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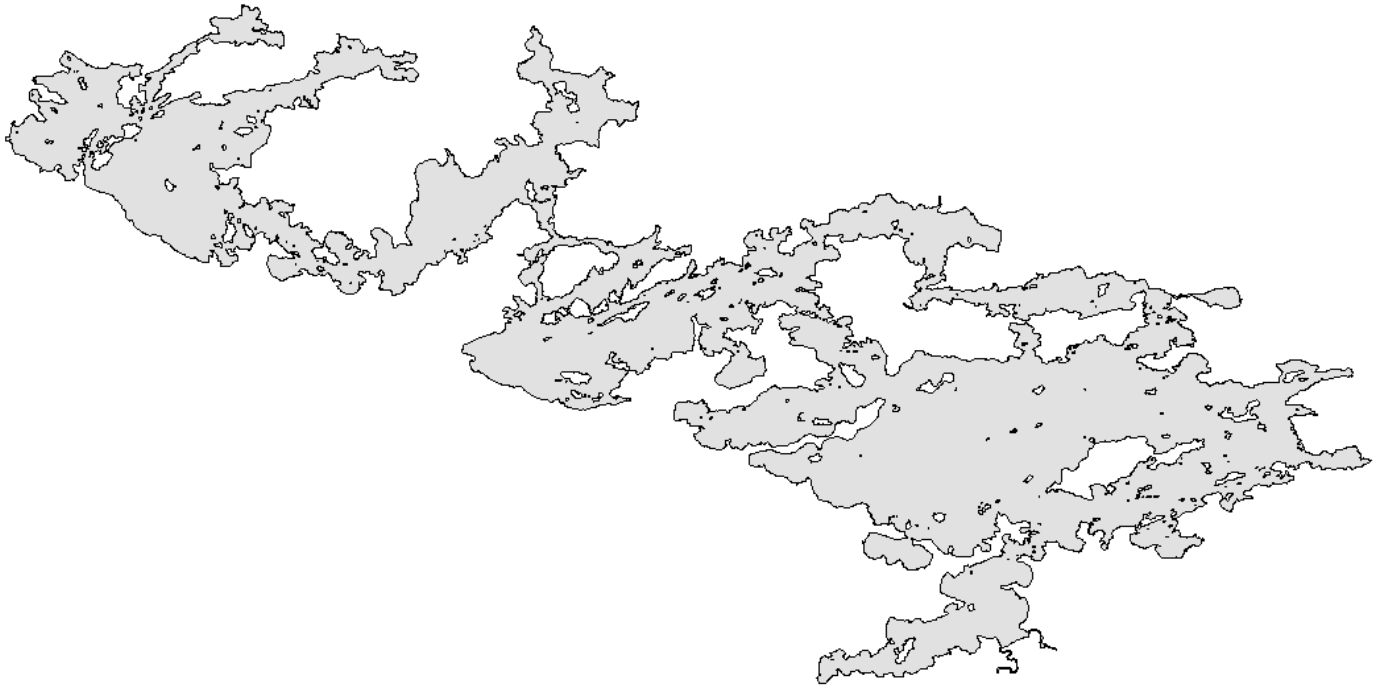
DEPARTMENT OF NATURAL RESOURCES

Lake Vermilion Fisheries Management Plan 2017-2022



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Executive Summary

Purpose

Develop a plan to guide fisheries management on Lake Vermilion for a six year period from 2017-2022, with the understanding that adaptive management strategies could occur outside the scope of this plan.

Background and Current Status

The last fisheries management plan for Lake Vermilion was developed in 2007 by Minnesota Department of Natural Resources (DNR) Fisheries staff with minimal input from stakeholders (Williams 2007). This plan defined goals and actions for managing specific fish species of primary management concern present within the fish community. Lake Vermilion is an important statewide resource and there has been increasing public interest in management issues in recent years. A more structured management planning process that included formal citizen participation and facilitated planning meetings was initiated to engage stakeholders in the development of this plan.

The DNR worked with a group of 20 stakeholders, which comprise the Lake Vermilion Fisheries Input Group (LVFIG) to provide input for the development of the 2017-2022 Lake Vermilion Fisheries Management Plan. This group provided diverse local and statewide perspectives and made recommendations on Lake Vermilion fisheries management. We will continue to work with the Input Group and other interested stakeholders through the duration of the plan. This will include holding annual update meetings to review the previous year's information, assess the status of the fishery with respect to the goals and objectives defined in the management plan, and provide opportunities to discuss any emerging issues.

The updated Lake Vermilion Fisheries Management Plan is designed to build on existing knowledge while preserving a sustainable, species-diverse fishery. The current plan is more detailed than previous management plans and will be updated on a more regular time frame. The plan will expire in 2022, however deviations from the plan may be necessary and appropriate under certain conditions. Potential deviations from this plan will be discussed with the LVFIG before implementation. The management plan not only addresses fish populations, but also other topics of lakewide interest including habitat, double-crested cormorants, fishing tournaments, and aquatic invasive species.

New to the 2017-2022 Lake Vermilion Fisheries Management is an increase in the use of defined fisheries goals, objectives, and management activities for individual fish species. Goals are defined as broad qualitative statements encompassing what the management plan hopes to achieve. Objectives are specific quantitative statements that contribute to achieving the goals. Finally, management activities are specific actions designed to monitor, support, regulate, and maintain the Lake Vermilion fishery. It is important to note that not all fish species will have defined goals and objectives and some management actions cover multiple species.

While taking into account historical trends, the objectives set forth in this plan are based on the most recent 20 years (1996-2015) of fisheries data available. This time period was selected as the baseline for several reasons. First, it reflects ten years of data collection before and after the implementation of the special walleye regulation in 2006. Secondly, it represents a period of generally higher walleye abundance than observed in the 1984 to 1995 surveys. Third, in the face of changing climate, technology, and other issues, the previous 20 years is more representative of contemporary conditions than historic observations.

Additionally, new to this plan is the use of percentiles and 3-year moving averages to define most objectives. For example, the 25th percentile means 25% of observed data points fall below a certain value and 75% of data points are above that value. A 3-year moving average, the average of the current year plus the previous 2 years, is used to minimize year to year variability. Most objectives in this plan use the 3-year moving average of annually collected data for the point of comparison. Conversely, objectives set based on creel survey data use a mean of the results from the two consecutive years of creel surveys that have previously occurred during six year periods. Any other variations from this will be noted.

One unique feature of Lake Vermilion is that it is comprised of two major basins, East Vermilion (area east of Oak Narrows) and West Vermilion (area west of Oak Narrows), and there are significant differences in habitat and the fish communities present in each basin (Johnson 1968). In addition to lakewide goals, objectives, and management actions, basin specific metrics are defined separately in some cases. Since walleye are the most sought after species by anglers on Lake Vermilion, management has focused primarily on that population via regulations, fry stocking, and assessments. The walleye population will continue to be a primary focus in this management plan. Additional fish species that have defined goals and associated management actions in this plan include black crappie, bluegill, largemouth bass, muskellunge, northern pike, smallmouth bass, and yellow perch. Additional fish species of management importance that are addressed include cisco (tullibee), lake whitefish, and white suckers.

Fish Population Goals and Objectives

Walleye Goal: Support a robust walleye fishery with sufficient spawning stock to meet reproductive needs and provide the opportunity for anglers to both harvest walleye and catch quality-sized fish.

Walleye Objectives:

1) *Abundance:* Maintain lakewide walleye gill-net catch of 14 fish/net (25th percentile) or greater.
    a. Maintain East Vermilion walleye gill-net catch rate of 16 fish/net (25th percentile) or greater.
    b. Maintain West Vermilion walleye gill-net catch rate of 10 fish/net (25th percentile) or greater.
2) *Reproductive potential:* Maintain mature female walleye biomass between 1.3 and 2.1 pounds/acre (25th-75th percentiles).

a. Maintain East Vermilion mature female walleye biomass between 1.1 and 1.8 pounds/acre (25^{th}-75^{th} percentile).
b. Maintain West Vermilion mature female walleye biomass between 1.6 and 2.5 pounds/acre (25^{th} -75^{th} percentile).

3) *Recruitment:* Maintain walleye year class strength index of 0.4 (25^{th} percentile) or greater.
    a. Maintain East Vermilion walleye year class strength index of 0.5 (25^{th} percentile) or greater.
    b. Maintain West Vermilion walleye year class strength index of 0.5 (25^{th} percentile) or greater.
4) *Harvest:* Maintain summer (May through September) boat angler walleye harvest near 65,000 pounds.
5) *Angler catch rate:* Maintain a targeting boat angler catch rate of 0.38 walleye/hour (25^{th} percentile) or greater based on the open water creel survey.
    a. Maintain a targeting boat angler open water catch rate on East Vermilion of 0.45 walleye/hour (25^{th} percentile) or greater.
    b. Maintain a targeting boat angler open water catch rate on West Vermilion of 0.16 walleye/hour (25^{th} percentile) or greater.

Yellow Perch Goal: Support a self-sustaining yellow perch population that provides a stable prey base for other sportfish.

Yellow Perch Objective:

1) *Abundance:* Maintain gill net catch rate of 19 fish/net (25^{th} percentile) or higher.

Muskellunge Goal: Support a muskellunge population that provides opportunity to catch trophy fish (50 inches or larger).

Northern Pike Goal: Support a self-sustaining northern pike population that provides opportunity for harvest.

Smallmouth Bass Goal: Support a self-sustaining smallmouth bass population.

Largemouth Bass Goal: Support a self-sustaining largemouth bass population.

Bluegill Goal: Maintain a sustainable harvest level of bluegill.

Black Crappie Goal: Maintain a sustainable harvest level of black crappie.

Aquatic Habitat and Water Quality Goal

Goal: Protect and improve aquatic habitat and water quality through education, permitting, monitoring, and relevant projects.

Management Activities

Fisheries Assessments, Monitoring, and Analysis

Annual Large Lake Assessments

- Shoreline seining targeting young-of-the-year gamefish and other non-game fish species
    - Weekly sampling throughout July at 14 standard stations (7 stations in East Vermilion; 7 stations in West Vermilion)
- Multispecies gill netting
    - Twenty standardized gill net sets (12 nets in East Vermilion; 8 nets in West Vermilion)
    - Two additional research net sets in Head of the Lakes Bay, West Vermilion
- Fall night electrofishing targeting young-of-the-year walleye
    - Nine standard stations (6 stations in East Vermilion; 3 stations in West Vermilion)
    - Research additional sites
    - Implement collecting age-1 walleye also

Periodic Targeted Surveys

- Spring ice-out trap net assessments
    - Targeting northern pike (1 of 6 years)
        - Conduct an ice-out trap net assessment targeting northern pike in 2017
    - Targeting muskellunge (2 of 6 years)
        - Likely 2019 and 2020
        - Assess feasibility of mark and recapture techniques to obtain adult population estimates
- Spring night electrofishing targeting largemouth bass and smallmouth bass (1 of 3 years)
    - Conduct smallmouth bass and largemouth bass spring electrofishing assessments once every three years at nine standard stations (6 stations in East Vermilion; 3 stations in West Vermilion)
    - Assess the use of otoliths in developing age and length keys for both species
- Summer trap-netting targeting bluegill and black crappie (1 of 3 years)
    - Conduct summer trap-netting once every three years to assess black crappie and bluegill populations
    - Evaluate sampling methodology and use of otoliths for aging

Creel Survey

- Open water creel survey
    - Conduct an open water (May fishing opener through September) creel survey one out of every four years beginning in 2021

Hatchery Operation and Stocking

Pike River Hatchery Operation

- Ensure walleye spawn take is sustainable while producing Pike River strain walleye fry for Lake Vermilion and statewide stocking needs based on individual lake management plans
- Operate hatchery annually, adjusting production targets as needed
- Monitor walleye run for size and sex-ratios
- Continue white sucker harvest in cooperation with the Vermilion Lake Association

Walleye Fry Stocking

- Stock Pike River strain walleye fry based on the lakewide 3-year moving average of mature female walleye biomass (i.e., spawning stock biomass [SSB]) estimated from the gill-net catch:
    - 15,000,000 fry if the average SSB is below 1.3 pounds/acre
    - 10,000,000 fry if the average SSB is 1.3 to 2.1 pounds/acre
    - 5,000,000 fry if the average SSB is above 2.1 pounds/acre
- Fry are distributed proportionally lakewide based on littoral area per basin
- Surplus fry produced at the Pike River Hatchery will be stocked in Vermilion only on a limited basis
- Continue to refine fry stocking levels and relate to SSB
- Continue to investigate relationship between SSB and year class strength

Muskellunge Fingerling Stocking

- Stock 3,000 Leech Lake strain muskie fingerlings annually as a base quota
- Stock up to 2,000 additional (surplus) Leech Lake strain fingerlings per 2-year period when available (8,000 fish maximum per 2-year period)
- Manage stocking priority as a "Premier" lake as defined by the DNR Muskellunge Technical Committee
- Implanting Passive Integrated Transponder (PIT) tags into fingerling muskellunge stocked into Lake Vermilion as funding and time permit
- Consider outside partnerships and funding opportunities to support muskellunge management including PIT tagging supplies, rearing pond operations, and surplus fingerling muskie stocking if the fish meet DNR standards and protocols

Regulations

Walleye

- Implement a walleye regulation change in May 2017
    - All walleye from 20-26 inches must be immediately released, only one over 26 inches allowed in possession
    - Keep the four walleye possession limit
- Review walleye population metrics annually in response to the regulation and evaluate angler harvest following the next creel survey

Northern pike

- Consider regulation change to match statewide northern pike zone regulations
    - Evaluate regulation following additional data collection and analysis of the northern pike population
    - Follow state rulemaking procedures

Habitat, Water Quality, Zooplankton, Aquatic Invasive Species, and Disease

- Continue annual water quality, water temperature, and zooplankton monitoring
    - Evaluate additional water quality and zooplankton sites
    - Maintain water temperature loggers and deploy additional loggers
- Explore shoreline habitat assessments and aquatic vegetation sampling following DNR protocols (Perleberg et al. 2016)
- Coordinate with DNR Ecological and Water Resources staff and other government and non-government organizations to assist with aquatic invasive species (AIS) monitoring, prevention, education, and management efforts
- Continue partnership with the Minnesota Pollution Control Agency in the Watershed Restoration and Protection Strategy (WRAPS) process
- Protect aquatic habitat through permitting and technical advice
- Continue to monitor fish populations for disease such as viral hemorrhagic septicemia (VHS) and contaminants

Other Fisheries Management Concerns

<u>Double-crested Cormorant Monitoring and Management</u>

- Monitor the double-crested cormorant (DCCO) nesting colony on Potato Island and search for the establishment of new nesting colonies annually in cooperation with DNR Ecological and Water Resources Non-Game staff
- Gather data to better understand DCCO population dynamics, evaluate impacts on sportfish communities, and develop a lake specific consumption and control model
- Work with State, Tribal, and Federal resource management staff to evaluate potential DCCO impacts on fish populations and methods for population control
- Pursue control measures when legally available and impacts to sportfish populations are demonstrated
- Follow guidance in the Management Plan for DCCO on Lake Vermilion as appropriate
    - Reevaluate the plan annually and modify if necessary following review by the Minnesota Cormorant Work Group

<u>Fishing Tournaments</u>

- Continue Lake Vermilion specific fishing tournament permit restrictions
    - No more than 100 boats or 200 entrants per tournament, except for the grandfathered-in City Auto Glass Walleye Classic tournament with a 125 boat, 250 entrant maximum
    - No wake zones (e.g., Everetts Bay Narrows) and staggered starts and weigh-ins
- No bass tournaments permitted from Memorial Day up to the 3rd Saturday in June
- Bass tournaments will be allowed in June from the 3rd Saturday to the end of the month with conditions:
    - Bag limit of 3 fish per angler or 6 fish per boat (with 2 anglers)

    - No more than 5 weigh-in bags shall be in the queue to minimize time bass are out of the water at weigh-in
    - Live release boats/pontoons will be used to transport bass for release
    - Released fish are redistributed to the east or west basins in proportion to where they were caught
- Prior to 2017, no bass tournaments were allowed from Memorial Day to June 20th, so the reduced blackout period will be a trial
    - If excessive mortality occurs, DNR will return to not permitting tournaments from Memorial Day to June 20th
- Tournament organizers will be strongly encouraged to work with the Vermilion Lake Association and the Northern St. Louis Soil and Water Conservation District for voluntary AIS prevention and inspection

<u>Potential Research and Projects</u>

- Winter creel survey to estimate fishing pressure, catch, and harvest
- Broader water quality monitoring
- Walleye research focused on movement, behavior, and understanding basin specific population dynamics
- Further investigate the impacts of walleye fry stocking on year-class strength via oxytetracycline (OTC) marking and recapture methods
    - Quantify wild fry production, determine the contribution of stocked fry to the total fry density, and determine optimum fry densities
- Sport gill netting creel survey to assess pressure, bycatch, and harvest
- Partner with agencies and organizations to address shoreland zoning issues
- Aquatic vegetation surveys and restoration

Note: Many of these initiatives will only be possible with additional resources including both funding and staff.

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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.

Plan Purpose

The purpose of the Lake Vermilion Fisheries Management Plan (LVFMP) is to guide fisheries management on Lake Vermilion for a six-year period from 2017-2022, supporting the DNR mission statement. It is written for use by both the DNR and citizens that are interested in fisheries management on Lake Vermilion. The plan is designed to guide effective and efficient use of staff and fiscal resources to protect and enhance the fishery resource while providing for its sustainable use. The goals, objectives, and activities identified in this plan will define and focus DNR work plans over the next six years. Although this plan contains clearly defined goals, objectives, and activities, it is intended to be flexible and recognizes that deviations to the plan could occur, based on changes to the fishery or other unforeseen circumstances. Citizen participation is a major component in the development of this plan and will continue to be critical throughout its life.

Background and Current Status

Lake and Watershed Characteristics

Lake Vermilion is a large, natural reservoir located in northeastern Minnesota near the cities of Tower and Cook. The lake is irregularly shaped and consists of two primary basins, East and West, which encompass numerous smaller basins, bays, and over 350 islands. It is within the Northern Lakes and Forests ecoregion (Anderson and Heiskary 2009). The total surface area is 39,272 acres and the maximum depth is 76 feet, although most of the lake is less than 40 feet deep. In general, the lake repeatedly stratifies and mixes throughout the summer and is ice-covered from December through April depending on climatic conditions. Lake Vermilion is located at the southwestern edge of the Canadian Shield and has geological characteristics typical of Shield lakes. Most of the shoreline and islands are steep and rocky with only a thin covering of soil. Nearshore substrate in the large basins is predominately ledge rock, boulder, and rubble. Many of the shallow bays have bog shorelines and silt substrate along with areas of sand and gravel. The lake has naturally occurring tannin-stained (tea colored) water derived from the decomposition of plant and animal matter especially due to peatlands in the watershed. Aquatic vegetation is relatively sparse throughout the main basins of the lake, due in part to the stained water, and is generally in nearshore areas and shallow bays where it can be abundant.

Lake Vermilion is located within the Vermilion River watershed of the Rainy River Basin which is a portion of the Hudson Bay drainage basin. The Vermilion River watershed covers approximately 660,187 acres with about 60% of the land being publicly owned and managed by state and federal entities. The Lake Vermilion watershed covers approximately 312,320 acres of the Vermilion River watershed (Anderson and Heiskary 2009). Major tributaries to Lake Vermilion include the Pike, East Two, and West Two Rivers. The lake elevation is somewhat controlled by a fixed head dam at the outlet to the Vermilion River. Land use in the Lake Vermilion watershed is primarily forest, open water, and wetlands. The northeastern part of the lake lies within the Superior National Forest and is adjacent to the Boundary Waters Canoe Area Wilderness.

The lake has long been known as a recreational and vacation area. Urban and developed land comprises between 1-2 % of the entire watershed; however, lakeshore development continues to increase around the lake (Anderson and Heiskary 2009). There were an estimated 2,330 residences, on the lake in 2000 including homes, cabins, resorts, and other properties with "fire numbers" and that number increased to 2,957 by 2008 (Anderson and Heiskary 2009). It is estimated that over 80% of Lake Vermilion shoreland is privately owned and 45% of that is developed. In general, most of the development occurs along the southern and western shorelines. Several small islands scattered throughout the lake are owned and managed by the federal government.

