Minnesota
Study 2
Job 4

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
SECTION OF FISHERIES

COMPLETION REPORT FOR MINNESOTA WATERS OF LAKE SUPERIOR

2015

by

Josh Blankenheim

Reimbursed under Federal
Aid by the Sport Fish
Restoration Act

Executive Summary

Sea Lamprey (*Petromyzon marinus*) wounding rates, which were measured as the number of fresh wounds per 100 Lake Trout (*Salvelinus namaycush*), decreased in all statistical zones in the 2015 May Lake Trout assessment. The shorewide wounding rate decreased from 7.0 fresh wounds in 2014 to 3.8 fresh wounds in 2015, which was the second lowest rate on record.

Lake Trout catch rates in the May assessment decreased from 9.6 fish per 1,000 feet of net in 2014 to 8.2 fish per 1,000 feet of net in 2015. For unknown reasons, a large decrease was observed in MN-1 where the catch rate decreased from 25.1 per 1,000 feet of net in 2014 to 8.8 in 2015. Overall, 98% of Lake Trout caught in the May assessment were wild fish. In the juvenile Lake Trout assessment (fish less than 17 inches), the catch rate decreased from 16.8 Lake Trout per 1,000 feet of net in 2014 to 14.6 in 2015, but the catch rate has remained relatively consistent the past ten years. Shorewide, 96% of the juvenile Lake Trout captured were wild fish.

Lake Trout harvest in the summer commercial assessment in MN-2 declined from 2014 whereas the Lake Trout harvest in MN-3 continued to increase towards the quota. Lake Trout harvest in MN-2 decreased to just 287 fish in 2015, which was only 14% of the quota. The catch rate decreased from 4.0 Lake Trout per 1,000 feet of net in 2014 to 3.6 Lake Trout per 1,000 feet of net in 2015. The number of Lake Trout harvested in MN-3 increased to 2,468 fish which was 82% of the quota. The catch rate decreased from 30.0 Lake Trout per 1,000 feet of net in 2014 to 19.6 Lake Trout per 1,000 feet of net in 2015.

Spawning Lake Trout assessments are conducted in alternate years. Catch rates in 2015 were 102, 37, and 100 Lake Trout per 1,000 feet of net in MN-1, MN-2, and MN-3, respectively. In 2015, the proportions of wild Lake Trout sampled in the spawning assessment were 38% (MN-1), 81% (MN-2), and 98% (MN-3), which continues the long term positive trend suggestive of a Lake Trout population rehabilitation. Overall, Lake Trout rehabilitation in the Minnesota waters of Lake Superior has progressed well over the past few decades, and the criteria to discontinue Lake Trout stocking have been

met in all zones. Lake Trout stocking was discontinued in MN-3 and MN-2 in 2003 and 2007, and will be discontinued in MN-1 in 2016.

Siscowet assessments are conducted every three years. The siscowet catch rate in 2015 was 11.8 fish per 1,000 feet of net, which was very similar to the previous six siscowet assessments with the exception of 2009 (5.9 fish per 1,000 feet of net). All siscowet were captured at depths greater than 240 feet. Siscowet ranged from age-5 to age-33. The catch rate of Lake Trout was 2.5 fish per 1,000 feet of net and the Burbot (*Lota lota*) catch rate was 3.3 fish per 1,000 feet of net.

Cisco (*Coregonus artedi*) abundance in the commercial catch has decreased in recent years, primarily due to a lack of a strong year-class since 2003. This lack of a strong year-class has been observed in three independent surveys: MNDNR hydroacoustics, USGS lakewide hydroacoustics, and USGS trawling. Cisco harvest in the traditional gill net fishery (all year excluding November) was only 133,422 pounds, which was second only to 2014 as the lowest harvest since 1987. The catch rate decreased for the third consecutive year to 164 Cisco per 1,000 feet of net. Harvest during the November Cisco fishery increased from 85,533 pounds in 2014 to 111,832 pounds in 2015 and the catch rate increased from 463 pounds per 1,000 feet of net in 2014 to 528 pounds per 1,000 feet of net in 2015. The catch rate of Cisco in the November fishery shows a decreasing trend since 2004. Additionally, the total catch of Cisco of 245,254 pounds was over 100,000 pounds below the 1992-2012 average.

The commercial harvest of non-native Rainbow Smelt (*Osmerus mordax*) increased from 2,685 pounds in 2014 to 23,280 pounds in 2015. Rainbow Smelt catches in recent years have only been 5% of levels observed in the 1970s. Rainbow Smelt remain an important diet item for many fish species, including Lake Trout. However, Rainbow Smelt may also negatively impact Cisco populations due to predation on larval Cisco and competition for food resources.

Table of Contents

Tables

Figures

Introduction

In 1995, the Minnesota Department of Natural Resources (MNDNR), working closely with stakeholders, developed the *Fisheries Management Plan for the Minnesota Waters of Lake Superior* (LSMP) describing specific goals for the Lake Superior fishery and outlining management strategies to accomplish these goals over the next 10 years (Schreiner 1995). With significant public input, the LSMP was revised in 2006 (Schreiner et al. 2006) and again in 2016 (Goldsworthy et al. 2016) to reflect both the progress in achieving previous goals as well as developing new objectives for emerging threats to the lake and its fishery resources. The LSMP serves as the guiding document for implementing a variety of management and assessment strategies for fishery management in the Minnesota waters of Lake Superior. This report summarizes annual assessment work conducted by the Lake Superior Area Office in Minnesota's portion of Lake Superior in 2015 including the May Lake Trout (*Salvelinus namaycush)*, siscowet Lake Trout, juvenile Lake Trout, summer expanded commercial Lake Trout, spawning Lake Trout, and forage fish (Cisco *Coregonus artedi* and Rainbow Smelt *Osmerus mordax*) assessments.

Rehabilitation of self-sustaining Lake Trout stocks has been the major goal for agencies around Lake Superior since the collapse of the Lake Trout fishery due to commercial over-exploitation and predation by Sea Lamprey (*Petromyzon marinus*) (Horns et al. 2003). Lake Trout is the primary species caught by anglers and at present supports a recreational fishery with an average annual harvest of 23,708 fish (2006-2015) in the Minnesota waters of Lake Superior (Reeves 2016). Lake Trout is the dominant predator species in Lake Superior and have a large influence on prey fish abundance, particularly the non-native Rainbow Smelt. Chinook Salmon (*Oncorhynchus tshawytscha)*, Coho Salmon (*O. kisutch)*, and Rainbow Trout (*O. mykiss*) are not vulnerable to MNDNR assessment gill nets. The status of these salmonid species is discussed in creel survey reports and reports on the operation of the French and Knife River traps (Peterson 2016a; Peterson 2016b; Peterson 2016c; Reeves 2016).

The deepwater morphotype of Lake Trout is known as the siscowet, generally lives in depths greater than 240 feet, and is the most abundant predator in Lake Superior. For consistency throughout this report, lean Lake Trout will be referred to as "Lake Trout" and siscowet Lake Trout will be referred to as “siscowet”. Trends in siscowet and other predator populations are monitored by a tri-annual lake-wide gillnet assessment which samples a depth range from near zero to over 600 feet. The goal of assessing the siscowet population is to gain insight into their ecological role, determine fish abundance in offshore waters, and better understand diet, age, and size structure of the population.

Cisco and Rainbow Smelt are important forage species in Lake Superior and both support commercial fisheries. Population dynamics are monitored by analyzing commercial fishing records, hydroacoustic surveys, and MNDNR assessment netting (Blankenheim 2015). Although Rainbow Smelt abundance has decreased since the 1960s, they are the primary prey item in the spring diets of Lake Superior predators (Ray et al. 2007).

Methods

Assessment methods for the May Lake Trout, juvenile Lake Trout, spawning Lake Trout, and forage fish populations have been previously described in Halpern and Schreiner (2003). Locations for May and juvenile Lake Trout net sets and statistical zones are shown in Figures 1 and 2. Gillnets for the siscowet assessment consisted of nine 250 foot panels with stretch mesh sized from 2.0 to 6.0 inches in ½-inch increments. Randomly selected mesh sizes were combined into two gangs, one of five nets (1,250 feet) and one of four nets (1,000 feet). Six different depth strata of 120 feet apiece were sampled during the siscowet assessment covering depth ranges from near zero to 600+ feet deep. Each gang fished one night in a particular depth strata, then was re-deployed in the complementing depth strata occupied by the other gang the previous night. For example, on the first day of the assessment in 2015 the five-net gang was set in the 120-240 foot depth strata and four-net gang was set in the 480-600 foot depth strata. The next day the five-net gang was set in the 480-600 foot depth strata and the four-net gang was set in the 120-240 foot depth strata. This way, two different depth strata were fished with the entire compliment of mesh sizes in two days. Detailed net specifications can be found in Ebener (2001).

A limited summer expanded commercial Lake Trout assessment fishery was permitted beginning in 2007 for MN-3 and in 2010 for MN-2. The annual Lake Trout limits were 3,000 fish in MN-3 and

2,000 fish in MN-2 and the season was open from June 1st through September 30th. In 2015, four commercial operators fished in MN-3 and two commercial operators fished in MN-2. This limited commercial fishery serves as a surrogate for the September Lake Trout assessment that was discontinued in 2010 due to reduced budgets and staff. Detailed information on the limited commercial Lake Trout fishery can be found in Blankenheim (2015).

Beginning in 2006, catch per unit effort (CPUE) has been corrected for soak time (i.e., the numbers of nights the nets were fished). Correction factors for gill-net CPUE developed by G.L. Curtis (Great Lakes Science Center, unpublished; cited in Hansen et al. 1998) were used to standardize 2- and 3-night sets to a uniform base of one night. Thus, the net length was multiplied by 1.52 for 2-night sets and 1.8 for 3-night sets. Sampling locations are shown in Fig. 1 and statistical districts are shown in Fig. 2.

Previously in MN-1, Lake Trout CPUE was calculated using an average of individual net CPUE's:

$$\overline{CPUE_i} = \frac{\sum \frac{C_i}{f_i}}{n},$$

where C_i = individual net catch (number of Lake Trout), f_i = fishing effort (1,000 feet of gill net), and n = the number of net sets in a given year. The benefit of this equation is confidence limits can be calculated for the CPUE value, which we do not utilize in this report. For data clarity, consistency between statistical districts, and ease of understanding in reporting, the CPUE calculation was changed to:

$$CPUE = \frac{\sum C_i}{\sum f_i},$$

and all previous years CPUE were recalculated for MN-1. Therefore, historical CPUEs in this report may be slightly different than in previous reports.

The MNDNR Cisco assessment consisted of two gangs of three multi-mesh (2.0-, 2.5-, and 3.0-inch stretch mesh) net which were each 100 feet long for a total of 300 feet of net per gang. One gang was set at 12 feet below the surface and the other at 25 feet below the surface. Sampling began in the first week of October with a goal of 100 Cisco samples. Due to the time constraints of otolith aging and reporting, age data of Cisco sampled in 2015 were not yet available.

