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Segment 33, Year 2
Study 2
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MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
SECTION OF FISHERIES

COMPLETION REPORT FOR THE MINNESOTA WATERS OF LAKE SUPERIOR

2018

Prepared by:

Josh Blankenheim

Reimbursed under Federal
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Restoration Act

Executive Summary

The Sea Lamprey (*Petromyzon marinus*) wounding rate in the May Assessment was above the target level of 5.0 fresh wounds per 100 Lake Trout (*Salvelinus namaycush)* in MN-1 (6.4) and MN-3 (7.7) but below the target level in MN-2 (1.6). The shorewide wounding rate was slightly below the target at 4.5 wounds per 100 fish. The overall catch rate of Lake Trout in the May assessment was 18.9 fish per 1,000 feet of net. CPUE by management zone was 25.3 in MN-1, 15.6 in MN-2, and 20.8 in MN-3. Shorewide, 98% of Lake Trout were wild fish. The shorewide CPUE of wild fish continued to trend upward.

In the juvenile Lake Trout assessment (fish less than 17 inches), the CPUE was 16.2 fish per 1,000 feet of net. The CPUE in the juvenile Lake Trout assessment has remained relatively consistent since the mid-2000s. Shorewide, 97% of juvenile Lake Trout captured were wild. Despite annual stocking in MN-1 through 2015, 93% of juvenile Lake Trout captured in MN-1 were wild fish.

In the summer expanded commercial assessment, commercial fishermen in MN-1 harvested 494 Lake Trout and the CPUE was 21.4 fish per 1,000 feet of net. Lake Trout harvest in MN-2 was 1,297 fish and the CPUE was 13.0 fish per 1,000 feet of net. In MN-3, 2,295 Lake Trout were harvested and the CPUE was 34.9 fish per 1,000 feet of net. Collectively, commercial fishermen harvested 77% of the quota.

In the deepwater predator assessment, the CPUE of Siscowet was 12.7 fish/1,000 feet of net and similar to all other years except 2009. Ninety-six percent of Siscowet were caught at depths deeper than 240 feet. The CPUE of Lake Trout was 4.4 fish/1,000 feet of net and the CPUE of Burbot was 1.9 fish/1,000 feet of net.

The estimated biomass of spawning size Cisco from the fall hydroacoustic survey was 3,216 metric tons and represents a 94% increase from 2017. Although the USGS recruitment index for the 2014 year-class of Cisco was not large, recruitment of this year-class to the fishery was likely the reason for the increase in Cisco biomass. Cisco harvest in the traditional gill net fishery (all months excluding November) was 103,705 pounds and the catch rate was 206 Cisco per 1,000 feet of net. Harvest during the November fishery was 119,113 pounds and the catch rate was 812 pounds per 1,000 feet of net.

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Introduction

This report summarizes the assessment work conducted by the Lake Superior Area Office in Minnesota's portion of Lake Superior in 2018 including the May Lake Trout (*Salvelinus namaycush)*, juvenile Lake Trout, deepwater predator, summer expanded commercial Lake Trout, and Cisco (*Coregonus artedi*) assessments.

Lake Trout are the top native predator in Lake Superior and historically supported important recreational and commercial fisheries. 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) in the mid-1950s. Over the past few decades, wild Lake Trout abundance has increased, limited commercial harvest of Lake Trout has been allowed, and stocking was deemed no longer necessary and discontinued. Lake Trout is the primary species caught by anglers, presently supporting a recreational fishery with an average annual harvest of 25,051 fish (2009-2018) in the Minnesota waters of Lake Superior (Reeves 2019). The deepwater morphotype of Lake Trout, 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".

Cisco are an important native forage species in Lake Superior and have also supported a commercial fishery since the late 1800s. Cisco stocks crashed in the 1950s, and although populations have rebounded, they remain well below historic levels. Cisco population dynamics are monitored by hydroacoustic surveys, MNDNR assessment netting, and analyzing commercial fishing records. Commercial harvest is summarized thoroughly in an annual commercial fishing report (Blankenheim 2019).

Chinook Salmon (*Oncorhynchus tshawytscha)*, Coho Salmon (*O. kisutch)*, and Rainbow Trout (*O. mykiss*) are generally not vulnerable to MNDNR assessment gill nets. The status of these salmonid species is discussed in creel survey reports (Peterson 2019a; Reeves 2019) and French and Knife River trap reports (Gottwaldt and Peterson 2019; Peterson 2019b).

Methods

MNDNR conducts the May Lake Trout assessment in MN-1 while commercial operators provide data for MN-2 and MN-3. The May Lake Trout assessment utilizes 4.5 inch stretch-measure mesh. In MN-1 each gang consists of three 250-foot nets for a total of 750 feet per gang; commercial fishermen set gangs of variable length. Gangs were set in eight locations in MN-1, two in MN-2, and one in MN-3, with each gang set between 120 and 240 feet of water. Gang sets were for one night unless weather interfered with net retrieval.

MNDNR conducts a deepwater predator assessment every third year near Fisherman's Point northeast of Two Harbors. Gillnets for the deepwater predator assessment consist of nine 250 foot nets 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 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 2018 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.

The juvenile Lake Trout assessment is conducted solely by MNDNR. The assessment utilizes five nets each 200 feet in length tied together for a total gang length of 1,000 feet. Mesh sizes include 1.5, 1.75, 2.0, 2.25, and 2.5 inch stretch-measure mesh. Gangs were set in six locations in MN-1, four locations in MN-2, and three locations in MN-3 with each set starting in 120 feet of water and ending shallower than 240 feet. Gang sets were for two nights, with the exception of Hovland which is always set for one night. In 2018 the gang set at Split Rock was fished three nights due to inclement weather.

A limited summer expanded commercial Lake Trout assessment fishery was permitted beginning in 2007 for MN-3, 2010 for MN-2, and 2017 for MN-1. The annual Lake Trout limits are 3,000 fish in MN-3, 2,000 fish in MN-2, and 500 fish in MN-1. Commercial operators must select the statistical zone and grid they wish to fish in, with no more than two operators per grid. Lake Trout are allotted evenly based on the number of applicants per zone, with a maximum of 1,000 Lake Trout per fisherman. The season is open from June 1st through September 30th. Detailed harvest information on the limited commercial Lake Trout fishery can be found in Blankenheim (2019).

Statistical zones, grids, and locations for May Lake Trout and juvenile Lake Trout net sets are shown in Figure 1. Detailed specifications for survey nets can be found in Ebener (2001). In all surveys length, weight, sex, fin clips, and lamprey wounds were recorded for each Lake Trout caught. MNDNR collected otoliths and stomach contents on all Lake Trout while commercial operators did so on a subsample of the fish they harvested in the May Assessment and summer expanded commercial assessment.

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.

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’ CPUEs were recalculated for MN-1. Therefore, historical CPUEs in this report may be slightly different than in some previous reports.

Cisco are assessed in two ways: netting assessments and hydroacoustic surveys. The MNDNR Cisco assessment consists of 300 foot multi-mesh (2.0-, 2.5-, and 3.0-inch stretch mesh) nets, with 100 feet of each mesh size per net. Two gangs were set: one at 12 feet below the surface and the other at 25 feet below the surface. Sampling began in late October with a goal of collecting length, weight, sex, and otoliths from at least 100 fish. Additional Cisco samples were collected from commercial fishermen in both spring/summer and fall from each statistical zone. Due to the time constraints of otolith aging and reporting, age data of Cisco sampled in 2018 were not yet available but 2017 age data are presented in this report.

