizations: Leech Lake Association, Leech Lake Fishing Task Force, City of Walker, Leech Lake Area Watershed Foundation, Leech Lake Band of Ojibwe, Statewide Walleye Work Group, Statewide Northern

Pike and Muskellunge Work Group, and the Statewide Bass Work Group. In addition, eight members were selected from a statewide web-based application process. Open seats include two resort owners, two local business owners, a local guide, local angler, statewide angler, and a Fisheries professor from Bemidji State University. The LLFIG built upon the successes of the previous plan by providing input and recommendations on specific goals, objectives, and/or actions aimed at preserving a quality fishery on Leech Lake. The DNR will hold annual update meetings with the LLFIG and other interested stakeholders with the previous year's information and status with regards to the management plan. A weight of evidence approach will be used annually to assess if deviations from the management plan are appropriate.

Sportfish Population Goals, Objectives, and Actions

Outlining population goals, objectives, and associated management actions are important, as they are the tools for evaluating results that can be applied to future decision-making processes. Goals are broad qualitative statements encompassing what the management plan hopes to achieve for a particular species and objectives are specific quantitative statements that contribute to achieving the goal. Management actions are specific activities implemented either to build long-term data sets or when an objective is exceeded or fails to be met. Placing proposed objectives within their proper historical context (1983-present) and relative to 2011-2015 objectives is necessary for an expectation of what is either realistic or sustainable. 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 14 Walleye/net and has only exceeded 9 Walleye/net seven times in the past 32 years. New to this management plan is the use of 3-year moving averages (most recent three observations) for most of the objectives. Moving averages are used to smooth the year to year variability and more closely reflect current trends. This management plan also attempts to be more representative of all sportfish species within the fish community, as Leech Lake supports a very strong and diverse multi-species fishery.

Walleye Goal:

Support a self-sustaining Walleye population that balances harvest opportunity with the opportunity to catch quality-sized fish while meeting reproductive needs.

Walleye Objectives:

Abundance. *Maintain Walleye gill net catch rate (3-year moving average) of 7-10 fish/net (40th-90th percentiles).*

Maintaining a stable abundance of Walleye benefits anglers and stabilizes recruitment. Walleye gill net catch rates have ranged from 4.6 fish/net (1993) to 13.4 fish/net (1988) during 1983-2014. The objective range of 7 to 10 fish/net represents the 40th and 90th percentiles. The objective under the 2011-2015 management plan was to maintain a gill net catch rate of ≥8.5 fish/net, the 75th percentile at the time. Maintaining a gill net catch rate at or above the 75th percentile is not realistic due to annual variability in the number of juvenile Walleye surviving to catchable sizes (i.e. recruitment) and relaxation of the protected slot limit (PSL) to allow for increased harvest opportunity (shift from 18-26 inch PSL to 20-26 inch PSL). For these same reasons, the upper end of the 2016-2020 objective range is aggressive, and will not be exceeded on a regular basis.

Peaks in gill net catch rates (i.e. catch rates ≥10 fish/net) have been attributed to a disproportionately large number of age-0 and/or age-1 fish being sampled relative to other years (1988, 1989, 1998, and 2007). Thus, gill net catch rates can be strongly influenced by recruitment variability, and the highs and lows in gill net catch rates tend to be driven by the frequency of unusually strong or weak year classes moving through the age-1 through age-6 age classes. Gill net catch rates can also be influenced by the growth rate of a particular cohort (gill net capture efficiency is related to the size of fish, particularly smaller and larger ones), and angler harvest which is typically correlated with pressure (angler hours). The objective range of 7 to 10 fish/net should accommodate for variability in catch rates over the duration of this plan, as gill net catch rates have remained within this range eight of the past ten years.

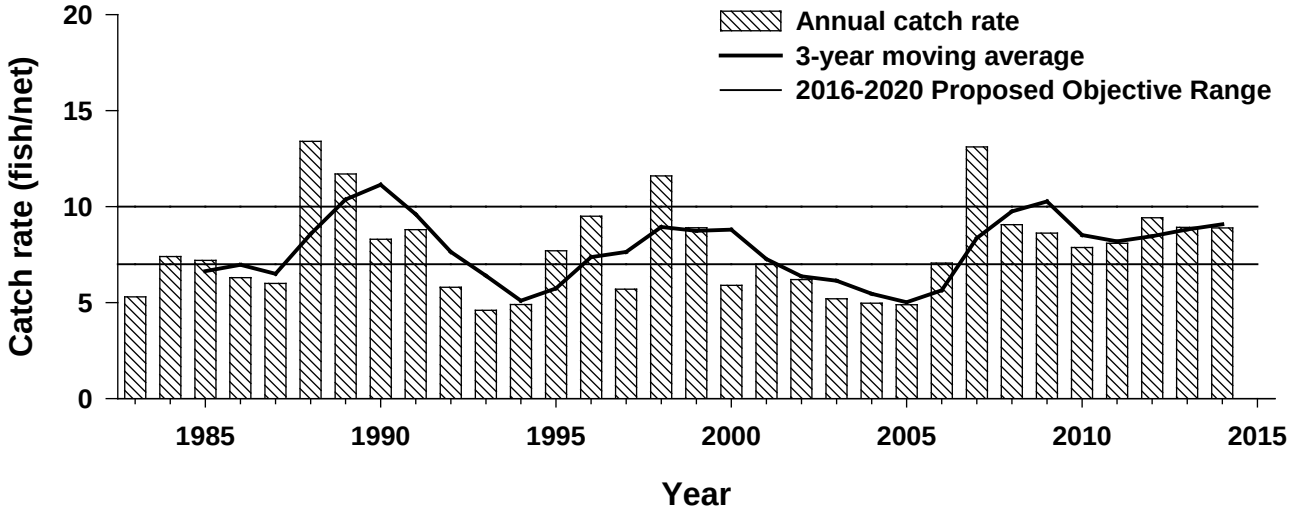

Figure 1. Gill net catch rates (fish/net) of Walleye in Leech Lake, 1983-2014. Horizontal lines represent the 40th and 90th percentiles. The darker line represents the 3-year moving average.

Reproductive Potential. *Maintain Walleye mature female biomass (3-year moving average) between 1.5-2.0 pounds/acre (50th-80th percentiles).*

Maintaining an adequate density of mature females (i.e. spawners) reduces recruitment variability and increases the relative abundance of subsequent year classes. Uncontrollable factors, such as weather, growing conditions, forage availability, density-dependence, and others, also influence year class strength. The density of mature females has ranged from 0.7 pounds/acre (1997) to 2.5 pounds/acre (2014) during 1989-2014. The values of 1.5 to 2.0 pounds/acre represent the 50th and 80th percentiles through this time series. Prior to 1989, maturity observations were not recorded for Walleye. The recruitment potential objective under the 2011-2015 management plan was to maintain a mature female density between 1.5 and 2.0 pounds/acre, the 60th to 90th percentiles at that time.

During 2005-2014 mature female density ranged from 1.0-2.5 pounds/acre, and overall Walleye fry densities during this time ranged from 61 to 779 wild fry/littoral acre and 237 to 908 total fry/littoral acre, respectively. Total fry densities were estimated by stocking known quantities of marked fry during 2005-2014 per the methods described by Logsdon (2006), and wild fry density was estimated by subtracting stocked fry density from total fry density. Stocking densities ranged from 129-391 fry/littoral acre (acres ≤15 feet deep).
For the seven years that mature female density exceeded 1.5 pounds/acre since 2005, wild fry densities have averaged 348 fry/littoral acre. The three years in which mature female densities were less than 1.5 coincided with the only three years subsequent Walleye year class strength index values were below average. Wild fry densities are expected to average between 270-370 fry/littoral acre relative to the mature female density range of 1.5-2.0 pounds/acre. Growth, survival, and recruitment of age-0 fish to the fishery increase as fry density decreases, and fry densities of 500 fry/littoral acre or higher have consistently resulted in lower recruitment. Given these observations over the past ten years, the current target range for spawner biomass is expected to be appropriate for supporting consistent fry production.

Spawner density is influenced by the strength of year classes reaching maturity, fishing pressure, and angler harvest. Walleye harvest regulations are an important tool for managing the Reproductive Potential objective. Adjustments to the existing 20-26 inch protected slot limit will be considered if mature female biomass continues to exceed the objective range of 1.5-2.0 pounds/acre and other key population metrics (Walleye and Yellow Perch gill net catch rates, the percentage of Walleye within the protected slot, lower than anticipated fishing pressure and Walleye harvest, and Walleye density dependence) indicate signs of an unbalanced Walleye population. Signs of density dependence include maturation at longer lengths and older ages, and below average growth and condition. The DNR will review the status of these metrics annually with the Leech Lake Fisheries Input Group. Regulation adjustment(s) over time should be used cautiously to avoid compulsive responses 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. Summer and winter creel surveys scheduled for 2016 and 2017 will provide critical information for considering potential Walleye regulation changes.

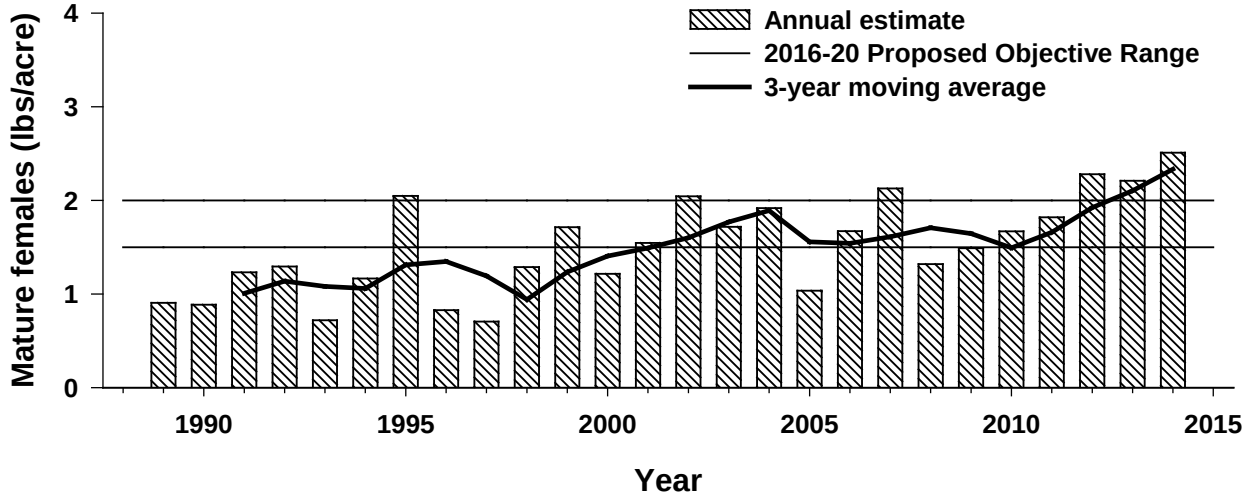

Figure 2. Estimated biomass (pounds/acre) of mature female Walleye in Leech Lake, 1989-2014. Horizontal lines represent the 50th and 80th percentiles. The darker line represents the 3-year moving average.

Size Structure. *Maintain the percentage of Walleye sampled in gill nets (3-year moving average) ≥20 inches between 10 and 20% (50th-80th percentiles).*

Maintaining a balanced size distribution of Walleye in a population ensures there are both fish available for angler harvest, and allows anglers the opportunity to catch larger sized individuals. Angler dissatisfaction with protective size regulations is often in response to the portion of their catch that they are required to release; this objective is intended to address that concern. The percentage of Walleye sampled in gill nets ≥20 inches has ranged from 2% (1984) to 26% (2006) during 1983 - 2014. The range of 10 to 20% represents the 50th to the 80th percentiles. The size structure objective under the 2011-2015 management plan stated that the proportion of Walleye sampled in gill nets ≤15 inches remain between 45-65%, the 25th - 75th percentiles at the time. The intent of this objective was to quantify the abundance of smaller fish entering the population that would be available for angler harvest. The Walleye recruitment objective accomplishes this also. The new size structure objective better reflects the effects of special harvest regulations on angler harvest.