The Lake Vermilion-Soudan Underground Mine State Park is located along the southern shoreline in the far eastern part of the lake. The Vermilion sector of the Bois Forte Band of Chippewa Reservation is located on Lake Vermilion and all of the lake is within the 1854 Treaty Area.

Lake Vermilion has a diverse fish community consisting primarily of bluegill *Lepomis macrochirus*; cisco *Coregonus artedi*; smallmouth bass *Micropterus dolomieu*, walleye *Sander vitreus*, white sucker *Catostomus commersoni*, and yellow perch *Perca flavescens*. Other species of primary management importance that are present include but not limited to black crappie *Pomoxis nigromaculatus*, lake whitefish *Coregonus clupeaformis*, largemouth bass *Micropterus salmoides*, muskellunge *Esox masquinongy*, and northern pike *Esox lucius*. Additional species present include but are not limited to: black bullhead *Ameiurus melas*, blackchin shiner *Notropis heterodon*, blacknose shiner *Notropis heterolepis*, bluntnose minnow *Pimephales notatus*, brown bullhead *Ameiurus nebulosus*, burbot *Lota lota*, central mudminnow *Umbra limi*, common shiner *Luxilus cornutus*, fathead minnow *Pimephales promelas*, finescale dace *Chrosomus neogaeus*, golden shiner *Notemigonus crysoleucas*, green sunfish *Lepomis cyanellus*, hybrid sunfish, Iowa darter *Etheostoma exile*, johnny darter *Etheostoma nigrum*, logperch *Percina caprodes*, mimic shiner *Notropis volucellus*, mottled sculpin *Cottus bairdi*, northern redbelly dace *Chrosomus eos*, ninespine stickleback *Pungitus pungitus*, pumpkinseed *Lepomis gibbosus*, rock bass *Ambloplites rupestris*, spottail shiner *Notropis hudsonius*, tadpole madtom *Noturus gyrinus*, and trout-perch *Percopsis omiscomaycus*. Several invasive species are present in the lake including mystery snails, curly-leaf pondweed, heterosporosis, purple loosestrife, rusty crayfish, and spiny waterfleas.

Survey and Research History

Numerous fisheries surveys have been conducted and documented dating back to the 1940s. The first comprehensive survey of Lake Vermilion was done by the Minnesota Department of Conservation (precursor to DNR) during the period of 1940-1943 (Carlander and Hiner 1943). It noted that the lake was a popular resort location and known for its walleye fishing. The comprehensive limnological survey collected information on water quality, habitat, vegetation, and zooplankton, in addition to fish species composition, abundance, size, age, growth, and life history. A creel survey was also conducted to assess fishing effort and various catch and harvest metrics.

Following the initial assessment, various fisheries surveys and research studies were conducted on Lake Vermilion prior to 1984. These investigations were done primarily to evaluate and monitor the walleye population, and to a lesser extent other gamefish, often in response to complaints of poor fishing. Additionally, a greater understanding of food web dynamics and limnological parameters were gained. Gill nets represent the primary sampling gear for monitoring trends in abundance of key sport fish populations, particularly walleye, and assessments were conducted biennially from 1973-1983. Assessments of the bluegill and black crappie populations using trap nets and young-of-the-year fishes via beach seining were also conducted during the 1970s and early 1980s.

Since 1984, annual standardized assessments including gill netting, shoreline seining, and water quality sampling have occurred for Lake Vermilion following protocols defined for the Large Lake Monitoring Program (Wingate and Schupp 1984). Additional sampling and monitoring activities have been added to the standard methodology including trap-netting, electrofishing, water temperature, and zooplankton. Summer trap-net assessments targeting black crappie and bluegill have been done annually since 1987. Trap-net assessments targeting muskellunge were conducted over two springs for East and West Vermilion in 1993-1994, 1997-1998, 2001-2002, 2005-2006, and 2011-2012. Electrofishing surveys targeting smallmouth bass have been conducted during most years since 1989, and surveys targeting young-of-the-year walleye have been done annually since 1988. Additionally, water temperature data has been collected continuously using temperature loggers since 2009. Zooplankton sampling has been conducted by DNR staff annually since 2012 using vertical tows. Increased aquatic invasive species (AIS) monitoring has occurred including rusty crayfish counts during annual gill-net surveys, curly-leaf pondweed surveys, and analysis of zooplankton samples.

Several creel surveys have been conducted on Lake Vermilion to collect data on fishing pressure and harvest. Summer creel surveys (May fishing opener through September) have been done for two consecutive years for every six-year period dating back to 1984. Creel surveys were done in 1984-1985, 1990-1991, 1996-1997, 2002-2003, 2008-2009, and 2014-2015. In general, fishing pressure has increased since the early 1980s and is relatively high in comparison to other lakes in the Large Lake Program (Williams 2016). Walleye are by far the most targeted species by anglers and account for the majority of harvest in terms of both total numbers and pounds. In the 2014 and 2015 creel surveys, 64-70% of angler parties were targeting walleye. A winter creel survey was conducted during the winter of 1985-1986 which displayed relatively light pressure primarily occurring in East Vermilion (Williams et al. 1988). A creel survey of the lake whitefish

and cisco (tullibee) sport gill netting season was conducted in 1985 obtaining an estimated 3,099 net-days of pressure during the 27 day season (Mix and Heywood 1986). Harvest was estimated for cisco (<15,000 fish) and lake whitefish (<6,000 fish) and bycatch of gamefish was primarily northern pike (<2,000 fish).

Research into various aspects of Lake Vermilion has occurred over the years and has primarily been focused on the walleye population. The Pike River walleye spawning run in East Vermilion has been analyzed primarily because spawn take operations occurred from 1892-1946, and then again from 1971-present. Characteristics of the walleye spawning stock at Pike River were compared from the period 1926-1942 to the period 1972-1985 (Heywood and Mix 1987). They concluded there was no significant change in numbers, size, and sex ratio between the two time periods. Research into dispersion patterns and spawning behavior along with harvest characteristics was conducted on walleye captured and tagged at the Pike River spawning run in 1984 (Williams 1992). Results indicated walleye dispersed throughout the lake following spawning although most stayed in East Vermilion. Several of the tagged fish returned to the Pike River for spawning in subsequent years. Beginning in 2008, a research project was initiated to investigate the effects of walleye fry stocking on year-class strength in several lakes with walleye spawn-take operations, including Lake Vermilion (D. Logsdon, DNR, unpublished data). The goals of the project included quantifying wild fry production, determining the contribution of stocked fry to the total fry density, and determining optimum fry densities of both stocked and naturally produced fry to optimize growth and survival so as to maximize year-class strength in egg-source lakes.

The Minnesota Pollution Control Agency (MPCA) conducted comprehensive water quality assessments on Lake Vermilion in 2000 and 2008 to evaluate trophic status and nutrient-related trends (Anderson and Heiskary 2001; Anderson and Heiskary 2009). Overall, there were no significant trends observed between the two assessments indicating water quality was relatively stable. In general, water quality parameters fell within typical ranges observed for regional lakes and met Minnesota's Northern Lakes and Forest ecoregion lake nutrient standards. Phosphorus, chlorophyll-a, and Secchi disc measurements were on the upper range of values exhibited by reference lakes in this ecoregion and the measures indicated the lake was mesotrophic. Phosphorus is slightly lower and Secchi disc readings are higher in West Vermilion compared to East Vermilion. It was concluded that because of its moderate phosphorus and chlorophyll-a concentrations, the lake would be sensitive to a change in trophic status with increases in nutrient loading from watershed or in-lake sources. Sulfate concentrations in Lake Vermilion were relatively high compared to other lakes in the ecoregion and slightly exceeded the water quality standards.

Management History

Early management on Lake Vermilion was focused on the development of a fish hatchery at the Pike River falls just upstream from Lake Vermilion. A major walleye spawning run occurs where the Pike River enters the lake at Pike Bay. This run has been utilized as an egg source dating back to the 1890s. A walleye hatchery was operated at the site from about 1892 to 1946. Walleye eggs were not taken during the period from 1947 to 1971 until a new hatchery started operating in 1972 and has continued to operate since. Currently, the Pike River Hatchery takes

roughly 100 million walleye eggs and produces approximately 70 million fry each year depending on statewide objectives. The DNR compensated for the egg removal by stocking walleye fry annually into Lake Vermilion based on a long-standing DNR practice to stock "put-back" fry into lakes used as egg sources. The first documented stocking of walleye in Lake Vermilion was in 1910 and primarily walleye fry have been stocked annually at various rates since 1971.

A variety of other species have been stocked by fisheries managers in Lake Vermilion with these activities first being documented in 1908. The stocked species include black crappie, brown trout, cisco, lake trout, lake whitefish, largemouth bass, muskellunge, northern pike, smallmouth bass, sunfish, and white sucker. Only muskellunge, northern pike, and walleye have been stocked since the early 1970s. Northern pike were initially stocked as fry in 1909 and fry, fingerlings, yearlings, and adults were stocked periodically from 1943 to 2004.

Anecdotal reports and historic photographs from as early as the 1920s indicate muskellunge may have been present in Lake Vermilion, however the first record in fisheries assessments occurred only after 1987. The first documented muskellunge (muskie) stocking occurred in 1968 and there were several other minor stockings from 1969 to 1985, primarily with Shoepac Lake strain fish. An intensive muskie stocking program using Leech Lake strain fish began in 1987 and continues to the present. Leech Lake strain fingerlings were stocked annually from 1987 to 1994 and biennially from 1996 to 2006. From 2007 to 2015, muskie fingerlings and yearlings were stocked at various levels.

Smallmouth bass are not believed to be native to lakes in the Hudson Bay drainage (Eddy and Underhill 1974), but how and when smallmouth bass entered Vermilion is unknown. The earliest record of stocking smallmouth was in 1943 but there is anecdotal evidence that the arrival of trains and loggers brought undocumented stocking to many places.

Several small wetlands adjacent to Lake Vermilion were used as controlled northern pike spawning areas prior to 1988 in cooperation with the Vermilion Lake Association (VLA, formerly the Sportmen's Club of Lake Vermilion). A controlled northern pike spawning area was also operated from 1984 to 2009 at Sunset Creek as a cooperative project with the VLA. No population level effects were realized from these small scale projects and interest diminished, therefore the effort was discontinued.

White suckers have been trapped and removed at various sites around the lake dating back to 1968. Recently, white sucker removal has primarily been at the Pike River walleye trap used to collect fish during the spawning run since 1972. Suckers are still removed annually at the walleye trap as VLA members have continued to volunteer to sell these to the public as a fundraiser. These removal activities were once considered beneficial to sportfish populations but this assumption has been disproved particularly on a lake the size of Vermilion. White sucker can be an important prey species and their impact on walleye spawning success is likely negligible.

The Large Lake Monitoring Program was developed in 1983 to guide the systematic collection of data needed to track potential trends and changes over time in Minnesota's large lakes

(>25,000 acres) including Lake Vermilion (Wingate and Schupp 1984). Large Lake Specialists were assigned to fisheries management areas with large lakes present in order to direct the program at the area level. Fisheries and water quality assessments were to be done annually on all the large lakes. Most of the large lakes, including Lake Vermilion, were scheduled to have creel surveys done two consecutive years out of every six years.

A compendium of data from Minnesota's 10 largest walleye lakes was synthesized in 1997 to estimate potential fish yields and establish target harvest levels for key fish species using predictive models and lake-specific population data (MNDNR 1997). The potential yield and harvest target for walleye in Lake Vermilion was set at 76,000 pounds per year. Most of this was apportioned to a target of 65,000 pounds per year for walleye harvest during the open water boat season. This amount has been monitored by periodic creel surveys in two out of every six years since 1984 and harvest estimates have ranged between 40,000 and 90,000 pounds per year. The remaining 11,000 pounds of the target was estimated to be sufficient to cover unquantified harvest not captured by the creel survey (shore, night, fall, and ice fishing, etc.). Part of this unquantified harvest was based on a onetime winter creel survey in 1985-1986 (Williams et. al 1988) and anecdotal evidence. Also included in this "unquantified" amount is the harvest in the waters adjacent to the Bois Forte Band of Chippewa Lake Vermilion Reservation by Band members exercising their reservation rights under the 1854 Treaty Authority. In 2016, the Fond du Lac Band of Ojibwe declared 2,500 pounds of walleye harvest exercising their 1854 Treaty Rights, resulting in 1,700 pounds of walleye harvest. This harvest was not accounted for in the 1997 harvest target calculations and is not considered part of the "unquantified" amount. However, this recent additional harvest will likely not result in the total annual harvest exceeding 76,000 pounds. Because our harvest metrics have some uncertainty, especially in years when creel surveys are not being conducted, it should be noted that alternative metrics such as reduced spawning stock biomass, increased growth, and change in age or length at maturity can be used to determine if the fishery is over exploited.

Statewide fishing regulations have applied and currently apply to all species except for northern pike and walleye in Lake Vermilion. A special regulation for northern pike was implemented in 2003. The regulation adopted was a 24 to 36 inch protected slot limit with one fish over 36 inches allowed in the three fish possession limit. The regulation change was part of a state-wide initiative to improve the size structure of pike populations in a number of lakes.

A special walleye regulation was implemented in 2006 after creel surveys in 2002 and 2003 documented walleye harvest well above the harvest target and an increasing trend in fishing pressure. Additionally, there was interest among local stakeholder groups and anglers for a more restrictive walleye regulation. The initial regulation was a 17 to 26 inch protected slot limit with one fish allowed over 26 inches in a four fish possession limit. The primary goal of the regulation was to maintain walleye harvest at or below the harvest target and secondarily to increase female spawning stock biomass which would in turn increase size structure. The regulation achieved these goals. In 2012, stakeholder concerns regarding the number of harvestable sized walleye, especially in the western basin, lead the DNR to reconsider the regulation to allow more harvest. As a result, the regulation was modified to an 18 to 26 inch protected slot with one fish allowed over 26 inches in a four fish possession limit. The goal of the modified regulation was to provide additional harvest opportunity while still maintaining sustainable harvest levels and protecting adequate female spawning stock.

1854 Treaty Harvest

In 1854, the Chippewa of Lake Superior entered into a treaty with the United States whereby the Chippewa ceded to the United States ownership of their lands in northeastern Minnesota. By the treaty of September 30, 1854, 10 Statute 1109, the United States not only established permanent Reservations for the Chippewa signatories to the treaty, but also secured to them the right to hunt, fish, and gather in the territories ceded by the treaty. These treaty rights have been affirmed by the Supreme Court of the United States. Lake Vermilion is within the 1854 ceded territory. The 1854 Treaty established the Vermilion sector of the Bois Forte Band of Chippewa Reservation on land adjacent to Everetts and Pike Bays of Lake Vermilion. The Bois Forte Band has gillnetted for many years in waters adjacent to the reservation boundary. There is no requirement in the treaty for monitoring, recording, and reporting of subsistence fishing harvest by band members on these waters.

The Fond du Lac Band harvest by gill net and spear follows the 1854 Ceded Territory Conservation Code and the negotiated harvest plan agreement between the Fond du Lac Band and the State of Minnesota. Under the harvest plan, the Fond du Lac Band makes a declaration of harvest from specific waterbodies, issues permits with specific provisions to Band members, and monitors and records harvest information. This information is then shared with the DNR.

In 2016 and 2017, the Fond du Lac Band declared an annual harvest of 2,500 pounds from Lake Vermilion, alternating harvest between the east and west basins. Band harvest was well below the declaration in both years.

Fisheries Trends and Status

Walleye

Walleye abundance has generally remained high over the last twenty years compared to the 1980s and early 1990s when gill net catches averaged around 12 fish per net (Appendix B; Figure A). Management goals were met for the 2007 management plan as net catches from 2007 to 2015 averaged above the goal of 14.0 walleye per gill net (Williams 2007). In fact, catches in the four of the last five years were above average with the exception of 2014 when an unusually low gill-net catch was observed. Historically, gill-net catches have been higher on East Vermilion indicating greater abundance in that basin.

Besides abundance, differences between walleye captured in East and West Vermilion are most evident in age and size structure. Overall, walleye in West Vermilion tend to grow faster and live longer than walleye in the east basin. For example, by age-5, walleye captured in East Vermilion average about 16 inches compared to 18 inches in West Vermilion. Walleye on Lake Vermilion can survive to age-8 or older, however older walleye (age-7+) tend to be more abundant in West Vermilion.

There have been significant changes in the size structure of the walleye population and density of mature female walleye (spawning stock biomass [SSB]). The protected slot limit has increased the portion of large walleye, mainly females, on the lake as a whole but the increases seem to be more pronounced in the west basin. Over the course of the protected slot regulation, this has resulted in a smaller portion of the population that is legal to harvest. Walleye size on the east end has also shifted but more slowly and there still has been a large proportion of harvestable sized fish.

Walleye year class strength is generally variable and driven primarily by climatic and ecological conditions. Both strong and weak year classes have been produced at various levels of SSB and stocking rates in Lake Vermilion. Generally strong and weak year classes have trended together in the east and west basins, but in recent years there have been some differences.

Maintaining harvest opportunity is extremely important as walleye are by far the most targeted and harvested species in Lake Vermilion. Walleye harvest had declined in the most recent creel surveys in 2008-09 and 2014-15, compared to the exceptionally high harvest levels in 2002-2003. This is largely due to the protected slot regulation that was implemented in 2006 and reduced fishing pressure in terms of angler hours. Lower abundance of harvestable-sized walleye particularly in West Vermilion also contributed to lower harvest in recent years. In contrast, the total walleye catch in numbers and pounds has generally been above average in creel surveys since 2007, except for 2015 when walleye catch was slightly below average.

Yellow Perch

Historically, yellow perch have the highest catch rates in our gill-net surveys. Abundance is extremely variable based on the gill-net catch data, but the overall trend has been stable. The two main basins of the lake tracked relatively closely until the late 2000s. Recently, yellow perch have been more abundant in West Vermilion than East Vermilion with unusually low catches observed from 2007-2012. It was suspected that predation from an expanding double-crested cormorant (DCCO) *Phalacrocorax auritus* colony located on the east end of the lake was likely one of the contributing factors to the low perch abundance observed. A DCCO control program began in 2013 and perch numbers initially increased, however after three consecutive years of control, perch had declined again to pre-control levels (see Double-crested Cormorant Evaluation and Control section for further details).

Historically, yellow perch harvest is relatively insignificant on Lake Vermilion with an average of about 3,000 pounds harvested annually. Most of this is likely incidental catch by anglers targeting walleye. Harvest primarily comes from East Vermilion where there tend to be more perch of preferred harvest size. The importance of yellow perch in the fish community is more as a prey item than a target for angler harvest.

Muskellunge (muskie)

Anecdotal reports and photographs from as early as the 1920s indicate muskellunge may have historically been present in Lake Vermilion, however the first record in fisheries assessments occurred in the late 1980s following stocking efforts. Lake Vermilion was selected as part of a statewide initiative to add muskie fishing opportunities and the lake met criteria for suitable characteristics, including spawning habitat. The muskie population was established with the goal of providing a low density, high quality fishery. Leech Lake strain muskie fingerlings were stocked annually from 1987 to 1994 to establish the population and this has been followed by less intensive stocking to supplement the natural reproduction that is assumed to be occurring (Appendix B; Table A). Ice-out trap net assessments have indicated a shift in the size structure over time and an increase in the abundance of fish over 50 inches. Creel surveys indicate that the total number of muskies caught by anglers has been relatively stable over the last 20 years. Additionally, catch rates for anglers targeting muskie increased in the 2014-15 creel compared to the rates observed in 2008-09.

Northern Pike

Northern pike abundance in Lake Vermilion has historically been quite low, with gill-net catches typically about 1 fish/net. Gill-net catches have declined slightly in recent years, although the low sample size per net makes trend analysis uncertain. Low catches are partly due to a focus on walleye sampling; northern pike tend to be more abundant in shallow, vegetated bays not sampled by our standard gill net sets. Gill-net catches are usually higher on West Vermilion, reflecting better habitat available in that basin.