Results and Discussion

May Assessment

The number of fresh Sea Lamprey wounds per 100 Lake Trout, or wounding rate, observed in MN-1 during the May assessment decreased from 8.1 fresh wounds in 2014 to 2.1 fresh wounds in 2015 and marked only the second time in the past decade that the wounding rate in MN-1 was below the target of 5.0 (Table 1, Figure 3). In MN-2, the zone that typically has the lowest wounding rate, the number of fresh wounds decreased from 3.6 wounds in 2014 to 0.7 in 2015 and represents the lowest wounding rate ever observed in MN-2. The wounding rate also decreased in MN-3, dropping from 8.6 fresh wounds to 5.9 wounds, but again remained above the target rate. The overall wounding rate was 3.8 fresh wounds which was the second lowest wound rate ever observed (Figure 4).

Sea Lamprey control efforts have kept the population at or below 10% of peak abundance. Nevertheless, Sea Lamprey are still a major cause of Lake Trout mortality in Minnesota waters and in most years kill more Lake Trout than the sport, commercial, assessment, and tribal fisheries combined. In 2005 and 2006, increased Sea Lamprey wounding was observed not only in Minnesota waters of Lake Superior, but in other jurisdictions of Lake Superior as well. Sea lamprey control efforts were intensified and wounding rates have generally been nearer the target rate of <5% in the Minnesota waters of Lake Superior, demonstrating the importance of continued control efforts by the U.S. Fish and Wildlife Service.

Lake Trout CPUE in the May assessment decreased from 9.6 fish per 1,000 feet of net in 2014 to 8.2 in 2015. Lake Trout CPUE was highest for fish in the 21.0-24.9 inch range (Table 2). Lake Trout CPUE for MN-1, MN-2, and MN-3 were 8.8, 3.5, and 24.3 fish per 1,000 feet of net (Table 3). Since the mid-2000s, a positive trend has been observed in Lake Trout CPUE in MN-1 and MN-3, whereas CPUE in MN-2 has been lower and has not displayed a positive trend (Figure 5). However, in 2015 CPUE in

MN-1 dropped significantly causing immediate concern among some anglers. The cause of this low CPUE is unknown. The data point may simply be a single year anomaly rather than an indication of a problem such as excessive harvest, but nevertheless CPUE in MN-1 should be monitored closely over the next few years. Wild fish comprised 98% of Lake Trout sampled during the 2015 May assessment which continued the positive trend for percent wild fish (Figure 6).

Age-7 through age-9 Lake Trout have been the most abundant age-classes in recent May assessments. In 2015, age-6 (n = 28), age-7 (n = 73), age-8 (n = 47), age-9 (n = 28), and age-10 (n = 28) Lake Trout were most abundant (Table 4). Of the 201 Lake Trout ages six through ten, only 1.5% (n = 3) were hatchery fish. This provides additional evidence that stocked Lake Trout survival is extremely low.

By weight, diet composition of Lake Trout in the 2015 May assessment was Burbot (*Lota lota*; 24.6%), unidentifiable fish remains (23.5%), Rainbow Smelt (21.1%), *Mysis* (15.0%), coregonids (9.0%), Lake Trout (2.1%), Bloater (*Coregonus hoyi*; 2.0%), and other diet items (2.7%) (Table 5). In the three previous May assessments Rainbow Smelt comprised over 70% of stomach content biomass, which was much higher than observed in 2015. Twenty-two percent of Lake Trout had no prey items in their stomachs (n = 77), which was a greater percentage than in 2012 (12%), 2013 (3%), and 2014 (17%).

Decreases in overall CPUE of Lake Trout, as well as increases in the proportions of wild and larger Lake Trout, have been observed by other agencies around Lake Superior as rehabilitation of Lake Trout has progressed. It is likely that high Lake Trout abundance observed in the 1980s resulted from stocked fish filling niches made vacant by Sea Lamprey predation and increased availability of forage in the form of extremely high numbers of Rainbow Smelt. Subsequent decreases in overall Lake Trout abundance were predominantly the result of a decrease in the survival of stocked fish, probably due to direct predation and competition with wild fish (Hansen et al. 1996), and reflect a fishery approaching a more sustainable level (Corradin et al. 2008; Negus et al. 2008). Decreases in overall abundance of Lake Trout may also reflect changes in behavior and catchability of adult Lake Trout in the May assessment. As the Rainbow Smelt population declined, a shift in forage to Cisco could have resulted in Lake Trout dispersing over broader areas in search of food.

Juvenile Lake Trout Assessment

In 2015, CPUE of juvenile Lake Trout (less than 17 inches) was 14.6 fish per 1,000 feet of net and CPUE has been relatively consistent during the past ten years (Table 6, Figure 7). Wild fish comprised 96% of the juvenile Lake Trout catch (Table 7, Figure 7). By weight, juvenile Lake Trout diets were comprised of *Mysis* (48.4%), terrestrial insects (18.9%), unidentifiable fish remains (16.7%), Rainbow Smelt (7.0%), various sculpin species (7.8%), and other prey items (1.2%) (Table 5). Twenty-seven percent (n = 83) of juvenile Lake Trout stomachs contained no prey items in 2015, similar to the 24% observed in 2014.

Lake Trout recruitment may be reaching a level representative of self-sustaining Lake Trout populations in Lake Superior indicated by high proportions of wild adults and juveniles sampled in recent years. Continued stocking of large numbers of Lake Trout in areas where wild fish account for over 50% of the catch may depress the rehabilitation of wild fish. Shorewide reductions in stocking numbers were initiated when criteria from the Lake Trout Rehabilitation Plan (LTRP) were met (Hansen 1996; Schreiner et al. 2006). Criteria to discontinue stocking were met in both MN-3 and MN-2, and stocking ceased in 2003 and 2007, respectively. Additionally, during the revision of the LSMP in 2006 the decision was made to reduce stocking in MN-1 to 170,000 yearling per year (Schreiner et al. 2006). More recently, all criteria in the LTRP were met in MN-1 and during the revision of the LSMP in 2015 (Goldsworthy et al. 2016) the decision was made to discontinue Lake Trout stocking in MN-1 beginning in 2016. In addition to the criteria being met, an outbreak of furunculosis in the Crystal Springs hatchery resulted in the depopulation of the facility, including the Lake Trout brood stock. Contingency planning is currently underway to develop strategies should development of a brood stock be needed in the future.

Based on what was observed with post-rehabilitated Lake Trout populations in eastern Lake Superior, it can be expected in Minnesota waters that wild Lake Trout abundance will continue to increase to its peak and subsequently decline to a point of equilibrium. It is also expected that the increase in wild Lake Trout abundance will negate any potential negative effect of discontinuing stocking with little overall impact to the sport fishery. This scenario is similar to what occurred in other jurisdictions following the discontinuation of stocking. MNDNR will continue Lake Trout assessment activities to determine whether rehabilitated wild stocks can remain self-sustaining given current and anticipated future rates of harvest.

Summer Expanded Commercial Assessment

In 2015, the limited commercial fishery for Lake Trout in MN-2 entered its sixth year. The number of Lake Trout harvested in MN-2 decreased from 423 fish in 2014 to 287 fish in 2015, and CPUE decreased to 3.6 Lake Trout per 1,000 feet of net (Figure 8). Commercial netters only harvested 14% of the total-allowable-catch (TAC) of 2,000 Lake Trout from MN-2. The estimated number harvested in the 2015 sport fishery in MN-2 was 4,923 Lake Trout, demonstrating that commercial fishing accounted for only a small percentage (6%) of the total Lake Trout harvest in MN-2.

In 2015, the limited commercial fishery for Lake Trout in MN-3 entered its ninth year. Commercial netters harvested 2,468 Lake Trout in MN-3, which was the highest harvest to date (Figure 8). However, the catch rate decreased to 19.6 Lake Trout per 1,000 feet of net. Commercial netters harvested 82% of the 3,000 fish TAC. Sport anglers harvested an estimated 3,254 Lake Trout in MN-3 in 2015; therefore commercial fishing accounted for 43% of the total Lake Trout harvest in MN-3.

Lake Trout diet composition by weight in the summer commercial assessment was *Mysis* (36.9%), coregonids (28.3%), unidentifiable fish remains (15.8%), terrestrial insects (7.5%), Burbot (3.9%), Kiyi (2.3%), Rainbow Smelt (1.4%), various sculpin species (1.3%), salmonids (1.0%), and other items (1.6%) (Table 5). Thirty-seven percent of Lake Trout stomachs (n = 203) had no diet items, which was similar to 41% in 2014.

Spawning Assessment

Lake Trout spawning assessments are conducted in alternate years. Aging data was not available at the time of this writing. In 2015, CPUEs for MN-1, MN-2, and MN-3 were 102, 37, and 100 fish per

1,000 feet of net, respectively (Table 8, Figure 9). The percent wild Lake Trout was 38% in MN-1, 81% in MN-2, and 98% in MN-3 (Table 8, Figure 10). The percent of the Lake Trout catch that was wild fish changed very little compared to 2013, but the long term trend for each management zone is positive, further reinforcing stocking is not necessary at this point in rehabilitation. The percentage of wild fish in MN-1 will likely increase in the future as rehabilitation in this zone continues and no additional Lake Trout are stocked in Minnesota waters.

Despite sampling into the first week of November, the sex ratio was still heavily skewed towards males. Eight-five percent of the catch in MN-1 was males, while in MN-2 76% of examined fish were males, and in MN-3 77% of examined fish were males. Ninety-two percent of Lake Trout sampled during the spawning assessment had no prey items in their stomachs (n = 231), which is not unusual for spawning fish. Prey items were mostly unidentifiable fish remains (47.7%) and Rainbow Smelt (41.3%) (Table 5).

Lake Trout Modeling

In 2005, we developed a Statistical Catch-at-Age (SCAA) model for Lake Trout. This is an important tool for assessing the status of Lake Trout stocks in Minnesota waters of Lake Superior and will assist us in determining sport and commercial harvest levels. This type of model is presently used to help manage the tribal, sport and state commercial fisheries in Wisconsin and Michigan. A description of the model and discussion of the results from 2005 through 2009 can be found in Halpern (2010).

Lake Trout total annual mortality and spawning stock biomass (SSB) are parameters estimated in SCAA models. Healey (1978) suggested that a Lake Trout population would decline if it suffered more than 50% total annual mortality. Other models showed that Lake Trout spawner abundance decreased when total annual mortality exceeded 45% (Technical Fisheries Review Committee 1992; Ebener et al. 1989), so this figure was used as the maximum acceptable mortality in the LTRP (Hansen 1996) and in the LSMP (Schreiner et al. 2006). However, Nieland et al. (2008) suggested Lake Trout populations in the eastern Wisconsin waters of Lake Superior are likely to be sustainable when total mortality is 40% or less. Moving forward we will manage the Lake Trout fishery using the 40% total mortality threshold. We will continue to monitor the fishery closely and adjust harvest levels, if appropriate. We are monitoring SSB and investigating its usefulness as another criterion for managing the Lake Trout population. Presently, we are updating and evaluating the Lake Trout SCAA model and investigating various means of assessing it, such as retrospective analysis, Monte Carlo simulations and others.