Peaks in the percentage of larger Walleye sampled in gill nets (exceeding 20%) have occurred twice. The peak from 2005-07 was attributed to increased cormorant predation on juvenile Walleye shifting size structure to primarily larger individuals, and the peak from 2012-2014 was attributed to overshooting the management objective goal for female spawner abundance and triggered the relaxation of the protected slot limit (PSL). Cormorant control measures, angler pressure and harvest, and the current regulation play a key role in accomplishing this objective. If this management objective continues to be exceeded the weight of evidence approach will be used to assess if further modification of the PSL is appropriate.

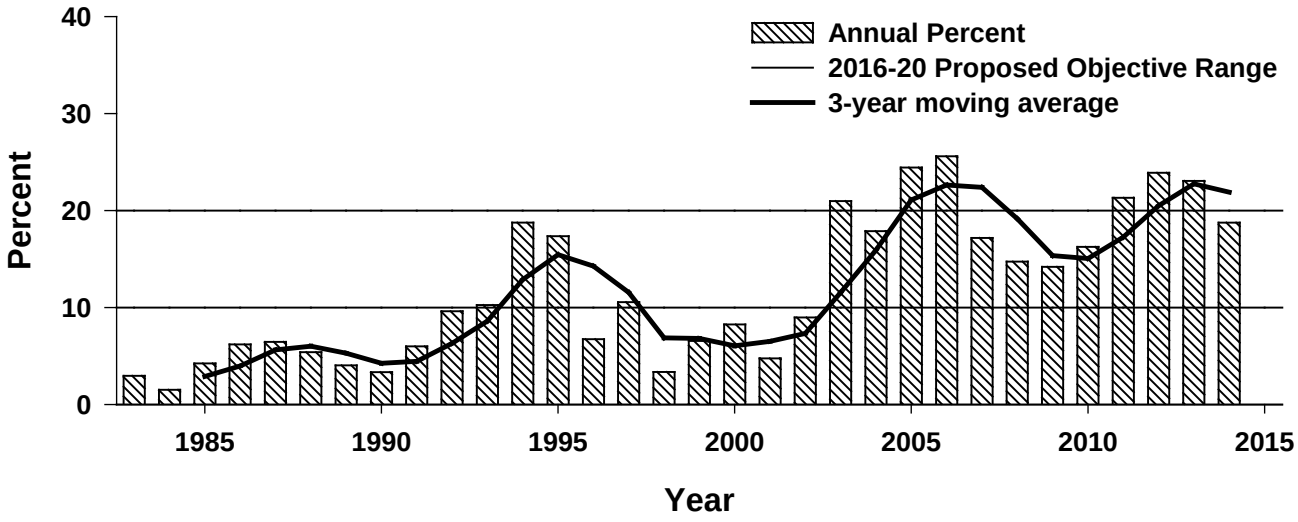

Figure 3. The percentage of Walleye in gill nets ≥20 inches in Leech Lake, 1983-2014. Horizontal lines represent the 50th and 80th percentiles. The darker line represents the 3-year moving average.

Recruitment. *Maintain Walleye year class strength index (3-year moving average) greater than 1.1 (25th percentile).*

Maintaining a stable number of juvenile Walleye surviving to catchable sizes (i.e. recruitment) ensures there are both fish available for angler harvest and sexually mature individuals entering the spawning population. Recruitment variability, or the variability in the size or strength of a year class, is influenced by a number of factors. These include spawner abundance, spawning conditions, juvenile density, length and intensity of growing season, predation, and prey abundance among others. Most recruitment concerns center on consecutive years where the year class strength index (i.e. the relative abundance of Walleye produced in an individual year) is below the 25th percentile. The 25th percentile is a threshold below which year class strength is defined as poor. Year class strength values have ranged from 0.30 (1993) to 2.30 (1988) during 1983-2014. The threshold of 1.1 refers to the 25th percentile for the 1983-2014 time series. The recruitment objective under the 2011-2015 management plan stated that year classes should have a measured strength at or above the long-term average (1983-2009 = 1.35) during two of four consecutive years. This objective was exceeded and the result was elevated predation pressure on the prey base, specifically Yellow Perch, and corresponding reductions in Yellow Perch recruitment.

Since 1983, the year class strength index has dropped below the 25th percentile for two consecutive years on two occasions, from 1992-1993 and from 2000-2004. The low experienced in 1992 and 1993 was attributed to those summers being several of the coldest on record since 1983 (i.e. having the fewest days with average air temperatures ≥50°F). Lower water temperatures result in reductions in growth, survival, and recruitment of Walleye, and this pattern was prominent throughout Minnesota (Schupp 2002). Year class strength values below the 25th percentile from 2000-2004 were attributed to increased cormorant predation (Schultz et al. 2013).

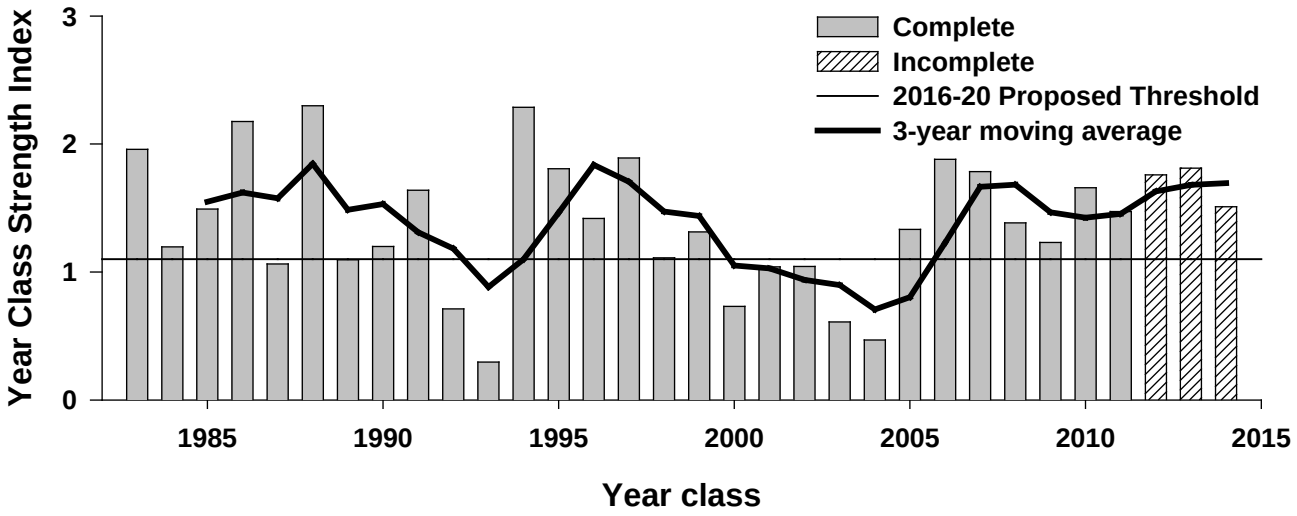

Figure 4. Year class strength index of Walleye in Leech Lake, 1983-2014. Both year classes fully recruited to the fishery and those still incomplete are indicated. The horizontal line represents the 25th percentile. The darker line represents the 3-year moving average.

Angler Catch Rate. *Maintain a targeting angler summer catch rate of 0.30 fish/hour or higher (50th percentile).*

Maintaining stable abundance of Walleye for anglers to catch and harvest is important, as Walleye are the species most frequently targeted by summer and winter anglers. Length limits, such as protective slot limits (PSLs), are intended to reduce or eliminate harvest of a particular size group of fish, improve size structure and/or improve the quality of fishing with higher catch rates and larger fish. Uncontrollable factors such as weather, forage availability, and others also influence angler catch rates

Targeting angler summer catch rates have ranged from 0.05 (2005) to 0.41 (2009) during 1991-2014. Prior to 1991, anglers were not asked what species they were fishing for and this metric could not be calculated. Targeting angler statistics are a more precise measure of fishing quality for a particular species than statistics generated across all anglers, as targeting anglers only fish for that particular species. The threshold of 0.30 represents the 50th percentile for the 1991-2014 time series. This threshold tracks well with good fishing experienced throughout the 1990s and 0.30 is an above average catch rate compared to the nine other 'large Walleye lakes' in Minnesota (Wingate and Schupp 1984).

The only angler oriented Walleye objective in the 2011-2015 management plan was harvest oriented. The angler oriented objective in the 2011-2015 management plan stated that the targeting angler summer harvest rate should be 0.25 fish/hour or higher. This objective was acknowledged as likely unachievable in light of the regulation change that was intended to reduce harvest. This objective also exceeded the 90th percentile for the 1991-2009 time series, which included pre-protected slot limit fishing seasons.

The two objectives in the 2016-2020 management plan (Angler Catch Rate and Angler Harvest) are intended to recognize catch and release anglers, the harvest oriented anglers, and the contribution of fish that are released due to the protected slot limit.

This objective is only applicable during years creel surveys are conducted.

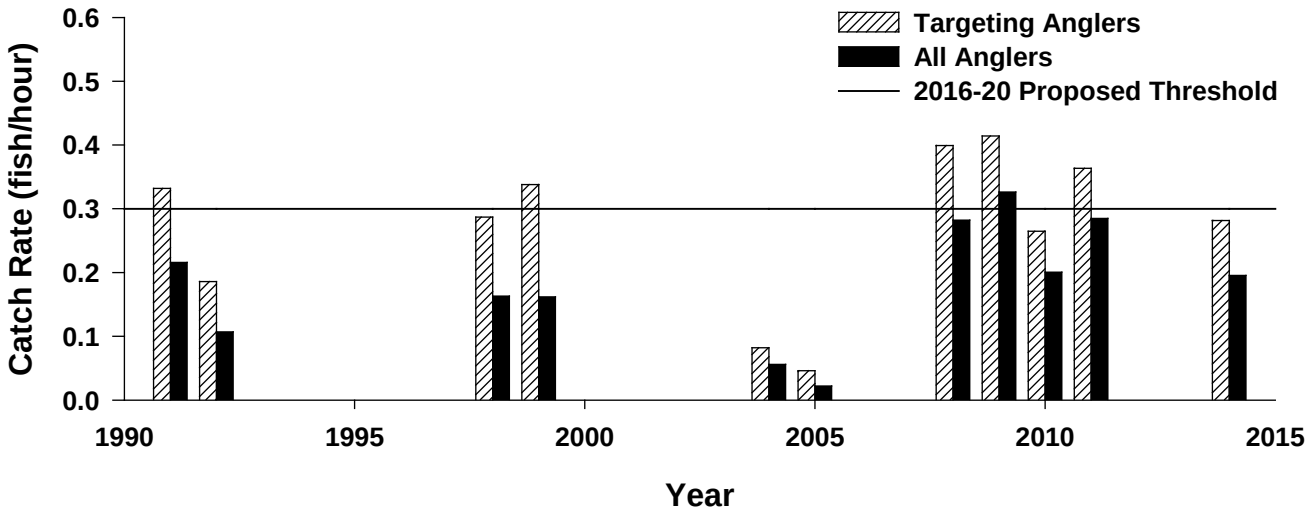

Figure 5. Angler catch rates of Walleye in Leech Lake, 1991-2014. Catch rates for targeting anglers and all anglers are indicated. The horizontal line represents the 50th percentile.