Northern pike are an important gamefish for a portion of anglers. Angler harvest of northern pike has steadily declined since the first set of creel surveys were conducted in 1984 and 1985. In the 2014 and 2015 creels, northern pike harvest was about 5,000 pounds, well below the sustainable harvest level of 29,000 pounds (MNDNR 1997). Declining harvest may be related to several factors including a special regulation implemented in 2003 and increased catch and release fishing. Recent creel surveys suggest there may have also been a decline in northern pike abundance, as angler catch rates in 2014 and 2015 were the lowest ever observed on Lake Vermilion.

Smallmouth Bass

Sampling with electrofishing indicates smallmouth bass catches have increased since the gear was first used in 1989. Smallmouth bass electrofishing catches are usually higher on West Vermilion, while the average size of fish sampled is larger on East Vermilion. The estimated numbers caught by anglers in our creel surveys have increased over time as well, however harvest has been relatively stable over the last 25 years.

Largemouth Bass

Limited long-term data is available to review trends for the largemouth bass population as they are not generally captured in our standard surveys. The population is likely small and limited to specific areas of preferred habitat in the lake. However, creel data indicates the population may be expanding due to higher catches observed since 2003.

Bluegill

According to summer trap net data, bluegill abundance has remained relatively stable since 1989. Catches are significantly higher in West Vermilion, indicating better habitat for bluegill in that basin. Despite not being highly sought after by anglers, bluegill are generally the second most harvested species behind walleye in terms of the number of fish harvested. Over the last 25 years, bluegill harvest has declined, based on creel survey data.

Black Crappie

Summer trap net catches of black crappie indicate no observable trend in abundance. Catches tend to be slightly higher in West Vermilion. Black crappie are occasionally targeted by anglers and harvest tends to be low and relatively stable.

Other Species:

Additional species of management concern include cisco (tullibee), lake whitefish, and white sucker. Ciscoes are the third most common species by number in gill-net surveys and abundance has been variable but stable. Generally, higher catches are observed in West Vermilion. Information on the lake whitefish population is lacking. Current harvest data during the sport gill netting season is limited, but pressure seems to be fairly stable and sustainable based on anecdotal data. White

suckers have been trapped and removed at various sites around the lake dating back to 1968. However, gill-net catches indicate the population has been relatively stable. Higher catches are generally observed in East Vermilion and there has been a declining trend in West Vermilion catches.

Invasive Species

Invasive species in the context of this management plan are defined as not native to Minnesota and causing varying levels of economic and/or environmental harm. Several invasive species are present in Lake Vermilion including mystery snails *Cipangopaludina* spp., curly-leaf pondweed *Potamogeton crispus*, *Heterosporis sutherlandae*, purple loosestrife *Lythrum salicaria*, rusty crayfish *Orconectes rusticus*, and spiny waterflea *Bythotrephes longimanus*. Mystery snails were discovered in 2011 in Spring Bay at the far west end of the lake. They have since been reported in an adjacent bay, although that has not been confirmed. A small, but dense population of curly-leaf pondweed was first surveyed by DNR Ecological and Water Resources (EWR) Division staff in Everetts Bay in 2009. Since then, it has been found in low densities in Stuntz Bay.

Rusty crayfish are very abundant in East Vermilion and are now expanding further into West Vermilion. Aquatic vegetation has been greatly diminished in areas of the lake that have been colonized. Purple loosestrife has been found at several sites on the lake, usually in wetland areas adjacent to lake. *Heterosporis sutherlandae* is a microsporidian parasite that causes the fish disease heterosporis. Heterosporis has been identified in several walleye and yellow perch from Lake Vermilion, mostly from the west end of the lake.

Spiny waterfleas (SWF) are invasive zooplankton first discovered in Lake Vermilion in 2015. DNR staff received angler reports of SWF in July 2015 from the Big Bay area. Subsequently, samples were obtained from anglers. SWF were then verified by DNR EWR staff in the Big Bay area on July 15, 2015 and the lake was subsequently placed on the infested waters list. No SWF have been sampled in West Vermilion as of 2016. No significant trends in native zooplankton densities or biomass have been observed in Lake Vermilion following the discovery of SWF; however other large lakes with a longer history of its presence including Rainy Lake, Lake Kabetogama, and Lake of the Woods have seen significant declines (Staples et al. 2017).

Social Considerations

Lake Vermilion and its fishery have long been recognized as an important economic, recreational, and cultural asset. The DNR recognizes the economic importance of Lake Vermilion to the region. There are approximately 30 resorts, several boat marinas, multiple campgrounds, and numerous other businesses in the Lake Vermilion area that have a vested interest in the lake. A number of stakeholder groups advocate for issues concerning Lake Vermilion, including the Vermilion Lake Association, the Lake Vermilion Resort and Tourism Association, the Lake Vermilion Guides League, and the Lake Vermilion Fisheries Committee. Additionally, many lakeshore property owners and lake users are interested in issues that impact the lake, including fish management. Furthermore, the cities of Tower and Cook promote tourism in the area that is centered on Lake Vermilion.

Communication and cooperation between the DNR and stakeholders is critically important. Creating an adaptive management framework with stakeholder involvement increases interaction and understanding of biological goals. Adaptive management promotes flexible decision making that can be adjusted over time as circumstances change and outcomes are better understood.

The DNR engaged 20 stakeholders with diverse local, statewide, and tribal interests to comprise the Lake Vermilion Fisheries Input Group (LVFIG) which provided critical input into the development of the Lake Vermilion Fisheries Management Plan. The LVFIG contained representatives from organizations including: Vermilion Lake Association, Lake Vermilion Resort and Tourism Association, Lake Vermilion Guides League, Lake Vermilion Fisheries Committee, Bois Forte Band of Chippewa, Fond du Lac Band of Lake Superior Chippewa, and Statewide DNR Esocid (muskellunge and northern pike), Walleye, and Bass Workgroups. In addition, six at-large members were selected from a statewide application process and one academic representative from Vermilion Community College was chosen. The LVFIG provided input and recommendations on specific goals, objectives, and management activities aimed at preserving quality fisheries and aquatic habitat on Lake Vermilion. The DNR will hold annual meetings to update the LVFIG and other interested stakeholders with the most recent information and track the status of goals and objectives defined in the management plan. A weight of evidence approach will be used annually to assess if deviations from the management plan are appropriate.

Fish Population Goals and Objectives

Defined goals and objectives for fish populations of primary management concern were important in the development of the current management plan, as they will serve as the basis for evaluating results that can be applied to future decision-making processes. Goals are defined as broad qualitative statements describing what the management plan hopes to achieve for an individual fish species. Objectives are specific quantitative statements that contribute to achieving the goals. It is important to note that not all fish species will have defined numerical objectives even if the species is of high management priority. In most cases, this was due to a lack of data that is appropriate for tracking trends as a result of difficulties in sampling some species or because the methods used for sampling do not provide precise and accurate of certain population metrics. It was deemed important by the LVFIG to develop walleye specific objectives for both the East and West basins of Lake Vermilion in addition to lakewide objectives. East Vermilion is defined as the area east of Oak Narrows and West Vermilion is the area west of Oak Narrows. While taking into account historical trends, the objectives set forth in this plan are primarily based on the most recent 20 years (1996-2015) of fisheries data available. Additionally, new to this plan is the use of percentiles and 3-year moving averages to define most objectives. For example, the 25th percentile means 25% of data points fall below a certain value and 75% of data points are above that value. The 3-year moving average is the average of the current year plus the previous two years which is used to moderate year to year sampling variability.

Walleye

Goal

Support a robust walleye fishery with sufficient spawning stock to meet reproductive needs and provide the opportunity for anglers to both harvest walleye and catch quality-sized fish.

Objectives

Abundance

Maintain lakewide walleye gill-net catch rate (3-year moving average) ≥14 fish/net (25th percentile).

a) *Maintain East Vermilion walleye gill-net catch rate (3-year moving average) ≥16 fish/net (25th percentile).*
b) *Maintain West Vermilion walleye gill-net catch rate (3-year moving average) ≥10 fish/net (25th percentile).*

Walleye are by far the most sought after species by anglers in Lake Vermilion and maintaining a healthy and abundant population is extremely important. Standardized, annual gill-net surveys are the primary method used to sample the walleye population. Gill-net data is used to monitor the relative abundance of the population (Figure 1). Lakewide walleye gill-net catches were relatively stable from 1996 to 2015 ranging from 10.8 to 20.0 fish/net. The objective of at least 14 fish/net represents the 25th percentile for that time period. Gill-net catch rates ranged from 13.8 to 26.6 fish/net for East Vermilion and from 6.4 to 19.6 fish/net for West Vermilion during the same period. Maintaining gill-net catch rates at or above the 25th percentile is realistic given historical trends of a stable and abundant fishery.

Increasing catch rates to significantly higher levels is unrealistic due to limits on productivity of the fishery. Constraints include annual variability in the number of juvenile walleye surviving to catchable sizes (i.e., recruitment) and relaxation of the protected slot limit to allow for increased harvest opportunity (i.e., shift from 18-26 inch protected slot limit to 20-26 inch protected slot limit). Gill-net catch rates can be strongly influenced by recruitment variability (i.e., unusually strong or weak year classes), growth rates, and angler harvest. However, if the 3-year moving average falls below the 25th percentile, additional investigation will be done to determine what, if any, management action is necessary. At this time, there is no management reason to set an upper limit, but realistically we expect walleye abundance to stay around its current median of 16.3 fish/net over the last 20 years.

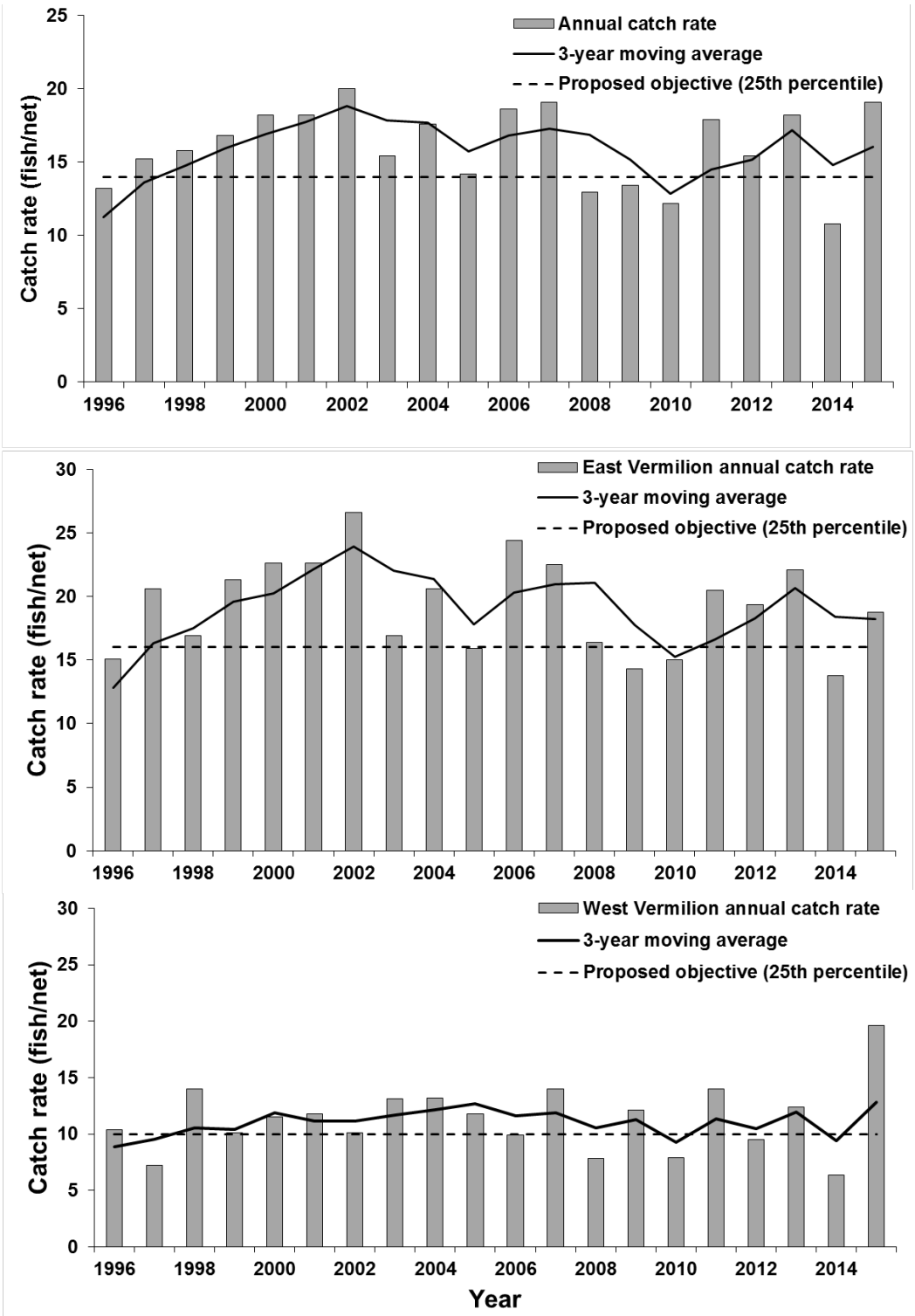

Figure 1. Gill-net catch rates (fish/net) of walleye in Lake Vermilion (top), East Vermilion (middle), West Vermilion (bottom), 1996-2015. Dashed horizontal lines represent the 25th percentile objectives. Solid lines represent the 3-year moving averages.

Reproductive Potential

Maintain mature female walleye biomass (i.e., spawning stock biomass; 3-year moving average) between 1.3 and 2.1 pounds/acre (25^{th}-75^{th} percentiles).

a) *Maintain East Vermilion mature female walleye biomass (3-year moving average) between 1.1 and 1.8 pounds/acre (25^{th}-75^{th} percentiles).*
b) *Maintain West Vermilion mature female walleye biomass (3-year moving average) between 1.6 and 2.5 pounds/acre (25^{th}-75^{th} percentiles).*

An important measure of a fisheries health is the abundance of mature fish that will produce future year classes that maintain the population. The density of mature female walleye is called the spawning stock biomass (SSB) and is expressed as pounds per surface acre. Estimates of SSB are made based on catches in annual gill-net surveys. Maintaining an adequate density of mature female fish results in long-term sustainability of a population even with natural recruitment variability. Year class strength can be quite variable from year to year due to many uncontrollable factors such as weather, growing conditions, prey availability, density-dependence, and predation.

Spawner density is influenced by the strength of the year classes reaching maturity, natural mortality, and angler harvest. Since initial estimates of SSB were made in 1988, density has ranged from 0.4-2.7 pounds/acre with a steadily increasing trend. From 1996-2015, SSB ranged from 0.8-2.7 pounds/acre (Figure 2). The objective range of 1.3-2.1 pounds/acre represents the 25^{th} and 75^{th} percentiles for that time period. Spawner density estimates range from 0.4-2.4 pounds/acre on East Vermilion and from 0.8-3.2 pounds/acre on West Vermilion during the same period. Our understanding of the dynamics between spawning stock densities, natural reproduction of fry, and ultimately recruitment is somewhat limited in part due to fry stocking activities that occur. Both strong and weak year classes have been produced at low and high levels of SSB. We do understand that the most recent 20 years of spawner density has resulted in generally adequate recruitment providing an abundant walleye population. Based on this, the middle range of spawning stock abundance was chosen as a reasonable management objective.

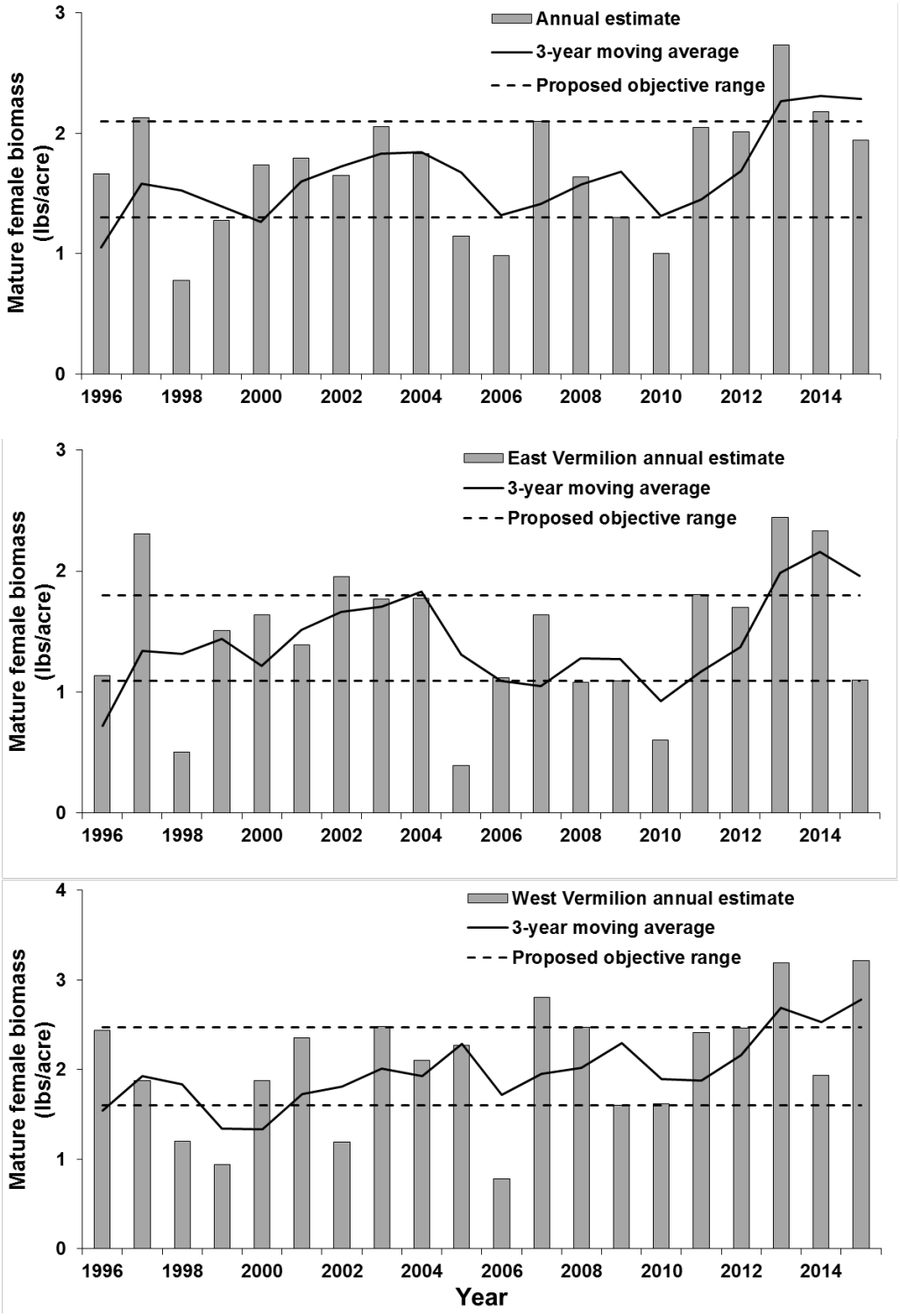

Figure 2. Estimated biomass (pounds/acre) of mature female walleye in Lake Vermilion (top), East Vermilion (middle), and West Vermilion (bottom), 1996-2015. Horizontal dashed lines represent the 25th and 75th percentile objective ranges. Solid lines represent the 3-year moving averages.

Walleye harvest regulations are an important tool for managing SSB. The 17-26 inch protected slot limit, initially implemented in 2006, has played a role in the increasing density of mature female walleye in the lake, and the increases seem to be more pronounced in the west basin. The adjustments made in 2012 to an 18-26 inch protected slot and in 2017 to 20-26 inch protected slot were primarily done to increase harvest opportunity with the understanding that SSB would likely be reduced over time. Future adjustments to the regulation will be considered if mature female biomass continues to exceed the objective range and other key population metrics (e.g., gill-net catch rates, growth, condition, and maturity) are outside of optimum ranges. Another factor that will be taken into account is fishing pressure and walleye harvest. The next summer creel survey will provide critical information for the regulation adjustment made in 2017. Future regulation adjustments should be used cautiously to avoid overreaction to short-term dynamics commonly observed in walleye populations, as rapidly changing regulations may negatively impact the population, fishery, and our overall understanding of specific regulation impacts.