In general, Lake Trout restoration in Minnesota waters of Lake Superior has proceeded well. However, there is little expectation for further large increases in the number of Lake Trout (Schreiner et al. 2006; Corradin et al. 2008; Negus et al. 2008). Importantly, the transition from a fishery dominated by stocked fish to one dominated by wild fish has occurred. Therefore, Lake Trout abundance should stabilize around a new equilibrium more aligned with forage availability, natural population dynamics, Sea Lamprey predation, and commercial and sport harvest. We are continuing to refine our assessment of fish stocks, and our models for Lake Trout and Cisco, in order to better understand the population dynamics of these important fish in Minnesota waters of Lake Superior.

Siscowet Assessment

Siscowet CPUE was 11.8 fish per 1,000 feet of net in 2015 (Table 9, Figure 11). With the exception of 2009, siscowet CPUE has remained very consistent since 1997. No siscowet were captured shallower than 240 feet and their abundance was highest in waters deeper than 600 feet. Lean Lake Trout CPUE was 2.5 in 2015 (Table 9, Figure 11). Lean Lake Trout were most abundant in waters shallower than 360 feet and only comprised 3% of the total Lake Trout catch in waters greater than 360 feet. Burbot CPUE was 3.3 fish per 1,000 feet of net, which was the lowest observed in any siscowet assessment but still similar to all other survey years except 2012 when CPUE was 7.9 (Table 9, Figure 11). Burbot were caught in all depth strata in 2015. Both Bloater and Kiyi were also captured, and all were at depths greater than 360 feet (Table 9).

Age-13 (n = 10) and age-15 (n = 14) siscowet were most abundant, but the age distribution was spread widely across age-5 to age-25 (Table 10). The oldest fish was age-33 but only 21.3 inches in length. There was considerable overlap in age for any given length, which was not surprising given the slow-growing nature and longevity of siscowet. For example, a siscowet in the nineteen inch class was anywhere from eleven to twenty-five years old.

Siscowet diet composition by weight was sculpin species (41.4%), unidentifiable fish remains (38.1%), terrestrial insects (10.9%), fish eggs (2.9%), coregonids (2.7%), *Mysis* (2.0%), and other items (2.0%) (Table 11). Eighteen percent (n = 24) of siscowet stomachs contained no prey items. Although sculpins comprised a large percentage of siscowet diet, 11% of the diet biomass was terrestrial insects, which indicates that these fish make feeding excursions to the surface where terrestrial insects often accumulate in large “bug slicks”. This finding has been corroborated by recent research demonstrating that some siscowet make vertical migrations through the entire water column (unpublished data, Michigan DNR). Nearly half of the biomass in Lake Trout stomachs was *Mysis* (47.6%), while unidentifiable fish remains (20.7%) and Burbot (19.5%) comprised most of the rest of the biomass (Table 5). Burbot stomachs contained primarily rocks (32.3%), unidentifiable fish remains (25.4%), sculpin species (14.8%), and *Mysis* (13.7%) (Table 11). Twenty-six percent (n = 9) and 18% (n = 8) of Lake Trout and Burbot stomachs contained no prey items.

<u>MNDNR Cisco Assessment</u>

Age data from the 2015 spring and fall Cisco assessments were not yet available at the time of this writing. Age analysis from the 2014 spring and fall Cisco samples collected by MNDNR and commercial netters (n = 765) showed that the 1998, 2003, and 2009 year-classes accounted for the vast majority of the catch (Figure 12). Most Cisco were age-5 (2009 year-class), age-11 (2003 year-class), and age-16 (1998 year-class), and fish up to age-29 (1985 year-class) were captured. Unfortunately, U.S. Geological Survey trawling data indicates no significant year-classes have been produced since the 2003 year-class (Figure 12; Gorman et al. 2013). Despite being small, the 2009-year class accounted for 32% of the fish in the Cisco assessments. There will not be a significant source of Cisco entering the fishery until a strong year-class is produced. Until then, the Cisco stocks will likely decline as the weak year-classes are fished heavily, so care must be taken to manage conservatively and avoid collapse of the fishery.

A management strategy to assess forage species as stated in the LSMP is to use hydroacoustic sampling and trawl surveys to monitor year-class strength and determine biomass of Cisco and Rainbow Smelt in Minnesota's portion of Lake Superior. In late summer of 2003 a pilot project was initiated to address this objective. The Lake Superior Area fisheries staff collaborated with Dr. Tom Hrabik from the University of Minnesota Duluth to develop a hydroacoustic program that would quantify prey fish abundance (Hrabik et al. 2006). From 2003- 2015, hydroacoustic surveys of Minnesota waters of Lake Superior were conducted. These surveys have confirmed that the 2003 year-class is relatively strong in Minnesota waters of Lake Superior, and have yielded estimates of Cisco biomass that are being used to determine the TAC for Cisco (Hrabik et al. 2006; Schreiner et al. 2006). The feasibility of using a harvest-based model for Cisco is being explored by the Quantitative Fisheries Center at Michigan State University, and in the future may be used to complement the hydroacoustic surveys in determining the TAC in the commercial Cisco fishery.

<u>Commercial Cisco and Rainbow Smelt Harvest</u>

From the mid-1980s through early 2000s, Cisco harvest by commercial netters gradually increased from a low of 55,000 pounds to a peak of 450,000 pounds annually, driven largely by strong year-classes produced in 1984 and 1988-1990, and moderately strong year-classes in 1985, 1998, and 2003 (Figures 12 and 13). In 2001, harvest in November began due to a developing roe fishery but the overall harvest did not increase; rather, the traditional gill net fishery (i.e. all months except November) declined. From 1992 through 2012, the total Cisco harvest exceeded 300,000 pounds every year but 2010 and averaged 363,384 pounds per year. The total catch in 2013 (263,263), 2014 (214,494), and 2015 (245,254) has been at least 100,000 pounds below the previous 21 year average. In 2015, the Cisco catch in the traditional fishery was only 133,422 pounds, which represents the second lowest catch since 1987. Cisco CPUE in the traditional fishery decreased for the third consecutive year to 164 fish per 1,000 feet of net.

Experimental netting for a potential November roe fishery began in 2001 in Minnesota waters, and beginning in 2006 harvest was permitted during November using total-allowable-catch (TAC) quotas established for each statistical district (Schreiner et al. 2006). In 2015, the Cisco harvest and CPUE in the November fishery were 111,832 pounds and 528 fish per 1,000 feet of net, which were increases from the 2014 catch of 85,533 pounds and CPUE of 463 fish per 1,000 feet of net. However, the November roe fishery has shown a pronounced declining trend in CPUE since its peak in 2004, which further indicates that Cisco stocks are being fished heavily and a strong year-class of Cisco is desperately needed to support the future of the fishery. Cisco do not fully recruit to commercial gear until age-4, so no additional Cisco biomass will be available at least through 2017, meaning November quotas may have to be reduced until a strong year-class of Cisco recruits to the fishery.

In 2015, the spring Rainbow Smelt spawning run along the Minnesota shore of Lake Superior remained at a very low level, and anecdotal reports suggest few fish were captured in the dip net fishery, compared to the pre-1980 period. From 1980-1990, commercial harvest had stabilized at approximately 15% of the average harvest during the 1970s. Since then, harvest has declined further to less than 5% of the average harvest of the 1970s (Figure 14). In 2015, one commercial Rainbow Smelt operation located in MN-1 fished the pound net fishery and harvested 23,280 pounds of Rainbow Smelt. Details on both the Cisco and Rainbow Smelt fisheries can be found in Blankenheim (2015).

Stocking

Criteria regarding the use of Lake Trout stocking as a management tool in Lake Superior are discussed in *A Lake Trout Restoration Plan for Lake Superior* (LTRP, Hansen ed. 1996) and the LSMP (Schreiner et al. 2006). Lake Trout stocking has been discontinued in MN-3 (2003), MN-2 (2007) and will be discontinued in MN-1 in 2016. In 2013, the stocking criteria were re-evaluated for MN-1 and revealed low survival of stocked fish to age-7 and a high proportion of spawning sized Lake Trout in the May assessment. These results indicate the criteria have been met to discontinue stocking since 2001. Furthermore, an outbreak of furunculosis in the Crystal Springs hatchery resulted in the depopulation of the facility, including the Lake Trout brood stock.

Two strains of Rainbow Trout were stocked in Minnesota waters of Lake Superior in 2015: steelhead and Kamloops. All steelhead originated from Minnesota stocks. Summaries of the 2015 stocking and proposed 2016 stocking are given in Table 12. More information on the return rates of these programs are available in the annual spring creel and trap reports (Peterson 2016a; Peterson 2016b; Peterson 2016c).

Summary

Overall, the fish community of Lake Superior represents a native fish community with Lake Trout as the dominant predator. The high proportion of wild juvenile and adult Lake Trout in Minnesota waters of Lake Superior is indicative of positive results from restoration efforts. The Lake Trout population may be reaching a new equilibrium more aligned with natural population dynamics, Sea Lamprey predation, and commercial and sport harvest. Managers, commercial operators, and sportsmen must use caution regarding increased harvest of Lake Trout, since history has proven long-lived fish species are quite vulnerable to overharvest.

Catch rates in the traditional and November commercial Cisco fishery have decreased due to a lack of a strong year-class since 2003. The strength of the 2009 year-class has been only moderate at best, but is being heavily relied upon to supply harvest. Cisco biomass declines have been observed in MNDNR hydroacoustics surveys, United States Geologic Survey (USGS) lakewide hydroacoustic surveys, and USGS bottom trawl surveys. Based on USGS bottom trawl surveys, no new year classes were produced from 2010-2013 and the 2014 year-class appears moderate at best. Therefore, knowing that Cisco fully recruit to the commercial gear at age 4, no additional Cisco biomass will contribute to the commercial fishery through 2017. This will likely lead to reduced November quotas in the commercial Cisco fishery and will further strain the already diminished prey base in Lake Superior.

Literature Cited

Blankenheim, J. Commercial fishing summary, Minnesota waters of Lake Superior, 2015. Minnesota Department of Natural Resources, St. Paul, MN.

Corradin, L., M.J. Hansen, D.R. Schreiner, and M.J. Seider. 2008. Recruitment dynamics of Lake Trout in Western Lake Superior during 1980-1995. North American Journal of Fisheries Management 28: 663-677.

Ebener, M.P., J.H. Selgeby, M.P. Gallinat and M.Donofrio. 1989. Methods for determining total allowable catch of Lake Trout in the 1842 treaty-ceded area within Michigan waters of Lake Superior, 1990-1994. Great Lakes Indian Fish and Wildlife Commission, Biological Services Division, Administrative Report 89-11.

Ebener, M.P. (Editor). 2001. Sampling and reporting protocols of the Lake Superior Technical Committee. Report to the Lake Superior Technical Committee.

Goldsworthy, C.A., K.A. Reeves, J.E. Blankenheim, and N.R. Peterson. 2016. Fisheries management plan for the Minnesota waters of Lake Superior. Minnesota Department of Natural Resources, St. Paul, MN.