Angler Harvest. *Maintain annual total Walleye harvest between 130,000 - 190,000 pounds (50th-80th percentiles).*

Maintaining an angler oriented Walleye harvest objective is important, as it is a measure of fish returned to the angler. Walleye are the 1st and 3rd most harvested species by pounds in summer and winter, respectively. The total annual pounds of Walleye harvested have ranged from 6,881 (2005) to 224,310 (1966) during 1965-2014. The objective range from 130,000 to 190,000 pounds represents the 50th and 80th percentiles for the 1965-2014 time series. This range demonstrates that additional harvest is currently available and management steps have been taken to provide additional harvest opportunity (i.e. the relaxation of the protected slot effective 2014 Walleye opener). The total annual fishing pressure and regulation type will have strong influences on this objective.

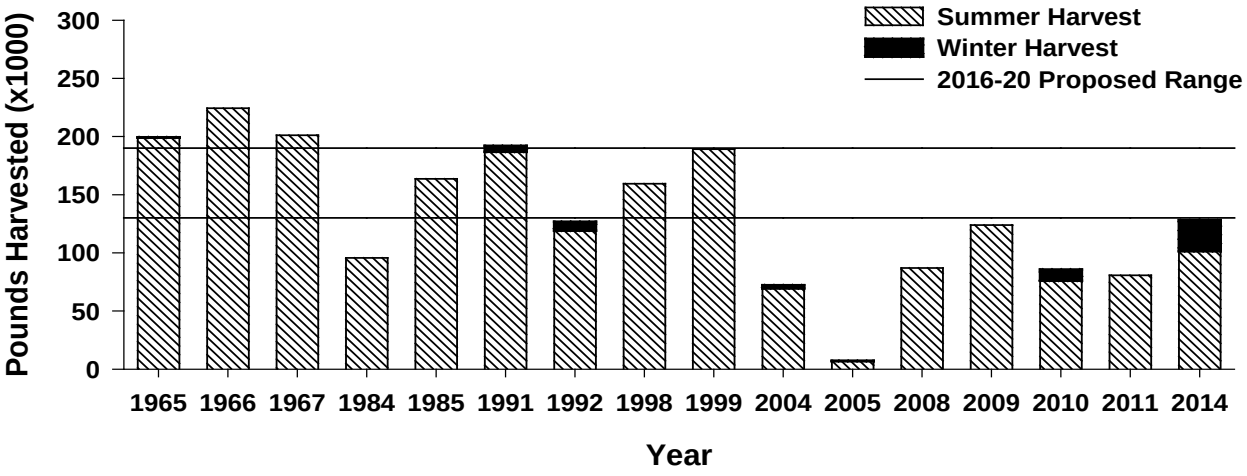

Figure 6. Total harvest (pounds x 1,000) of Walleye by Leech Lake anglers throughout summer and winter seasons, 1965-2014. Horizontal lines represent the 50th and 80th percentiles.

Condition. *Maintain Walleye condition factor (3-year moving average) between 82 - 86 (25th-75th percentiles).*

Walleye condition is assessed using relative weight (*Wr*), which is a ratio of individual weight versus its length (Murphy et al. 1990). Condition can be used as a surrogate to assess prey availability. If an individual has to increase the amount of energy expended to locate preferable prey or if it has to opt for less desirable prey, its condition values are lower. Lower Walleye condition values over the past several years coincide with the time period Yellow Perch gill net catch rates were below the 25th percentile. Walleye condition values have ranged from 78 (2011) to 90 (2004) during 1983-2014. Values of 82 and 86 are the 25th and 75th percentiles for the 1983-2014 time series. There was not a condition objective for Walleye in the 2011-2015 management plan.

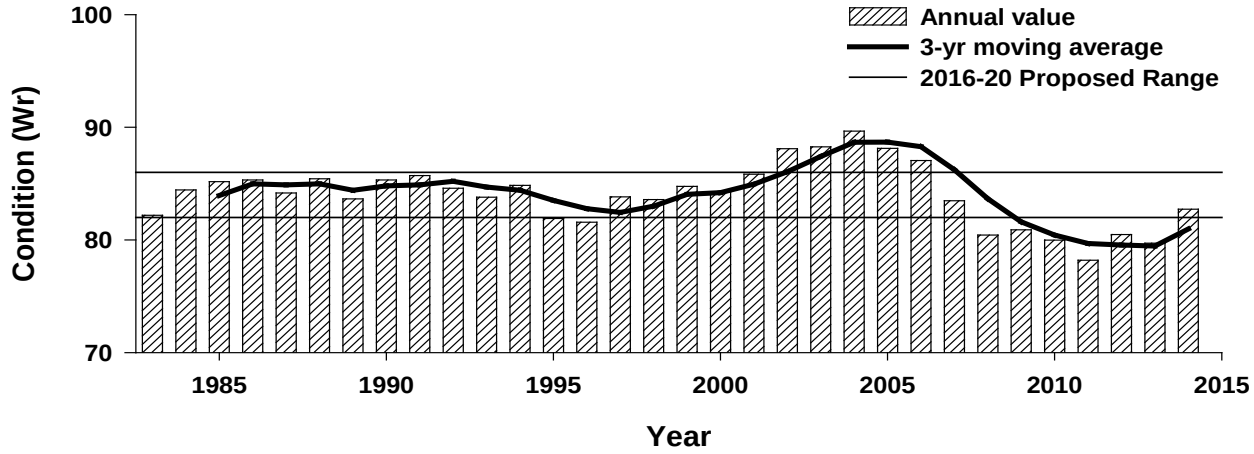

Figure 7. Annual mean condition (Wr) of Walleye in gill nets in Leech Lake, 1983-2014. Horizontal lines represent the 25th and 75th percentiles. The darker line represents the 3-year moving average.

Yellow Perch Goal:

Support a self-sustaining Yellow Perch population that provides both a stable prey base for sportfish and harvest opportunities for anglers.

Yellow Perch Objectives:

Abundance. *Maintain Yellow Perch gill net catch rate (3-year moving average) ≥16 fish/net (25th percentile).*

Yellow Perch are the primary prey species for most predator sportfish. Anglers also harvest more Yellow Perch (by number) than any other species throughout the year. Yellow Perch gill net catch rates have ranged from 12.1 fish/net (2013) to 37.7 fish/net (1995) during 1983-2014. The objective threshold of 16.0 fish/net is the 25th percentile for the time series. The abundance objective under the 2011-2015 management plan was to maintain a gill net catch rate ≥16.3 fish/net, the 25th percentile for that time series.

Although some variability in catch rates can be attributed to fluctuations in recruitment, the decline in perch catch rates from 1997-2005 occurred concurrently with marked increases in the cormorant population. Cormorant diet studies indicated that Yellow Perch were the principal prey of cormorants at that time (Schultz et al. 2013). Elevated predation by juvenile and adult Walleye and increases in total harvest of Yellow Perch by winter anglers are both suspected as primary causes of recent declines. In particular, a strong negative relationship exists between Yellow Perch recruitment and total Walleye fry density (Appendix 2, Figure 4). Recent steps taken to reduce predation pressure on Yellow Perch include reductions in Walleye fry stocking and expanded Walleye harvest opportunity for anglers. Based on the time series, 25th percentile represents a threshold below which Yellow Perch recruitment and Walleye growth and condition are negatively impacted. From the perspective of sportfish management, maintaining Yellow Perch abundance above the 25th percentile is necessary.

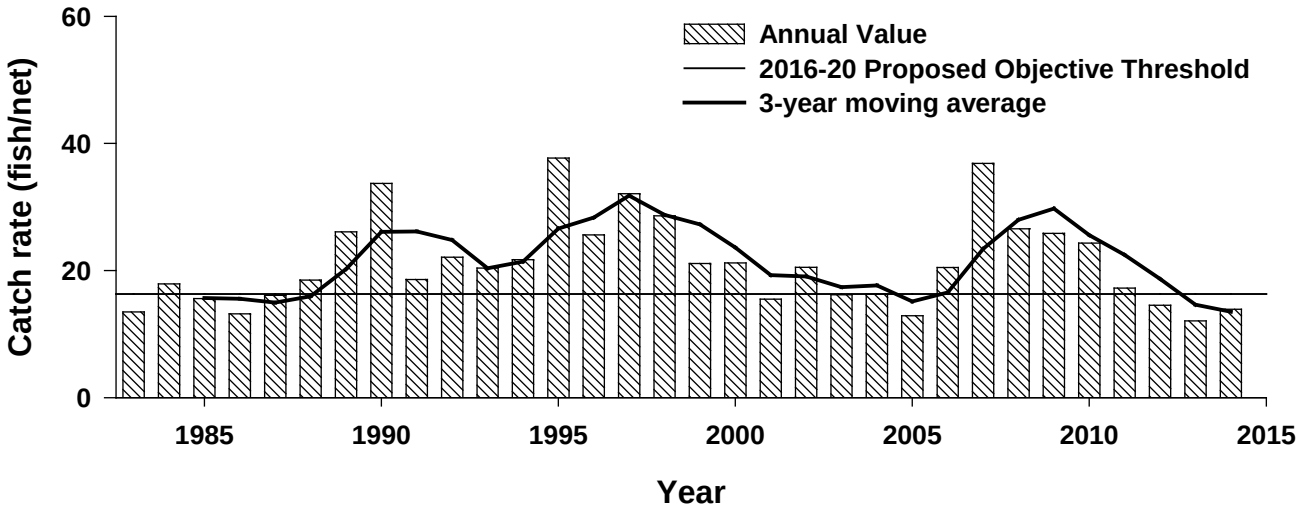

Figure 8. Gill net catch rates (fish/net) of Yellow Perch in Leech Lake, 1983-2014. The horizontal line represents the 25th percentile. The darker line represents the 3-year moving average.

Size Structure. *The percentage of Yellow Perch sampled in gill nets (3-year moving average) ≥8 inches should exceed 30% (25th percentile).*

Summer and winter anglers start harvesting Yellow Perch on Leech Lake at 8 inches. It is important to maintain a certain percentage of the Yellow Perch population that is of a size anglers elect to harvest. Acknowledging that Yellow Perch are managed as both a primarily prey species and as for a species angler harvest, we have established the 25th percentile (30%) for this time series as the management objective.

The percentage of Yellow Perch sampled in gill nets ≥8 inches has ranged from 20% (2014) to 49% (1999) during 1983-2014, and the threshold of 30% represents the 25th percentile for the time series. The size structure objective under the 2011-2015 management plan stated that the percentage of Yellow Perch sampled in gill nets ≥8 inches (PSD-8) and ≥10 inches (RSD-10) exceed the 25th percentile thresholds for the 1983-2009 time series, which were 30% and 7%, respectively (Murphy and Willis 1996). Although the previous objectives did quantify length-frequency data and the portion of the population that was sexually mature and large enough for anglers to catch, the method was complex.

The time periods where the metric fell below the 30% threshold for multiple years included the early to mid-2000s and two of the three years from 2012-2014. Reductions in the early to mid-2000s were attributed to elevated cormorant predation of juvenile Yellow Perch, which resulted in lower numbers of fish reaching harvestable sizes. Reductions in recent years are suspected to be attributed to elevated Walleye predation of juvenile Yellow Perch and elevated winter angler harvest of adults.

