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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

2020

Prepared by:

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Reimbursed under Federal
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Restoration Act

Executive Summary

The global pandemic affected the surveys scheduled for the 2020 field season. The juvenile Lake Trout assessment, fall Cisco survey, and hydroacoustics survey were all cancelled. Additionally, all net sets in the May Lake Trout assessment were by commercial operators rather than both the MNDNR and commercial operators as in normal years.

The Sea Lamprey (*Petromyzon marinus*) wounding rate in the May Lake Trout assessment was below the target level of 5.0 fresh wounds per 100 Lake Trout (*Salvelinus namaycush)* in MN-1 (4.4), MN-2 (0.0), and MN-3 (4.0). The shorewide wounding rate was below the target at 3.0 wounds per 100 fish. The overall catch rate of Lake Trout in the May assessment was 9.8 fish per 1,000 feet of net. CPUE by management zone was 10.5 in MN-1, 5.8 in MN-2, and 15.7 in MN-3. Shorewide, 99% of Lake Trout were wild fish.

In the summer expanded commercial assessment, commercial fishermen in MN-1 harvested 341 Lake Trout and the CPUE was 12.4 fish per 1,000 feet of net. Lake Trout harvest in MN-2 was 220 fish and the CPUE was 4.4 fish per 1,000 feet of net. In MN-3, 2,109 Lake Trout were harvested and the CPUE was 22.3 fish per 1,000 feet of net. Collectively, commercial fishermen harvested 52% of the available quota.

Cisco harvest in the traditional gill net fishery (all months excluding November) was 125,927 pounds and the catch rate was 262 pounds per 1,000 feet of net. Harvest during the November fishery was 129,212 pounds and the catch rate was 778 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 2020 including the May Lake Trout (*Salvelinus namaycush),* juvenile Lake Trout, 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 resumed, 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 23,869 fish (2011-2020) in the Minnesota waters of Lake Superior (Reeves 2021). 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 2021).

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 (Reeves 2021) and Knife River and French River trap reports.

Methods

Typically the MNDNR conducts the May Lake Trout assessment in MN-1 while commercial operators provide data for MN-2 and MN-3. Due to the global pandemic the MNDNR did not set May Lake Trout assessments nets in 2020, but allowed two commercial fishermen to set nets in MN-1 instead. It should be noted that the stations they fished were not the historical stations used by the MNDNR and were limited to stations in the vicinity of Lakewood Pump House, Stoney Point, and Larsmont. The May Lake Trout assessment utilizes 4.5 inch stretch-measure mesh. Net gangs were set in three 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.

The juvenile Lake Trout assessment is conducted solely by MNDNR, but was cancelled in 2020 due to the pandemic.

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 (2021).

Statistical zones, grids, and locations for 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) for Lake Trout 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 was not conducted in 2020 due to the pandemic. However, 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 2020 were not yet available but 2019 age data are presented in this report.

Hydroacoustic surveys with accompanying mid-water trawls have been conducted since 2003, but this survey was cancelled for 2020 due to the pandemic. It should resume in the fall of 2021.

Results and Discussion

May Assessment

As noted in the Methods section, due to the pandemic net sets in MN-1 were conducted by commercial fishermen rather than the MNDNR. Net locations for 2020 did not include all locations typically utilized by the MNDNR and this should be considered when interpreting results.

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 4.4 in MN-1, 0.0 in MN-2, and 4.0 in MN-3 (Table 1, Figure 2). Rarely have all three zones had wounding rates below 5.0 in the same year. The wounding rate in MN-2 has always been relatively low, but it was surprising that there were no fresh lamprey wounds noted on any fish harvested by commercial fishermen. The overall wounding rate was 3.0 (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 9.8 fish per 1,000 feet of net in the May assessment, which was only about half of both the record-high 2018 and 2019 CPUEs (Table 2, Figure 4). The wild Lake Trout CPUE was 9.7 fish per 1,000 feet of net while the stocked Lake Trout CPUE was 0.1 fish per 1,000 feet of net (Figure 4). Wild fish comprised 99% of all Lake Trout sampled in the assessment (Table 3, Figure 4). By zone, Lake Trout CPUEs for MN-1, MN-2, and MN-3 were 10.5, 5.8, and 15.7 fish per 1,000 feet of net (Table 3, Figure 5).

Lake Trout ages ranged from age-3 to age-29 (Table 4). By design, the May assessment typically captures Lake Trout age-6 to age-10. Seventy-six 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. Overall the commercial operators who assisted with the May assessment did a good job correctly identifying Lake Trout and Siscowet in 2020. In MN-1 only one fish was misidentified by commercial operators (98% agreement, n = 65). Commercial operators in MN-2 also misidentified one fish (99% agreement, n = 117). MN-3 typically is the most problematic zone but only two fish were misidentified (98% agreement, n = 87). Misidentifying Lake Trout could create a variety of problems such as biased CPUEs or poorly functioning Lake Trout models.