Recruitment

Maintain walleye year class strength index (3-year moving average) ≥0.4 (25th percentile).

a) *Maintain East Vermilion walleye year class strength index (3-year moving average) ≥0.5 (25th percentile).*
b) *Maintain West Vermilion walleye year class strength index (3-year moving average) ≥0.5 (25th percentile).*

The number of fish hatched in a given year that survive to a defined size or age (e.g., catchable size, harvestable size, reproductive) is referred to as recruitment. Fish populations are primarily driven by variability in recruitment (i.e., the size or strength of a year class). Recruitment variability is driven by numerous factors including spawner abundance, spawning conditions, juvenile density, growing season conditions, predation, and prey abundance. Walleye fry stocking is another factor that plays a role in recruitment in Lake Vermilion. However, our understanding of the dynamics between spawning stock densities, natural reproduction of fry, fry stocking, and ultimately recruitment is somewhat limited. Maintaining relatively stable walleye recruitment is important in ensuring fish are available for angler harvest and sexually mature individuals reach the spawning population. However, weak and strong year classes invariably occur and drive the fishery.

A linear mixed model was developed to estimate year class strength based on gill net catches of age-1 to age-3 walleye (D. Staples, DNR, unpublished data). This model assigns an index to each year class indicating their relative strength to each other. Generally, a year class with an index below the 25th percentile is defined as weak. Recruitment concerns occur when weak year classes are produced in consecutive years. Values near zero indicate that few fish recruited from those years relative to historical recruitment levels. It should be noted that year class strength index values assigned to the two most recent year classes are not complete and have greater error associated with them because those cohorts have not been sampled for 3 consecutive years.

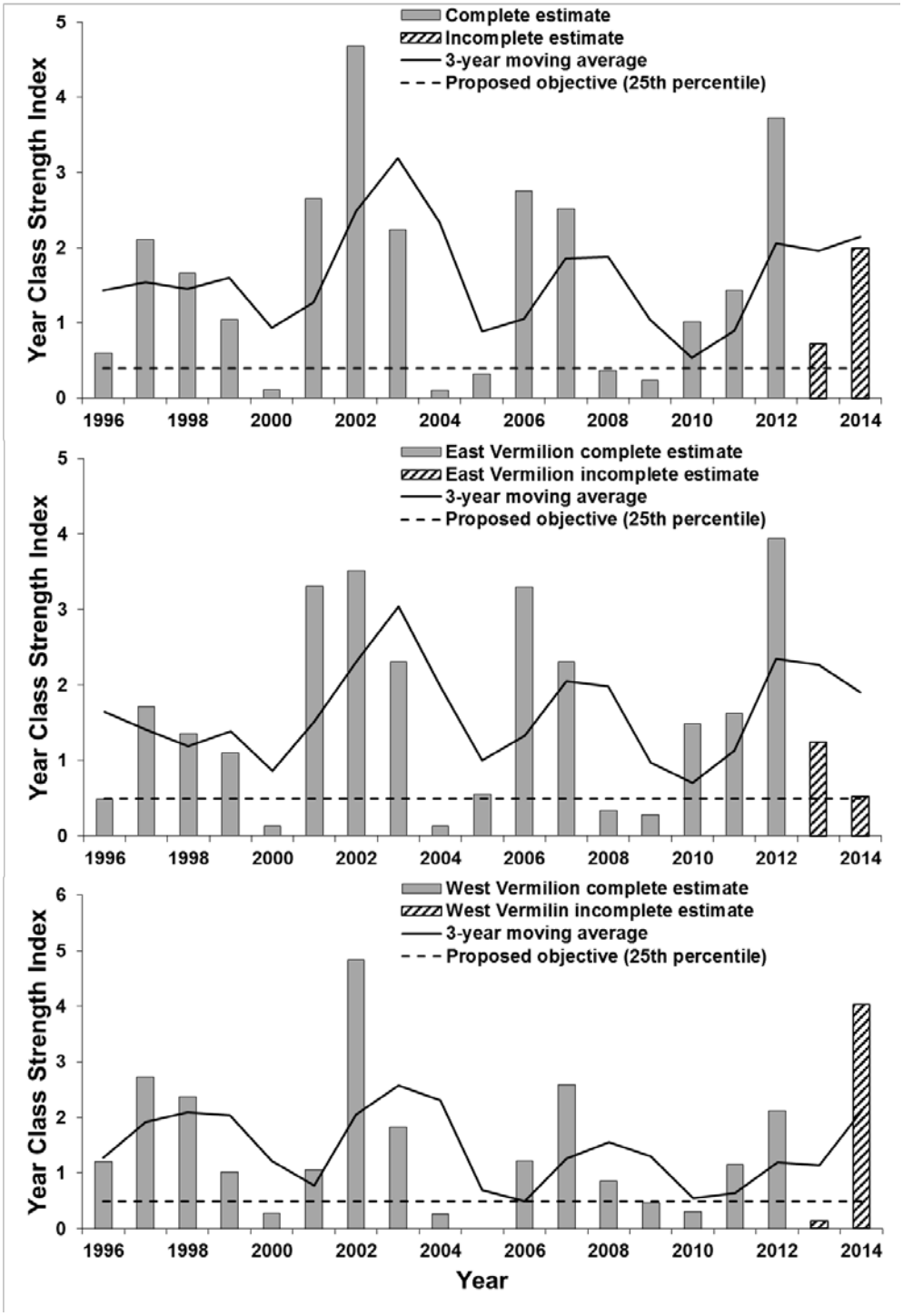

Figure 3. Walleye year class strength index in Lake Vermilion (top), East Vermilion (middle), and West Vermilion (bottom), 1996-2014. Both complete and incomplete estimates are indicated. Horizontal dashed lines represent the 25th percentile objectives. Solid lines represent the 3-year moving averages.

Year class strength values have ranged from 0.1 to 4.7 from 1996-2014 lakewide (Figure 3). The threshold of 0.4 represents the 25th percentile for that time period. Recent strong year classes occurred in 2006, 2007, and 2012 and weak year classes occurred in 2008 and 2009. As observed in lakewide estimates, strong year classes were produced in 2006, 2007 and 2012 in East Vermilion while weak year classes were produced in 2008 and 2009. In West Vermilion strong year classes were produced in 2007 and 2012 in conjunction with year classes produced in East Vermilion, but in contrast a weak year class was observed in 2010.

Year class strength estimates have ranged from 0.1 to 3.9 in East Vermilion and from 0 to 4.8 in West Vermilion. The 25th percentile objective thresholds of 0.5 for the east and west basins are numerically different than the lakewide objective because the indexes for the basins are based on subsets of the whole lake sampling (i.e., the 12 nets in East Vermilion and 8 nets in West Vermilion). Since the model creates indexes that relate year classes to one another based on the data collected, the numerical values are different, however all objectives are based on the 25th percentile threshold.

Harvest

Maintain summer (May through September) boat angler walleye harvest near 65,000 pounds.

A predictive model used to estimate the potential yield and target harvest for walleye in Lake Vermilion estimated 76,000 pounds could be sustainably harvested annually (MNDNR 1997). In 1998, the walleye harvest target was refined to allocate approximately 85% of the harvest (65,000 pounds) to the open water boat fishery as quantified by the summer creel survey. The remaining approximately 15% of the target (11,000 pounds) was left to cover unquantified harvest including shore and dock fishing, night fishing, late fall fishing, winter fishing, and Bois Forte Band reservation netting. These harvest allocations were broadly defined based on harvest levels and activities observed at the time and were designed to be flexible with changing conditions. Harvest estimates are made only for the years that summer creel surveys are conducted (Figure 4). The creel estimate for harvest does include mortality attributed to released fish. Total harvest from all sources (i.e., quantified and unquantified) was estimated to be about 54,000 and 51,000 pounds in 2014 and 2015, the most recent years in which creel surveys were conducted.

In 2016, the Fond du Lac Band exercised their ceded territory rights on Vermilion and will continue to do so for the foreseeable future. The DNR works with Fond du Lac to ensure harvest is sustainable, but the DNR does not regulate their harvest. Their harvest is managed by individual permits to Band members, with the harvest recorded by date, pounds of each species harvested, and gear used. In 2016, they harvested 1,758 pounds of a 2,500 pound harvest declaration for walleye. For purposes of calculating total annual walleye harvest in this management plan, the Fond du Lac harvest is additive to the summer angling harvest, as estimated by the creel survey, and the 11,000 pounds characterized as unquantified harvest.

Maintaining harvest opportunity is extremely important as walleye are by far the most targeted and harvested species in Lake Vermilion. Harvest levels are driven by several factors including abundance, angling pressure, catch rates, and regulations. Walleye harvest during the open water season has ranged from about 40,000 (2015) to 96,000 pounds (2003) as estimated from creel

surveys that occurred from 1984 to 2015 (Williams 2016). High walleye harvest in 2002 (87,000 pounds) and 2003 (96,000 pounds) prompted the implementation of a special walleye regulation to reduce harvest to a level near the open water harvest target of 65,000 pounds. The 17-26 inch protected slot limit implemented in 2006 reduced harvest to sustainable levels in the subsequent creel surveys done in 2008 and 2009. The regulation was adjusted to an 18-26 inch protected slot in 2012 to allow more harvest opportunity in response to angler concerns. Despite the adjustment, the most recent creel survey indicated that total walleye harvest was well below the sustainable level. In 2014 and 2015, harvest measured in the summer creel survey was 43,000 and 40,000 pounds, respectively (Williams 2016). The 2017 adjustment of the regulation to a 20-26 inch protected slot will provide more harvest opportunity for anglers while attempting to maintain harvest at a sustainable level. However, significant changes in the fishery, such as a large increase in fishing pressure or catch rates, could result in harvest being notably different than predicted by the model used to develop regulation options.

The walleye population has functioned relatively well over time using the open water harvest target of 65,000 pounds. This objective is intentionally flexible to allow for overages in harvest which have occurred in the past without dramatic effects to the population. However, maintaining harvest levels above 65,000 pounds for an extended period is likely not sustainable. The harvest objective for the open water boat season can be adjusted in the future to ensure harvest does not exceed the total annual target on a consistent basis if other sources of harvest increase or additional data changes harvest estimates.

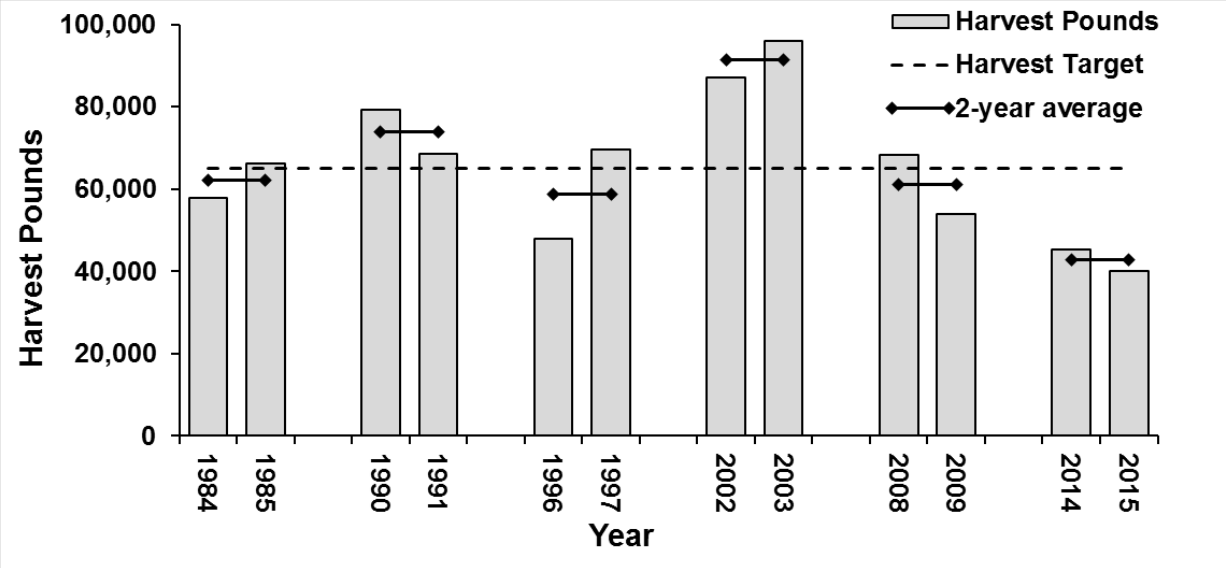

Figure 4. Estimated angler harvest of walleye (pounds) on Lake Vermilion during open water creel survey years, 1984-2015. The harvest target of 65,000 pounds is indicated by the dashed line.

This objective can only be properly assessed in the years that creel surveys are conducted. In non-creel years other indictors of overexploitation such as growth rates, SSB, and age and length at maturity can also be used to evaluate the walleye population and effects of harvest.

Angler Catch Rate

Maintain a targeting boat angler catch rate ≥0.38 walleye/hour (25th percentile) based on the open water creel survey.

a) *Maintain a targeting boat angler catch rate on East Vermilion ≥0.45 walleye/hour (25th percentile).*
b) *Maintain a targeting boat angler catch rate on West Vermilion ≥0.16 walleye/hour (25th percentile).*

Providing the opportunity for anglers to catch walleye is important, as they are the most sought after species in Lake Vermilion. Angler creel surveys previously conducted on Lake Vermilion two of every six years during the open water season from mid-May through September provided information on the catch rates of anglers. Due to statewide budget constraints, this plan schedules a single creel survey once every four years starting in 2021. Catch rate goals were based on the two year average of consecutive creels, however future analysis will utilize single year data to examine trends.

The protected slot limit initially implemented in 2006 was intended to reduce harvest and improve size structure without having negative impacts on catch rates. The improved size structure also provides increased opportunity to catch larger fish. Angler catch rates are often influenced by many uncontrollable factors including weather and suitable prey availability.

Targeting angler summer catch rates have ranged from 0.28 (1996) to 0.47 walleye/hour (2009 and 2014) from 1996-2015 (Figure 5). Walleye targeting anglers were those that answered that they were fishing for walleye when questioned in the creel survey interviews. Targeting angler statistics are a more precise measure of angling success, because it takes into account only those anglers who are targeting a particular species rather than all anglers. Prior to 1996, anglers were not asked what species they were fishing for therefore this metric could not be calculated. Catch rates (which include both harvested and released fish) ranged from 0.41 to 0.56 fish/hour for East Vermilion and from 0.15 to 0.22 fish/hour for West Vermilion during the same period. The catch rate objective was set to be at or above the 25th percentile for the 1996-2015 time series. Although the sample size is small, catch rates for walleye have remained fairly steady and this is a reasonable objective given the historical trends. This objective falls within the range of catch rates observed at other large walleye lakes in Minnesota and can only be properly assessed during years in which creel surveys are conducted.

Although catch rates have remained steady in both basins, harvest rates have declined primarily due to the protected slot limit, which was expected. However, the decline has occurred to a greater degree in the west basin, likely due to the shift in size structure to larger fish and a disproportional effect of weak year classes. The management activity to change the regulation in 2017 should address the concern expressed by some anglers that they have not been able to catch harvestable-sized fish in West Vermilion.

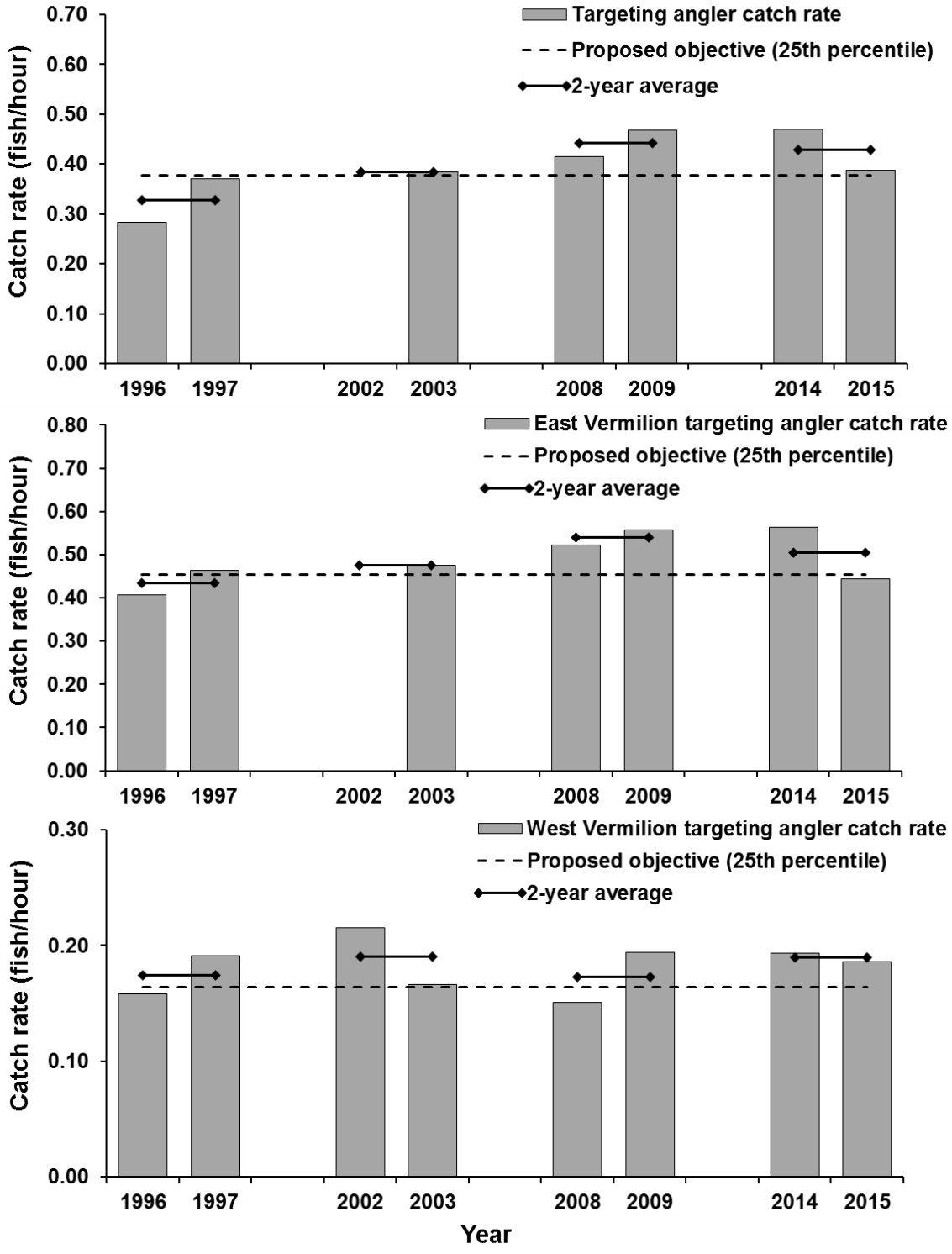

Figure 5. Estimated catch rates of anglers targeting walleye on Lake Vermilion (top), East Vermilion (middle), and West Vermilion (bottom) during open water creel survey years, 1996-2015. Horizontal dashed lines represent the 25th percentile objectives. (Note: Some catch rates were not calculated in 2002 due to lack of a reliable census of released fish.)

Yellow Perch

Goal

Support a self-sustaining yellow perch population that provides a stable prey base for sportfish.

Objective

Maintain yellow perch abundance (3-year moving average) above 19 fish/gill net (25th percentile).

The importance of yellow perch is primarily as a prey species on Lake Vermilion as few anglers target this species and harvest is limited. However, they do provide opportunity for anglers to catch fish as they tend to be the third most caught fish in terms of numbers in creel surveys. Yellow perch are one of the most important prey species in the lake as they are the primary forage for many sportfish populations, including walleye. The main tool used to assess the yellow perch population is annual gill-net surveys. There have been no strong trends in relative abundance based on the annual gill-net assessments. Lakewide gill-net catches were extremely variable from 1996 to 2015 ranging from 14.0 to 55.3 fish/net (Figure 6). The objective of 19 fish/net represents the 25th percentile for that time period.

The estimated target (sustainable) harvest was estimated to be 10,000 pounds annually (MNDNR 1997). However, harvest observed during creel surveys has averaged about 3,000 pounds and has not exceeded 6,500 pounds (Williams 2016). Differences are observed in the perch found in the two lake basins. Abundance is higher in the west while the perch tend to be faster growing and larger in the east on average.