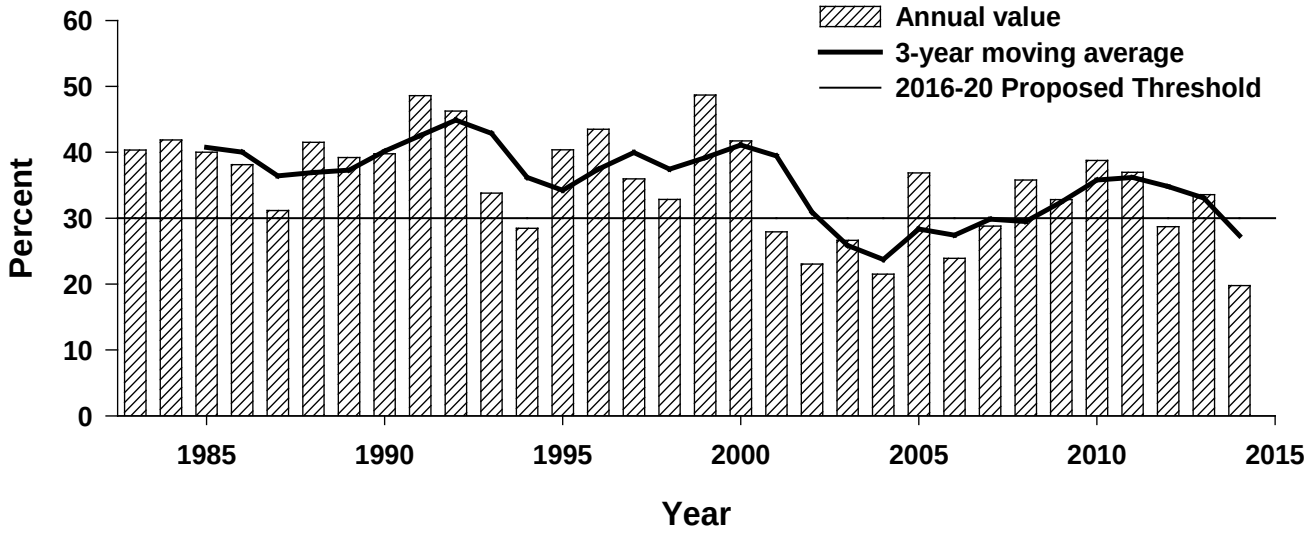

Figure 9. The percentage of Yellow Perch in gill nets ≥8 inches in Leech Lake, 1983-2014. The horizontal line represents the 25th percentile. The darker line represents the 3-year moving average.

Recruitment. *Maintain gill net catch rate (3-year moving average) of age-4 Yellow Perch ≥3.2 fish/net (25th percentile).*

Maintaining stable Yellow Perch recruitment ensures fish are both available for consumption by sportfish and angler harvest. Monitoring Yellow Perch recruitment is important as it is a metric that indicates increased mortality of juvenile Yellow Perch or declines in producion. Although young-of-the-year and age-1 Yellow Perch are annually sampled via seine in mid-July and bottom trawl in mid-August, there are no statistical relationships between the relative abundance of juvenile Yellow Perch sampled with standardized gears at standardized locations and the number of individuals sampled in gill nets. Likely reasons include the numerous bottlenecks present between juvenile life stages and maturity or gear type and sampling locations. Bottleneks include, but are not limited to climate shifts, consumption by predators, and abundance of alternative prey such as cisco for predators. Age-4 Yellow Perch are a size (approximately 7 inches on Leech Lake) at which all individuals in a year class are large enough to be sampled in a gill net yet are smaller than most anglers elect to harvest. Therefore, age-4 gill net catch rates are a good index of recruitment.

Yellow Perch gill net catch rates for age-4 individuals have ranged from 2.1 (2006) to 9.0 (2007) during 2001-2014. Yellow Perch were aged with scales prior to 2001 and sample sizes were small and not distributed around the lake; consequently, the data set used to calculate this metric is limited to 2001 and later. The threshold of 3.2 fish/net refers to the 25th percentile. Suspected reasons for the precipitous decline in gill net catch rates since 2007 include increased predation pressure by Walleye in response to aggressive Walleye management actions in previous plans. There was not a recruitment objective for Yellow Perch in the 2011-2015 management plan.

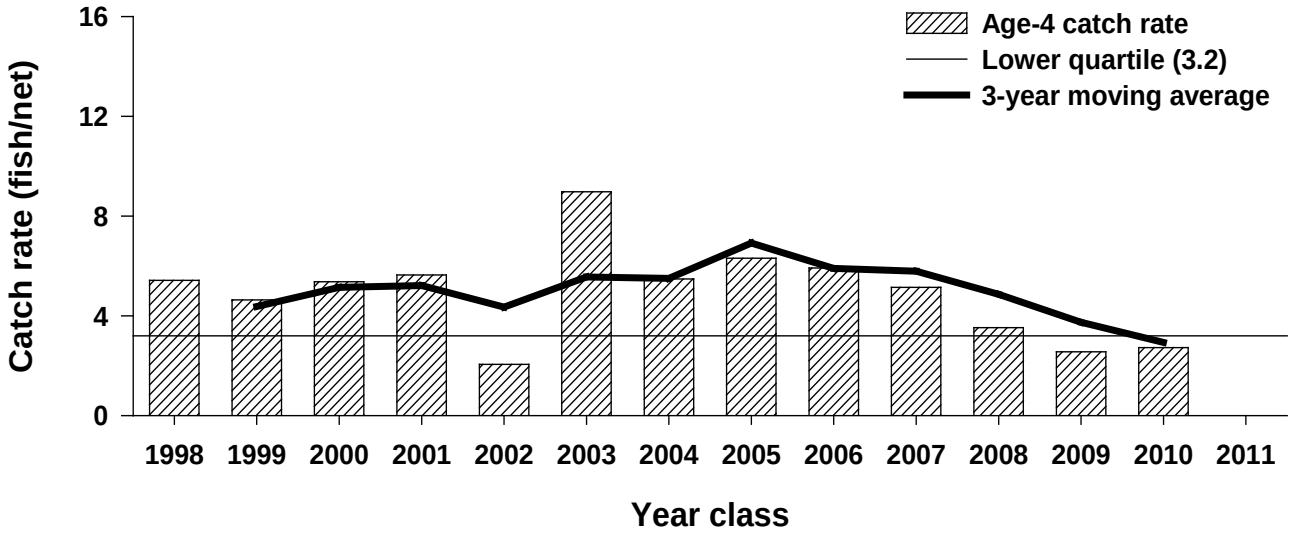

Figure 10. Gill net catch rates (fish/net) of age-4 Yellow Perch by year class in Leech Lake, 1998-2010. The horizontal line represents the 25th percentile. The darker line represents the 3-year moving average.

Angler Harvest. *The annual total Yellow Perch harvest should be less than 98,000 pounds.*

An angler oriented objective focused on Yellow Perch harvest is important, as it is a measure of fish returned to the angler. Yellow Perch are the 3rd and 1st most harvested species by pounds, by summer and winter anglers, respectively. The total annual pounds harvested (summer + following winter) have ranged from 28,909 (2004) to 160,217 (2010) between 1965 and 2014. The threshold of 98,000 pounds represents harvest levels below which angling quality is protected or enhanced (DNR 1997). If the annual pounds harvested exceeds the threshold on an infrequent basis, changes to population metrics (e.g. abundance, growth, age at maturity, etc.) will not likely be observed. Although the threshold can be exceeded in an individual year, sustained exceedance may result in changes to population metrics. For example, if annual total harvest consistently and significantly exceeds the objective, then growth rates may increase and maturity rates may decrease in response to elevated mortality. If harvest is driving this effect, then a noticeable decline in Yellow Perch ≥8.0 inches should also occur. Therefore, if annual harvest routinely exceeds the threshold and changes to population metrics similar to those described above are observed, then the weight of evidence approach should be used to determine if regulation modifications are appropriate. There was not an angler harvest objective for Yellow Perch in the 2011-2015 management plan.

Lower angler harvest in the mid-2000s corresponded with the declines in angler pressure at that time. Reductions in angler pressure and harvest in the mid-2000s was attributed to declines in Walleye and Yellow Perch abundance which corresponded with increases in cormorant abundance. Increases in angler pressure and harvest over the past five years, specifically in the winter, have resulted in unprecedented winter harvest of Yellow Perch. As a result, harvest and other population metrics (e.g. abundance, growth, and length at maturity, size structure) will be closely monitored during the life of this plan.

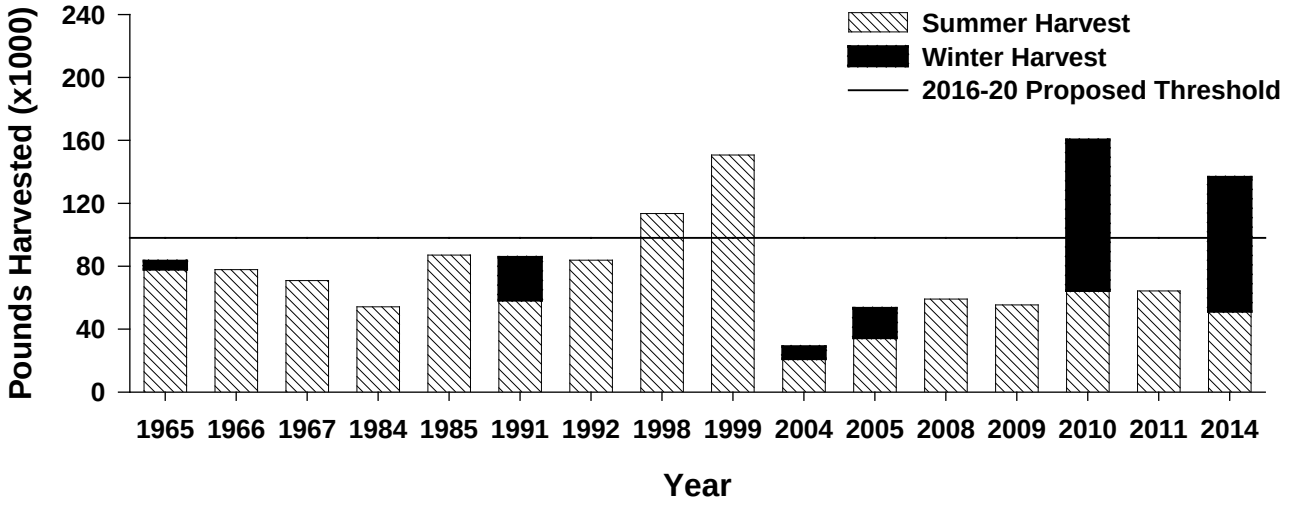

Figure 11. Total harvest (pounds x 1,000) of Yellow Perch by Leech Lake anglers throughout summer and winter seasons, 1965-2014. The horizontal line represents the harvest level below which angling quality is protected or enhanced (DNR 1997).

Maturity. *Female length at 50% maturity exceeds 5.5 inches.*

The length at which individuals become sexually mature is one of several metrics that can indicate overharvest or, more precisely, increased mortality. As mortality increases, populations respond by shifting more energy to reproduction than growth, resulting in maturation at shorter lengths. Changes in growth rate and recruitment patterns are two additional metrics that can indicate increased mortality.

Female length at 50% maturity refers to the length at which females have a 50% chance of being mature. That length was 6.2 inches in 2014. Therefore, individuals less than 6.2 inches had less than a 50% chance of being mature, while individuals greater than 6.2 inches had greater than a 50% chance of being mature. Prior to 2000, maturity observations were not recorded for Yellow Perch. Two distinct time periods exist within this time series, 2000-2005 and 2007-2014. From 2000-2005 when cormorant predation was excessive, female length at 50% maturity never exceeded 5.4 inches. Specifically, in 2002, 2004, and 2005, less than four immature individuals were sampled in gill nets, while no immature fish were sampled in 2006. However, from 2007 through 2014 the length at 50% maturity had an average of 6.3 inches (range 6.1-6.5), and greater than 65 immature individuals were annually sampled.

The differences in these metrics across the two respective time periods indicates the expected population responses by Yellow Perch to changes in mortality as cormorant abundance increased and was then reduced and maintained by control efforts (Schultz 2013). There was not a maturity objective for Yellow Perch in the 2011-2015 management plan.