Hydroacoustic surveys with accompanying mid-water trawls have been conducted since 2003; methodology can be found in Hrabik et al. (2006). From 2003-2013 hydroacoustic surveys were conducted in the summer but have been conducted in the fall since 2014. Beginning in 2017, all hydroacoustic work has been conducted aboard the Large Lakes Observatory’s R/V Blue Heron rather than split between the R/V Blue Heron and the MNDNR vessel. Sampling MN-3 nearshore was discontinued after 2015 because it contributes very little to the overall Cisco biomass estimate. Data analysis procedures are described in the MNDNR Lake Superior Hydroacoustics Standard Operating Procedure. In both 2017 and 2018, a 38-kHz transducer was operating simultaneously with the standard 120-kHz transducer to examine the possibility of switching to a lower frequency transducer. The 38-kHz data from 2018 have not been analyzed yet and results of the two year study will be presented next year.

Results and Discussion

May Assessment

Sea Lamprey control is conducted by the U.S. Fish & Wildlife Service and Fisheries and Oceans Canada. 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. The number of fresh Sea Lamprey wounds per 100 Lake Trout (wounding rate) in the May assessment was 6.4 in MN-1, 1.6 in MN-2, and 7.7 in MN-3 (Table 1, Figure 2). The overall wounding rate was 4.5 (Figure 3). The target wounding rate for all zones is not more than 5 fresh wounds per 100 Lake Trout. Overall, wounding rates increased by size category (Table 1).

The overall CPUE of Lake Trout was 18.9 fish per 1,000 feet of net in the May assessment (Table 2, Figure 4). The 2018 CPUE was the highest recorded, even topping CPUEs from the mid-1980s when the high Lake Trout abundance observed most likely resulted from stocked fish filling niches made vacant by Sea Lamprey predation, and high numbers of Rainbow Smelt as prey. As encouraging as an individual CPUE may be, placing too much emphasis on a single year's CPUE should be avoided. Rather, emphasis should be placed on long term trends. The wild Lake Trout CPUE was 18.5 fish per 1,000 feet of net which continued the positive trend for wild Lake Trout abundance, while stocked Lake Trout CPUE was 0.4 fish per 1,000 feet of net (Figure 4). By zone, Lake Trout CPUEs for MN-1, MN-2, and MN-3 were 25.3, 15.6, and 20.8 fish per 1,000 feet of net (Table 3, Figure 5). Wild fish comprised 98% of all Lake Trout sampled in the assessment (Table 3, Figure 4). Creel survey data and anecdotal reports have indicated that a higher proportion of the summer Lake Trout catch in MN-1 is stocked fish compared to what is observed in the May assessment, so Lester River/Brighton Beach was added as a station starting in 2015 after not being sampled since 2008. Even with the addition of this station, wild fish have still accounted for over 90% of the catch in MN-1 each year since it was added back into the survey.

Lake Trout ages ranged from age-4 to age-24 (Table 4). By design, the May assessment typically captures Lake Trout age-6 to age-10. Eighty-five percent of Lake Trout captured were age-6 to age-10.

The age and growth patterns observed on otoliths help confirm correct species identification from the calls made in the field by MNDNR staff and commercial operators. In some years there are discrepancies between species identification in the field compared to otolith analysis, with some Siscowet mistakenly identified as Lake Trout, primarily in MN-3. In 2018, there were three discrepancies with fish in MN-1 that were identified as Lake Trout but otolith analysis suggested they were Siscowet (99% agreement, n=278). In MN-2 two fish were discrepancies (99% agreement, n=180). In MN-3 a new commercial operator began participating in the May assessment due to the retirement of the previous participant. Of the heads he provided, nine were discrepancies based on otolith analysis, resulting in 90% agreement (n=91). However, MNDNR staff identified these nine fish as Siscowet while extracting otoliths, which is 100% agreement with otolith analysis. Misidentifying Lake Trout could create a variety of problems such as biased CPUEs or poorly functioning Lake Trout models.

By weight, diet composition of Lake Trout in the May assessment was almost entirely Rainbow Smelt (89.5%) and unidentifiable fish remains (9.9%) (Table 5). Rainbow Smelt commonly comprise the greatest weight of diet items in Lake Trout stomachs during the May assessment. Nine percent of Lake Trout (n=53) had no prey items in their stomachs, which was in the range observed the previous five years (3% to 30%).

Juvenile Lake Trout Assessment

The CPUE of juvenile Lake Trout (less than 17 inches) was 16.2 fish per 1,000 feet of net (Table 6). CPUE has been relatively consistent since the mid-2000s (Figure 6). The CPUE of wild juveniles was 15.6 Lake Trout per 1,000 feet of net and the CPUE of stocked fish was only 0.6 Lake Trout per 1,000 feet of net. Ninety-seven percent of the juvenile Lake Trout catch was wild (Table 7, Figure 6).

CPUEs in MN-1, MN-2, and MN-3 were 18.4, 14.3, and 14.1 Lake Trout per 1,000 feet of net, respectively (Table 7). All juveniles captured in MN-2 and MN-3 were wild as expected due to the discontinuation of stocking in 2003 (MN-3) and 2007 (MN-2). Even though annual stocking occurred in MN-1 through 2015, 93% of the juvenile Lake Trout catch in MN-1 were wild fish. Lake Trout recruitment may be reaching a level representative of self-sustaining Lake Trout populations in Lake Superior indicated by a plateauing CPUE.

By weight, juvenile Lake Trout diets were comprised primarily of Rainbow Smelt (34.5%), *Mysis* (26.4%), and unidentifiable fish remains (16.2%) (Table 5). Kiyi accounted for 10% of the diet biomass, but was from a single large specimen. Thirty-five percent (n = 128) of juvenile Lake Trout stomachs contained no prey items in 2018, which was in the range observed the previous five years (15% to 40%).

<u>Summer Expanded Commercial Assessment</u>

In accordance with the 2016 Lake Superior Management Plan (LSMP; Goldsworthy et al. 2017), a limited commercial fishery for Lake Trout in MN-1 was established in 2017 and commercial fishermen in this zone got to target Lake Trout for the first time since the 1960s. The quota for MN-1 was set at 500 Lake Trout. A total of 494 Lake Trout were harvested and the CPUE was 21.4 Lake Trout per 1,000 feet of net (Figure 7). One Siscowet was also harvested. Commercial fishermen harvested 99% of the total-allowable-catch (TAC). Commercial harvest of Lake Trout represented 2.6% of the estimated total Lake Trout harvest in MN-1 between sport (18,532) and commercial (494) fishers combined.

In MN-2, the number of Lake Trout harvested by commercial fishermen was 1,297 and the CPUE was 13.0 Lake Trout per 1,000 feet of net (Figure 7). Twenty Siscowet were also harvested. Commercial netters harvested 66% of the 2,000 fish TAC (Lake Trout and Siscowet) from MN-2. Commercial harvest of Lake Trout represented 19.2% of the estimated total Lake Trout harvest in MN-2 between sport (5,466) and commercial (1,297) fishers combined.

In MN-3, commercial fishermen harvested 2,295 Lake Trout and the CPUE was 34.9 Lake Trout per 1,000 feet of net (Figure 7). An additional 110 Siscowet were harvested. Commercial fishermen harvested 80% of the 3,000 fish TAC. Commercial harvest of Lake Trout represented 38.4% of the estimated total Lake Trout harvest in MN-3 between sport (3,683) and commercial (2,295) fishers combined. In the three zones combined, commercial fishermen harvested 77% of the TAC. Overall, commercial harvest accounted for 12.9% of the total shorewide Lake Trout harvest between sport (27,681) and commercial (4,086) fishermen.

Lake Trout diet composition by weight in the summer commercial assessment was predominately Rainbow Smelt (47.6%), coregonids (Cisco, Kiyi, and coregonids that couldn't be identified to species; 20.2%), and unidentifiable fish remains (18.3%) (Table 5). *Mysis* comprised only 6.1% of diet biomass, and Alewife were present for the first time since 2014. Forty-six percent of Lake Trout stomachs (n = 352) had no diet items, which was very similar to the previous five years (37%-44%).