Basin specific objectives are not set for the yellow perch population in this management plan. However, control strategies in the double-crested cormorant management plan are based on basin specific gill-net catches (MNDNR 2013). The cormorant management plan was implemented following low yellow perch gill-net catches observed on East Vermilion from 2007-2012 which coincided with significant increases in the DCCO nesting colony in that basin. During that same period West Vermilion catches were relatively stable. Due to data limitations and the complexity of the system, conclusive or strong evidence of a link between DCCO predation and perch abundance is difficult to attain. A “weight of evidence” approach was used to evaluate factors that may have contributed to the low perch abundance in East Vermilion observed from 2007-2012. After analyzing historic population trends and predator/prey relationships, DCCO predation was identified as the most likely factor contributing to low perch abundance at that time (see Double-crested Cormorant Evaluation and Control section for further details).

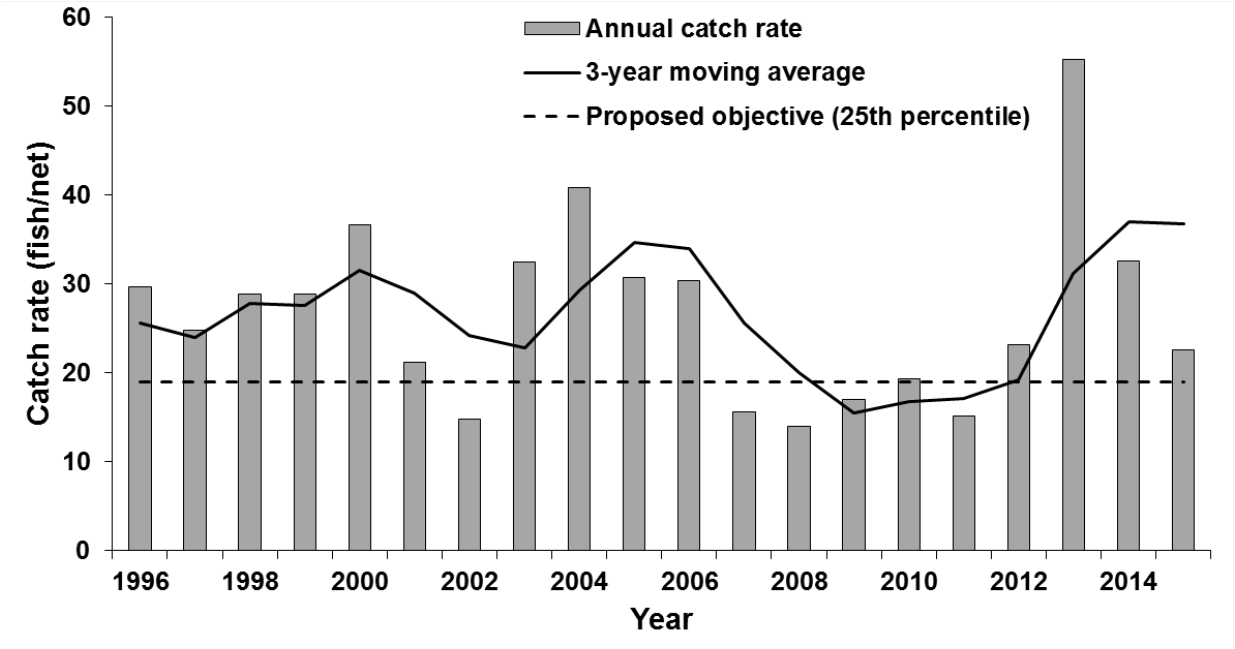

Figure 6. Gill net catch rates for yellow perch in Lake Vermilion, 1996-2015. The dashed horizontal line represents the 25th percentile. The solid line represents the 3-year moving average.

Muskellunge (muskie)

Goal

Support a muskellunge population that provides opportunity to catch trophy fish (50 inches or larger).

Objective

No numerical objectives were set for muskellunge.

Muskies provide an important sport fishery on Lake Vermilion. The muskie population was established with the goal of providing a low density, high quality fishery. Leech Lake strain muskie fingerlings were stocked annually from 1987-1994 to establish the population and this has been followed by less intensive stocking as a supplement to the natural reproduction that is assumed to be occurring (Appendix B; Table A).

Data on the muskellunge population has been collected through creel surveys and spring trap net assessments. Catch rates by anglers targeting muskies were initially very high when they were first recorded about ten years after the initial stocking (Appendix B; Figure B). Muskies were relatively lightly pressured at this time and average size was smaller in the developing population. After those early years, muskellunge targeting catch rates have remained in the 0.010 to 0.024 range across six creel surveys. Anglers targeting muskies have gone from less than 5% of all anglers in the 1996 and 1997 creel suveys to about 15% in the most recent surveys.

The spring trap net surveys provide useful information primarily on the size of spawning muskies. These surveys indicate that the muskie population is maturing and the average size of fish in the system has continued to increase. The rate of increase in the average size has slowed, however the percentage of fish 50 inches or larger captured in the trap nets has continued to increase (Figure 7). Therefore, the goal of providing the opportunity to catch fish 50 inches or larger is attainable.

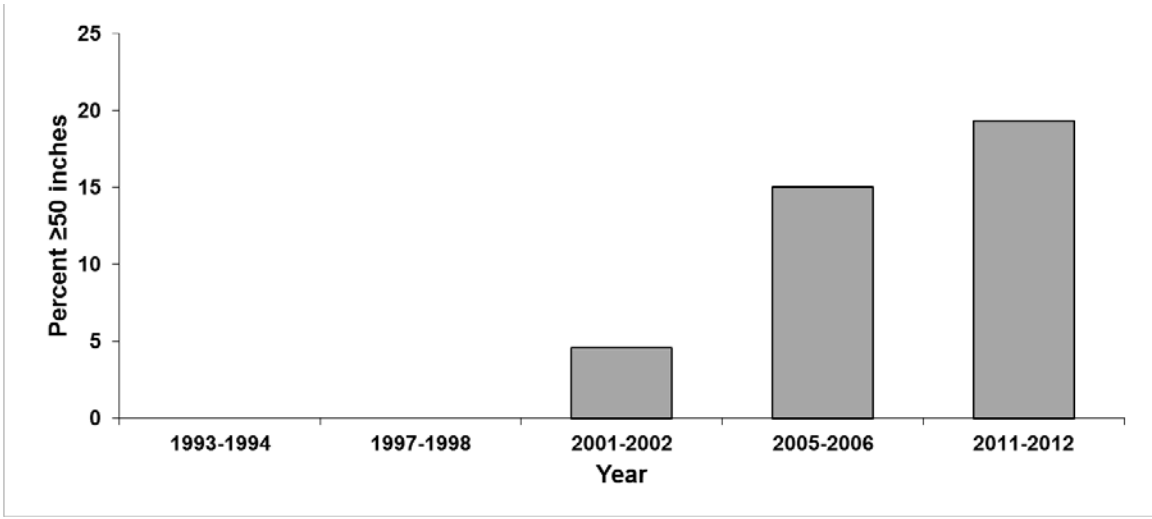

Figure 7. Percent of muskellunge caught in spring trap nets that were 50 inches or longer on Lake Vermilion, 1993-2012. Paired years are combined as east and west sampling was done in consecutive years.

Northern Pike

Goal

Support a self-sustaining northern pike population that provides opportunity for harvest.

Objective

No numerical objectives were set for northern pike.

Northern pike are in relatively low abundance in Lake Vermilion but are an important gamefish for a portion of anglers. The fishery is currently managed to protect large pike while providing some harvest opportunities. The estimated target (sustainable) harvest was set at 29,000 pounds (MNDNR 1997). Data on the northern pike population is collected from the annual fall gill-net assessment, targeted ice-out trap netting, and the creel survey. Annual gill-net assessments indicate a slightly decreasing trend in abundance over time, but the trend is difficult evaluate with a low sample size of about 1 fish/net (Appendix B, Figure C).

Angler harvest of northern pike has been steadily declining since the first set of creel surveys were conducted in 1984 and 1985 (Figure 8). In the 2014 and 2015 creels, northern pike harvest was about 5,000 pounds, well below the sustainable harvest level of 29,000 pounds. Declining harvest may have been related to several factors including a special regulation and increased

catch and release fishing. However, catch rates have also declined in recent years based on creel survey estimates. In 2016, the Fond du Lac Band harvested 687 pounds of northern pike exercising their treaty rights.

In 2003, a 24-36 inch protected slot limit regulation with one fish over 36 inches allowed in the three fish possession limit was implemented for northern pike. The regulation change was part of a state-wide initiative to improve the size structure of pike populations in a number of lakes across the state. There is some evidence in the creel and gill net data that the average size of pike has increased following the regulation, but the total number of northern pike sampled in gill nets annually is relatively small limiting analysis. Information collected from spring ice-out trap-netting in 2017 will be used to assess changes in size structure. The last assessment of this type was done during the springs of 1997 and 1998 prior to implementation of the special regulation. The higher samples sizes should allow meaningful comparisons to be made.

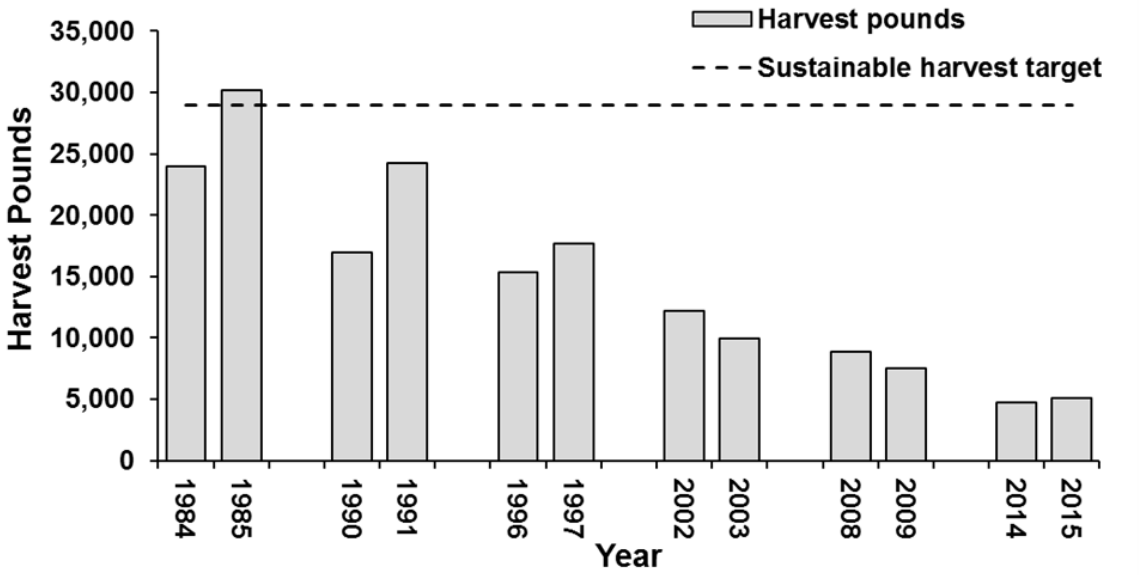

Figure 8. *Estimated northern pike harvest on Lake Vermilion during creel survey years, 1984-2015. The dashed line represents the sustainable harvest level of 29,000 pounds.*

Smallmouth Bass

Goal

Support a self-sustaining smallmouth bass population.

Objective

No numerical objectives were set for smallmouth bass.

Smallmouth bass are found throughout Lake Vermilion and they provide an important fishery. Abundance tends to be higher in West Vermilion but the average size is larger in East Vermilion. Spring night electrofishing is the primary tool for assessing the smallmouth bass population and the standard stations were designed to target their habitat. Angler creel surveys also provide some information on trends.

Catch rates during spring night electrofishing surveys have displayed and increasing trend since 1991 indicating an increase in smallmouth bass abundance (Figure 9). Estimates of total catch by anglers and catch rates have also increased reflecting an abundance increase. Recently, angling parties targeting smallmouth bass make up about 12% of all parties. Based on creel surveys, angler harvest has been fairly consistent at about 7,500 pounds annually, well below the estimated target (sustainable) harvest of 12,000 pounds (MNDNR 1997). From the 2014 and 2015 creel surveys, over 90% of bass caught were released.

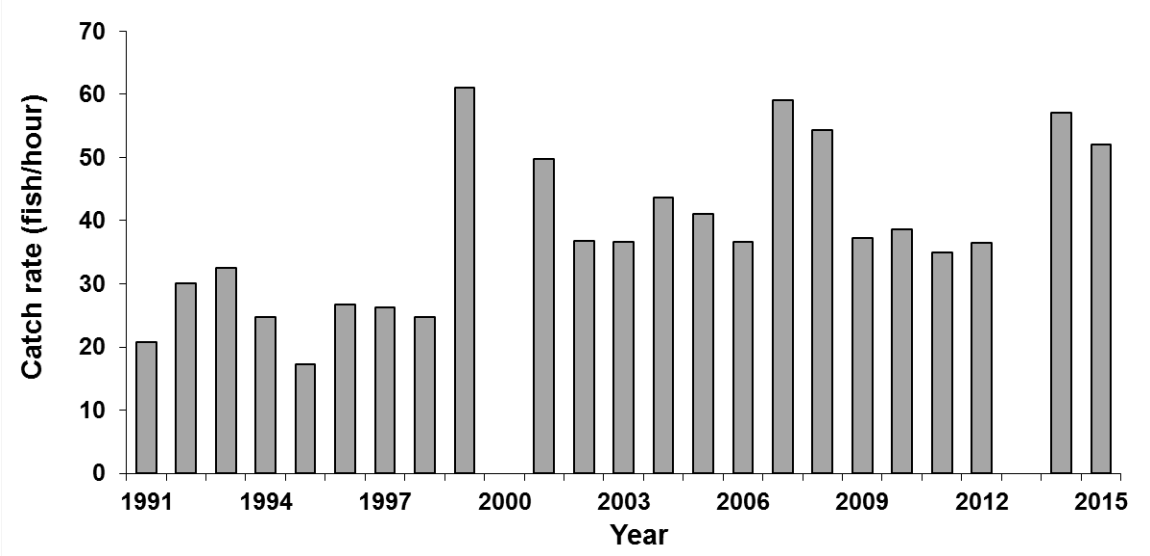

Figure 9. Spring electrofishing catch rates (fish/hour) of smallmouth bass in Lake Vermilion, 1991-2015. Missing bars are non-surveyed years. (Note: A late-summer electrofishing survey targeting smallmouth bass was conducted in 1989 but is not displayed in this figure.)

Largemouth Bass

Goal

Support a self-sustaining largemouth bass population.

Objective

No numerical objectives were set for largemouth bass.

Largemouth bass are a minor component of the Lake Vermilion fishery and are predominantly found in West Vermilion. Typically less than 3% of angling parties are specifically targeting largemouth bass and harvest has averaged about 2,000 pounds. Spring night electrofishing is the standard assessment technique to assess largemouth bass populations, however historically these assessments have been targeted toward smallmouth bass habitat in Lake Vermilion. Creel surveys have provided the most information on the largemouth bass population and they have indicated an increase in abundance since 1990 based on total catch estimates.

Black Crappie

Goal
Maintain sustainable harvest levels.

Objective
No numerical objectives were set for black crappie.

Black crappies are generally a minor component of the Lake Vermilion fishery and abundance has been relatively stable. They tend to be more abundant in West Vermilion. Black crappie populations are monitored with summer trap-netting and creel surveys. Typically less than 2% of angling parties are targeting black crappie specifically and harvest has averaged about 3,500 pounds. Harvest levels are likely driven by sporadic strong year classes of fish and the estimated target (sustainable) harvest of 11,000 pounds annually was only slightly exceeded once in 1991 (Figure 10) (MNDNR 1997; Williams 2016).

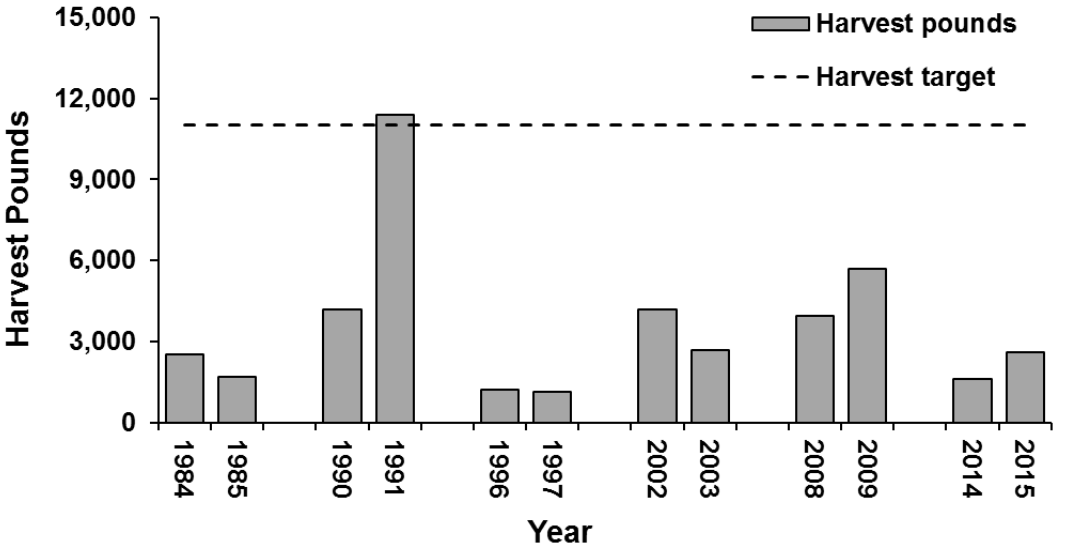

Figure 10. Estimated black crappie harvest (pounds) on Lake Vermilion during creel survey years, 1984-2015. The dashed line represents the sustainable harvest level of 11,000 pounds.

Bluegill

Goal
Maintain sustainable harvest levels.

Objective
No numerical objectives were set for bluegill.

Bluegills provide significant catch and harvest opportunity on Lake Vermilion and they tend to be more abundant in West Vermilion. The bluegill population is monitored with summer trap-net assessments and creel surveys. Their abundance has been relatively stable with a slightly

increasing trend as indicated in summer trap-net catches. Despite only about 3% of anglers specifically targeting bluegills on average, they tend to be the second most caught and harvested species in terms of total numbers. The most recent estimates of bluegill catch and harvest numbers from creel surveys in 2014 and 2015 were the lowest observed. Sustainable harvest for bluegills was estimated to be 15,000 pounds (MNDNR 1997). Bluegill harvest estimates have varied tremendously over twelve creel surveys from a low of 2,200 pounds in 2014 to over 23,000 pounds in 1991 (Figure 11).

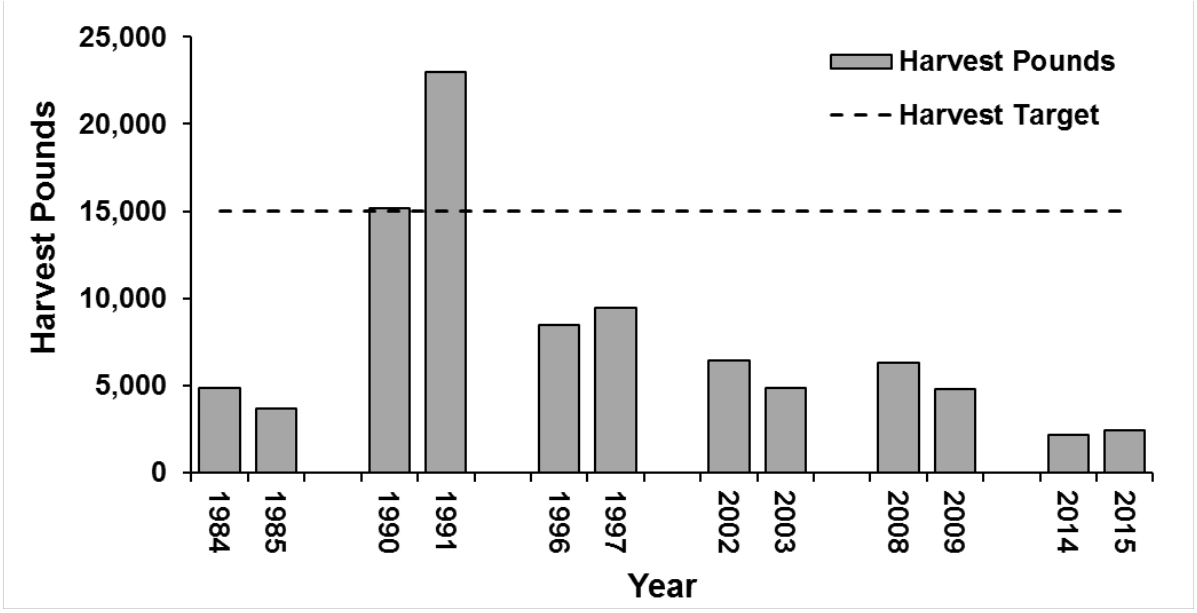

Figure 11. Estimated bluegill harvest (pounds) on Lake Vermilion during creel survey years, 1984-2015. The dashed line represents the sustainable harvest level of 15,000 pounds.