Rainbow Smelt commonly comprise the greatest weight of diet items in Lake Trout stomachs, in some years exceeding 90% of stomach biomass. By weight, diet composition of Lake Trout in the 2020 May assessment was mainly Rainbow Smelt (60.5%) and unidentifiable fish remains (15.8%) (Table 5). Coregonids (Bloater, Cisco, Kiyi, and coregonids that couldn't be identified to species; 11.6%), Burbot (5.2%), and *Mysis* (4.5%) also had notable contributions. Eighteen percent of Lake Trout (n=57) had no prey items in their stomachs, which was within the range observed the previous five years (9% - 30%).

Juvenile Lake Trout Assessment

The Juvenile Lake Trout assessment was cancelled for 2020 due to the pandemic. It is scheduled to resume in the summer of 2021.

Summer Expanded Commercial Assessment

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 341 Lake Trout were harvested and the CPUE was 12.4 Lake Trout per 1,000 feet of net (Figure 6). Commercial fishermen harvested 68% of the total-allowable-catch (TAC). Commercial harvest of Lake Trout represented 3.6% of the estimated total Lake Trout harvest in MN-1 between sport (9,136) and commercial (341) fishers combined.

In MN-2, 220 Lake Trout were harvested by commercial fishermen and the CPUE was 4.4 Lake Trout per 1,000 feet of net (Figure 6). Twenty-nine Siscowet were also harvested. Commercial netters harvested 12% of the 2,000 fish TAC (Lake Trout and Siscowet combined) from MN-2. Commercial harvest of Lake Trout represented 5.3% of the estimated total Lake Trout harvest in MN-2 between sport (3,899) and commercial (220) fishers combined.

In MN-3, commercial fishermen harvested 2,109 Lake Trout and the CPUE was 22.3 Lake Trout per 1,000 feet of net (Figure 6). An additional 177 Siscowet were harvested. Commercial fishermen harvested 76% of the 3,000 fish TAC. Commercial harvest of Lake Trout represented 41.4% of the estimated total Lake Trout harvest in MN-3 between sport (2,991) and commercial (2,109) fishers combined. In the three zones combined, commercial fishermen harvested 52% of the TAC. Overall, commercial harvest accounted for 14.3% of the total shorewide Lake Trout harvest between sport (16,026) and commercial (2,670) fishermen.

Lake Trout diet composition by weight in the summer commercial assessment was predominately Rainbow Smelt (32.9%), *Mysis* (20.1%), coregonids (Bloater, Cisco, Kiyi, and coregonids that couldn't be identified to species; 17.4%), unidentifiable fish remains (15.6%), and terrestrial insects (9.7%) (Table 5). Thirty-two percent of Lake Trout stomachs (n = 259) had no diet items, which was slightly lower than the previous five years (37% - 46%).

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 7). Due to the backlog of otoliths, age data from the 2020 spring and fall commercial Cisco samples were not yet available at the

time of this reporting. However, age analysis from the 2019 spring and fall Cisco samples collected from commercial fishermen (n=600) showed the 2014 (35%), 2015 (25%), 2009 (15%), and 2003 (11%) year-classes accounted for 86% of their catch (Figure 7). In total there were 14 year-classes present, ranging from age-3 to age-30. The MNDNR fall Cisco assessment uses multi-mesh nets that includes both smaller mesh sizes (2.0 and 2.5 inch) and a larger mesh size (3.0 inch) than used by commercial fishermen. From the 2019 samples (n=131), the 2014 (29%), 1998 (18%), 2015 (15%), 2009 (15%), and 2003 (15%) year-classes accounted for 92% of the catch. Ten year-classes were represented in the MNDNR survey, with fish ranging from age-3 to age-27. Young fish seemed to be more common in the fall catches than in the spring commercial catch.

Unfortunately the pandemic caused the cancellation of all hydroacoustics work in 2020, so an estimate of spawning-sized Cisco biomass could not be calculated. Hydroacoustic work is scheduled to resume in the fall of 2021.

Commercial Cisco Harvest

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.

Commercial netters set 480,645 feet of net for Cisco during the traditional fishery (all months except November) in 2020, which was the smallest amount ever set during the time series dating back to the 1960s. Cisco harvest in the traditional fishery was 125,927 pounds (Figure 8). The CPUE was 262 pounds per 1,000 feet of net and was one of the higher CPUEs observed over the past twenty years (Figure 8).