Gorman, O.T., L.M. Evrard, G.A. Cholwek, and M.R. Vinson. 2013. Status and trends in the Fish Community of Lake Superior, 2012. Great Lakes Fishery Commission. Report to the Lake Superior Committee Meeting. Duluth, Minnesota.

Halpern, T.N. 2010. Model assessment for Lake Trout management units MN-1, MN-2 and MN-3, 2004-2008. Minnesota Department of Natural Resources.

Halpern, T.N. and D.R. Schreiner. 2003. Completion Report for Minnesota waters of Lake Superior. Minnesota Department of Natural Resources, F-29-R(P)-22, Study 2, Job 4.

Hansen, M.J. (Editor). 1996. A Lake Trout restoration plan for Lake Superior. Great Lakes Fishery Commission.

Hansen, M.J., M.P. Ebener, R.G. Schorfhaar, S.T. Schram, D.R. Schreiner, J.H. Selgeby and W.W. Taylor. 1996. Causes of declining survival of Lake Trout stocked in U.S. waters of Lake Superior in 1963-1986. Transactions of the American Fisheries Society 125(6):831-843.

Hansen, M.J., R.G. Schorfhaar and J.H. Selgeby. 1998. Gill-net saturation by Lake Trout in Michigan waters of Lake Superior. North American Journal of Fisheries Management 18:847-853.

Healey, M.C. 1978. The dynamics of exploited Lake Trout populations and implications for management. Journal of Wildlife Management 42:307-328.

Horns, W.H., C.R. Bronte, T.R. Busiahn, M.P. Ebener, R.L. Eshenroder, T. Gorenflo, N. Kmiecik, W. Mattes, J.W. Peck, M. Petzold and D.R. Schreiner. 2003. Fish Community Objectives for Lake Superior. Great Lakes Fishery Commission Special Publication 03-01, Ann Arbor, MI.

Hrabik, T., D. Schreiner, M. Balge and S. Geving. 2006. Development of a hydroacoustic survey design to quantify prey fish abundance in the Minnesota waters of Lake Superior. Minnesota Department of Natural Resources Investigational Report 530.

Negus, M., D.R. Schreiner, T.N. Halpern, S.T. Schram, M.J. Seider and D.M. Pratt. 2008. Bioenergetics evaluation of the fish community in the western arm of Lake Superior in 2004. North American Journal of Fisheries Management 28(6):1649-1667.

Nieland, J. L., M. J. Hansen, M. J. Seider, and J. J. Deroba. 2008. Modeling the sustainability of Lake Trout fisheries in eastern Wisconsin waters of Lake Superior. Fisheries Research 94:304–314.

Peterson, N. 2016a. Results of operating the juvenile and adult fish traps on the French River 2015. Minnesota Department of Natural Resources. F29R (P) Segment 32 (yr 1), Study 3 Job 3.

Peterson, N. 2016b. Results of operating the Juvenile and adult fish trap on the Knife River, 2015. Minnesota Department of Natural Resources. F29R (P) Segment 32 (yr 1), Study 3 Job 3.

Peterson, N. 2016c. Completion Report: Lake Superior Spring Creel Survey 2015. Minnesota Department of Natural Resources, R29G60F29RP32 Segment 32-1, Study 4 Job 976.

Ray, B.A., Hrabik, T.R., Ebener, M.P., Gorman, O.T., Schreiner, D.R., Schram, S.T., Sitar, S.P., Mattes, W.P., and Bronte, C.R. 2007. Variability in Lake Superior Lake Trout diet characteristics and selectivity from 1986-2001. Journal of Great Lakes Research 33: 104-113.

Reeves, K. 2016. Completion Report Lake Superior summer creel survey, 2015. Minnesota Department of Natural Resources, R296G60F29RP31 Segment 32-1, Study 4 Job 977.

Schreiner, D.R. (Editor) 1995. Fisheries management plan for the Minnesota waters of Lake Superior. Minnesota Department of Natural Resources Special Publication 149.

Schreiner, D.R., J.J. Ostazeski, T.N. Halpern and S.A. Geving. 2006. Fisheries Management Plan for the Minnesota waters of Lake Superior. Minnesota Department of Natural Resources Special Publication 163.

Technical Fisheries Review Committee. 1992. Status of the fishery resource-1991, a report by the Technical Fisheries Review Committee on the assessment of Lake Trout and lake whitefish in treaty-ceded waters of the upper Great Lakes: State of Michigan. Mimeo report.

Minnesota
Study 2
Job 4

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
SECTION OF FISHERIES

COMPLETION REPORT FOR MINNESOTA WATERS OF LAKE SUPERIOR

2015

by

Josh Blankenheim

Approved by: ____________________ Date 05/04/2016
Area Fisheries Supervisor

Approved by: ____________________ Date 5/10/2016
Regional Fisheries Approval

Reimbursed under Federal
Aid by the Sport Fish
Restoration Act

Table 1. Number of fresh lamprey wounds per 100 Lake Trout in 4.5 inch stretch mesh May assessment gill nets, by size class and statistical district, 2015. Number of Lake Trout sampled in each length range is listed in parenthesis.

	Size Class				
	432-532 mm (17-20.9 in.)	533-634 mm (21-24.9 in.)	635-736 mm (25-28.9 in.)	737 + mm (29 + in.)	Total
MN-1	0.0 (34)	0.0 (31)	3.7 (27)	25.0 (4)	2.1 (96)
MN-2	1.7 (59)	0.0 (50)	0.0 (16)	0.0 (14)	0.7 (139)
MN-3	2.4 (125)	8.0 (138)	12.0 (25)	0.0 (2)	5.9 (290)
TOTALS	1.8 (218)	5.0 (219)	5.9 (68)	5.0 (20)	3.8 (525)

Table 2. Number of Lake Trout per 1,000 feet of 4.5 inch stretch mesh May assessment gill nets, 2015.

	Size Class					
Assessment	<432 mm (<17 inches)	432-532 mm (17-20.9 inches)	533-634 mm (21-24.9 inches)	635-736 mm (25-28.9 inches)	737+ mm (29 + inches)	Overall
May	0.24	3.31	3.32	1.03	0.3	8.21

Table 3. Corrected Lake Trout catch by station in the May assessment, 2015.

Location	Effort in Feet (corrected effort)	Total Catch (number)	Total Weight (pounds)	Number per 1,000 feet	Pounds per 1,000 feet	Percent Wild
MN-1						
All Stations (n = 7)	11,250 (11,250)	99	401	8.8	35.6	92.9
MN-2						
Split Rock	24,500 (29,980)	99	421	3.3	14.0	94.9
Silver Bay	8,500 (12,530)	48	140	3.8	11.2	100
Totals MN-2	33,000 (42,510)	147	561	3.5	13.2	96.6
MN-3						
Grand Marais	8,850 (12,140)	295	931	24.3	76.7	99.7
Totals MN-3	8,850 (12,140)	295	931	24.3	76.7	99.7
All locations						
Shorewide	**53,100 (65,900)**	**541**	**1,893**	**8.2**	**28.7**	**97.6**

Table 4. Age-length frequency distribution of otolith aged Lake Trout in 4.5 inch stretch measure gill nets, May assessment, 2015.

Length (in)	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI+
9.0 - 9.9													
10.0 - 10.9													
11.0 - 11.9	1												
12.0 - 12.9	1												
13.0 - 13.9	1												
14.0 - 14.9		1											
15.0 - 15.9		1	1										1
16.0 - 16.9		2	4										
17.0 - 17.9		1	11	3	1								1
18.0 - 18.9			7	12	1			1		1	1		
19.0 - 19.9			4	16	7	3	2	2	1				
20.0 - 20.9			1	30	5	5	1	1	2	1	1		3
21.0 - 21.9				10	18	6	3	2					
22.0 - 22.9				2	13	5	4	3	2	1			1
23.0 - 23.9					1	6	5	4			2	2	
24.0 - 24.9					1	1	5	3	1	1			1
25.0 - 25.9						2	2		4		1		1
26.0 - 26.9							5	3	6	3			
27.0 - 27.9								4	1	2	2		2
28.0 - 28.9							1		2	1			2
29.0 - 29.9										1	1	1	6
30.0 - 30.9											1	1	
31.0 - 31.9								1		1	1		1
32.0 - 32.9													1
33.0 - 33.9													1
34.0 - 34.9												1	
35.0 - 35.9													2
36.0 - 36.9													
37.0 - 37.9													
38.0 - 38.9													
39.0 - 39.9													
Total	3	5	28	73	47	28	28	24	19	12	10	5	23
Average Length	12.5	15.9	17.9	19.9	21.3	22.1	23.7	24.0	24.9	25.7	25.8	28.4	27.3

Table 5. Diet composition by weight of Lake Trout prey items in the May, juvenile, summer, siscowet and spawning assessments, 2015. The number of stomachs sampled with prey items is shown in parentheses.

	Lake Trout									
Diet item	May		Juvenile		Summer		Siscowet		Spawning	
Aquatic insects	0.1%	(8)	1.6%	(16)	0.4%	(14)				
Artificial fishing bait					0.2%	(1)				
Bird	0.0%	(1)			0.2%	(3)			0.3%	(1)
Bloater	2.0%	(3)								
Burbot	24.6%	(10)			3.9%	(5)	19.5%	(1)	2.7%	(1)
Cisco									2.0%	(1)
Clam sp.					0.0%	(1)				
Coregonid sp.	9.0%	(23)			28.3%	(40)				
Deepwater Sculpin	0.2%	(4)	0.3%	(2)	0.2%	(4)				
Empty		(77)		(83)		(203)		(9)		(231)
Fish eggs	0.1%	(2)			0.0%	(1)	0.5%	(1)		
Kiyi					2.3%	(4)				
Lake Trout	2.1%	(4)								
Larval fish	0.0%	(2)							5.2%	(1)
Mysis	15.0%	(71)	48.4%	(133)	36.9%	(155)	47.6%	(8)		
Ninespine Stickleback	0.0%	(3)			0.0%	(1)				
Other	0.0%	(2)	0.4%	(2)						
Rainbow Smelt	21.1%	(68)	7.0%	(6)	1.4%	(14)			41.3%	(4)
Rocks	0.2%	(18)	0.3%	(3)	0.3%	(18)	0.2%	(1)	0.1%	(2)
Salmonid sp.	0.5%	(1)			1.0%	(1)				
Sculpin sp.	0.6%	(19)	6.0%	(20)	0.8%	(17)	3.4%	(2)		
Slimy Sculpin	0.1%	(2)			0.3%	(7)				
Spoonhead Sculpin	0.1%	(2)	0.2%	(1)	0.0%	(1)				
Stickleback sp.	0.0%	(3)			0.0%	(1)				
Terrestrial insects	0.6%	(30)	18.9%	(84)	7.5%	(72)	8.1%	(12)	0.6%	(3)
Unidentifiable fish remains	23.5%	(150)	16.7%	(43)	15.8%	(99)	20.7%	(13)	47.7%	(12)
Woody debris	0.1%	(20)	0.2%	(3)	0.3%	(13)				

Table 6. Summary of fishing effort, catch, percentage of wild Lake Trout and CPUE (number of fish per 1,000 feet) in the juvenile Lake Trout (less than 17 inches; 432 mm) assessment, 2015.