Other Species

White sucker, cisco (tullibee), and lake whitefish are important prey fish in Lake Vermilion and they provide some harvest opportunity. Overall, prey abundance is considered an important aspect to examine in managing Lake Vermilion's fishery but no numerical objectives have been established. Survey methods are not specifically targeted for these species but there is some data for examining long-term trends.

White Sucker

White sucker abundance has remained relatively stable based on gill net data from the annual assessments. Higher catches are generally observed in East Vermilion and there has been a declining trend in West Vermilion catches. However, West Vermilion gill net catches have traditionally been relatively low. White suckers have been trapped and removed at various sites around the lake dating back to 1968. There is a long tradition of white sucker harvest at the Pike River walleye trap operated each spring, but trend analysis is not possible due to variation in the timing and duration of the trap set. Removal of white suckers initially began based on

assumptions that the fish negatively impacted walleye and other gamefish species, however evidence from multiple lakes over the years indicates they likely have little to no impact on these populations and removal is unnecessary. Nevertheless, there is limited biological impact and sufficient community interest to justify continuing the annual harvest of white suckers from the Pike River walleye trap.

Cisco (tullibee) and Lake Whitefish

Cisco (tullibee) and lake whitefish are important prey species that require cold, oxygenated water. Due to their specific habitat requirements and sensitivity to changing conditions, they are considered indicator species and are subject to occasional die-offs. Generally, ciscoes are captured at the third highest rate in gill net surveys behind walleye and yellow perch. Cisco abundance has been variable over the years ranging from 1.9 to 19.5 fish/net but no trends are evident. Gill net catches tend to be higher in West Vermilion indicating greater abundance in that basin. Information on the lake whitefish population is sparse as they are not sampled effectively with our current techniques.

A sport gill netting season targeting ciscoes and lake whitefish has occurred over a several week period generally from mid-October to mid-November for several decades on Lake Vermilion. Most sport gillnetters primarily target whitefish on Lake Vermilion. Ciscoes are less targeted due to the prevalence of a parasite, Triaenophorus, in this species. The opening of the sport gill net season is based on historic netting by DNR Fisheries crews that established a temperature threshold as well as spawning characteristics of these species. The season is announced at least 48 hours ahead of time and is set to try to avoid bycatch of gamefish as much as possible. Current harvest data during the sport gill netting season is lacking, however harvest is considered to be sustainable. Sport gill netting is an important form of recreation, though practiced by a small number of participants. DNR will continue to support this sport as long as there are no compelling biological reasons to discontinue it.

Aquatic Habitat and Water Quality Goal and Issues

Goal

Protect and improve aquatic habitat and water quality through education, permitting, monitoring, and relevant projects.

Issues

The primary aquatic habitat issues of concern include aquatic invasive species (AIS), water quality, habitat availability, and land use. Fisheries acts as a technical consultant on some of these concerns, as jurisdiction may fall to other local government units or agencies. The DNR's Division of Ecological and Water Resources (EWR) addresses AIS with an assigned specialist for the Northeast Region. EWR is involved in training boat inspectors and monitoring invasive species, as well as making the determination that a water is infested with AIS. Fisheries gives support as available and often functions as a local intermediary on AIS concerns.

Invasive species present in Lake Vermilion include mystery snails, curly-leaf pondweed, *Heterosporis sutherlandae*, purple loosestrife, rusty crayfish, and spiny waterflea. Most of these

have not appeared to have a negative impact on fish populations at this time. There are no established, effective control methods for *H. sutherlandae*, rusty crayfish, or spiny waterflea.

Annual surveys by EWR have been conducted on small, isolated patches of curlyleaf pondweed located in Everetts and Stuntz bays but it has rarely, if ever, reached nuisance levels. Control and removal techniques have been evaluated and used sporadically under permit with varied success. The curly-leaf pondweed infestations are often intermingled with native aquatic vegetation and there is a concern that increased herbicide treatments could reduce native plant diversity. Purple loosestrife occurs in isolated patches and there are no records of treatment.

Rusty crayfish have been monitored in the gill net catch since the early 1990s. Rusty crayfish have been more abundant in East Vermilion and are now expanding further into West Vermilion. The greatest impact that rusty crayfish have is their removal of much of the aquatic vegetation in parts of the lake that have been colonized. The crayfish seem to prefer aquatic vegetation in sandy areas so less impact has been observed in bays with soft bottom substrates.

Spiny waterflea (SWF) are invasive zooplankton first discovered in Lake Vermilion in 2015 and as of 2016 had only been sampled as far west as Frazer Bay in East Vermilion. No significant trends in native zooplankton densities or biomass have been observed in Lake Vermilion following the discovery of SWF, however other large lakes with a longer history of its presence including Rainy Lake, Lake Kabetogama, and Lake of the Woods have seen significant declines (Staples et al. 2017). This decrease in zooplankton has been associated with a decrease in growth of young-of-the-year (YOY) yellow perch although the impacts on perch recruitment has been inconclusive. We continue monitoring SWF and native zooplankton, as well as growth of YOY perch.

Projects that impact Minnesota's water resources are regulated by a variety of state, local, and federal agencies. The DNR has regulatory authority of public waters and is involved in permitting any activity affecting the lake bed that takes place below the ordinary high water level (OHWL). The Division of Ecological and Water Resources (EWR) issues public waters work permits for projects that alter the course, current, or cross section of public waters or public waters wetlands. These projects include boat house construction, beach sand blankets, and the installation of rip-rap. Fisheries advises on these public waters permits to minimize impacts to aquatic habitat. Aquatic plant management (APM) permits for both removal and restoration of native aquatic vegetation are issued by DNR Fisheries while permits for invasive species removal are issued by EWR. There are very few APM permits issued for Lake Vermilion. Other permits DNR Fisheries comments on relate to water crossings which are fairly common on Lake Vermilion, mainly as cable (e.g., telephone and power) crossings.

The area Fisheries office is also involved in technical advice for shoreland use, planning, and zoning issues while EWR is the official DNR lead on these issues. Local governmental units adopt controls to provide for the orderly development and protection of Minnesota's shorelands (both rivers and lakes) which are generally based on the statewide standards set in rule and administered by the DNR (Minnesota Rules 6120.2500 - 3900). The DNR is often the first stop for local stakeholders when they have an issue. As part of our mission to protect habitat, we help refer these issues to the correct authority and may be available for technical consulting if needed.

The LVFIG was very concerned with land use changes that impact habitat as well as non-compliant septic systems on the lake that may negatively impact water quality.

Fisheries is actively working with internal and external partners on watershed issues such as forest management, environmental assessments, and watershed plans. Partners include the U.S. Forest Service and the Minnesota Pollution Control Agency among others.

Management Activities

Management activities are specific actions intended to monitor, support, regulate, and maintain the Lake Vermilion fishery. These activities include: fisheries assessments, monitoring, analysis, fish stocking, hatchery operations, regulations, specialized projects, and permitting. Most of the actions are designed to collect data used to determine if fish population goals and objectives are being met. For the most part, fisheries assessments are "standardized," indicating that they are performed at approximately the same locations, during the same of year, and using the same gear. This standardization is important for trend analysis. Several activities are intended to cover multiple species of management interest.

Fisheries Assessments, Monitoring, and Analysis

Annual Large Lake Assessments

Shoreline seining targeting young-of-the-year (YOY) gamefish and other non-game fish species will include the following:

- Weekly sampling throughout July at 14 standard stations (7 stations in East Vermilion; 7 stations in West Vermilion)

Multispecies gill netting will include the following:

- Twenty standardized gill net sets (12 nets in East Vermilion; 8 nets in West Vermilion)
- Two additional research net sets in Head of the Lakes Bay, West Vermilion for a limited time

Fall night electrofishing targeting YOY walleye will include the following:

- Nine standard stations (6 stations in East Vermilion; 3 stations in West Vermilion)
- Research additional sites
- Implement collecting age-1 walleye also

Annual surveys include zooplankton sampling (May through November), water temperature and dissolved oxygen profiles (May through November), shoreline seining (July), water quality sampling (August), gill netting (late-August through mid-September), and night electrofishing (mid-September through early October). The data collected will be stored, managed, and analyzed appropriately.

Young-of-the-year largemouth bass, smallmouth bass, yellow perch, and walleye are the primary targets with shoreline seining and non-game fish are also collected. Gathering YOY yellow perch information will be a primary focus as this data can be used to evaluate growth in relation to the presence of spiny waterflea.

Annual gill netting is the main method of assessing walleye, yellow perch, northern pike, and cisco relative abundance and population dynamics. The standardized gill nets have been placed in the same locations at roughly the same time of year since 1984. Catch rates are compared across years to track and assess trends. Recruitment can be evaluated by aging collected samples.

Fall electrofishing provides some general information on the abundance of YOY walleye at or near the end of their first growing season, but it has not proven to be a strong predictor of future year class strength. We have observed a relationship that indicates that the average size of walleye at the end of the first growing season is a good predictor of future year class strength. Preliminary data from other Minnesota lakes indicates that collecting 1-year-old fish during fall electrofishing may be useful in predicting the ultimate success of a year class. The LVFMP calls for investigating this relationship in future surveys.

Periodic Targeted Surveys

Spring ice-out trap net assessments (3 of 6 years)

- Targeting northern pike (1 of 6 years)
    - Conduct an ice-out trap net assessment targeting northern pike in 2017 to gather necessary data to evaluate the size structure and current special regulation
- Targeting muskellunge (2 of 6 years)
    - Likely in 2019 and 2020, but depending on funding and staffing requirements
    - Following muskellunge sampling guidelines developed by the DNR Muskellunge Technical Committee, conduct muskellunge population assessments to obtain information on spawning adult size structure and potentially adult population estimates
    - Assess feasibility of mark and recapture techniques to obtain adult population estimates

Spring night electrofishing targeting largemouth bass and smallmouth bass (1 of 3 years)

- Conduct smallmouth bass and largemouth bass spring electrofishing assessments once every three years at nine standard stations (6 stations in East Vermilion; 3 stations in West Vermilion)
- Assess the use of otoliths in developing age and length keys for both species

Summer trap-netting targeting black crappie and bluegill (1 of 3 years)

- Conduct summer trap-netting once every three years to assess black crappie and bluegill populations
- Evaluate sampling methodology and use of otoliths for aging

Spring ice-out trap-netting targets mature muskies and northern pike as they move to spawning areas. Trap-net catches are influenced by weather and timing, so they may not provide the best method for examining relative abundance in all cases. However, they can be used to assess the size distribution of mature fish. Recently, the DNR Muskellunge Technical Committee recommended that spring trap net catch rates should not be used to assess changes in muskie population abundance. Rather, it is recommended that adult muskie population estimates are generated via the use of mark-recapture techniques (MNDNR 2017). However, these

recommendations were developed for Minnesota's smaller lakes, not those in the Large Lake Monitoring Program. The size and complexity of lakes such as Vermilion makes this technique extremely challenging to conduct for monitoring long-term trends in abundance. We will explore sampling design and methodology options to potentially conduct these surveys in the future.

Spring night electrofishing and summer trap-net assessments are also somewhat coarse methods for looking at bass and panfish populations. Both help assess changes in size structure but catch rates are very influenced by weather and timing so only large shifts in relative abundance or size structure tend to be detected.

Creel Survey

Open water creel survey (1 of 4 years)

- Conduct an open water (May fishing opener through September) creel survey one of four years beginning in 2021

Creel surveys are conducted from May through September on Lake Vermilion to obtain estimates of fishing pressure, catch, and harvest. These metrics can be used to analyze long-term trends as well as evaluate harvest in relation to sustainable harvest levels defined for Lake Vermilion (MNDNR 1997). The next scheduled creel survey will be in the summer of 2021. The creel survey frequency had been two consecutive years out of every six years dating back to 1984 (i.e., 1984 and 1985, 1990 and 1991, etc.). However, the frequency has been adjusted to one of every four years due to budgetary constraints.

Hatchery Operation and Stocking

Pike River Hatchery Operation

- Operate hatchery annually, adjusting production quota as needed
- Monitor walleye run for size and sex-ratios
- Continue white sucker harvest

Early management on Lake Vermilion was focused on the development of a fish hatchery at the Pike River falls just upstream from Lake Vermilion. A major walleye spawning run occurs where the Pike River enters the lake at Pike Bay. This run has been utilized as a walleye egg source dating back to the 1890s. Currently, the Pike River Hatchery takes roughly 100 million walleye eggs and produces approximately 70 million fry each year depending on statewide objectives. White sucker harvest has occurred at the Pike River walleye trap for decades. Suckers are removed annually and sold by the VLA as a fundraiser. The goal of the hatchery is ensure the walleye spawn take is sustainable while producing Pike River strain walleye fry for statewide stocking needs.

Walleye Fry Stocking

- Stock Pike River strain walleye fry based on the lakewide 3-year moving average of mature female walleye biomass (i.e., spawning stock biomass [SSB]) estimated from the gill-net catch:
    - 15,000,000 fry if the lakewide 3-year moving average of SSB is <1.3 pounds/acre

    - 10,000,000 fry if the lakewide 3-year moving average of SSB is from 1.3 to 2.1 pounds/acre
    - 5,000,000 fry if the lakewide 3-year moving average of SSB is >2.1 pounds/acre
- Fry are distributed proportionally lakewide based on littoral area per basin
- Surplus fry produced at the Pike River Hatchery will be stocked in Vermilion only on a limited basis
- Continue to refine fry stocking levels and relate to SSB
- Continue to investigate relationship between SSB and year class strength

Initial efforts to stock walleye were motivated by an intent to improve the Vermilion fishery; later efforts have been to replace the production lost due to walleye eggs that are removed to hatch into fry used to fulfill statewide DNR needs in rearing ponds and lakes. The first documented stocking of walleye in Lake Vermilion was in 1910 and primarily walleye fry have been stocked annually at various rates since 1971. The amounts of fry returned to Lake Vermilion were not determined based on the condition of the walleye population or an identified biological need. The LVFMP establishes stocking levels that relate to the potential natural reproduction from mature female walleye (i.e., spawning stock biomass) present in the lake. Walleye fry are distributed proportionally throughout the lake based on the littoral acreage of the east and west basins. East and West Vermilion are further broken down into sub-basins for fry distribution, however only the primary basin of stocking has been recorded in Fisheries records.

A relationship between walleye fry stocking and recruitment has not been established for Lake Vermilion at this time. Fry are stocked into Vermilion to compensate for fry which would have hatched naturally if eggs had not been taken at the Pike River Hatchery walleye trap. Historically, the amount of fry returned to Lake Vermilion was roughly 10% of the total egg take based on statewide stocking needs. Recent research indicates that this 10% return rate is likely far more than the amount of fry that would have hatched naturally from an equal amount of eggs in the lake. In addition, research has indicated that the 10% fry return stockings on some lakes resulted in greater competition between walleye in their first year resulting in poor growth and ultimately poorer survival. Observations from other natural walleye lakes indicate that there are potentially fry density (stocked and natural) levels (both low and high) that would negatively impact recruitment. Where this might be on Vermilion is unknown as this aspect of walleye recruitment is less understood.

Because of some of these factors, this plan calls for adjusting the fry stocking level based on the amount of lakewide spawning stock biomass estimated from fall gill netting on Vermilion rather than a 10% put-back amount. In an effort to better understand the relationship between fry stocking, SSB, and recruitment, three stocking levels are being used. The fry stocking quota will differ depending on whether the lakewide 3-year moving average of SSB is below the 25th percentile of 1.3 pounds/acre, in the middle between 1.3 to 2.1 pounds/acre, or above the 75th percentile of 2.1 pounds/acre. By using a more standard approach, we hope to get a better understanding of whether and how much stocking contributes to eventual recruitment reflected in gill nets. In all years, surplus fry may also be stocked but will be avoided as much as possible to keep stocking levels standardized as planned. By standardizing the stocking levels based on spawning stock biomass, it is hoped we will better understand how stocking effects total fry

density (stocked plus natural) and what kind of response that recruitment has to various levels of fry density.

In recent years, a mark and recapture research project was done on Vermilion to try to determine how many fry were being produced and how it related to recruitment in an effort to better determine the most efficient fry stocking density (D. Logsdon, DNR Fisheries Research). The research indicated that natural fry densities on Vermilion were high compared to other large lakes, however other relationships were inconclusive because the reliability of the marks was poor. It is possible the fry stocking on Vermilion does not add substantially to overall recruitment because the supply of fry via natural reproduction is high and spawning habitat is not limited. Because we have established a positive relationship between fall YOY walleye size and year class success on Vermilion, stocking should be done at a level that does not create excessive competition resulting in reduced YOY growth.

It should also be noted that there were very high stocking levels in Lake Vermilion from 1980 into the early 1990s compared to the last twenty years. These high stocking levels did not result in a greater abundance of walleye compared to more recent years, although we can only speculate on the cause and effect. The walleye gill net catch from 1984 to 1994 averaged 12 fish per net compared to 16 fish per net from 1995 to 2016 (Appendix B, Figure A).

Muskellunge Fingerling Stocking

- Stock 3,000 Leech Lake strain muskie fingerlings annually as a base quota
- Stock up to 2,000 additional (surplus) Leech Lake strain fingerlings per 2-year period when available (8,000 fish maximum per 2-year period) given all conditions have been met
- Manage stocking priority as a “Premier” lake as defined by the DNR Muskellunge Technical Committee
- Investigate feasibility of implanting Passive Integrated Transponder (PIT) tags into fingerling muskellunge stocked into Lake Vermilion
- Consider outside partnerships and funding opportunities to support muskellunge management including PIT tagging supplies, rearing pond operations, and surplus fingerling muskie stocking if the fish meet DNR standards and protocols

Anecdotal reports and photographs from as early as the 1920s indicate muskellunge may have historically been present in Lake Vermilion, however the first record in fisheries assessments occurred in the late 1980s following DNR stocking efforts. The first documented muskie stocking occurred in 1968 and there were several other minor stockings from 1969 to 1985, primarily with Shoepac Lake strain fish (Appendix B; Table A). Lake Vermilion was selected as part of a statewide initiative to add muskie fishing opportunities in the 1980s because the lake met criteria for suitable characteristics. Therefore, Leech Lake strain muskie fingerlings were stocked annually from 1987 to 1994 at a rate of about 6,000 fish/year to establish the population and this has been followed by less intensive stocking to supplement the natural reproduction that is assumed to be occurring. The muskie population present today is due to stocking and natural reproduction within the lake which is intended to provide a low density, high quality fishery.

The muskie stocking quota in the 2007 Lake Vermilion Management Plan was 4,000 muskie fingerlings biennially, but stocking on this schedule had been irregular in recent years. Internal review of the statewide muskie program by DNR Fisheries in 2016 resulted in the creation of a priority stocking list. Vermilion's categorization as a "Premier" lake raises the lake's priority on the statewide stocking list and should result in the base quota being met regularly. The early draft of the LVFMP continued with a base stocking of 4,000 muskie fingerlings every other year but added that up to 4,000 additional fingerlings could be stocked within a two year period if available as surplus. Input from the public and some members of the LVFIG indicated that there was a desire for a higher amount of base level stocking and increased frequency. As part of the statewide review, it was determined that we could change the base stocking quota to 3,000 fingerlings annually with up to 2,000 additional fingerlings as surplus per two year period. Either strategy would allow stocking of up to 8,000 fingerlings per two year period. Muskie are stocked proportionally at numerous locations around the lake based on surface area of the east and west basins. The largest data gaps involve an understanding of the contribution of stocked fish to the fishery and assessing the amount of natural reproduction that occurs within the population.