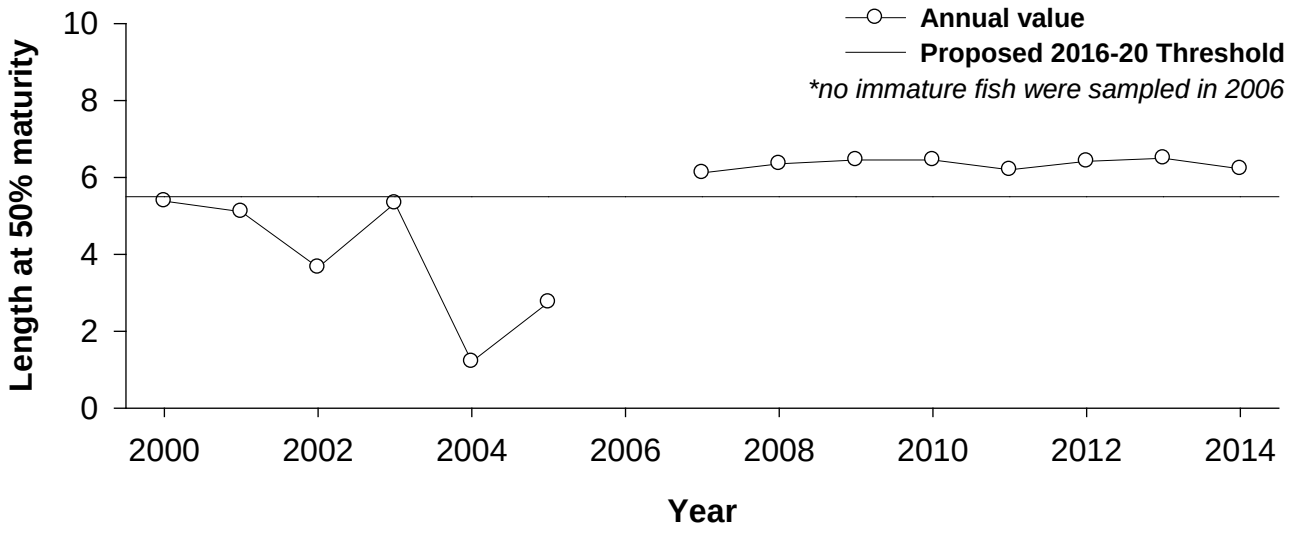

Figure 12. Total length of female Yellow Perch at 50% maturity in gill nets in Leech Lake, 2000-2014. The horizontal line represents the mortality threshold below which Yellow Perch matured at shorter lengths.

Northern Pike Goal:

Support a self-sustaining Northern Pike population that balances harvest opportunity with catch quality.

Northern Pike Objectives:

Abundance. *Maintain a gill net catch rate (3-year moving average) between 4.2 - 5.3 fish/net (25th and 75th percentiles).*

Maintaining a stable abundance of Northern Pike is important as they are the 2nd most harvested species (pounds) annually and comprise 5-10% of angling trips. Overall, gill net catch rates have varied little since 1983, ranging from 3.6 fish/net (1993) to 6.2 fish/net (1995) during 1983-2014. The objective range of 4.2 to 5.3 fish/net represents the 25th and 75th percentiles, respectively. The abundance objective under the 2011-2015 management plan was to maintain a gill net catch rate of 4.1 fish/net or higher, the 25th percentile for the 1983-2009 time series. Although catch rates exceeded the 25th percentile 9 of the past 10 years, having a threshold at the 25th percentile does not account for statewide concerns of increasing pike abundance. Therefore a range instead of a threshold is more appropriate. If gill net catch rates above the 75th percentile are sustained for consecutive years, then the weight of evidence approach should be used to determine if regulation modifications are appropriate. Growth and maturity rates, recruitment, and harvest statistics are additional metrics to monitor for determining the appropriateness of regulation changes.

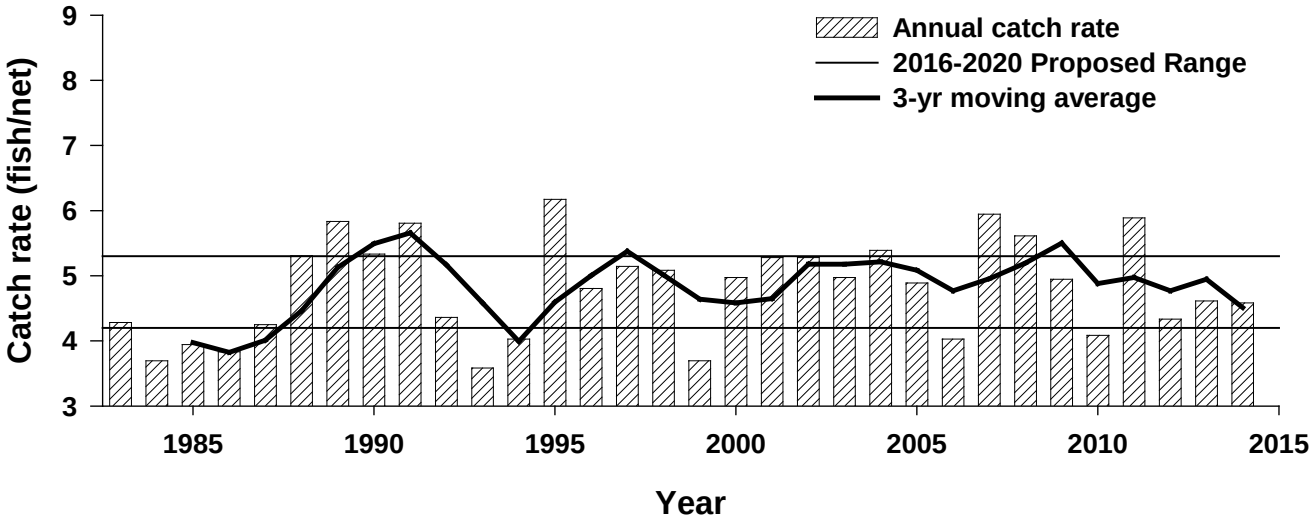

Figure 13. Gill net catch rates (fish/net) of Northern Pike in Leech Lake, 1983-2014. Horizontal lines represent the 25th and 75th percentiles. The darker line represents the 3-year moving average.

Size Structure. *The percentage of Northern Pike sampled in gill nets (3-year moving average) ≥22 inches should exceed 30% (25th percentile).*

Increases in the abundance of small Northern Pike can result in poor size structure, slow growth, increases in consumption of prey (Yellow Perch and Walleye), and lower harvest potential. Therefore, maintaining a balanced size structure of Northern Pike reduces the likelihood these conditions will occur and maintains the catch quality and harvest potential for anglers.

Anglers on Leech Lake begin harvesting Northern Pike at lengths of 22 inches. It is important to maintain a certain percentage of the Northern Pike population that is of a size anglers elect to harvest. The percentage of Northern Pike sampled in gill nets ≥22 inches has ranged from 22% (2001) to 62% (2007) during 1983-2014. The threshold of 30% represents the 25th percentile throughout the time series, and provides perspective on mid-size and larger individuals. The size structure objective under the 2011-2015 management plan stated the percentage of Northern Pike sampled in gill nets ≥21 inches (PSD-21) and ≥28 inches (RSD-28) exceed the 25th percentiles for the 1983-2009 time series, which were 43% and 5% respectively (Murphy and Willis 1996). Although the previous objectives did quantify length-frequency data and the portion of the population that was sexually mature and large enough for anglers to catch, the metric was overly complex.

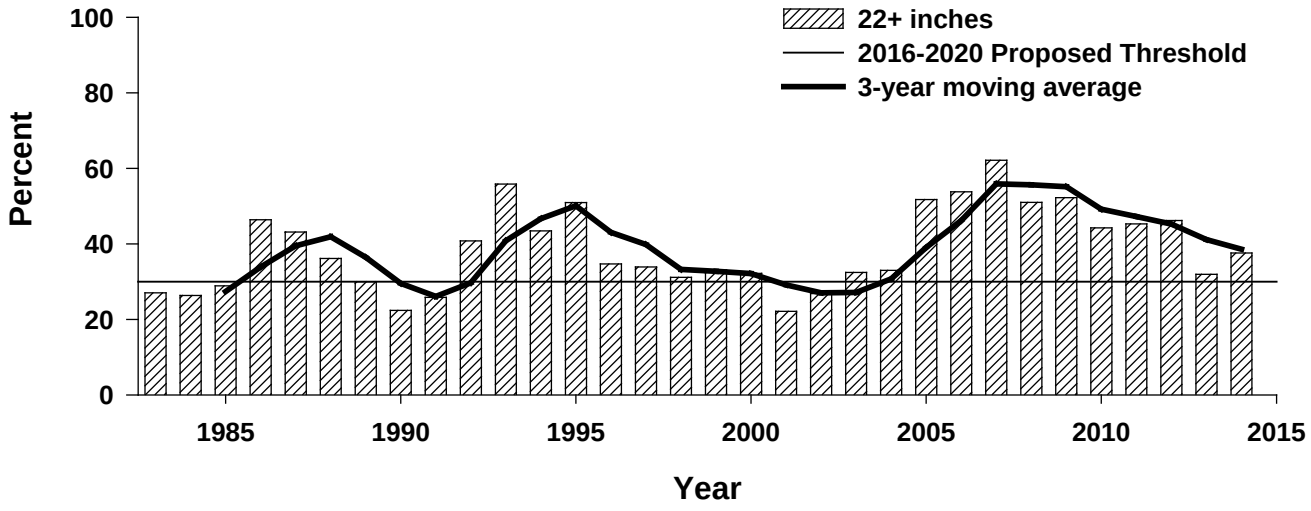

Figure 14. The percentage of Northern Pike in gill nets ≥22 inches in Leech Lake, 1983-2014. The horizontal line represents the 25th percentile. The darker line represents the 3-year moving average.

Recruitment. *Maintain gill net catch rate of age-3 Northern Pike (3-year moving average) between 1.0 - 1.6 fish/net (25th and 75th percentiles).*

Maintaining a stable number of juvenile Northern Pike recruiting to the fishery ensures there are both fish available for anglers and sexually mature individuals continually entering the spawning population. Most Northern Pike concerns center on the elevated abundances of small pike and this objective provides perspective on smaller sized individuals. Age-3 Northern Pike are a size (approximately 18-19 inches) at which all individuals in a year class are large enough to be sampled by gill nets, yet are smaller than most anglers elect to harvest. Therefore, age-3 gill net catch rates are a good index of recruitment.

Northern Pike gill net catch rates for age-3 individuals have ranged from 0.4 (1993) to 2.4 (2004) during 1990-2014. Northern Pike were aged with scales prior to 1990; consequently, the data set is limited to when cleithera have been used as the aging structure. The ranges of 1.0 and 1.6 refer to the 25th and 75th percentiles, respectively. Maintaining gill net catch rates between 1.0 and 1.6 fish/net indicates stable lakewide recruitment. There was not a recruitment objective for Northern Pike in the 2011-2015 management plan.

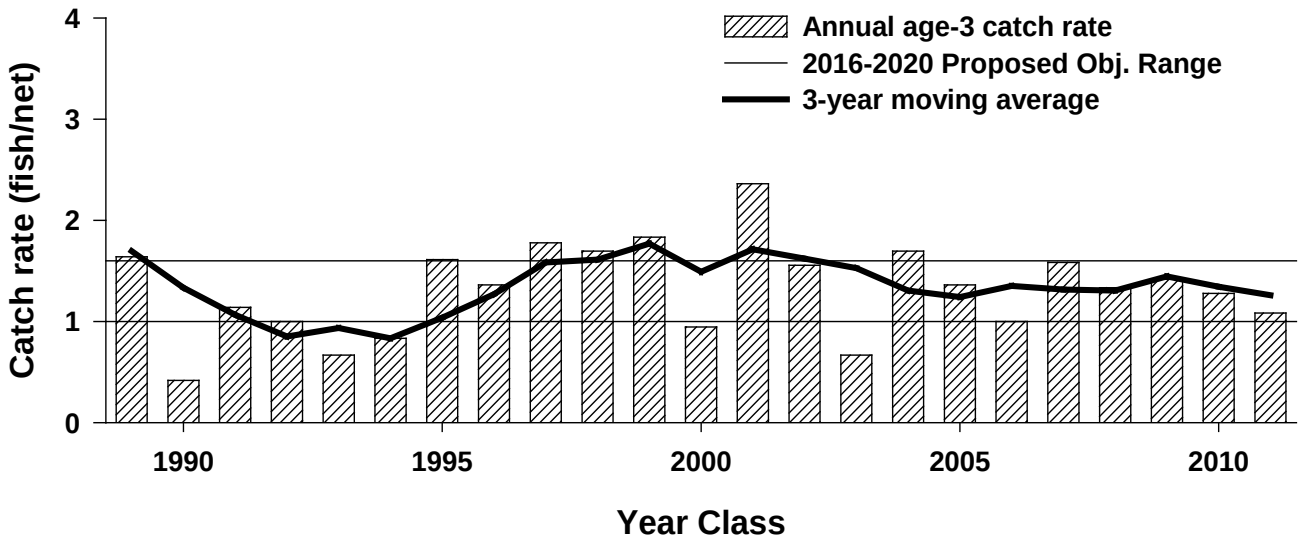

Figure 15. Gill net catch rates (fish/net) of age-3 Northern Pike by year class in Leech Lake, 1998-2011. Horizontal lines represent the 25th and 75th percentiles. The darker line represents the 3-year moving average.