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 2020 was set at 438,005 pounds for Minnesota waters. Beginning in 2016, the Grand Portage Band of Chippewa set a November Cisco TAC for their waters. With permission, some Minnesota-licensed commercial fishermen are allowed to harvest from Grand Portage waters. Commercial fishermen operating in Minnesota waters harvested 96,557 pounds of Cisco and Minnesota-licensed commercial fishermen fishing in Grand Portage waters harvest 32,655 pounds for a combined harvest of 129,212 pounds of Cisco in the November season (Figure 8). The CPUE was 778 pounds per 1,000 feet of net. Further detail of commercial Cisco harvest is available in the annual Commercial Fishing Summary (Blankenheim 2021).

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Prepared by:

Josh Blankenheim

Approved by: Cory Goldsworthy Digitally signed by Cory Goldsworthy Date: 2023.04.25 12:41:16 -05'00'
Area Fisheries Supervisor Date

Approved by: Leslie George Digitally signed by Leslie George Date: 2023.04.29 23:26:16 -05'00'
Regional Fisheries Approval Date

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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, 2020. 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 (1)	4.9 (61)	4.0 (50)	4.0 (25)	4.4 (137)
MN-2	0.0 (32)	0.0 (102)	0.0 (23)	0.0 (1)	0.0 (158)
MN-3	2.9 (35)	2.0 (202)	12.1 (33)	25.0 (8)	4.0 (278)
TOTALS	1.5 (68)	1.9 (365)	5.7 (106)	8.8 (34)	3.0 (573)

Table 2. Number of Lake Trout by size class per 1,000 feet of 4.5 inch stretch mesh May assessment gill nets, 2020.

	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	0.2	1.1	6.2	1.8	0.6	9.8

Table 3. Corrected Lake Trout catch by station in the May assessment, 2020.

Location	Effort in Feet (corrected effort)	Number Caught	Total Pounds	Number per 1,000 feet	Pounds per 1,000 feet	Percent Wild
MN-1						
Lakewood Pumping Station	6,000 (6,000)	44	319	3.4	24.5	88.6
Stoney Point	4,500 (4,500)	10	48	0.8	3.7	100
Larsmont	2,500 (2,500)	83	454	6.4	34.9	100
Totals MN-1	13,000 (13,000)	137	821	10.5	63.2	96.4
MN-2						
Split Rock	3,500 (5,080)	30	105	5.9	20.7	96.7
Silver Bay	15,750 (23,420)	136	461	5.8	19.7	100
Totals MN-2	19,250 (28,500)	166	566	5.8	19.9	99.4
MN-3						
Grand Marais	12,750 (17,820)	280	987	15.7	55.4	100
All locations						
Shorewide	**45,000 (59,320)**	**583**	**2,374**	**9.8**	**40.0**	**99.0**

Table 4. Age-length frequency distribution of otolith-aged Lake Trout in 4.5 inch stretch measure gill nets, May assessment, 2020. 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	1													
11.0 - 11.9														
12.0 - 12.9														
13.0 - 13.9														
14.0 - 14.9														
15.0 - 15.9														
16.0 - 16.9			5											
17.0 - 17.9			1											
18.0 - 18.9				5										
19.0 - 19.9				3	4		1							
20.0 - 20.9				2	9	3	2	1			**1**			1
21.0 - 21.9					10	16	6	1						**1**
22.0 - 22.9					5	15	10	1	1	1			1	**2**
23.0 - 23.9			1		1	14	24	4	3	2	1			3
24.0 - 24.9				1		8	20	7	3	2				1
25.0 - 25.9					1	1	10	10	3	2	1	1		
26.0 - 26.9						1	1	4	5	2	1			1
27.0 - 27.9							2	2		2				2
28.0 - 28.9										1				
29.0 - 29.9														2
30.0 - 30.9									1				1	1
31.0 - 31.9														4
32.0 - 32.9														3
33.0 - 33.9												1		
34.0 - 34.9														
35.0 - 35.9														
36.0 - 36.9														
37.0 - 37.9														
38.0 - 38.9														
39.0 - 39.9														
Total	1	0	7	11	30	58	76	30	16	12	4	2	2	21
Average Length	10.1		17.2	19.5	21.1	22.6	23.6	24.7	25.3	25.2	23.9	29.0	26.4	28.0

Table 5. Diet composition by weight of prey items in Lake Trout stomachs in the May, and summer assessments, 2020. The number of stomachs sampled with prey items is shown in parentheses.