<u>Deepwater Predator Assessment</u>

Siscowet are the primary species captured in the deepwater predator assessment. In 2018, the Siscowet CPUE was 12.7 fish/1,000 feet of net (Table 8). With the exception of 2009, the CPUE of Siscowet has been very consistent, ranging only from 10.4 to 12.7 fish/1,000 feet (Figure 8). Siscowet were by far most abundant in the 480-599 foot depth stratum, and 96% of all Siscowet were captured at depths greater than 240 feet. The overall wounding rate on Siscowet was 2.9 fresh wounds per 100 fish. The Lake Trout CPUE was 4.4 fish/1,000 feet (Table 8, Figure 8). Whereas 96% of Siscowet were captured at depths greater than 240 feet, 78% of Lake Trout were captured at depths shallower than 240 feet. Overall, Siscowet were nearly three times as abundant as Lake Trout. Burbot CPUE was 1.9 fish/1,000 feet and were present at all depth strata (Table 8). Bloater and Kiyi, the "deepwater chubs", were present in low abundance at depths greater than 240 feet (Table 8). Most mesh sizes used in the deepwater predator assessment are too large for adequately sampling these forage species.

Siscowet diet composition by weight was predominantly unidentifiable fish remains (35.2%), sculpin species (Deepwater, Slimy, and sculpin that could not be identified to species; 33.1%), and coregonids (Kiyi and coregonids not identifiable to species; 20.9%) (Table 9). Twenty-one percent of

Siscowet stomachs were empty. Lake Trout captured during the deepwater predator assessment had consumed mainly Rainbow Smelt (61.8%) and unidentifiable fish remains (26.1%) (Table 5). Burbot consumed sculpin species (Deepwater and sculpin that could not be identified to species; 43.3%) and fish that were unidentifiable (36.0%) (Table 9).

Cisco Assessment

USGS trawling data continues to indicate that Cisco recruitment is very sporadic. Since 2003, only relatively weak or nonexistent year-classes have been produced (Figure 9). Due to the backlog of otoliths, age data from the 2018 spring and fall commercial Cisco samples and MNDNR Cisco assessment were not yet available at the time of this reporting. Age analysis from the 2017 spring and fall Cisco samples collected from commercial fishermen (n=488) showed that the 2003, 2009, and 2014 year-classes accounted for 20%, 31%, and 21% of their catch (Figure 9). Age-2 Cisco were also already being harvested, accounting for another 5% of the catch. In total there were 28 year-classes present, ranging from age-2 to age-34. The MNDNR fall Cisco assessment uses multi-mesh nets that includes a smaller mesh size (2.5 inch) than used by commercial fishermen. From the 2017 samples, 60% (n=114) of the catch was age-3 Cisco from the 2014 year-class (Figure 9).

The estimated biomass of spawning size Cisco in the fall of 2018 was 3,216 metric tons, and represents a 94% increase in biomass from the previous year (Figure 10). MN-2 offshore accounted for 52% of the total Cisco biomass estimate. Cisco biomass in nearshore waters was higher than previous years at 17% of the total estimate. Biomass had been showing a decreasing trend, but recruitment of the 2014 year-class to the fishery is likely the reason for the increase in spawning-size Cisco biomass. Although it is encouraging to observe an increase in Cisco biomass, the continual lack of any strong year-classes remains a concern for future sustainability.

Commercial Cisco Harvest

Cisco harvest in the traditional fishery (all months except November) was 103,705 pounds in 2018. Harvest in the traditional fishery was the lowest since 1987. However, the CPUE was similar to recent years at 206 pounds per 1,000 feet of net (Figure 11).

Experimental netting for a potential November roe fishery started in 2001 in Minnesota waters, and beginning in 2006 harvest was permitted during November using TAC quotas established for each statistical district (Schreiner et al. 2006). The yearly November TAC is calculated from hydroacoustic data and for 2018 was set at 192,040 pounds for Minnesota waters. Beginning in 2016, the Grand Portage Band of Chippewa set a Cisco TAC for their waters. With permission, some Minnesota-licensed commercial fishermen are allowed to harvest from Grand Portage waters. Commercial fishermen fishing in Minnesota waters harvested 83,782 pounds of Cisco and Minnesota-licensed commercial fishermen fishing in Grand Portage waters harvest 35,331 pounds for a combined harvest of 119,113 pounds of Cisco in the November season (Figure 12). The CPUE was 812 pounds per 1,000 feet of net. Further detail of commercial Cisco harvest is available in the annual Commercial Fishing Summary (Blankenheim 2019). Some caution should be used when assessing commercial Cisco CPUE data because it is not adjusted for soak time. It is possible that commercial fishermen could leave their nets in the water for longer periods of time to catch more fish when fishing is poor, thereby artificially inflating CPUE.

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2018

Prepared by:

Josh Blankenheim

Approved by: ______________________ Date: 5/29/2019
Area Fisheries Supervisor

Approved by: ______________________ Date: 6/2/19
Regional Fisheries Approval

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Table 1. Number of fresh lamprey wounds per 100 Lake Trout (>17") in 4.5 inch stretch mesh May assessment gill nets, by size class and statistical district, 2018. 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	1.8 (57)	6.2 (161)	10.3 (68)	7.7 (13)	6.4 (299)
MN-2	0.5 (204)	1.9 (270)	8.3 (24)	0.0 (2)	1.6 (500)
MN-3	1.8 (114)	8.3 (144)	23.8 (21)	50.0 (6)	7.7 (285)
TOTALS	1.1 (375)	4.7 (575)	12.4 (113)	19.1 (21)	4.5 (1,084)

Table 2. Number of Lake Trout by size class per 1,000 feet of 4.5 inch stretch mesh May assessment gill nets, 2018.

	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	0.1	6.5	10.0	2.0	0.4	18.9

Table 3. Corrected Lake Trout catch by station in the May assessment, 2018.

Location	Effort in Feet (corrected effort)	Number Caught	Total Pounds	Number per 1,000 feet	Pounds per 1,000 feet	Percent Wild
MN-1						
All Stations (n = 8)	12,000 (12,000)	303	1,338	25.3	111.5	93.1
MN-2						
Split Rock	7,000 (9,240)	224	785	24.2	85.0	99.6
Silver Bay	17,000 (22,740)	276	989	12.1	43.5	99.6
Totals MN-2	24,000 (31,980)	500	1,783	15.6	55.8	99.6
MN-3						
Grand Marais	13,750 (13,750)	286	957	20.8	69.6	100
Totals MN-3	13,750 (13,750)	286	957	20.8	69.6	100
All locations						
Shorewide	**49,750 (57,730)**	**1,089**	**4,069**	**18.9**	**70.5**	**98.0**

Table 4. Age-length frequency distribution of otolith-aged Lake Trout in 4.5 inch stretch measure gill nets, May assessment, 2018. Bold numbers indicate fish that were identified as Lake Trout but age analysis suggested they were Siscowet.