Management Actions

Fisheries Assessments

Annual Large Lake surveys

Annual surveys will continue to include water quality and seining in mid-July, trawling in mid-August, electrofishing in mid-September, gill netting in mid-September, water temperature loggers (recording hourly year round), and monthly zooplankton sampling (mid-May through mid-October).

Creel surveys

Summer and winter creel surveys will be conducted two of every six years. The next scheduled creel surveys on Leech Lake are for the summer of 2016 and 2017, and the winters of 2015-2016 and 2016-2017. Angler satisfaction surveys will be incorporated into future creel surveys at the request of the Leech Lake Fisheries Input Group.

Fall Electrofishing for YOY Walleye

To date, a combination of trawl and gill net catch rates at age-0 have been used to predict year class strength. The estimated year class strength at age-1, age-2, and age-3 is determined based solely on gill net catch rates. Age-3 Walleye are considered fully recruited to the fishery. The multivariate (multiple years) method for predicting age-0 year class strength has greater precision over the trawl-only prediction model (Schultz 2007), 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 and new gears are assessed. Electrofishing in mid-September was initiated in 2007 and appears to be a more accurate predictor of age-0 Walleye year class strength. If this relationship holds up over the next several years, we will consider switching from trawling to electrofishing as the primary indicator of year-class strength.

Bluegill, Black Crappie, Largemouth Bass, and Smallmouth Bass Sampling

Continue to conduct lakewide bluegill, black crappie, largemouth bass, and smallmouth bass assessments every three years, and standardize sampling methodology, locations, and timing by 2018. Monitor for potential changes in size structure and catch rates. The next scheduled survey is in 2018.

Muskellunge Sampling

Insert Passive Integrated Transponder (PIT) tags in all Muskellunge adults sampled during spawn take operations in Miller's Bay and all fingerlings returned to Leech Lake under the traditional DNR put-back policy during spawn take years. Leech Lake is the source stock for the statewide Muskellunge propagation program and tagging adults and fingerlings facilitates the opportunity for:

1) Tracking individuals mated during spawn take operations
2) Point observations of length-at-age and growth rates for repeat captures
3) Known-age fish for eventual validation of anal fin rays as an ageing technique, or to better describe the limitations of this method

While marking adults and fingerlings is necessary to determine adult population estimates, the sample size will potentially be limiting to assess survival and recruitment of stocked fish and to estimate natural reproduction.

Cisco and Whitefish Sampling

Coordinate with the Leech Lake Band of Ojibwe, Division of Resource Management to collect additional Cisco and Lake Whitefish data from the commercial fishery.

Burbot Sampling

Annually collect data from a subsample of Burbot registered at the Leech Lake Eelpout Festival. Burbot are a cold-water sensitive species that are poorly understood. Interest in Burbot has increased in recent years with numerous anglers inquiring why this species is not a sportfish. The collection of biological information to better understand population characteristics and dynamics is necessary.

Stocking & related activities

Walleye Fry Stocking

The DNR recognizes stocking is a valuable management tool when used to meet specific management objectives. In general, stocking has not been necessary for maintenance of Walleye populations in Minnesota's large natural Walleye lakes. However, a policy of returning a percentage of fry back to the source waters where spawn take operations are conducted exists.

Stocking OTC-marked Walleye fry (i.e. oxytetracycline-marked) was one of four tools used to increase Walleye abundance in Leech Lake following a decline in the fishery during the early to mid-2000s. Annual fry stocking densities during 2005-2014 ranged from 7.5 to 22.5 million fry. The use of variable densities of marked fry facilitated a thorough evaluation of total fry density effects on first-year growth and eventual recruitment to the fishery (Appendix 2, Figures 1-4).

These analyses have determined that:

- higher fry stocking rates have not resulted in more Walleye surviving to catchable sizes.
- higher fry stocking rates have resulted in slower growth rates for young-of-the-year Walleye.
- slower growth rates of young-of-the-year Walleye result in fewer Walleye surviving to catchable sizes.
- higher Walleye fry densities have increased predation on young-of-the-year Yellow Perch, resulting in lower abundances of Yellow Perch surviving to age-4.
- as Yellow Perch are the primary prey of Walleye, lower Yellow Perch abundances have resulted in below average adult Walleye condition (plumpness) and growth rates (see Walleye Condition objective).

Although annual stocking of Walleye fry is not necessary at this time on Leech Lake, it is important to outline circumstances when it would be an appropriate and/or an informative management action. Most recruitment concerns center on consecutive years where the year class strength index (i.e. the relative abundance of Walleye produced in an individual year) is below the 25th percentile. The 25th percentile is a threshold below which year class strength is defined as poor, and the most recent occurrence of this was during the early 2000s when cormorant predation was later determined to be excessive (Schultz et al. 2013). Cormorant control, Walleye stocking, and restrictive Walleye harvest regulations were all simultaneously implemented in 2005 to improve the Walleye population. Research indicates the current level of cormorant control is appropriate, and the stocking evaluation indicates wild fry production is sufficient to sustain a robust Walleye population. Discontinuation of walleye stocking as an annual management action in 2015 was based on strong empirical evidence indicating negative impacts of supplemental fry stocking. Thus, this management plan is testing the validity of the current cormorant control target in the absence of walleye fry stocking. Close monitoring of Walleye recruitment in the absence of fry stocking is the next step in fully evaluating cormorant impacts on the fishery.

This plan includes two scenarios when Walleye fry will be stocked. The first is directly related to the Walleye Recruitment objective (see figure on page 15). The action states that if the 3-year moving average (of year class strength index values) falls below the 25th percentile (for the 1983-2014 time series) 7.5 million Walleye fry will be stocked the following year. This stocking density has performed similarly to higher densities and minimizes the potential for negative effects on first-year Walleye growth, survival, and recruitment to the fishery as well as minimizing predation pressure on the Yellow Perch. Furthermore, failing to meet the recruitment objective one or more years would suggest revisions to the cormorant target may be warranted.

The second scenario when Walleye fry stocking action would be implemented would be for research purposes to expand on the range of total fry density observations (currently 237-908 fry/littoral acre) when yearly mature female density is below 1.25 pounds/acre or above 2.75 pounds per acre. The action states if the mature female density estimate observed in a single year is below 1.25 or above 2.75 pounds/acre, a low-density fry stocking will be considered the following year. A weight of evidence approach will be used to determine if implementing this action will pose low risk to Walleye or other sportfish populations, particularly Yellow Perch.

Any stocked Walleye fry will originate from the Boy River (Cass County) and will be marked with OTC prior to stocking. This genetic stocking strategy is based on recommendations from the University of Minnesota which determined that the Boy River strain is the most similar and appropriate strain to use in Leech Lake (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).

Muskellunge Spawn Take and Fingerling Stocking

Conduct Muskellunge spawn take operation every four years in Miller's Bay to maintain genetic diversity in brood stock lakes. To compensate for removing gametes during the Muskellunge spawn take operation, approximately 600 fingerlings will be returned to Leech Lake under the traditional DNR put-back policy on systems with spawn take operations. The next scheduled spawn take is in 2017.

Regulations

Walleye regulations

The existing Walleye regulation (20-26 inch protected slot limit, possession limit of 4, one over 26 inches allowed in possession) will be continued. If mature female biomass remains outside of the target range for several consecutive years, more liberal or restrictive regulations may be considered.

Whitefish and Cisco regulations

The existing bag limits (25 daily and 50 in possession) on Cisco (Tullibee) and Lake Whitefish within the Leech Lake Indian Reservation will be continued.

Potential Sunfish and Black Crappie regulations

The Leech Lake Fisheries Input Group requested DNR consider and evaluate bag limit reductions on panfish species to maintain the existing size quality of the populations.

Other species managed with statewide regulations

If changes to statewide regulations occur, implement regulations consistent with statewide recommendations and evaluate angler and fish population responses through standardized creel and gill net surveys.

Habitat

Protection

Many of the proposed habitat management actions will require additional funding and/or staff, or rely heavily on partner agencies or non-governmental organizations (NGOs) and will only be possible when specific opportunities present themselves (Appendix C). 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 continue to cooperate and partner with NGOs 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, Minnesota Pollution Control Agency's WRAPS program (Watershed Restoration and Protection Strategy), and other habitat-oriented evaluations.

DNR will continue to thoroughly review project proposals requiring a permit within the context of short- and long-term environmental impact.

Nearshore Habitat Inventory
Explore options for performing an inventory of nearshore aquatic habitat in Leech Lake, including substrate, vegetation, fish species presence, and human use.

Aquatic Vegetation Inventory
Explore options for performing an inventory of lakewide aquatic vegetation stands to identify potential long-term trends in species composition, abundance, and distribution.

Muskellunge Spawning Habitat Assessment
Explore options for performing a telemetry study to identify additional Muskellunge spawning locations to guide future priorities for shoreland protection.

Aquatic Invasive Species (AIS) management & education
Coordinate with DNR Ecological and Water Resources staff and Cass County Environmental Services to assist with aquatic invasive species prevention, education, and management efforts by DNR Ecological and Water Resources Division and other agencies.

Other Considerations

Double-crested cormorant control & evaluation
The Leech Lake Band of Ojibwe, Division of Resource Management (DRM) has jurisdiction over the double-crested cormorant control policy on tribal lands and waters on Leech Lake. The DNR supports maintaining the population at 500 reproducing pairs which equates to a total fall population at or below 2,000 cormorants. The annual removal of most birds earlier in the year will continue to be supported as this reduces total fish predation and is included under the existing federal Public Resource Depredation Order. The DNR will continue to support DRM's efforts to secure funding sources and provide technical assistance for continued cormorant control and research evaluating cormorant impacts on Leech Lake sportfish populations as requested by DRM.