Location	Effort in Feet	Corrected Effort in Feet*	Number of lake trout	Percent Wild	CPUE Wild	CPUE Stocked	CPUE Total
MN-1							
Lester River	1,000	1,520	10	80%	5.3	1.3	6.6
Pumping Station	1,000	1,520	29	86%	16.4	2.6	19.1
Stoney Point	1,000	1,520	21	81%	11.2	2.6	13.8
Larsmont	1,000	1,520	7	100%	4.6	0.0	4.6
Two Harbors	1,000	1,520	15	100%	9.9	0.0	9.9
Encampment Island	1,000	1,520	13	100%	8.6	0.0	8.6
MN-1 Total	**6,000**	**9,120**	**95**	**89%**	**9.3**	**1.1**	**10.4**
MN-2							
Split Rock	1,000	1,520	38	100%	25.0	0.0	25.0
Silver Bay	1,000	1,520	13	100%	8.6	0.0	8.6
Taconite Harbor	1,000	1,520	24	100%	15.8	0.0	15.8
Tofte	1,000	1,520	14	100%	9.2	0.0	9.2
MN-2 Total	**4,000**	**6,080**	**89**	**100%**	**14.6**	**0.0**	**14.6**
MN-3							
Grand Marais	1,000	1,520	44	100%	28.9	0.0	28.9
Hovland	1,000	1,000	12	100%	12.0	0.0	12.0
Grand Portage	1,000	1,520	41	100%	27.0	0.0	27.0
MN-3 Total	**3,000**	**4,040**	**97**	**100%**	**24.0**	**0.0**	**24.0**
Shorewide Total	**13,000**	**19,240**	**281**	**96%**	**14.1**	**0.5**	**14.6**

*For CPUE calculations fishing effort was corrected for two night sets (1,000 ft. actual effort x 1.52 = 1,520 feet except for Hovland, which was a one night set).

Table 7. Historical catch summary of Lake Trout less than 17 inches caught in small mesh gill nets (1.5-2.5 inch stretch measure), CPUE (number of fish per 1,000 feet) and percent wild in the juvenile Lake Trout assessment, Minnesota waters of Lake Superior, 1980-2015.

Year	No. Fish Sampled	Number of Wild Fish Per 1,000 Feet	Number of Stocked Fish Per 1,000 Feet	Total Number Per 1,000 Feet	Percent Wild
1980	586	1.2	29.6	30.9	4%
1981	914	2.2	51.7	54	4%
1982	551	1.9	37.7	39.6	5%
1983	454	4.5	22.2	26.7	17%
1984	585	6.7	33.7	40.4	17%
1985	336	4.1	19.9	24	17%
1986	404	5.6	22.6	28.2	20%
1987	350	6	16.8	22.8	26%
1988	271	3.7	12.7	16.4	23%
1989	168	2.7	8.6	11.3	24%
1990	242	3.7	11.1	14.7	25%
1991	384	4.8	15.5	20.3	24%
1992	278	5.1	11.7	16.8	31%
1993	389	6	18.5	24.5	24%
1994	458	6.7	19.4	26.1	26%
1995	352	7.3	12.6	20	37%
1996	468	10.3	16	26.3	39%
1997	439	12	14.9	26.9	45%
1998	557	13.5	16.9	30.4	44%
1999	640	19	17.2	36.2	53%
2000	454	14.4	9.9	24.3	59%
2001	370	12.9	6.3	19.2	67%
2002	484	20.3	4.5	24.8	82%
2003	249	10.5	3.1	13.7	77%
2004	334	13.7	3.7	17.4	79%
2005	402	14	6.3	20.3	69%
2006	306	11	4.9	15.9	69%
2007	222	8.4	3.1	11.5	73%
2008	282	13	1.6	14.7	89%
2009	295	14	1.3	15.3	92%
2010	235	11.5	0.7	12.2	94%
2011*	-	-	-	-	-
2012	332	16.6	0.7	17.3	96%
2013	219	11.0	0.4	11.4	96%
2014	324	16.4	0.5	16.8	97%
2015	281	14.1	0.5	14.6	96%

*No data due to State of Minnesota government shutdown.

Table 8. Catch summary, 2015 Lake Trout spawning assessment.

	MN-1	MN-2	MN-3
Total effort (feet)	2,000	4,260	1,500
Total catch (number)	204	157	150
Number/1,000 feet	102	37	100
Percent native	38.2	80.9	98.0
Number by Sex			
male	174	111	41
female	30	36	12
not examined	0	10	97

Table 9. Catch and CPUE (number per 1,000 feet) in the 2015 siscowet assessment.

Depth Stratum	Length of Net (ft)	Catch					CPUE (fish/1000 ft)				
		Lake Trout	Siscowet	Burbot	Bloater	Kiyi	Lake Trout	Siscowet	Burbot	Bloater	Kiyi
0-119	2,250	8	0	11	0	0	3.6	0.0	4.9	0.0	0.0
120-239	2,250	12	0	23	0	0	5.3	0.0	10.2	0.0	0.0
240-359	2,250	10	30	4	0	0	4.4	13.3	1.8	0.0	0.0
360-479	2,250	2	17	2	0	1	0.9	7.6	0.9	0.0	0.4
480-599	2,250	2	42	3	2	5	0.9	18.7	1.3	0.9	2.2
600+	2,250	0	70	1	0	10	0.0	31.1	0.4	0.0	4.4
Total	**13,500**	**34**	**159**	**44**	**2**	**16**	**2.5**	**11.8**	**3.3**	**0.1**	**1.2**

Table 10. Age-length frequency distribution of otolith aged siscowet in the 2015 siscowet assessment.

	Age																					
Length (in)	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV	XXV	XXVI+
9.0 - 9.9																						
10.0 - 10.9																						
11.0 - 11.9	1	1	1																			
12.0 - 12.9		2		1																		
13.0 - 13.9					3																	
14.0 - 14.9	1		1						1													
15.0 - 15.9						2	3	1	2		1						1					
16.0 - 16.9							1		1	1	5	1										
17.0 - 17.9						1	1	2	3	2	2	2	2		1	1	2					
18.0 - 18.9						1		3	1		2	1	1	1				1	1			
19.0 - 19.9							1	1	1			1	2		2	2	1				2	
20.0 - 20.9								1	1	3	3		1	1	3		1				1	
21.0 - 21.9											1	1								1		1
22.0 - 22.9													1			1	1					
23.0 - 23.9																			1			
24.0 - 24.9																		1				
25.0 - 25.9																						
26.0 - 26.9																	1					
27.0 - 27.9																						
28.0 - 28.9																						
29.0 - 29.9																						
Total	2	3	2	1	3	4	6	8	10	6	14	6	7	2	6	4	7	2	2	1	3	1
Average Length	12.9	12.0	12.9	12.6	13.6	16.8	16.9	18.4	17.2	19.0	18.1	18.5	19.5	19.7	19.7	19.4	19.9	21.3	21.3	21.0	19.9	21.3

Table 11. Diet composition by weight for Burbot and siscowet in the 2015 siscowet assessment. The number of stomachs sampled with prey items is shown in parentheses.

Diet item	Burbot		Siscowet	
Aquatic insects	10.1%	(8)	1.4%	(2)
Coregonid sp.			2.7%	(2)
Deepwater Sculpin	4.3%	(2)	8.4%	(12)
Empty		(8)		(24)
Fish eggs	2.4%	(2)	2.9%	(6)
Mysis	13.7%	(14)	2.0%	(5)
Rocks	32.3%	(13)	0.2%	(4)
Sculpin sp.	10.5%	(7)	33.0%	(46)
Stickleback sp.	0.1%	(1)	0.0%	(1)
Terrestrial insects			10.9%	(42)
Unidentifiable fish remains	25.4%	(11)	38.1%	(70)
Woody debris	1.1%	(7)	0.4%	(6)

Table 12. Trout and salmon stocked in 2015, and proposed stocking for 2016, Minnesota waters of Lake Superior.

2015 Salmonid Stocking			
Species	**Number**	**Size**	**Fin Clip**
Lake Trout	141,999	Yearling	Left Pectoral (LP)
Rainbow Trout			
Kamloops	26,445	Yearling	Adipose Right Ventral (ARV)
Kamloops	75,967	Yearling	Adipose (A)
Total Kamloops	102,412		
Steelhead	363,714	Fry	None
Steelhead	62	Adults	Right Maxillary (RM), T-bar anchor tag

Proposed 2016 Salmonid Stocking			
Species	**Number**	**Size**	**Fin Clip**
Rainbow Trout			
Kamloops	25,000	Yearling	Adipose Right Pectoral (ARP)
Kamloops	32,500	Yearling	Adipose (A)
Kamloops	35,000	Yearling	Adipose Left Pectoral (ALP)
Total Kamloops	92,500		
Steelhead	350,000	Fry	None

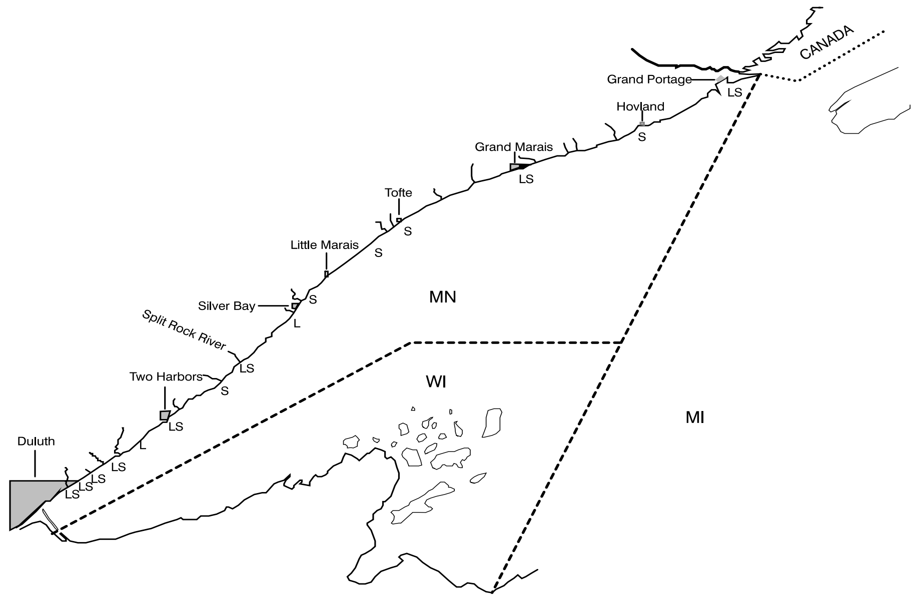

Figure 1. Sampling stations for adult (L) and juvenile (S) assessments, Minnesota waters of Lake Superior.