Length (in)	III	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														
12.0 - 12.9														
13.0 - 13.9														
14.0 - 14.9		1												
15.0 - 15.9			1											
16.0 - 16.9			1											
17.0 - 17.9				2										
18.0 - 18.9				8	7	1								
19.0 - 19.9				2	23	6	1			1		**1**		
20.0 - 20.9				3	52	18	6	1						**1**
21.0 - 21.9			4	1	37	43	5	1	1		1			
22.0 - 22.9					16	43	19	4	2			2		**1**
23.0 - 23.9					4	24	26	8	1	1	1		1,**1**	
24.0 - 24.9				1	4	12	23	10	4	1		1		
25.0 - 25.9					1	2	11	16	6	1	2			
26.0 - 26.9						1	3	7	5	2	6			**1**
27.0 - 27.9						1	1	2	1	1	3	1	2	2
28.0 - 28.9								3		1				1
29.0 - 29.9								1		3	3	1	2	2
30.0 - 30.9										1			1	
31.0 - 31.9														1
32.0 - 32.9														1
33.0 - 33.9														
34.0 - 34.9														
35.0 - 35.9														
36.0 - 36.9														
37.0 - 37.9														
38.0 - 38.9														1
39.0 - 39.9														
Total	0	1	6	17	144	151	95	53	20	12	16	6	7	11
Average Length		14.5	19.8	19.4	20.9	22.2	23.5	24.9	25.0	26.7	26.6	25.3	27.7	30.7

Table 5. Diet composition by weight of prey items in Lake Trout stomachs in the May, juvenile, summer, and deepwater predator assessments, 2018. The number of stomachs sampled with prey items is shown in parentheses.

	Lake Trout							
Diet item	May		Juvenile		Summer		Deepwater predator	
Alewife					0.4%	(2)		
Aquatic insects	0.0%	(4)	0.9%	(14)	0.2%	(34)		
Bird								
Brook Stickleback							0.9%	(1)
Burbot			4.3%	(1)	1.8%	(3)		
Central Mudminnow								
Cisco (lake herring)					5.6%	(1)		
Clam sp.			0.0%	(1)				
Coregonid sp.	0.3%	(5)			12.9%	(19)		
Deepwater Sculpin					0.3%	(4)	1.3%	(1)
Detritus			0.0%	(1)				
Empty		(53)		(128)		(352)		(32)
Fish eggs								
Kiyi	0.1%	(1)	10.0%	(1)	1.7%	(3)		
Larval fish			0.2%	(1)				
Minnow sp.								
Mysis	0.0%	(2)	26.4%	(134)	6.1%	(67)		
Ninespine Stickleback							1.2%	(2)
Rainbow Smelt	89.5%	(459)	34.5%	(19)	47.6%	(135)	61.8%	(7)
Rainbow Trout								
Rocks	0.1%	(14)	0.0%	(3)	0.2%	(15)	2.6%	(4)
Round Whitefish								
Salmonid sp.								
Sculpin sp.	0.1%	(5)	6.4%	(15)	1.0%	(23)	3.8%	(3)
Slimy Sculpin	0.0%	(2)			0.9%	(10)		
Spoonhead Sculpin								
Stickleback sp.	0.0%	(1)			0.0%	(2)		
Terrestrial insects	0.2%	(2)	0.8%	(10)	2.9%	(43)	2.2%	(3)
Unidentifiable fish remains	9.9%	(237)	16.2%	(51)	18.3%	(197)	26.1%	(17)
Woody debris	0.0%	(9)	0.4%	(8)	0.2%	(15)	0.2%	(1)

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, 2018.

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	19	89%	11.2	1.3	12.5
Pumping Station	1,000	1,520	30	97%	19.1	0.7	19.7
Stoney Point	1,000	1,520	48	85%	27.0	4.6	31.6
Larsmont	1,000	1,520	29	100%	19.1	0.0	19.1
Two Harbors	1,000	1,520	11	91%	6.6	0.7	7.2
Encampment Island	1,000	1,520	31	100%	20.4	0.0	20.4
MN-1 Total	**6,000**	**9,120**	**168**	**93%**	**17.2**	**1.2**	**18.4**
MN-2							
Split Rock	1,000	1,800	52	100%	28.9	0.0	28.9
Silver Bay	1,000	1,520	15	100%	9.9	0.0	9.9
Taconite Harbor	1,000	1,520	11	100%	7.2	0.0	7.2
Tofte	1,000	1,520	13	100%	8.6	0.0	8.6
MN-2 Total	**4,000**	**6,360**	**91**	**100%**	**14.3**	**0.0**	**14.3**
MN-3							
Grand Marais	1,000	1,520	37	100%	24.3	0.0	24.3
Hovland	1,000	1,000	9	100%	9.0	0.0	9.0
Grand Portage	1,000	1,520	11	100%	7.2	0.0	7.2
MN-3 Total	**3,000**	**4,040**	**57**	**100%**	**14.1**	**0.0**	**14.1**
Shorewide Total	**13,000**	**19,520**	**316**	**97%**	**15.6**	**0.6**	**16.2**

*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). Split Rock was left an additional night and corrected for three night sets (1,000 ft. actual effort x 1.80 = 1,800 ft.).

Table 7. Historical catch summary of Lake Trout less than 17 inches (432 mm) 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, 1980-2018.

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%
2016	276	13.8	0.5	14.3	96%
2017	273	13.4	0.4	13.8	97%
2018	316	15.6	0.6	16.2	97%

*No data due to State of Minnesota government shutdown.

Table 8. Catch and CPUE (number per 1,000 feet) in the 2018 deepwater predator 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	14	0	5	0	0	6.2	0.0	2.2	0.0	0.0
120-239	2,250	32	7	7	0	0	14.2	3.1	3.1	0.0	0.0
240-359	2,250	6	9	2	2	0	2.7	4.0	0.9	0.9	0.0
360-479	2,250	0	18	1	1	0	0.0	8.0	0.4	0.4	0.0
480-599	2,250	7	111	5	1	2	3.1	49.3	2.2	0.4	0.9
600+	2,250	0	27	5	1	0	0.0	12.0	2.2	0.4	0.0
Total	**13,500**	**59**	**172**	**25**	**5**	**2**	**4.4**	**12.7**	**1.9**	**0.4**	**0.1**

Table 9. Diet composition by weight of prey items in Burbot and Siscowet stomachs in the deepwater predator assessment, 2018. The number of stomachs sampled with prey items is shown in parentheses.

Diet item	Burbot		Siscowet	
Aquatic insects			0.4%	(1)
Clam sp.	0.6%	(1)		
Coregonid sp.			17.2%	(7)
Deepwater Sculpin	24.3%	(4)	5.4%	(14)
Empty		(4)		(36)
Fish eggs			0.3%	(1)
Kiyi			3.6%	(1)
Mysis	10.0%	(8)	0.0%	(1)
Ninespine Stickleback			1.6%	(2)
Rainbow Smelt			1.8%	(2)
Rocks	8.8%	(8)	0.4%	(6)
Sculpin sp.	19.0%	(3)	26.0%	(54)
Slimy Sculpin			1.7%	(5)
Stickleback sp.			0.1%	(1)
Terrestrial insects			5.8%	(30)
Unidentifiable fish remains	36.0%	(10)	35.2%	(76)
Woody debris	1.4%	(2)	0.3%	(5)
Yellow Bullhead			0.2%	(1)