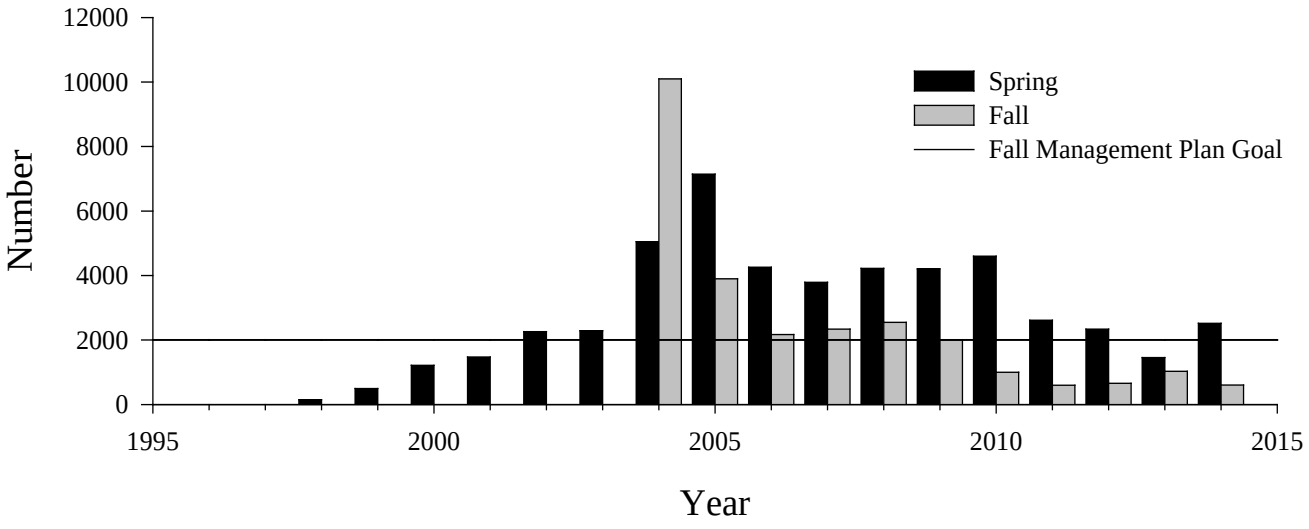

Figure 16. Spring and fall Double-Crested Cormorant numbers on Leech Lake, 1998-2014. The line depicts the current fall population goal of 2,000 birds ([500 nesting pairs x 2 adults] + 2 offspring/nest). (S. Mortensen, Division of Resource Management, Leech Lake Band of Ojibwe, personal communication).

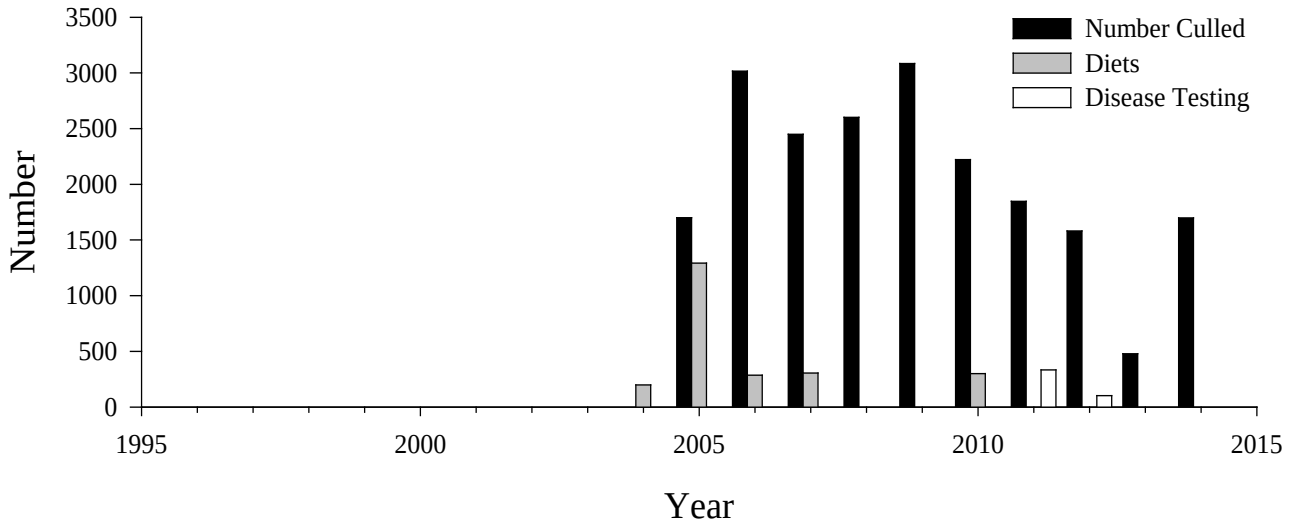

Figure 17. The number of Double-Crested Cormorants culled on Leech Lake, 2000-2014. The number of additional birds culled for diet and disease testing is also indicated. (S. Mortensen, Division of Resource Management, Leech Lake Band of Ojibwe, personal communication).

Climate effects on Walleye populations

Continue to evaluate climate effects on Walleye recruitment, specifically length and intensity of the growing season (i.e. growing degree days; GDD_{50}=GDD ≥50°F). Annual GDD_{50} values were calculated using water temperature data from loggers deployed in Leech Lake by the DNR. Growing season length and intensity have a strong influence on Walleye first-year growth and eventual recruitment (Appendix 2 Figures 5 and 6).

Muskellunge Tournament Data

Evaluate the potential for collecting additional data from participants during various Muskellunge tournaments. Options to consider include diaries, "creel forms", and others to monitor catch rates, size structure, etc.

Largemouth Bass Tournaments

The Leech Lake Fisheries Input Group requested DNR explore options for determining bass re-redistribution needs following tournaments if the number of tournaments increases to pre-2014 levels.

Annual stakeholder meetings

Annual update meetings with the LLFIG will occur in March. The purpose of these meetings during will be to share current data and information with the LLFIG 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 fish populations. Consequently, time is required for these populations to respond via metrics, such as recruitment, growth, and maturity rates, to 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 lessons learned can be applied to future decision-making processes.

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Appendix A.

A comparison of the 2005-2010, 2011-2015, and 2016-2020 Fisheries Management Plan objectives for Leech Lake.

	Management Plan		
Walleye	*2005 – 2010*	*2011 – 2015*	*2016 – 2020*
Female spawner abundance (pounds/acre)	1.25 – 1.75 (50^{th} - 80^{th} percentiles)	1.5 – 2.0 (60^{th} - 90^{th} percentiles)	3-year running average between 1.5 – 2.0 (50^{th} - 80^{th} percentiles)
Abundance (fish/gillnet)	≥7.4 (60^{th} percentile)	≥ 8.5 (75^{th} percentile)	3-year running average between 7-10 (40^{th} - 90^{th} percentiles)
Gillnet size distribution	50% < 15" (40^{th} percentile)	45 – 65% ≤ 15" (25^{th} - 75^{th} percentiles)	3-year running average between 10-20% ≥20" (50^{th} - 80^{th} percentiles)
Year class strength (recruitment)	Two strong year classes by 2009 ($\geq 75^{th}$ percentile)	Average or stronger year classes produced 2 out of 4 years (50^{th} percentile)	3-year running average >1.1 ($>25^{th}$ percentile)
Age 1 abundance	Age-1 trawl catch rate 45 fish/hour (50^{th} percentile)	None	None
Angler catch (fish/hour)	None	None	Targeting angler summer catch rate ≥0.30 (50^{th} percentile)
Angler harvest	None	Targeting angler summer harvest rate 0.25 (fish/hour) (90^{th} percentile)	Annual pounds harvested between 130,000 and 190,000 (50^{th} and 80^{th} percentiles)
Natural reproduction	None	Natural reproduction alone can maintain population	None
Condition	None	None	3-year running average between 82 and 86 (25^{th} and 75^{th} percentiles)
Yellow Perch			
Abundance (fish/net)	None	≥16.3 (25^{th} percentile)	3-year running average ≥16 (25^{th} percentile)
Gillnet size distribution	None	Proportion ≥8 inches (PSD-8) and ≥10 inches (RSD-10) (25^{th} percentiles)	3-year running average ≥8 inches exceeds 30% (25^{th} percentile)
Year class strength (fish/net; recruitment)	None	None	3-year running average age-4 perch ≥3.2 (25^{th} percentile)
Angler harvest	None	None	Harvest should be ≤98,000 pounds annually[1]
Maturity	None	None	Female length at 50% maturity >5.5"
Northern Pike			
Abundance (fish/net)	None	≥4.1 (25^{th} percentile)	3-year running average between 4.2 and 5.3 (25^{th} and 75^{th} percentiles)
Gillnet size distribution	None	Proportion ≥8 inches (PSD-21) and ≥10 inches (RSD-28) (25^{th} percentiles)	3-year running average ≥22 inches exceeds 30% (25^{th} percentile)
Year class strength (fish/net; recruitment)	None	None	3-year running average age-3 catch rate between 1.0 and 1.6 (25^{th} and 75^{th} percentiles)

[1]Threshold established in MNDNR 1997; Special Publication 151

Appendix B.

Relationships observed thorough the evaluation of total Walleye fry density effects on first-year growth and eventual recruitment to the fishery.

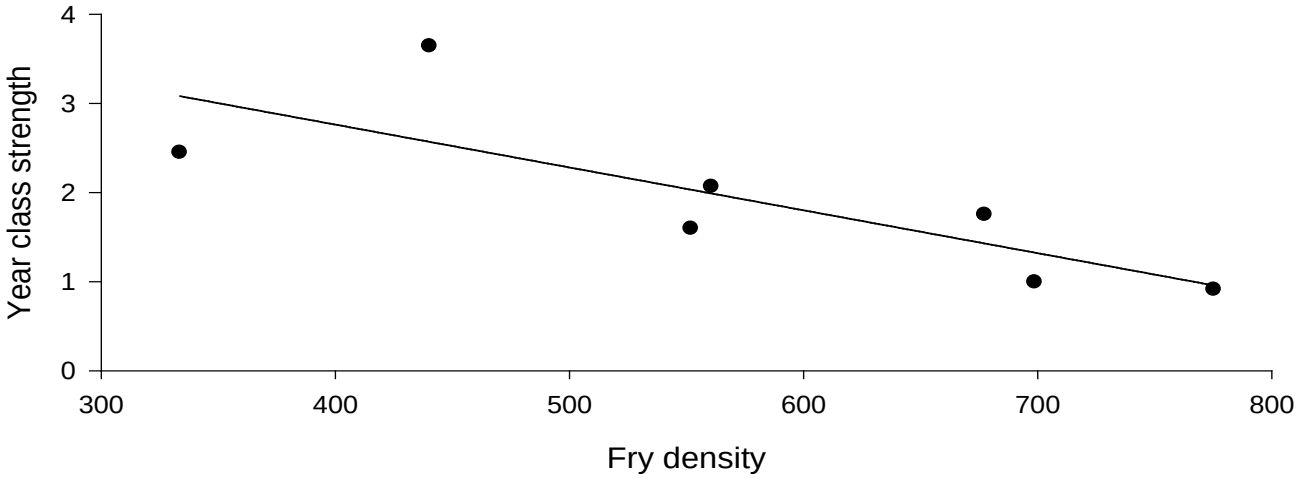

Figure B1. Estimated total Walleye fry density (fry/littoral acre, i.e. depths ≤15 feet) and the resulting strength of stocked year classes, 2005-2011. Year classes are considered fully recruited at age-3.

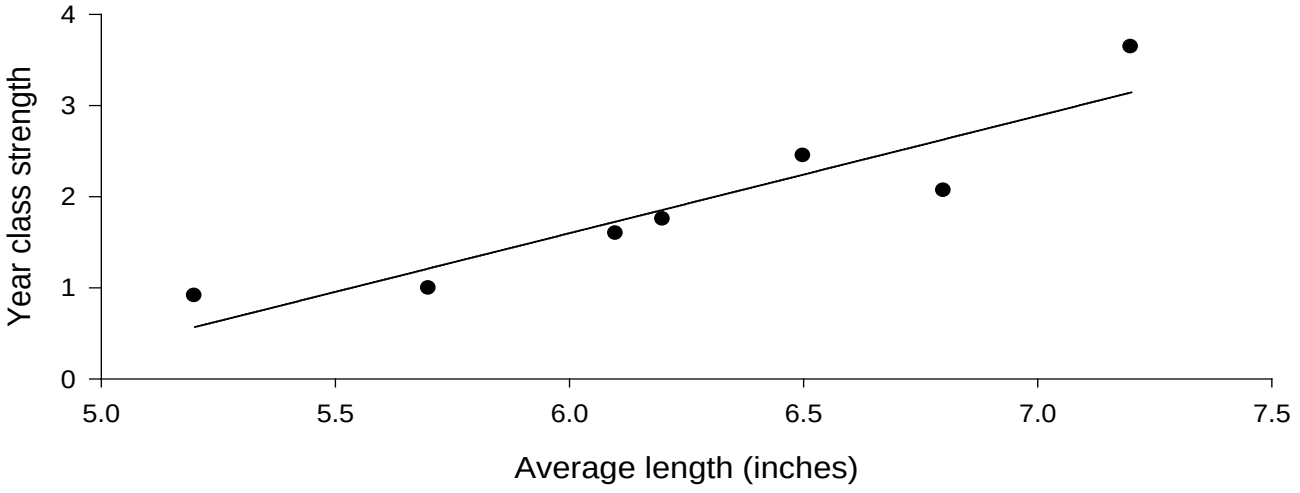

Figure B2. Estimated total Walleye fry density (fry/littoral acre, i.e. depths ≤15 feet) and the average length (inches) of young-of-the-year Walleye sampled by electrofishing in mid-September, 2005-2014.