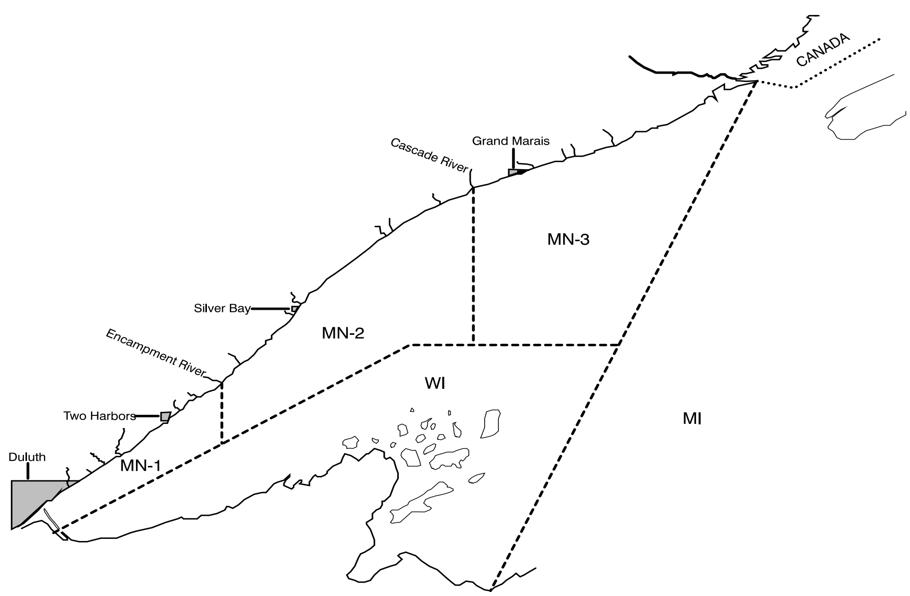

Figure 2. Statistical districts in Minnesota waters of Lake Superior.

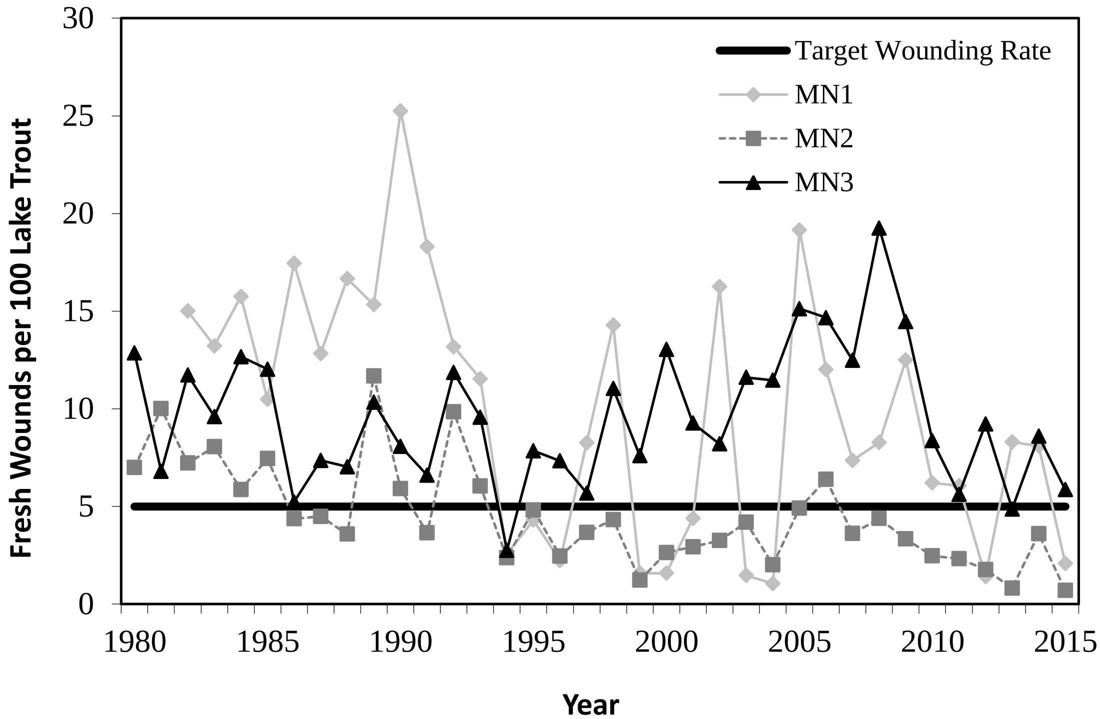

Figure 3. Number of fresh Sea Lamprey wounds per 100 Lake Trout in the May assessment, by statistical district, 1980-2015.

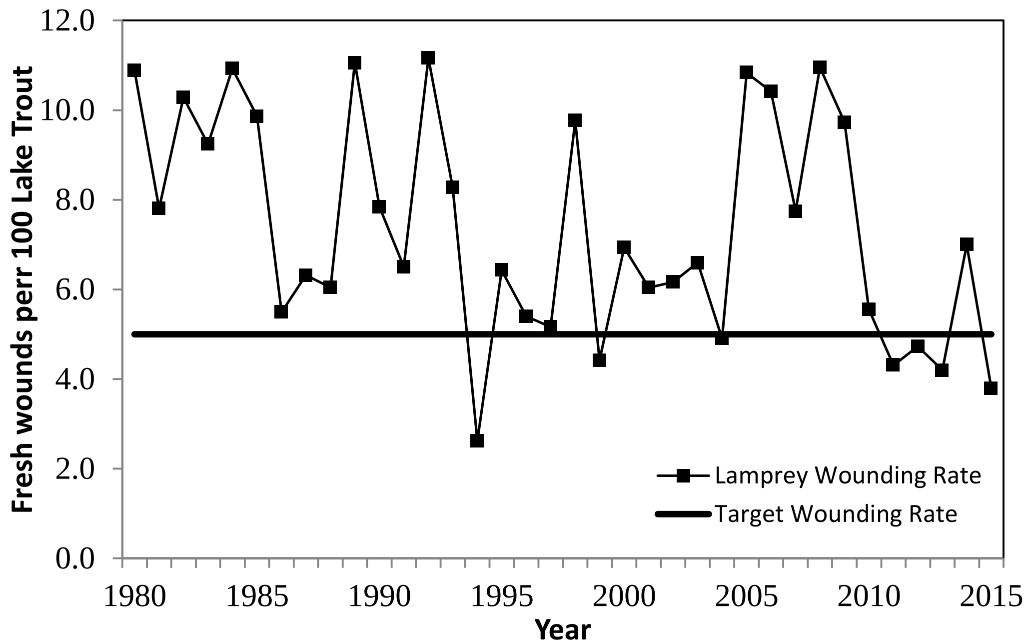

Figure 4. Shorewide number of fresh Sea Lamprey wounds per 100 Lake Trout in the May assessment, 1985-2015.

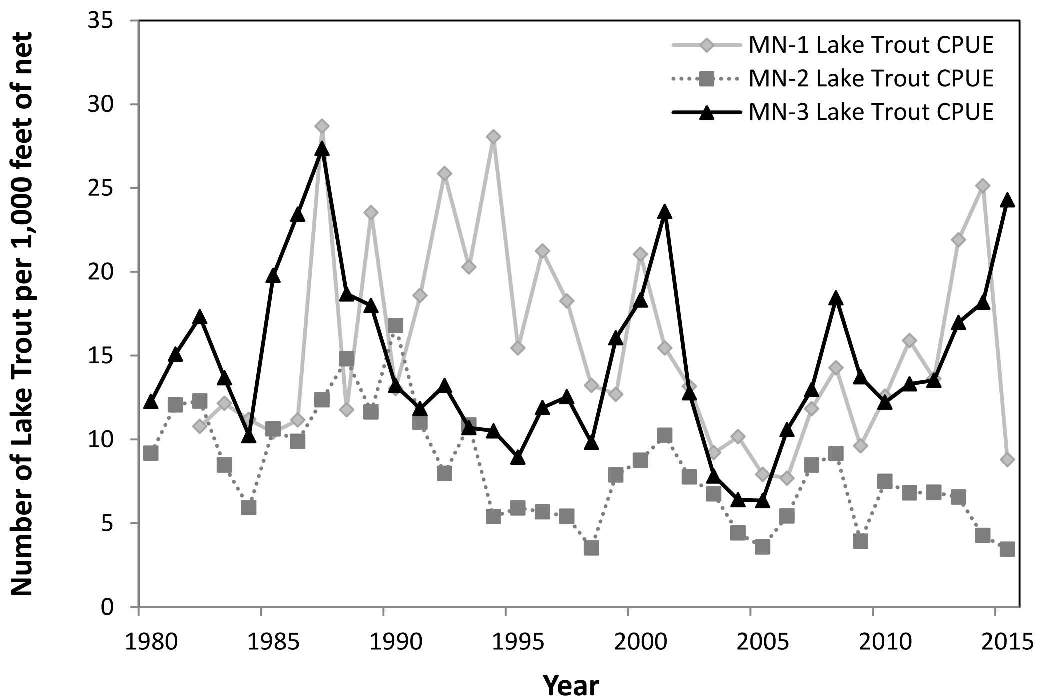

Figure 5. Lake Trout catch rate (number of fish per 1,000 feet of net; CPUE) by statistical district in the May assessment, 1980-2015.

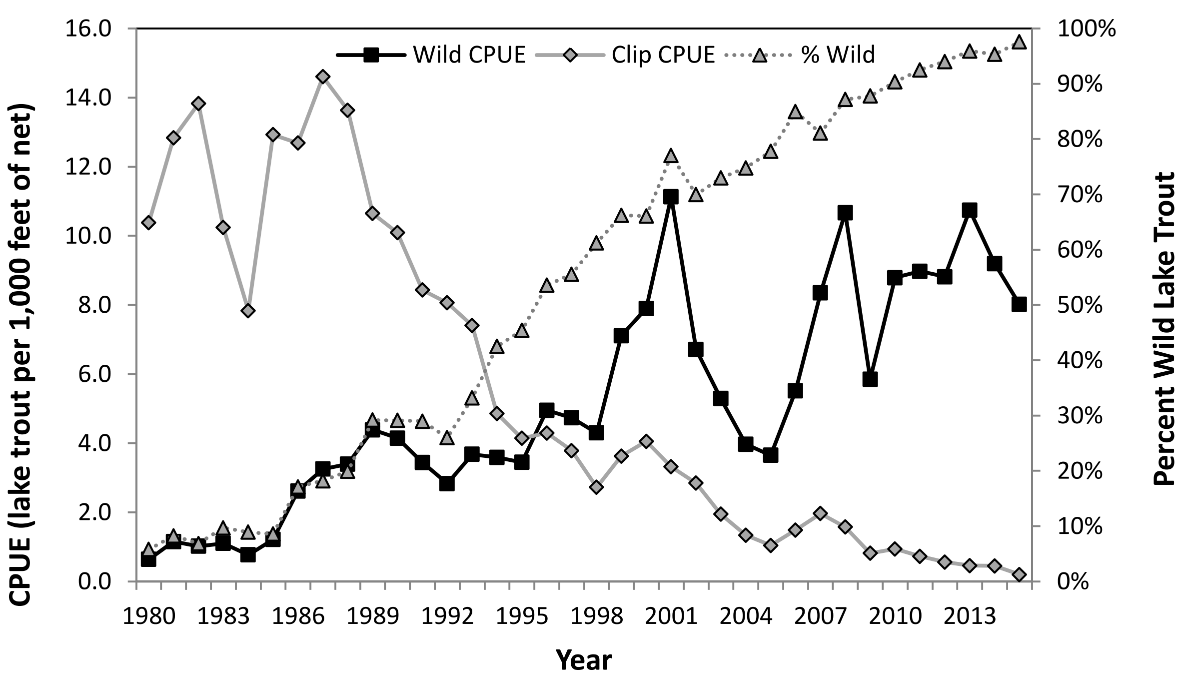

Figure 6. Catch rate (number of fish per 1,000 feet of net; CPUE) of wild and stocked Lake Trout, and percentage wild Lake Trout in the May assessment, 1980-2015.