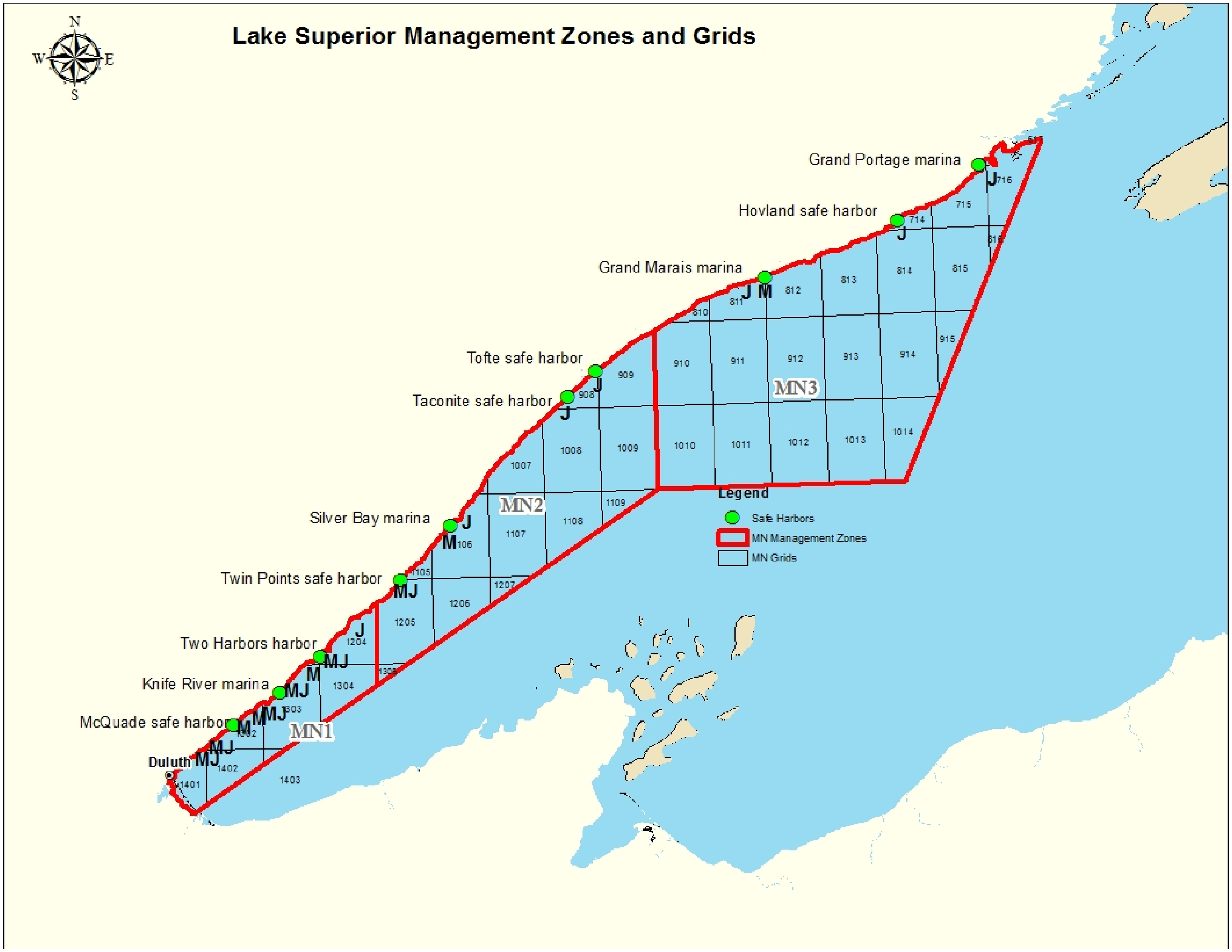

Figure 1. Statistical zones, grids, and sampling stations for May (M) and juvenile (J) assessments, Minnesota waters of Lake Superior.

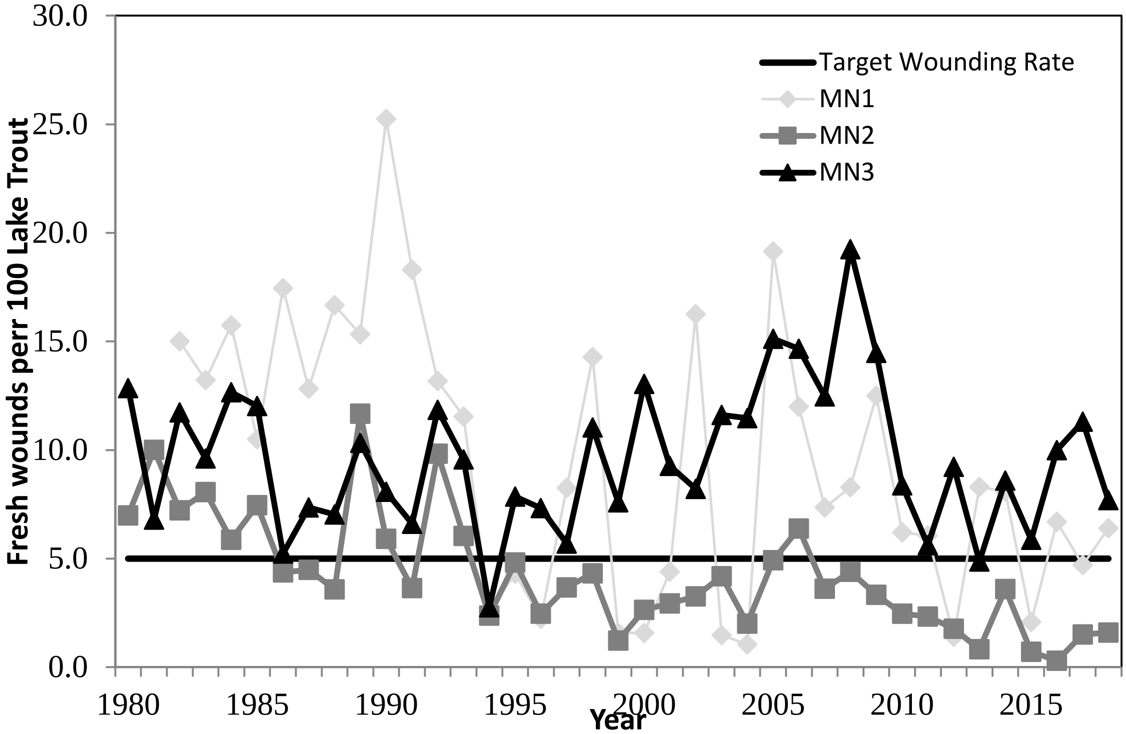

Figure 2. Number of fresh Sea Lamprey wounds per 100 Lake Trout in the May assessment, by statistical district, 1980-2018.

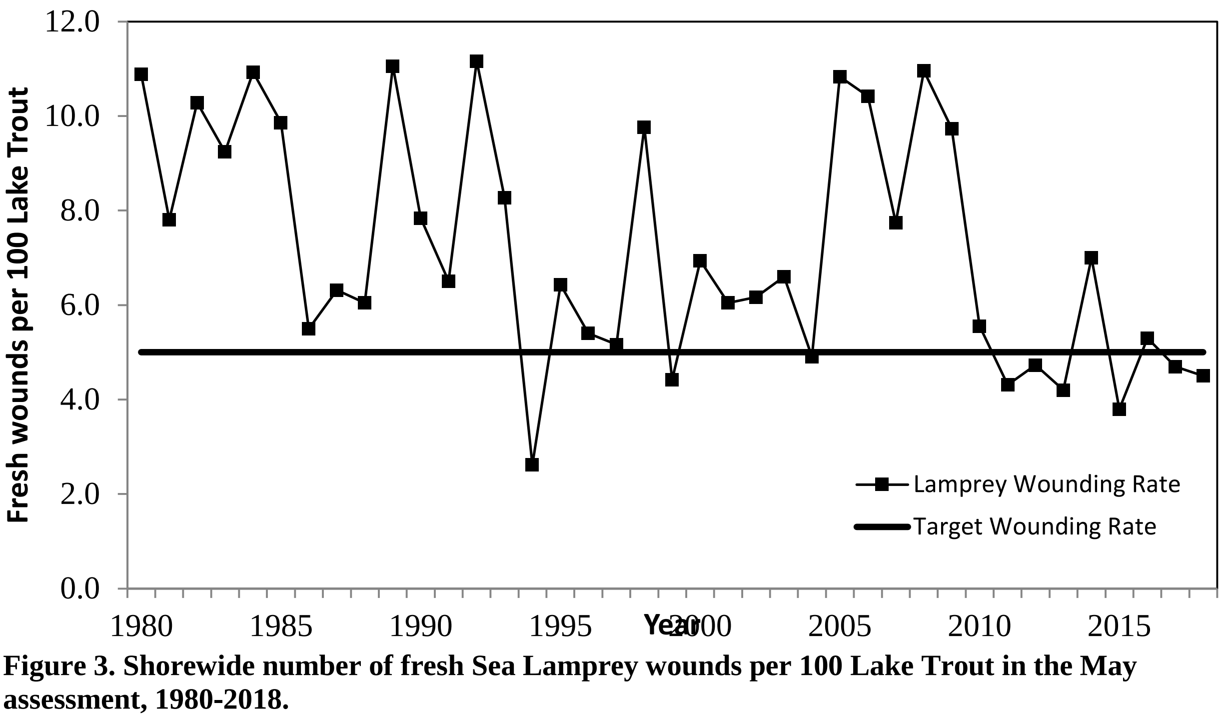

Figure 3. Shorewide number of fresh Sea Lamprey wounds per 100 Lake Trout in the May assessment, 1980-2018.