Regulations

Walleye

- Implement a regulation change in May 2017
    - All walleye from 20-26 inches must be immediately released, only one over 26 inches allowed in possession
    - Keep a four walleye possession limit
- Review walleye population metrics annually in response to the regulation and evaluate angler harvest following the next creel survey

A special walleye regulation for Lake Vermilion was first implemented in 2006 and then modified in 2012 (see Management History section for further details). In 2016, the regulation was again reviewed due to public interest and some flexibility in management because walleye harvest had been well below the sustainable harvest level. The regulation review followed a two-track process: input from the LVFIG was essential, as was input from the general public collected as part of the required rulemaking process. The rules process included posting signs announcing the consideration of a rule change at public boat accesses in the summer of 2016, news releases announcing the rule change consideration, and a public meeting on October 25th followed by an additional 10 day comment period.

Regulation alternatives were modeled for their impact on projected harvest as well as the health of the female spawning stock (P. Schmalz, DNR, unpublished data). These alternatives and their potential risks were presented both to the LVFIG and the general public.

The regulations that were modeled and considered were:

- Protected slot limit of 18-26" (i.e., keep regulation the same)
- Protected slot limit of 20-26"
- Protected slot limit of 18-22"
- 1 fish allowed over 18" (no slot)
- 1 fish allowed over 20" (no slot)

All options would have retained the four fish bag limit. The one fish over 20” option was dropped after modeling harvest and spawning stock biomass estimates and discussion with the LVFIG. Input was solicited from the general public on the remaining four options including the no change choice.

Most LVFIG members were in favor of a change to the walleye regulation that would allow more harvest. This group had the highest support for the one over 18 inch option, but there was no majority of opinion for any single option.

Of the 33 comments received from the general public, 20 supported some sort of change to the regulation compared to 11 indicating no change was preferred; the remaining two were unspecific. Of the 20 supporting change, the one over 18” and the 20 to 26” protected slot were preferred. At the public meeting, the one over 18” option seemed to be preferred.

The protected slot of 20 to 26 inches was selected as the best proposal to move forward. Public comments indicated support for a regulation change but there still was a substantial portion of the public that did not think a change was necessary. Most comments in favor of keeping the existing regulation indicated a concern that the fishery was in good condition and that there would be overharvest with a regulation change. Our modeling indicated that the 1 over 18” regulation was the riskiest of the four options in terms of potential to exceed the sustainable harvest level for walleye and reduce spawning stock biomass below preferred management levels. The risk of this occurring with a 20-26” protected slot was less and seems more appropriate with a portion of the public input indicating they would prefer less risk. Creel surveys in 2014 and 2015 indicate that walleye harvest was about 30% below sustainable harvest levels, so allowing more harvest is supported biologically as well as by a majority of stakeholders who gave input.

Northern Pike

- Consider regulation change to match statewide northern pike zone regulations
    - Evaluate regulation following additional data collection and analysis of the northern pike population
    - Follow state rulemaking procedures

A special regulation for northern pike in Lake Vermilion was implemented in 2003. The regulation adopted was a 24 to 36 inch protected slot limit with one fish over 36 inches allowed in the three fish possession limit. The regulation change was part of a state-wide initiative to improve the size structure of pike populations in a number of lakes.

The DNR completed a rulemaking process that partitions Minnesota into three northern pike management zones (northeast, north-central, and southern zones) in 2017 and the resultant regulations will be implemented in 2018. These zone regulations were designed to improve northern pike populations for anglers and dark-house spearers.

The northeastern management zone regulation is:

- When taking northern pike by angling:
    - All northern pike from 30 to 40 inches in length must be immediately returned to the water
    - Only 1 fish over 40 inches in length may be in possession
    - 2 fish possession limit

- When taking northern pike by dark-house spearing:
    - Only 1 fish over 26 inches in length may be in possession
    - 2 fish possession limit

Lake Vermilion is within the northeast management zone but the existing special regulation of a 24 to 36 inch protected slot will remain in place. The LVFIG suggested allowing more harvest opportunity, expressed low concern about the size structure of the pike population, and was open to the idea of reviewing the slot regulation. Therefore, consideration of a regulation change will follow standard rulemaking procedures with opportunity for general public input in 2018. In this case, dropping the special regulation on Vermilion would result in the lake being managed under the northeast zone regulation. The earliest implementation would be in May 2019, if there is public support.

Other species

Statewide fishing regulations apply to all other fish species in Lake Vermilion. If changes to statewide regulations occur, these changes will be implemented and evaluated in terms of angler and fish population responses via standardized creel and fisheries surveys.

Water Quality, Zooplankton, Aquatic Habitat, Aquatic Invasive Species, and Disease Monitoring

There are a variety of activities conducted by the DNR that monitor and protect fish and their habitat. Most of these activities focus on potential water quality impacts, habitat alteration, and aquatic invasive species.

- Continue annual water quality, water temperature, and zooplankton monitoring
    - Evaluate additional water quality and zooplankton sites
    - Maintain water temperature loggers and deploy additional loggers as feasible
- Explore shoreline habitat assessments and aquatic vegetation sampling following DNR protocols (Perleberg et al. 2016)
- Coordinate with DNR Ecological and Water Resources (EWR) staff and other government and non-government organizations to assist with aquatic invasive species monitoring, prevention, education, and management efforts
- Continue partnership with the Minnesota Pollution Control Agency in the Watershed Restoration and Protection Strategy (WRAPS) process
- Protect aquatic habitat through permitting and technical advice
- Continue to monitor fish populations for viral hemorrhagic septicemia (VHS) and contaminants

Other Fisheries Management Considerations

There are a few issues regarding Lake Vermilion that require statewide coordination or other broader partnerships beyond the DNR Tower Area Fisheries office. Managing double-crested cormorants (DCCO), tournament permitting, and research projects are these types of management issues.

Double-crested Cormorant Evaluation and Control

DNR Fisheries management activities for DCCO include:

- Monitor the DCCO nesting colony on Potato Island and search for the establishment of new nesting colonies annually in cooperation with DNR EWR Nongame staff
- Gather data to better understand DCCO population dynamics, evaluate impacts on sportfish communities, and develop a lake specific consumption and control model
- Work with State, Tribal, and Federal resource management staff to evaluate potential DCCO impacts on fish populations and methods for population control
- Pursue control measures when legally available and impacts to sportfish populations are demonstrated
- Follow guidance in the Management Plan for DCCO on Lake Vermilion (MNDNR 2013) as appropriate
    - Reevaluate the plan annually and modify if necessary following review by the Minnesota Cormorant Work Group

The double-crested cormorant *Phalacrocorax auritus* is a native, fish-eating colonial water bird that has historically used Lake Vermilion for nesting, foraging, and loafing in relatively low numbers. A population resurgence has occurred throughout North America since the 1970s when populations began rebounding from decades of human persecution and environmental contamination. However, this resurgence has led to natural resource and societal conflicts of varying degrees. Cormorants are protected by the Migratory Bird Treaty Act in the United States. However, following increasing resource conflicts in the early 1990s, the U.S. Fish and Wildlife Service (USFWS) and the U.S. Department of Agriculture Animal and Plant Health Inspection Services (USDA) issued an Aquaculture Depredation Order and a Public Resource Depredation Order (PRDO) allowing lethal control. The Depredation Orders allowed aquaculture facilities and state, federal, and tribal management agencies to deal with cormorant issues locally under USFWS review.

Within the last 15 years, the DCCO colony on Lake Vermilion has increased 10-fold and the relatively rapid growth of the colony generated concern within the local angling and business community that higher DCCO numbers would negatively impact sportfish populations, specifically yellow perch and walleye. Extensive research on DCCO impacts on fish populations has indicated that yellow perch and walleye populations have been affected in other percid-dominated fish communities including nearby Leech Lake (Rudstam et al. 2004; Schultz et al. 2013). Due to the expanding DCCO colony on Lake Vermilion, yellow perch population trend analysis, stakeholder concerns, and trends observed in other fisheries in response to increases in DCCO; DNR Fisheries and EWR staff collaborated on a management plan in 2013 to guide future management actions (MNDNR 2013).

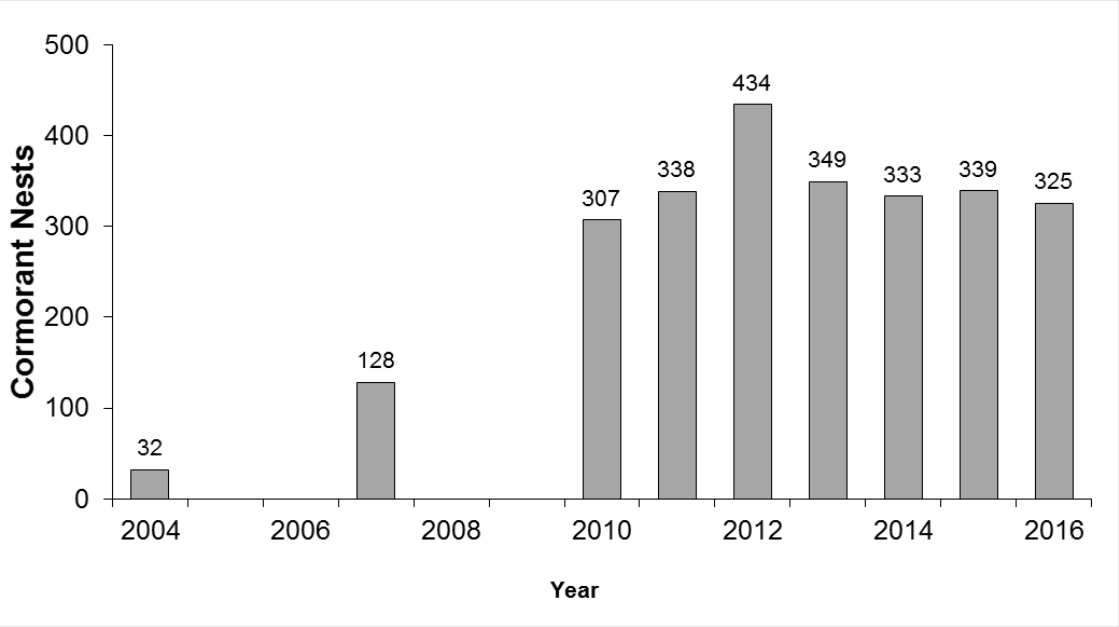

Figure 12. Double-crested cormorant nest counts on Lake Vermilion, 2004-2016. The count assumes two adult birds per nest. Missing bars are unsurveyed years. The total nest count number is displayed above each bar. Counts were taken approximately 4 week post-ice-out and prior to control efforts during control years (2013-2015). The only nesting colony present in 2004 was on a small island near Potato Island. From 2007 to 2016, nest counts were taken on Potato Island, the site of the only known nesting colony.

Based on a preponderance of evidence linking low perch abundance with DCCO predation, DNR entered into discussions with the USFWS and USDA to initiate a control program in 2013 under an existing Environmental Impact Statement, Environmental Assessment, and several Findings of No Significant Impact (FONSI) that established a PRDO. The control guidelines within the newly developed management plan were based on an adaptive management approach that would initially be conservative and then adjusted as necessary in response to fish population changes. The Minnesota Cormorant Coordinating Committee endorsed the 2013 DCCO Management Plan and received updates annually to review the control program. Control measures, including adult culling and egg oiling, were taken from 2013-2015 to reduce the DCCO population and limit foraging in Lake Vermilion. Control efforts were suspended in 2016 and 2017 due to a U.S. District Court decision to vacate the 2014 PRDO extension by the USFWS.

Currently, the only nesting colony of DCCO present on Lake Vermilion is on Potato Island in the Big Bay basin of East Vermilion. Therefore, it is assumed that DCCO foraging is primarily occurring in that region. There was a dramatic increase in DCCO nests on the lake from 2004-2012 (Figure 12). Recent nest counts from 2013-2016 have remained relatively stable following years where control measures have been taken and no new nesting colonies have been observed. Additionally, total bird counts taken in July were greatly reduced during years of control.

Yellow perch gill net catches were below the historic 25th percentile on East Vermilion from 2007-2012 (Figure 13) as the DCCO colony was expanding in that basin. The initial decline in the perch catch on East Vermilion observed in 2007 was possibly related to poor reproduction in 2004, however perch catches persisted at unusually low levels through 2012. Persistent low catches and the lack of variability indicated a potential significant change had occurred in perch population dynamics. Yellow perch gill-net catches were relatively stable on West Vermilion from 1984-2001 (Figure 14). Since that time however, catches have become less stable ranging from about 10 to 73 fish/net. Following initial control efforts in 2013, yellow perch abundance in the annual gill-net assessment was extremely high throughout the lake indicating strong recruitment during previous years of non-control and a potential release from predation.

From 2014-2016, the yellow perch gill-net catch declined dramatically lakewide, but especially in East Vermilion where it is assumed that DCCO primarily prey. Despite three consecutive years of DCCO control, the East Vermilion perch catch in 2015 and 2016 was similar to the unusually low catches observed in pre-control years from 2007 to 2012. Making direct links between DCCO predation and perch abundance is difficult because perch catch rates have been historically extremely variable and because catch rates declined during recent years of control. However, consecutive years with perch catch rates on East Vermilion below the 25th percentile along with 2016 catch rates below the historical median in West Vermilion are concerning. There is no indication that DCCO predation is affecting the walleye population at this time. It is important to recognize that yellow perch are a primary prey source for the walleye population in Lake Vermilion and that these populations are closely linked. Walleye gill-net catches have been at normal to high levels and the size structure has shifted towards larger fish during the time of DCCO colony expansion and control.

DNR Fisheries continues to evaluate alternative options for DCCO research and control. The USFWS is currently in the process of reviewing NEPA (National Environmental Policy Act) which is required before permits will be issued for control programs again.

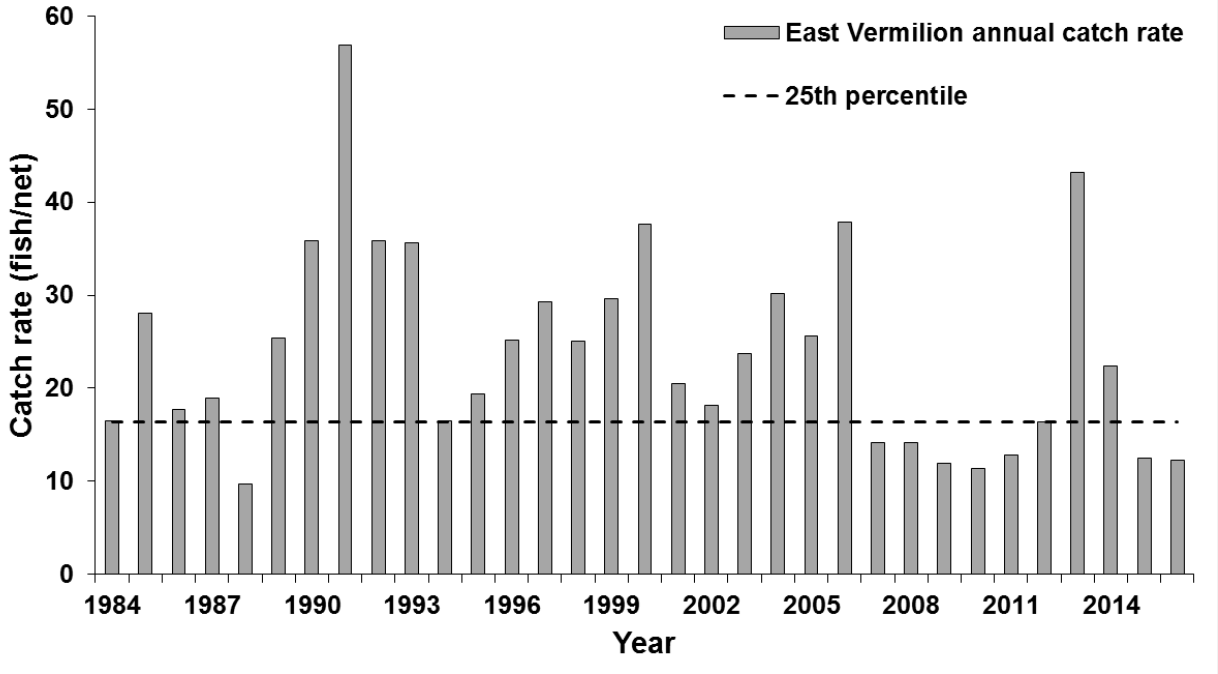

Figure 13. Gill net catch rates for yellow perch in East Vermilion, 1984-2016.

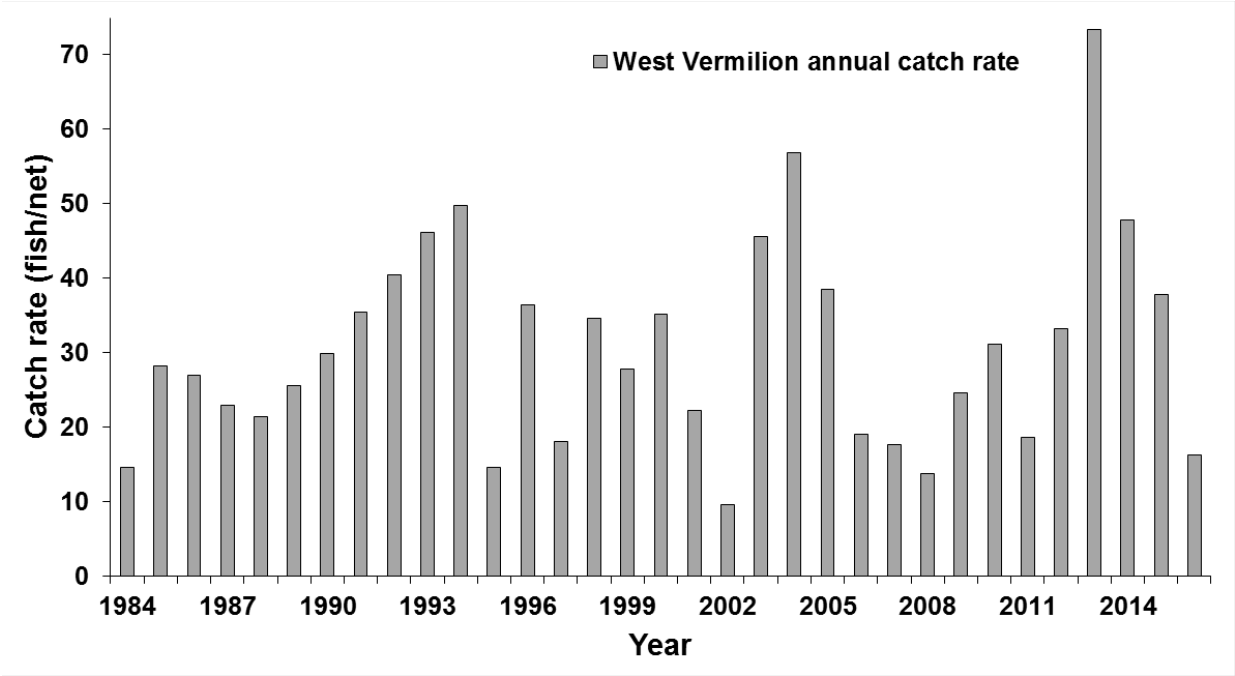

Figure 14. Gill net catch rates for yellow perch in West Vermilion, 1984-2016.

Tournaments

Historically, there have been relatively few permitted fishing tournaments on Lake Vermilion compared to other large lakes in Minnesota. Generally, from two to six permitted fishing tournaments are held annually. Fishing tournaments in Minnesota waters are guided by MN Statutes 97C.081 and MN Rules Chapter 6212.2400 through 6212.2800.

Permits are required if any of the following conditions are met:

- More than 25 boats for open-water contests, more than 150 participants for ice-fishing contests, more than 100 participants for shore-fishing ;
- Entry fees are more than $25 per person;
- The contest is limited to trout species; or
- The total prize value is greater than $500.00.

There may be smaller events that take place that do not require a permit and are not currently regulated by DNR. These smaller events would simply follow fishing regulations for any angler fishing that water. Tournaments and tournament participants are already held to a higher standard than other anglers. Opportunities for further restrictions are limited and will likely meet with opposition.