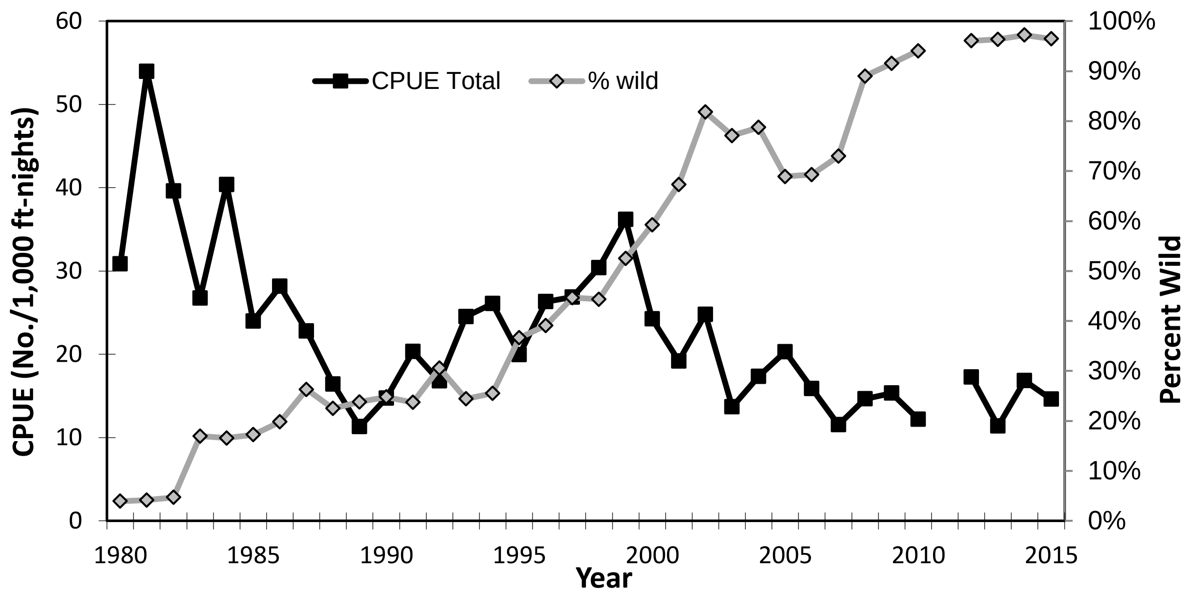

Figure 7. Catch rate (number of fish per 1,000 feet of net; CPUE) and percent wild Lake Trout in the juvenile (<17") Lake Trout assessment, 1980-2015.

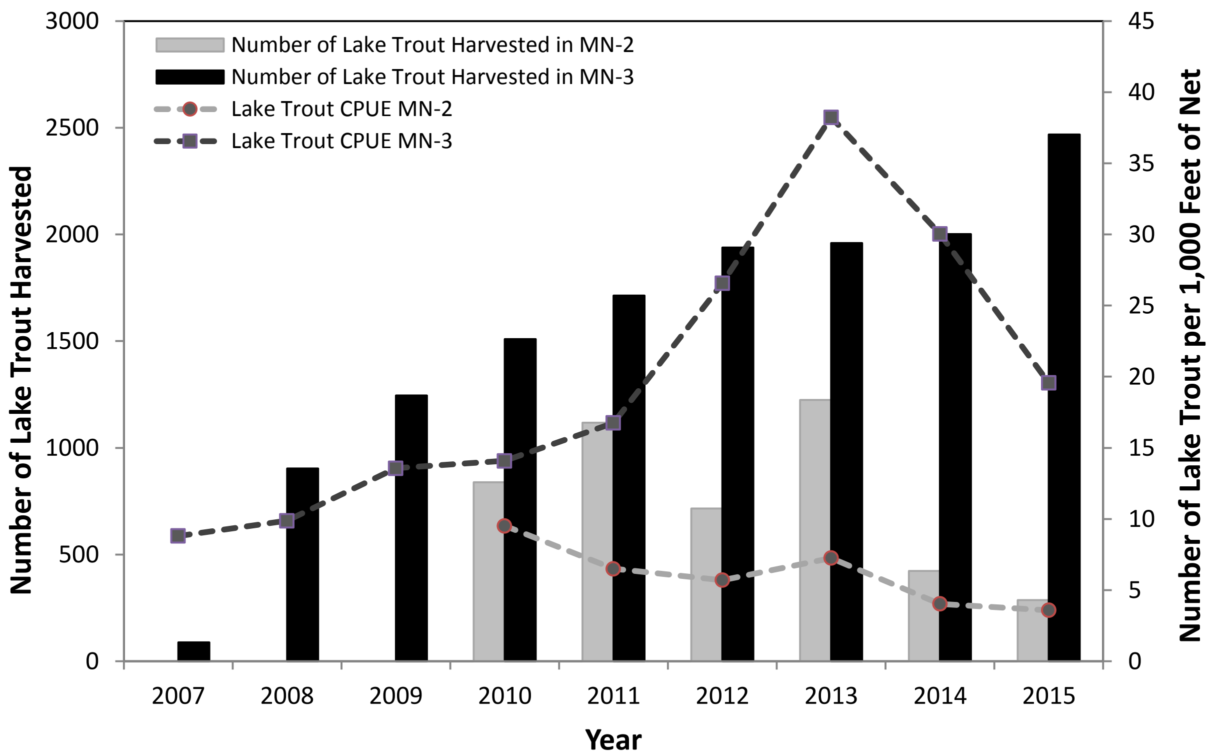

Figure 8. Lake Trout harvest and catch rate (number of fish per 1,000 feet of net; CPUE) in the summer commercial assessment, 2007-2015.

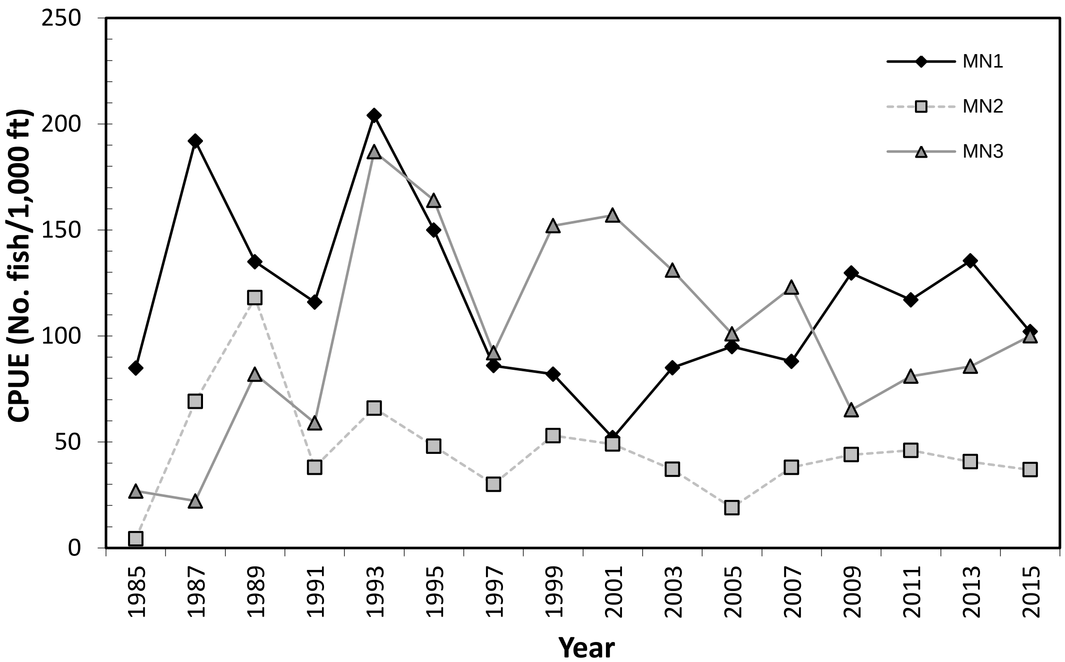

Figure 9. Catch per unit effort (number of fish per 1,000 feet of net) by management zone in the Lake Trout spawning assessment, 1985-2015. Spawning assessments are conducted every two years.

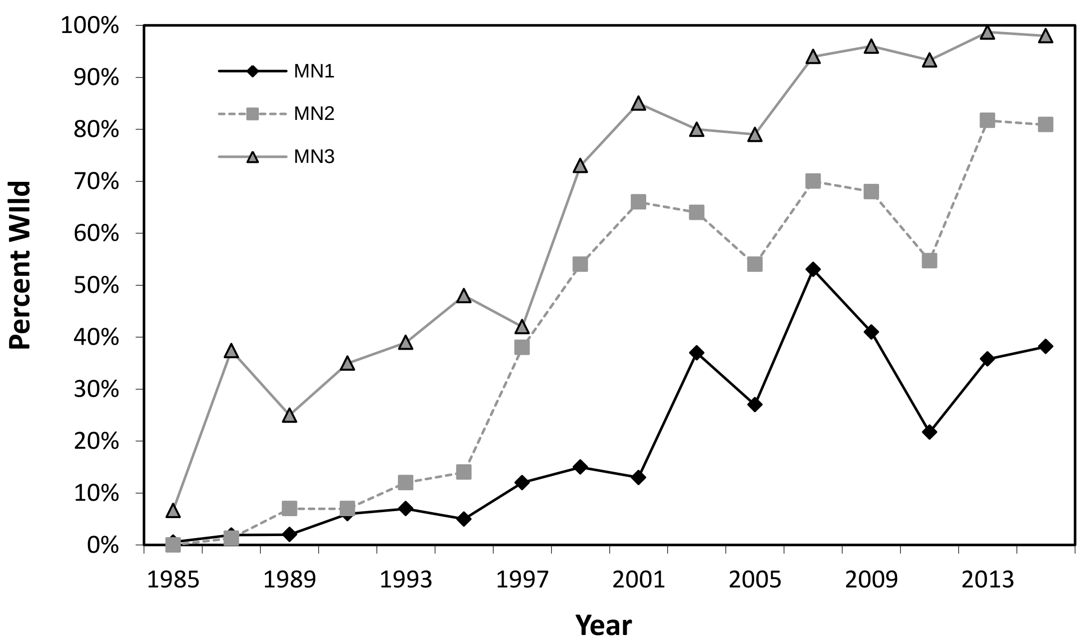

Figure 10. Percent wild Lake Trout in the Lake Trout spawning assessment, 1985-2015. Spawning assessments are conducted every two years.