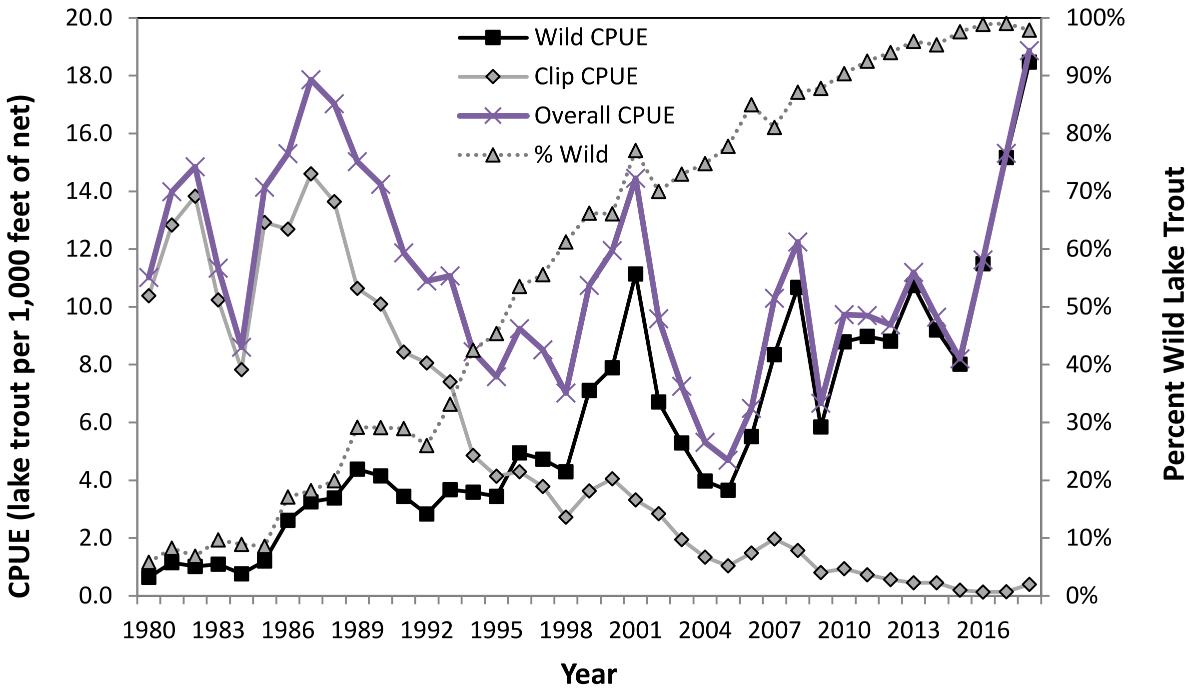

Figure 4. Catch rate (number of fish per 1,000 feet of net; CPUE) of wild, stocked, and overall Lake Trout, and percentage wild Lake Trout in the May assessment, 1980-2018.

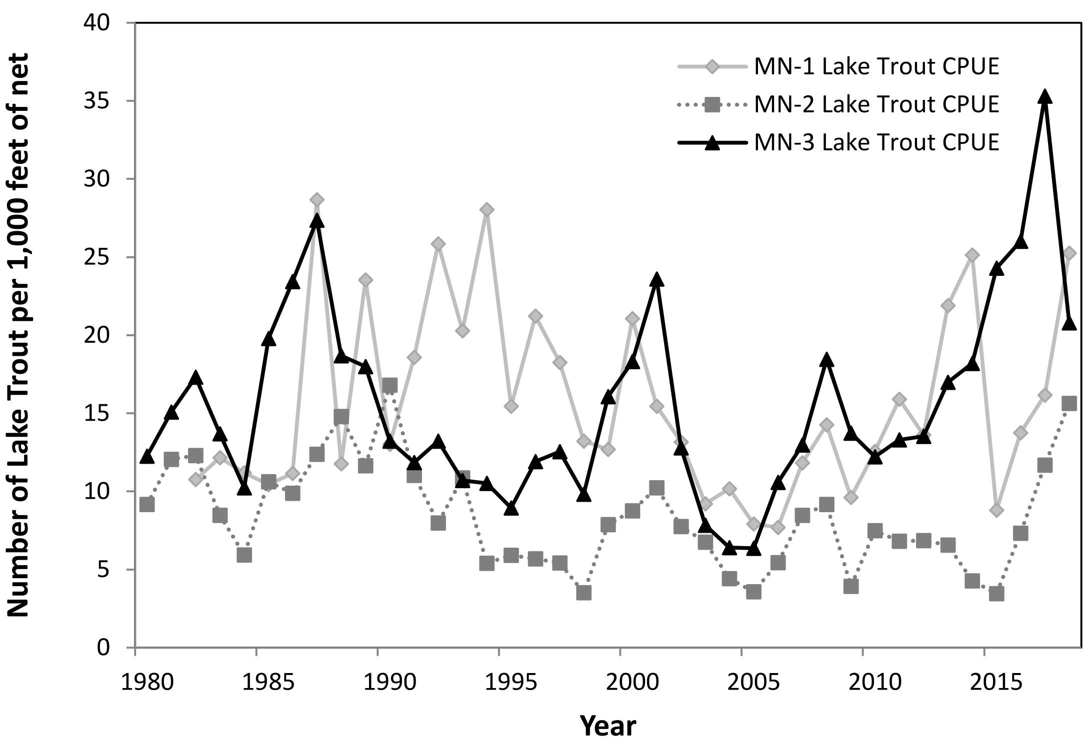

Figure 5. Lake Trout catch rate (number of fish per 1,000 feet of net; CPUE) by statistical district in the May assessment, 1980-2018.