Applying the Statute and Rule specifically to Vermilion, there shall be at least two weekends (i.e., Saturday and Sunday) per month with no permitted fishing contests. There may be no more than 5 permitted fishing contests in a month, no more than 3 may be large, and there may be no more than 10 permitted fishing days per month. Large fishing contests are defined as having more than 50 boats or 100 participants for open-water events. Permitted fishing contests that are conducted for more than one day may not include more than one weekend day from Memorial Day weekend through Labor Day weekend.

Some special provisions are typically written into permits on the lake mainly because of Vermilion's unique shape and safety concerns. Vermilion has little relatively "wide open" areas and many narrow passage points. The other primary concern was adding some additional protections for bass during June when they may be still spawning on Vermilion.

Standards for Lake Vermilion Tournaments

- No more than 100 boats or 200 entrants per tournament
    - Except for the grandfathered-in City Auto Glass Walleye Classic tournament with a 125 boat, 250 entrant maximum
- No wake zones and staggered starts and weigh-ins
    - If the tournament has an official checkpoint/weigh-in location within Everetts Bay:
        - There will be a no wake zone in Everetts Bay Narrows
        - The tournament start location and end of the day initial check-in point will be outside of Everetts Bay and away from Everetts Bay narrows to minimize conflict with other users
        - The tournament start will include tournament boats passing a start boat single file at low speed with the start boat sending out boats with a minimum interval (approximately 5 seconds) between boats

- Tournament organizers will be strongly encouraged to work with the Vermilion Lake Association and the Northern St. Louis Soil and Water Conservation District for voluntary AIS prevention and inspection
- Other standard statewide tournament policy applies

Standards Specific to June Bass Tournaments on Vermilion

- No bass tournaments will be permitted from Memorial Day up to the 3rd Saturday in June
- Bass tournaments may be permitted in June from the 3rd Saturday to the end of the month provided they have the following conditions:
    - Bag limit of 3 fish per angler or 6 fish per boat (of 2 anglers)
    - No more than 5 weigh-in bags shall be in the weighing queue to minimize time bass are out of the water at weigh-in
    - Live release boats/pontoons will be used to transport bass for release
        - Fish will be redistributed to the east or west basin (i.e., areas east or west of Oak Narrows) in proportion to where they were caught
        - Bass will be released where water depth is a minimum of 6 feet
        - Adequate capacity in live release boats/pontoons to accommodate no more than one pound of bass per gallon of water
        - Fish may not be released in Everetts Bay

Prior to 2017, no bass tournaments were allowed from Memorial Day to June 20th, so the reduced blackout period will be a trial. If excessive mortality occurs, DNR will return to not permitting tournaments from Memorial Day to June 20th. Excessive mortality is defined as more than 20% of bass not surviving post-weigh-in. Some of these restrictions may still be listed as tournament requirements after June.

Input Group member recommendations for improving protection of the lake from AIS:

- Encourage tournament organizers to apply for permits early and to work with the Vermilion Lake Association to address AIS concerns by creating a plan for prevention, including boat decontamination during pre-fishing and during tournaments
- Use removable stickers to mark boats that have been decontaminated; do not allow a boat to access the lake without a sticker showing proof of decontamination
- Find ways to check and clean boats that use private accesses
- Offer trainings on best practices to tournament organizers
- Engage DNR Conservation Officers or others to spot-check boats more frequently during tournaments, and set up clear consequences for noncompliance
- Encourage Catch-Photo-Release format where fish are released immediately at the site of capture

Potential Research and Project Ideas

Several potential projects aimed at better understanding Lake Vermilion and its fishery, as well restoration, and zoning were identified during the planning process. Many of these initiatives need additional scoping to develop and could require additional funding or cooperative agreements.

- Winter creel survey to estimate fishing pressure, catch, and harvest
- Sport gill netting creel survey to assess pressure, bycatch, and harvest
- Broader water quality monitoring including partnering with other agencies for real-time multiple variable station(s)
- Walleye research focused on movement, behavior, and understanding basin specific population dynamics
- Further investigate the impacts of walleye fry stocking on year-class strength via oxytetracycline (OTC) marking and recapture methods
    - Quantify wild fry production, determine the contribution of stocked fry to the total fry density, and determine optimum fry densities
- Partner with agencies/organizations to address shoreland zoning issues
- Aquatic vegetation surveys and restoration

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Appendix A. Issues and Concerns Not Included in Plan Body

Specific to Lake Vermilion

Walleye

Some LVFIG members expressed a desire for a size based objective to define what portion of the population should consist of harvestable-sized walleye (i.e., not protected under a regulation). Although we did not select an objective for size, it should be noted that there was interest in having about 90% of the walleye in East Vermilion and 60% in West Vermilion of a harvestable size. The group also recognized that there is a portion of anglers that enjoy the opportunity to catch and release large walleye. In practical terms this is a difficult aspect to manage because of population variability (i.e., strong and weak year classes) and because there are limited management tools to change how sizes are distributed. Complicating this, is the important goal of protecting a portion of the larger, female walleye (i.e., the spawning stock).

One walleye regulation option discussed by the LVFIG included having separate regulations for the east and west basins. This option was dropped, despite some support, because it would add further complexity to management, including future decisions to adjust the regulation, and it could be more confusing to the general public. Additionally, fish move freely between the two basins of the lake. A lakewide regulation option was preferred because there was room to increase harvest lakewide while still being protective of enough spawning stock in both basins.

A portion of the LVFIG was very concerned about recruitment primarily in West Vermilion. Some weak year classes combined with the protected slot regulation that was implemented in 2006 impacted angler's ability to catch harvestable sized fish. In West Vermilion, walleye between 12 and 18 inches are generally from two to three year classes, making a weak year class very noticeable. The adjusted protected slot regulation implemented in 2017 should alleviate some of this concern by making more year classes available to harvest and decreasing the impact of weak year classes. Since the walleye in East Vermilion tend to grow more slowly, they were available to harvest longer. This, combined with the historic higher abundance makes weak year classes less evident to anglers in that basin.

A portion of the LVFIG and other stakeholders felt that fingerling walleye stocking in West Vermilion should be considered to increase the abundance of harvestable-sized walleye in that basin. Some stakeholders wanted private stocking considered. It was suggested that this in turn would increase angler harvest rates in that basin (i.e., improve fishing for keeper-size walleye). DNR feels that fingerling stocking is not currently a biologically sound management activity because it would not noticeably increase walleye abundance or angler harvest.

There are a number of reasons that fingerling stocking is not supported. First, adding more fish on top of the natural production would increase competition for resources (e.g., prey, habitat, etc.) and could negatively impact growth and survival. Historically, we have seen larger young-of-the-year fish in West Vermilion during fall electrofishing surveys than we see in East Vermilion and first year growth is an important predictor of survival. Adding additional fish to compete with during the

fall in West Vermilion would not be advantageous to their winter survival. Second, West Vermilion's walleye gill net catch rate of about 11 fish/net (1996-2015) is already significantly higher than lakes where fingerling stocking has shown positive results. Third, it was suggested that these fish should be stocked in a relatively small portion of West Vermilion (i.e., the area west of Wakemup Narrows). Fingerling walleye would need two or three years of growth before they would reach preferred harvest size and during this time they could freely disperse throughout the lake. Thus, providing any noticeable improvement in angler harvest is unlikely via fingerling stocking in Lake Vermilion. Therefore, DNR will not propose fingerling stocking using DNR funds and would be opposed to any fingerling stocking due to the reasons outlined. The most effective management action for increasing the number of harvestable walleye at this time was to adjust the special regulation, an action that was pursued.

Group members felt it would be advantageous to know the level of walleye harvest along the Bois Forte Band of Chippewa Reservation for the management of Lake Vermilion. The Bois Forte Band has gillnetted for many years in waters adjacent to the reservation boundary. There is no requirement in the 1854 Treaty or any subsequent agreements for monitoring, recording, or reporting of subsistence fishing harvest by band members on these waters. This harvest is taken into consideration by the DNR in the "unquantified harvest" estimate.

Northern Pike

Several LVFIG members supported pursuing a regulation change that could provide more harvest opportunities for northern pike while still protecting some large pike. There was some support for bringing Lake Vermilion's regulation in-line with the DNR's planned northeast northern pike management zone regulation set to be implemented in 2018, but choice of a specific regulation is not in the LVFMP. We did agree to consider opening the rulemaking process so that a regulation change could be considered.

Muskellunge

Several LVFIG members and stakeholders expressed interest in higher muskie fingerling stocking levels. Suggestions included returning to stocking levels similar to the period from 1987 to 1994 when muskies were stocked at a rate of about 6,000 fish annually. On the other hand, some LVFIG members and stakeholders indicated a desire to discontinue muskie stocking all together. Originally, the draft plan had no changes to the stocking strategy, maintaining a stocking quota of 4,000 fingerlings every other year. After public input on the draft LVFMP, the stocking quota was changed (see Muskellunge Fingerling Stocking for further details).

Statewide Concerns

Tournaments

Broader concerns on tournament rules would have to be addressed by statewide statutes and rules. Suggestions were:

- Require any tournaments with more than 10 boats to apply for a permit to provide additional data about smaller tournaments

- Require earlier due dates for permit applications (e.g., at least two weeks before the tournament date)
- Require certain procedures for fish handling; for example, requiring weigh-in at landings to reduce mortality
- Require fish to be redistributed closer to where they were caught

Sport Gill Netting

There were concerns about bycatch of game fish, such as northern pike, and net marking requirements and enforcement. LVFIG members would like to see improved notification about net marking requirements. There were suggestions to consider a survey of sport gill net license holders to collect data on lakes fished, fishing effort, numbers and type of fish harvested, and numbers and type of bycatch.

Fishing Regulations

LVFIG members expressed support for reviewing possession limits for yellow perch and considering a reduction to a 10 fish possession limit. LVFIG members also expressed support for reviewing possession limits on bluegill and black crappie and considering a reduction to 5 or 10 fish possession limits as part of a statewide rule change.

Appendix B. Historic data

Walleye

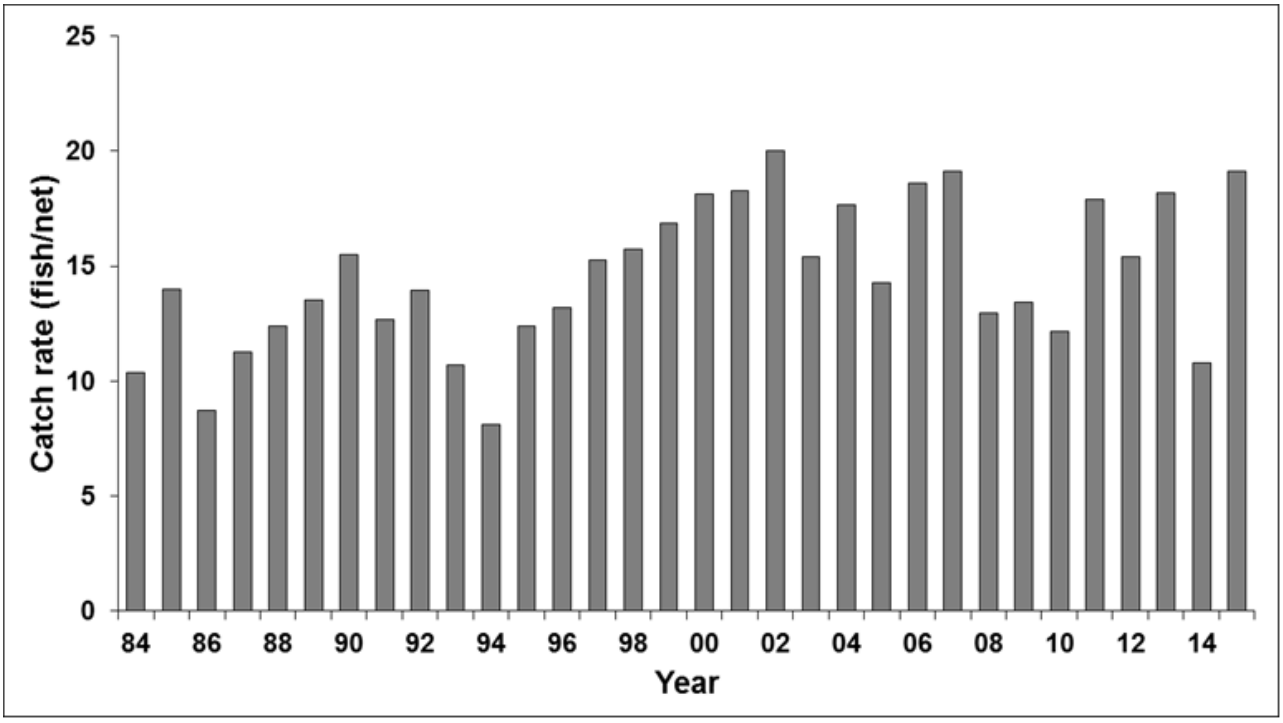

Figure A. Historic walleye gill-net catch rates (fish/net) on Lake Vermilion, 1984-2015.

Muskellunge

Table A. Number, size, and genetic strain of muskellunge stocked in Lake Vermilion, 1968-2015. The modern program began with stocking Leech lake strain muskies in 1987.

Year	Size	Number	Strain
1968	fingerling	475	Shoepac
1969	fingerling	500	Shoepac
1972	fry	21,921	Shoepac
1984	fingerling	1,536	Shoepac
1985	fingerling	1,040	Wisconsin
1987	fingerling	4,979	Leech
1988	fingerling	4,973	Leech
1989	fingerling	5,513	Leech
1990	fingerling	6,648	Leech
1991	fingerling	7,969	Leech
1992	fingerling	4,995	Leech
1993	fingerling	4,999	Leech
1994	fingerling	7,784	Leech
1996	fingerling	4,739	Leech
1998	fingerling	7,749	Leech
2000	fingerling	5,995	Leech
2002	fingerling	5,000	Leech
2004	fingerling	3,955	Leech
2006	fingerling	1,268	Leech
2007	fingerling	2,355	Leech
2008	fingerling	1,292	Leech
2009	fingerling	2,706	Leech
2010	fingerling	4,828	Leech
2012	fingerling	1,993	Leech
2015	fingerling	6,229	Leech
2015	yearling	2,071	Leech

Muskellunge

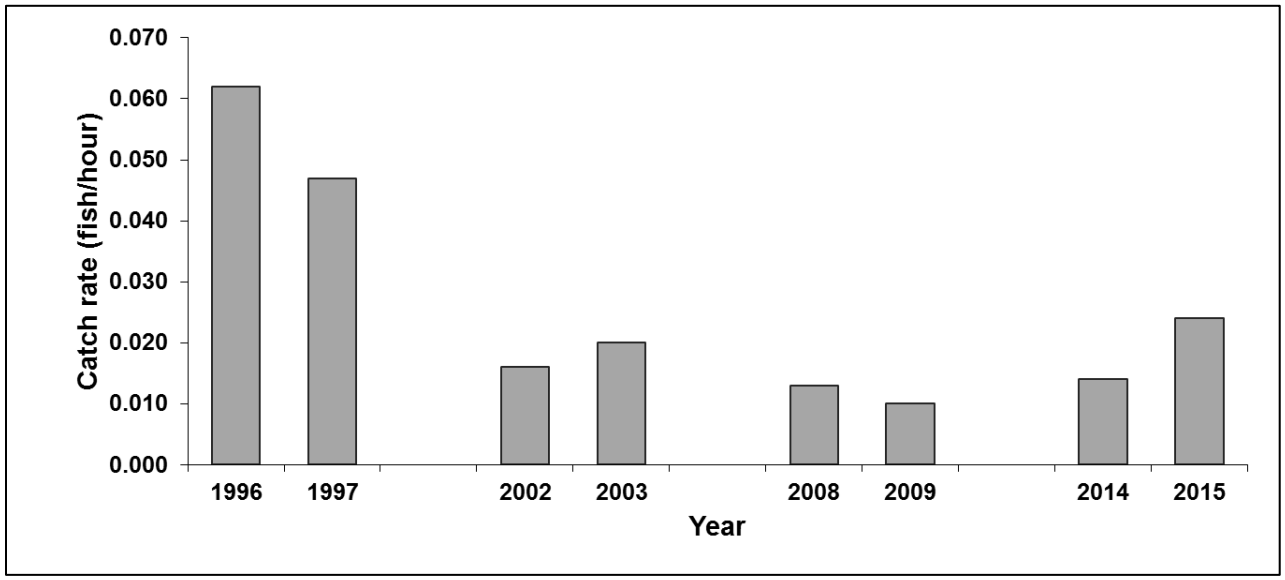

Figure B. Estimated catch rates of anglers targeting muskellunge on Lake Vermilion during open water creel survey years, 1996-2015.

Northern Pike

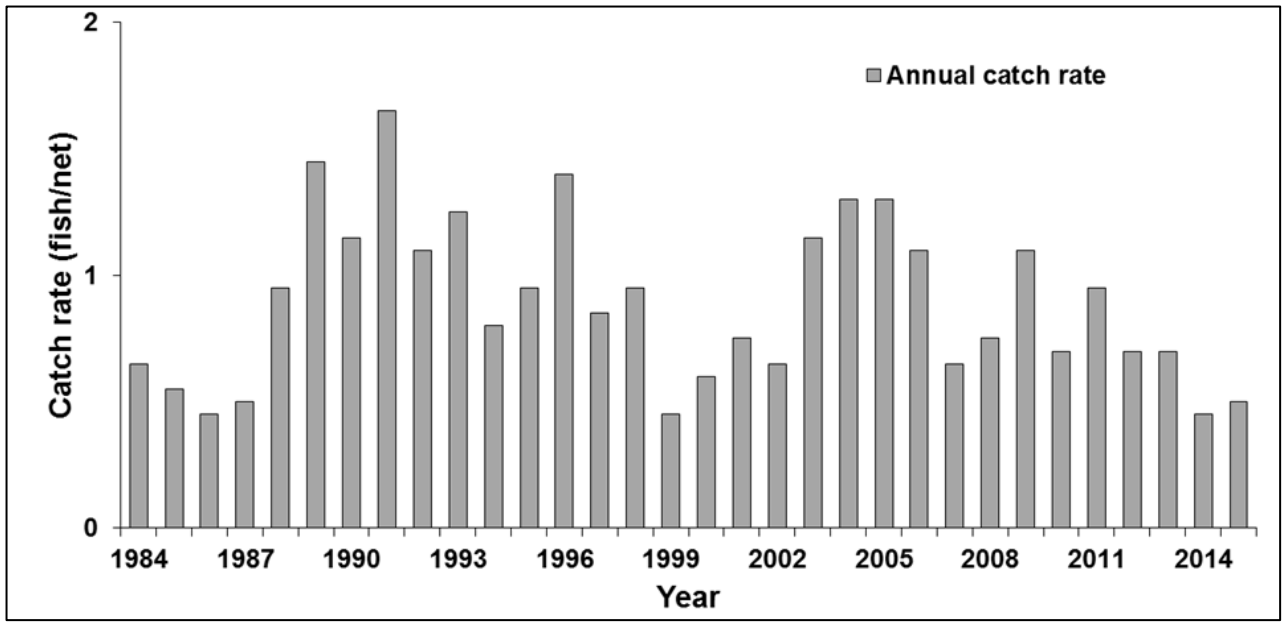

Figure C. Gill-net catch rates (fish/net) of northern pike in Lake Vermilion, 1984-2015.

Appendix C. Acronyms in this Document

AIS	Aquatic invasive species
APM	Aquatic plant management
DCCO	Double-crested cormorant
DNR	Minnesota Department of Natural Resources
EWR	Division of Ecological and Water Resources
FONSI	Findings of No Significant Impact
GIS	Geographic information system
LVFIG	Lake Vermilion Fisheries Input Group
LVFMP	2017-2022 Lake Vermilion Fisheries Management Plan
MNDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
NEPA	National Environmental Policy Act
OHWL	Ordinary high water level
PIT	Passive integrated transponder
PRDO	Public Resource Depredation Order
SSB	Spawning stock biomass; mature female walleye
SWF	Spiny waterflea
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
VHS	Viral hemorrhagic septicemia
YOY	Young-of-the-year