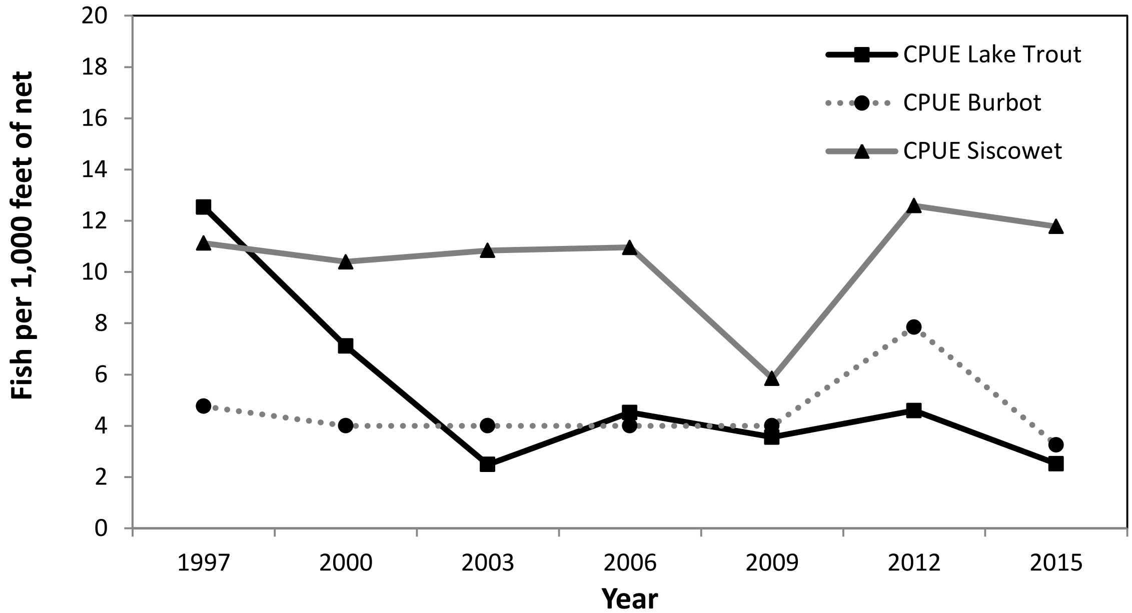

Figure 11. Catch per unit effort (CPUE) of Lake Trout, Burbot, and siscowet sampled in the siscowet assessment, 1997-2015.

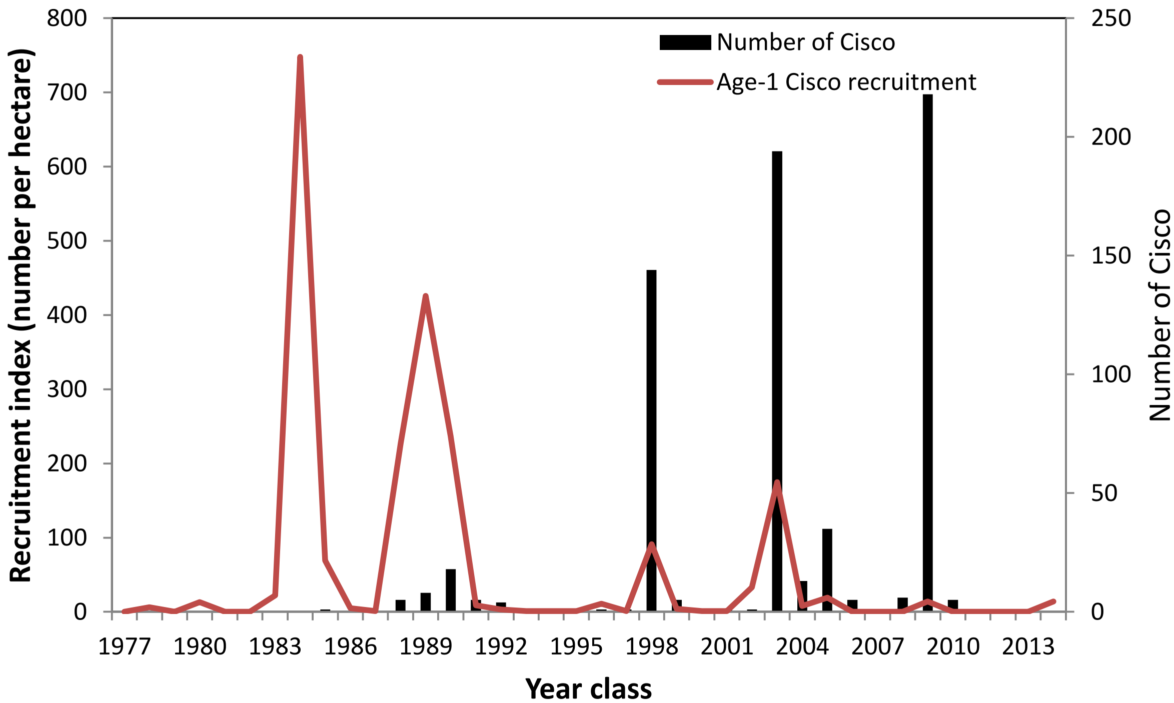

Figure 12. Cisco year-class strength, 1977-2014, as measured by the relative density of age-1 Cisco that were caught during USGS bottom trawl surveys, and the number of Cisco caught by age-class sampled in spring and fall surveys in 2014.

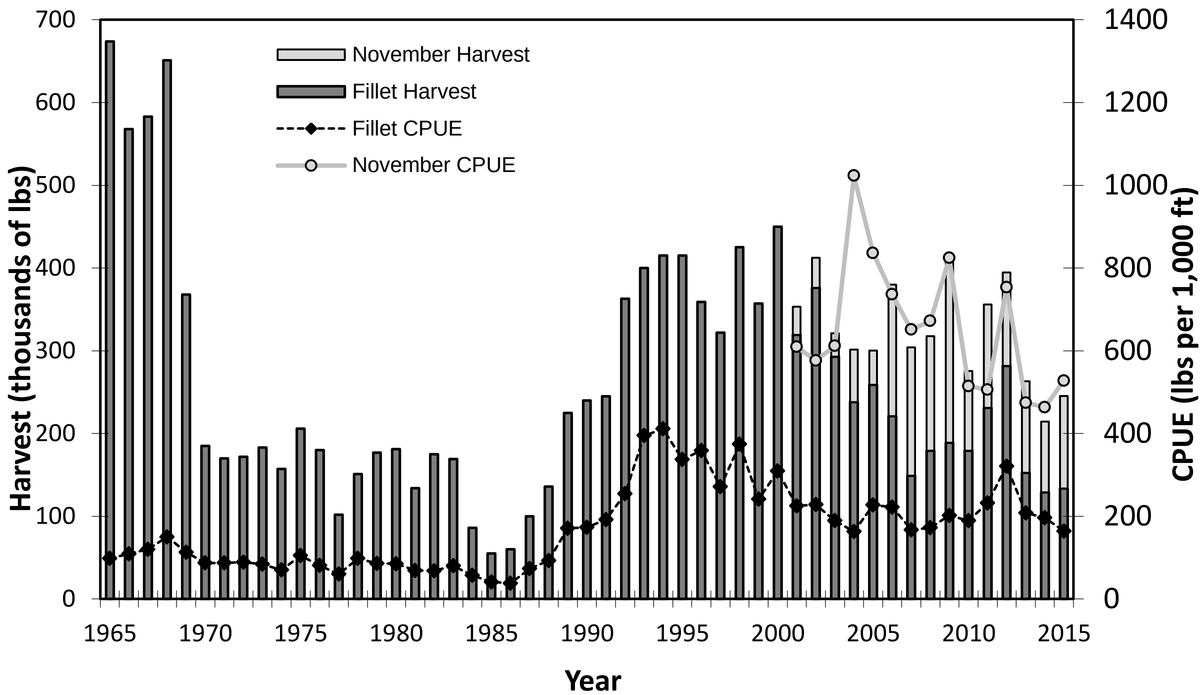

Figure 13. Cisco harvest (thousands of pounds) and catch rate (pounds per 1,000 feet of net; CPUE) in the commercial gill net fishery in Minnesota waters of Lake Superior, 1965-2015.

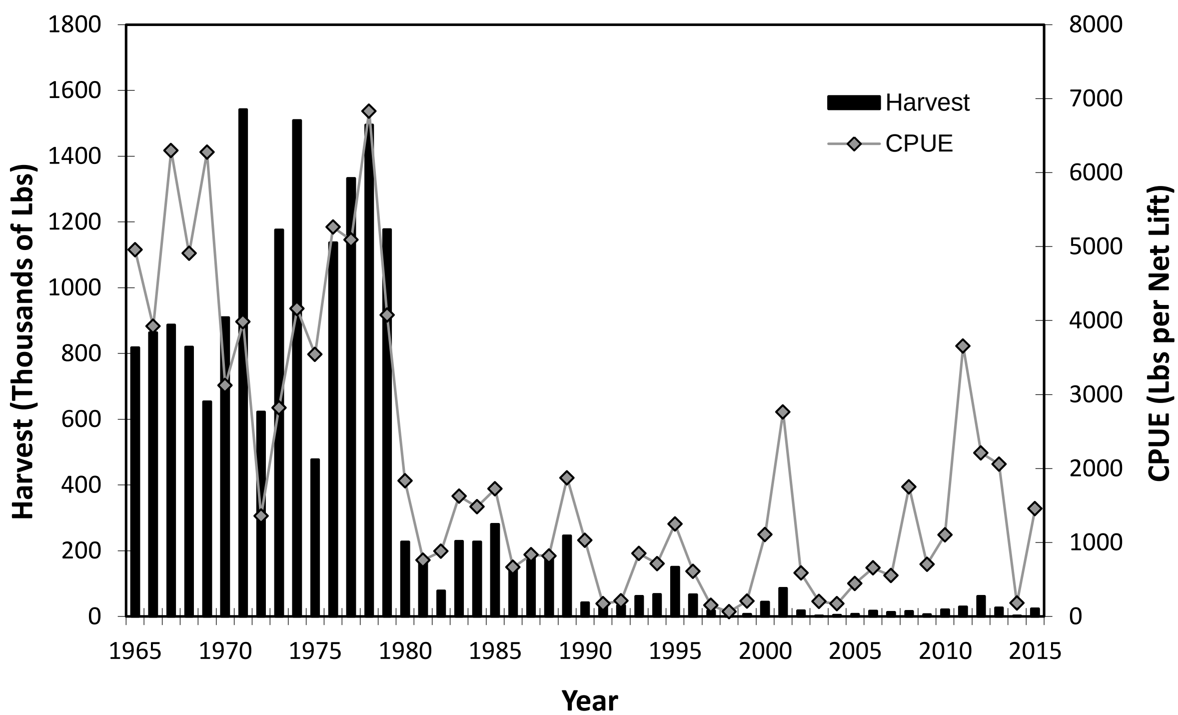

Figure 14. Rainbow Smelt harvest (thousands of pounds) and catch per unit effort (pounds per lift; CPUE) in the commercial pound net fishery, Minnesota waters of Lake Superior, 1965-2015.