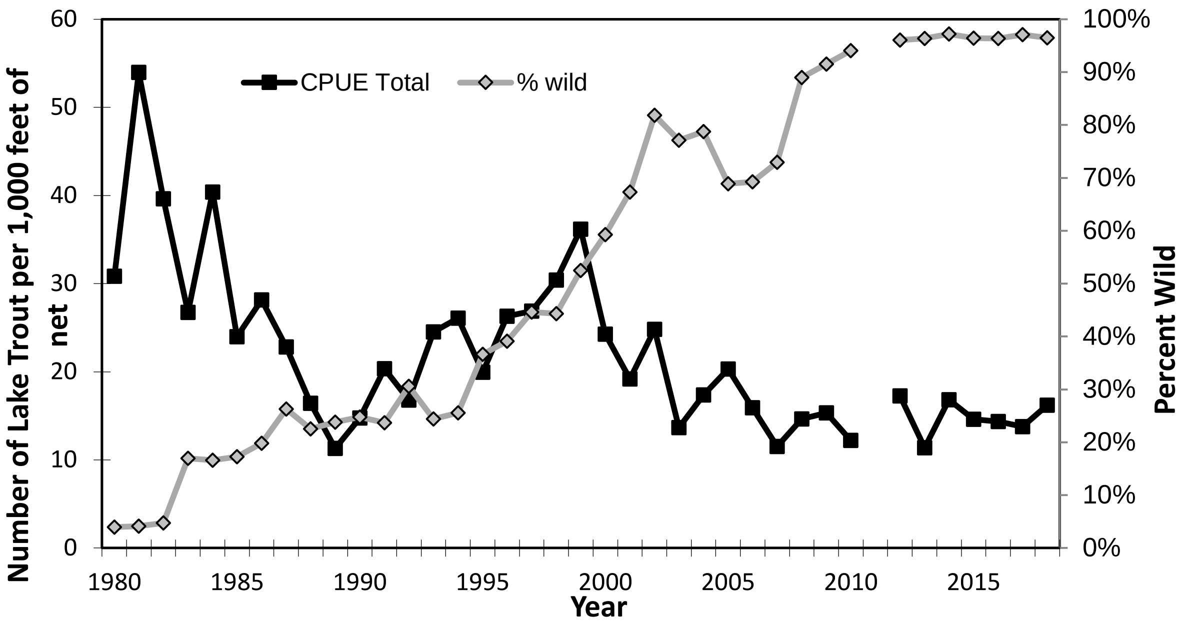

Figure 6. Catch rate (number of fish per 1,000 feet of net; CPUE) and percent wild Lake Trout in the juvenile (<17”) Lake Trout assessment, 1980-2018.

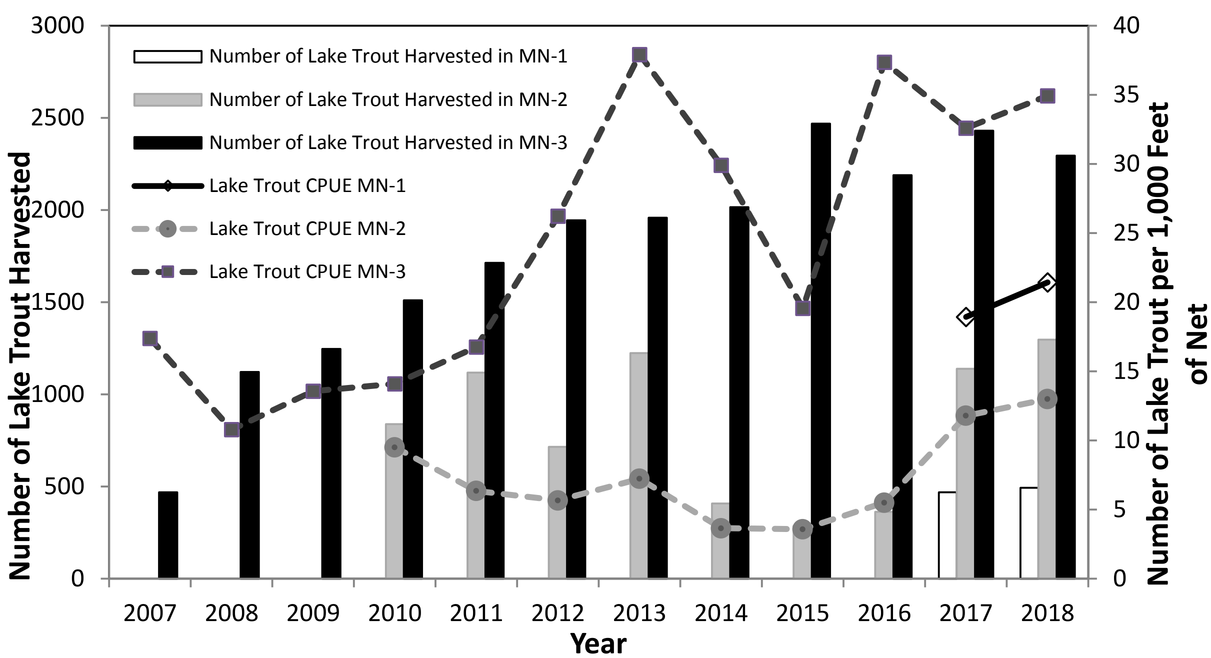

Figure 7. Lake Trout harvest and catch rate (number of fish per 1,000 feet of net; CPUE) in the summer commercial assessment, 2007-2018.

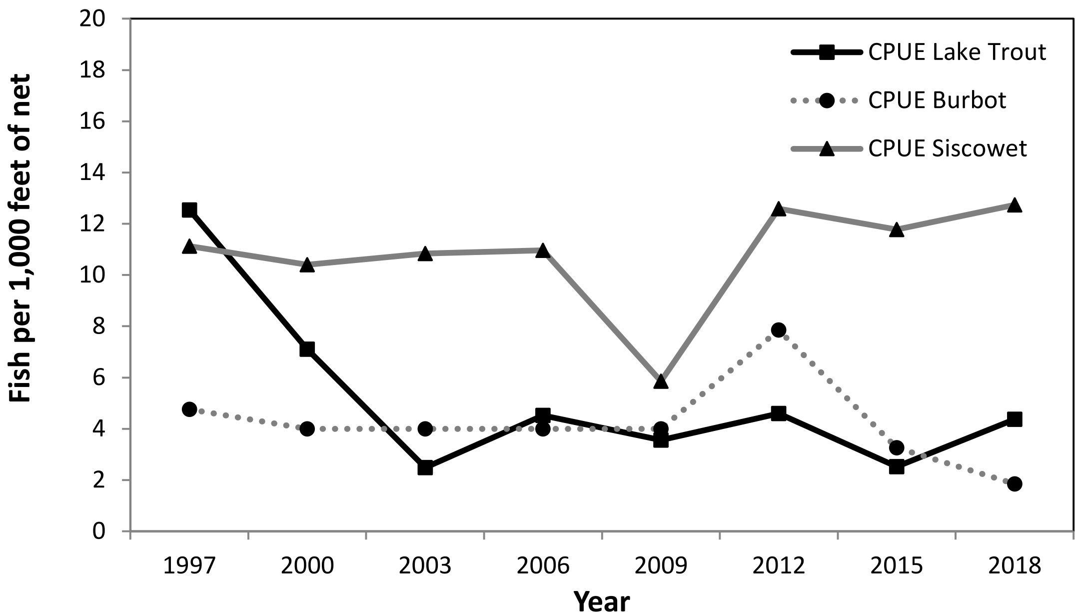

Figure 8. Catch per unit effort (CPUE) of Lake Trout, Burbot, and Siscowet sampled in the deepwater predator assessment, 1997-2018.