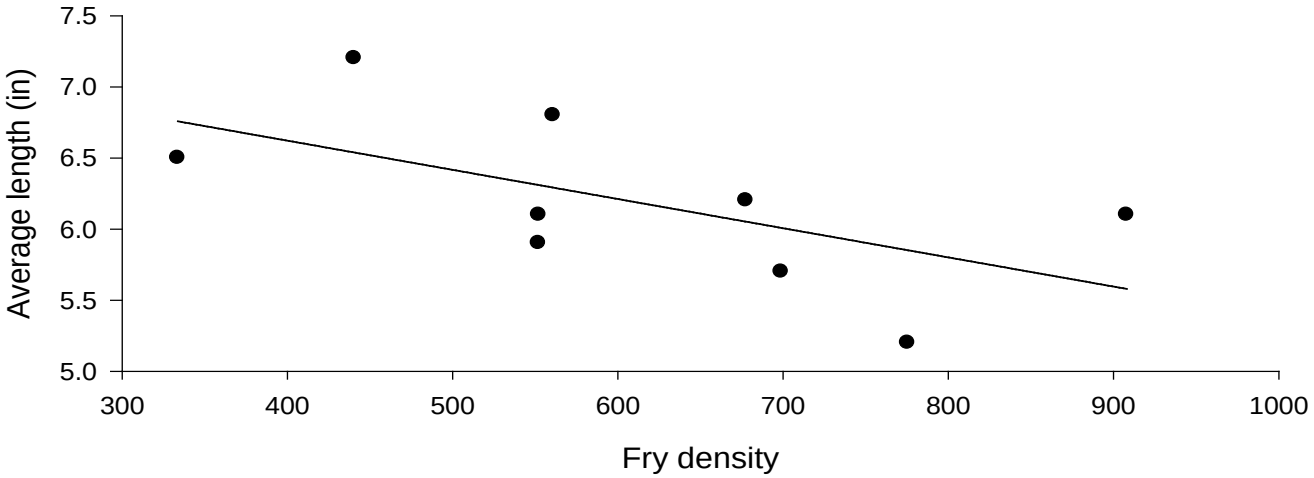

Figure B3. The average length (inches) of young-of-the-year Walleye sampled in mid-September and the resulting strength of stocked year classes, 2005-2011. Year classes are considered fully recruited at age-3.

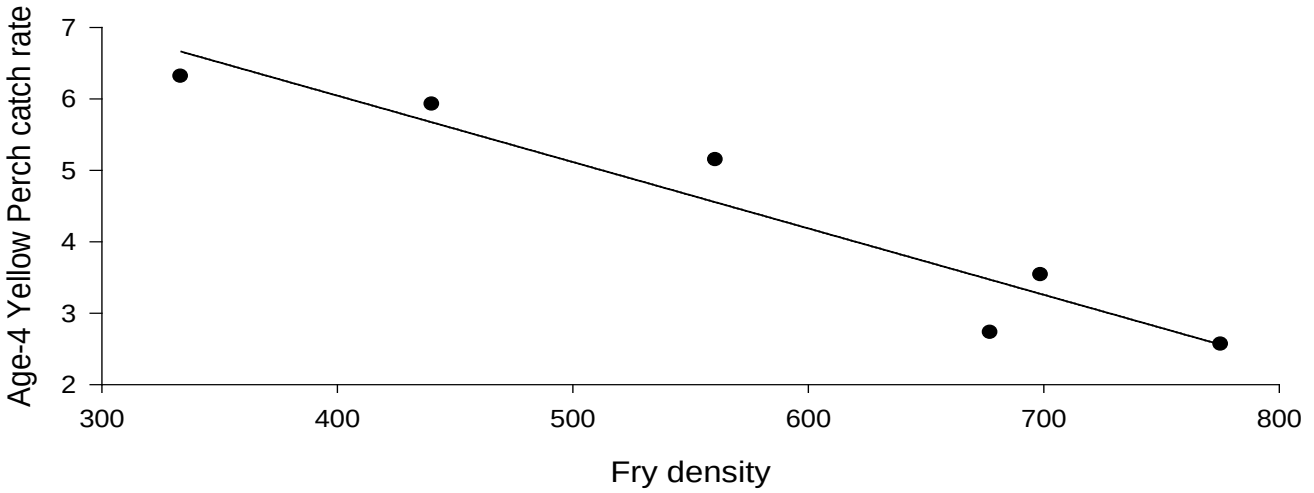

Figure B4. Estimated total Walleye fry density (fry/littoral acre, i.e. depths ≤15 feet) and the resulting strength of Yellow Perch year classes (age-4 gill net catch rate) produced the same year, 2005-2010.

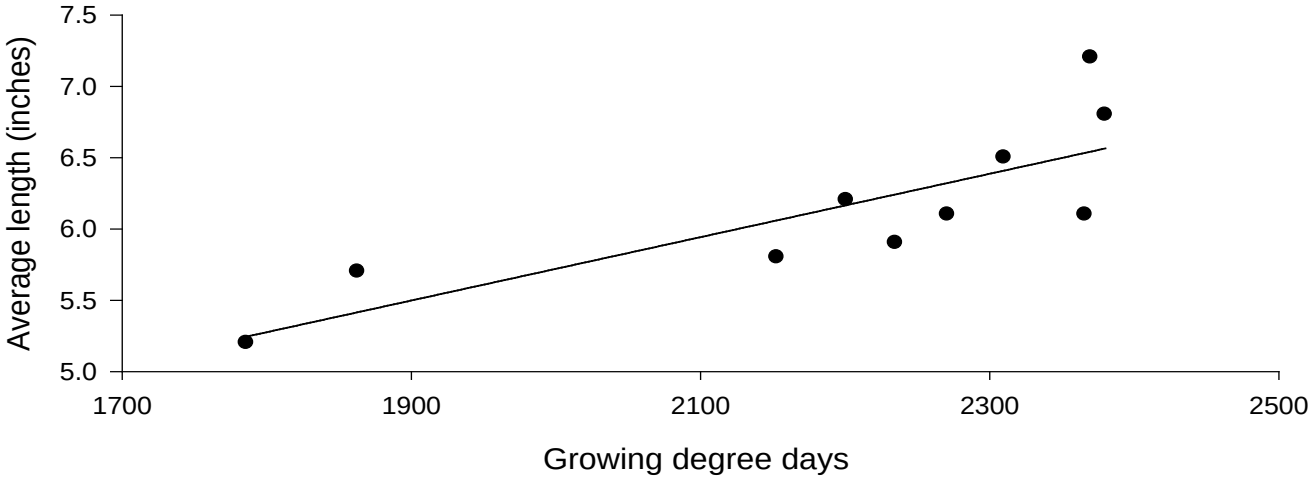

Figure B5. Growing degree days (GDD_{50}) and the average length (in) of young-of-year Walleye sampled by electrofishing in mid-September, 2005-2014.

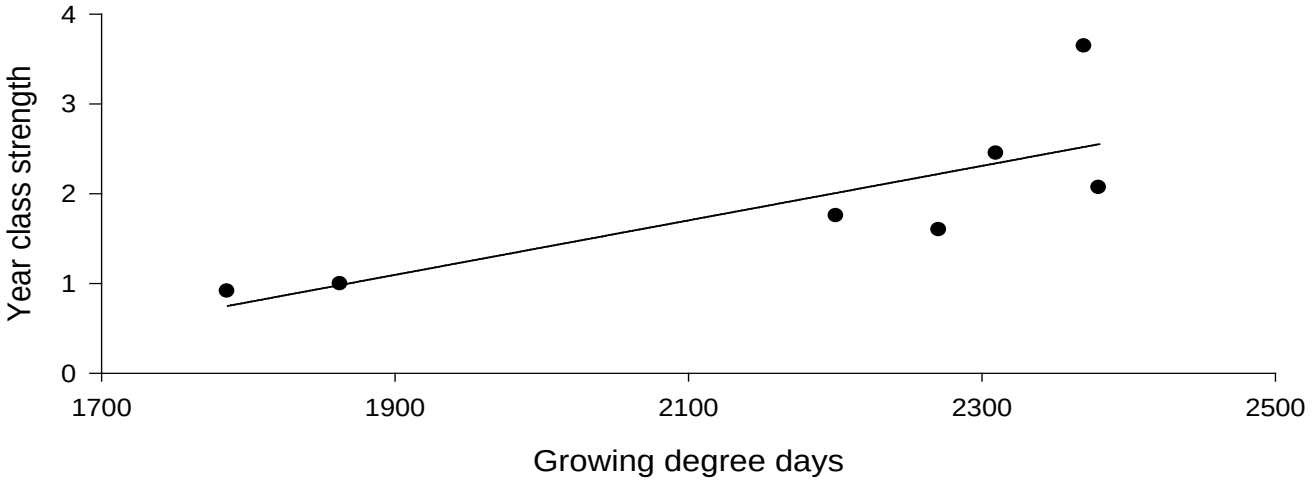

Figure B6. Growing degree days (GDD_{50}) experienced by young Walleye during their first growing season and the resulting strength of stocked year classes, 2005-2011.

Appendix C.

Habitat and aquatic invasive species initiatives outlined by the LLFIG to pursue throughout the life of the 2016-2020 fisheries management plan. 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.

Habitat Related Recommendations		Lead Agency/Partners	Relative Priority (1 = high, 2 = moderate, 3 = low)	Funding
1	Inventory nearshore aquatic habitat	FAW[1], partners	2	External funding
2	Lakewide inventory of aquatic vegetation	FAW, partners	2	External funding
3	Inventory and evaluate spawning areas	FAW, partners	2	External funding
4	Continue Environmental Review	FAW, EWR[2], COE[3], ESDCC[4]	1	Agency base funding
5	Protect vegetation beds including wild rice	EWR, ESDCC	1	Agency base funding
6	Enforce shoreland rules, vegetation removal, and invasive species	DOE, EWR, ESDCC	1	Agency base funding
7	Acquire important shoreland	FAW, LLAWF[6], LLA[7], partners	1	External funding
8	Continue shoreland development rulemaking	EWR, ESDCC	1	Agency base funding
9	Continue invasive species prevention and treatment	EWR, ESDCC, partners	1	Agency base funding
10	Continue tournament watercraft inspections, enforcemnt and education	EWR, ESDCC, partners	1	Agency base funding
11	Continue invasive species and vegetation management education and outreach for guides, resorts, law enforcement and industries	EWR, ESDCC, partners	1	Agency base funding

FAW[1] DNR Division of Fish and Wildlife

EWR[2] DNR Division of Ecological and Water Resources

COE[3] Army Corps of Engeneers

ESDCC[4] Environmental Services Division, Cass County

DOE[5] DNR Division of Enforcement

LLAWF[6] Leech Lake Area Watershed Foundation

LLA[7] Leech Lake Association