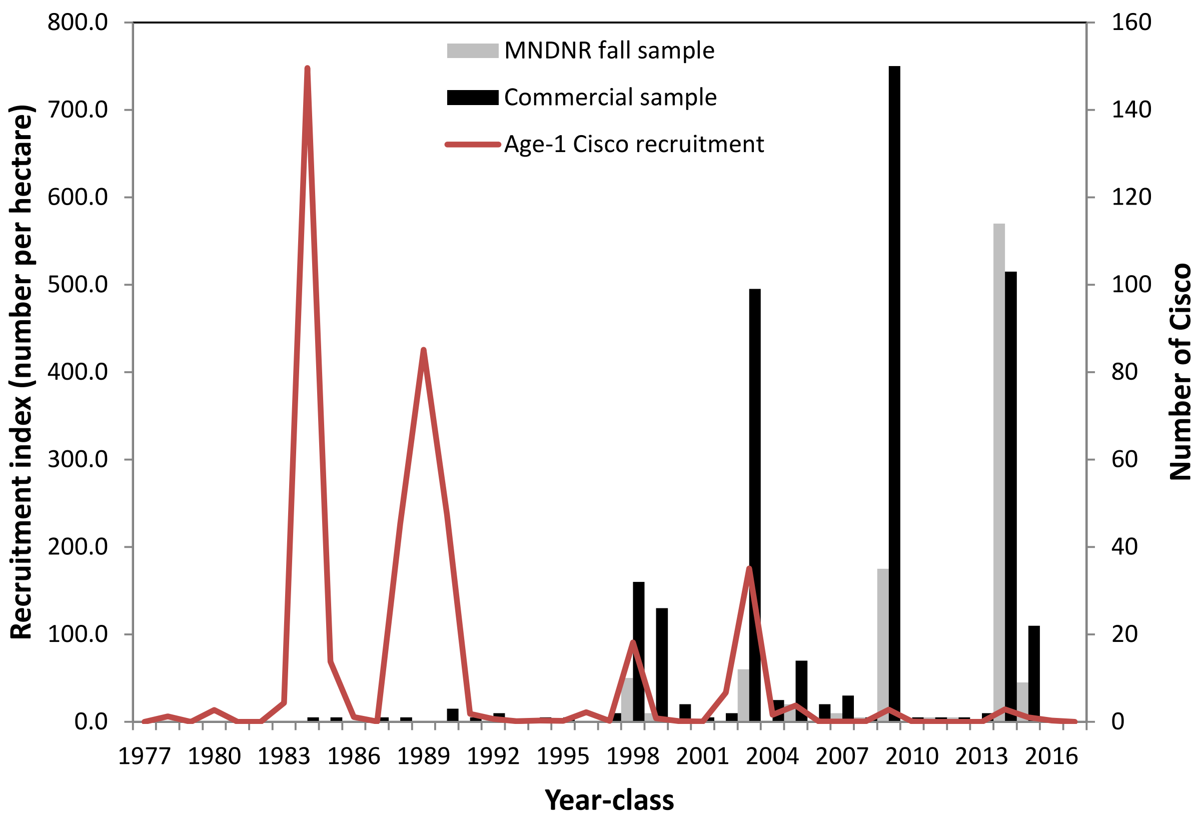

Figure 9. Cisco year-class strength, 1977-2017, as measured by the relative density of age-1 Cisco that were caught during USGS bottom trawl surveys, and the number of Cisco caught by year-class in MNDNR surveys and from commercial fishermen samples (spring and fall combined), 2017.

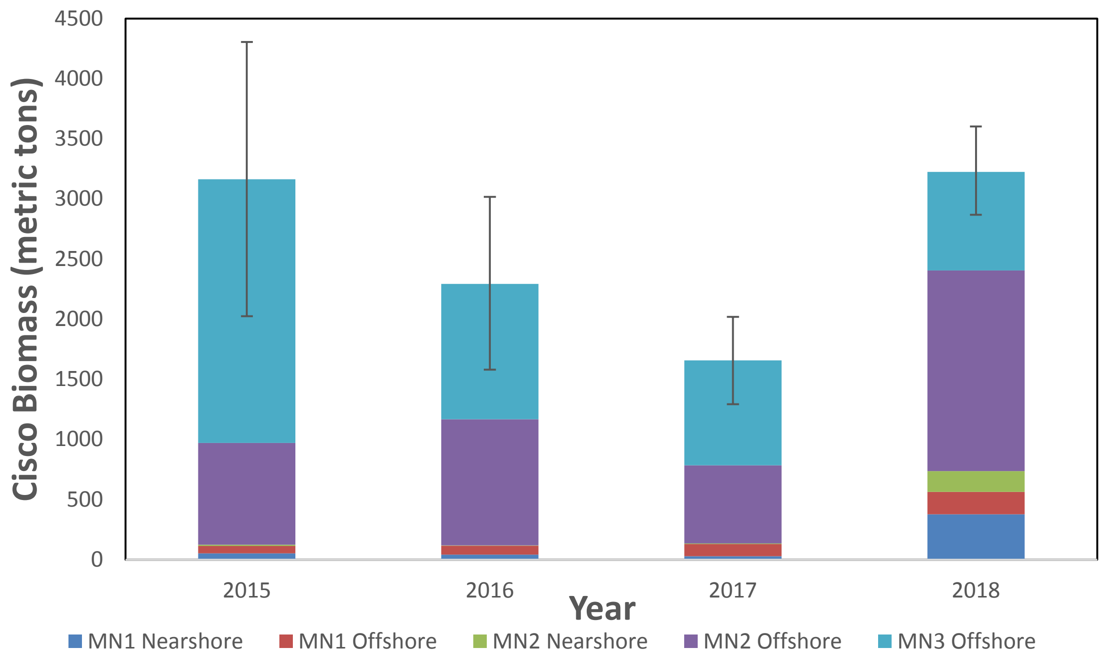

Figure 10. The estimated biomass of spawning-size Cisco from fall hydroacoustic surveys, 2015-2018.

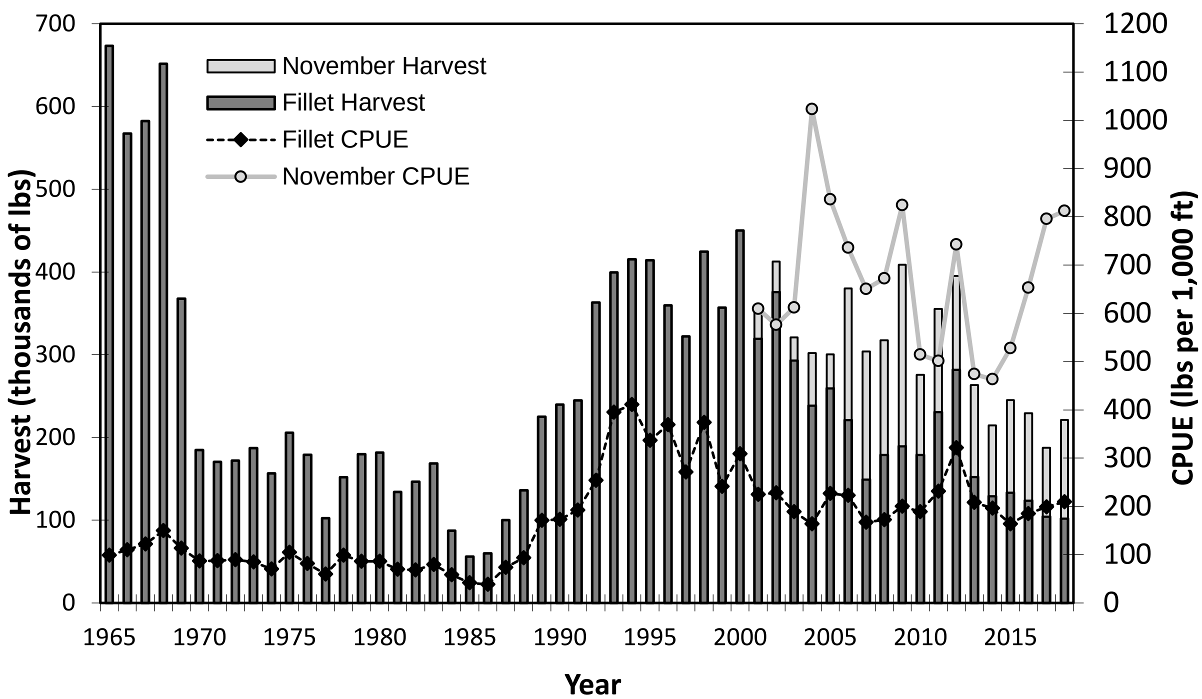

Figure 11. Cisco harvest (thousands of pounds) and catch rate (pounds per 1,000 feet of net; CPUE) in the commercial gill net fishery in Minnesota waters of Lake Superior, 1965-2018.