	Lake Trout			
Diet item	May		Summer	
Alewife			0.1%	(1)
Aquatic insects	0.2%	(19)	0.3%	(17)
Artificial fishing bait			0.2%	(3)
Bird			0.1%	(3)
Burbot	5.2%	(9)	1.7%	(3)
Cisco (lake herring)	8.8%	(2)	4.8%	(2)
Clam sp.	0.0%	(1)		
Coregonid sp.	2.8%	(5)	12.6%	(25)
Deepwater Sculpin	0.0%	(1)	0.1%	(3)
Empty		(57)		(176)
Fish eggs	0.0%	(1)	0.0%	(1)
Minnow sp.	0.9%	(7)		
Mysis	4.5%	(46)	20.1%	(119)
Ninespine Stickleback	0.0%	(2)	0.1%	(1)
Rainbow Smelt	60.5%	(88)	32.9%	(66)
Rocks	0.1%	(11)	0.4%	(26)
Sculpin sp.	0.0%	(1)	0.8%	(17)
Slimy Sculpin	0.3%	(4)	0.3%	(6)
Spoonhead Sculpin	0.0%	(1)		
Stickleback sp.	0.0%		0.1%	(2)
Terrestrial insects	0.8%	(17)	9.7%	(70)
Threespine stickleback	0.0%	(1)		
Unidentifiable fish remains	15.8%	(128)	15.6%	(126)
Woody debris	0.1%	(12)	0.2%	(15)

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

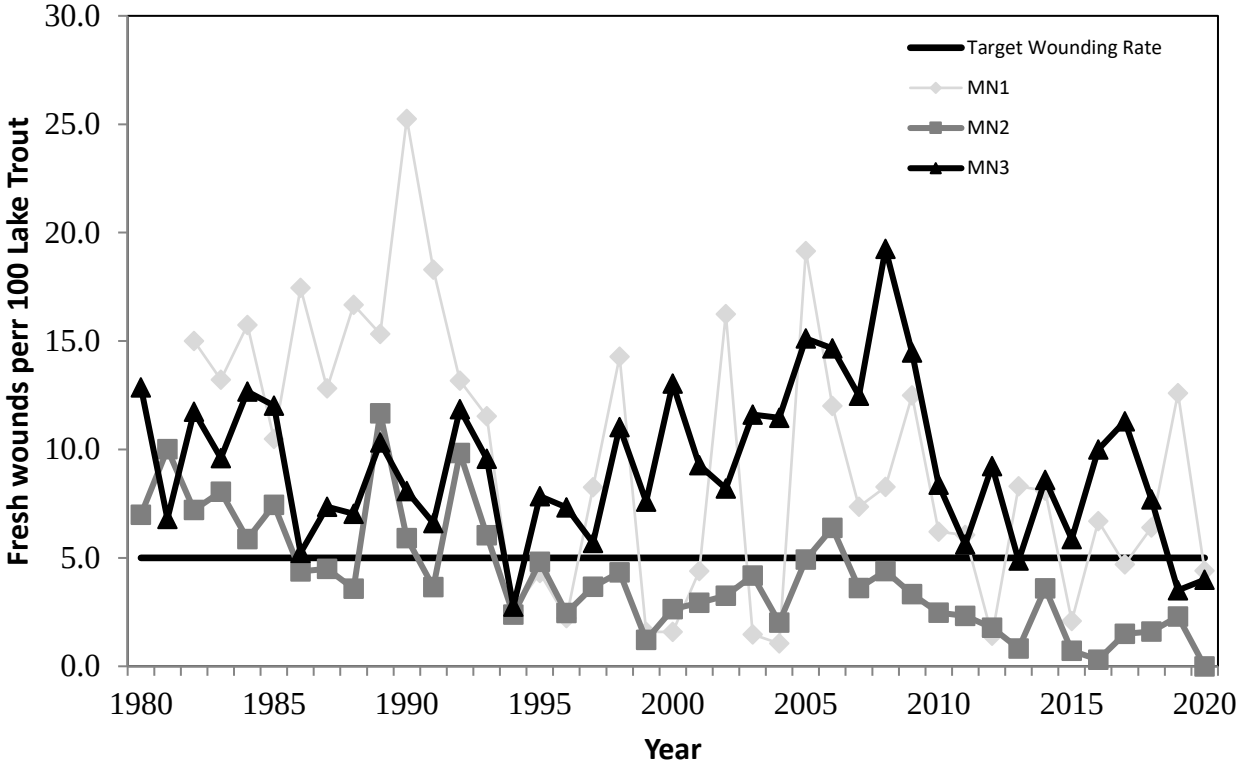

Figure 2. Number of fresh Sea Lamprey wounds per 100 Lake Trout in the May assessment, by statistical district, 1980-2020.

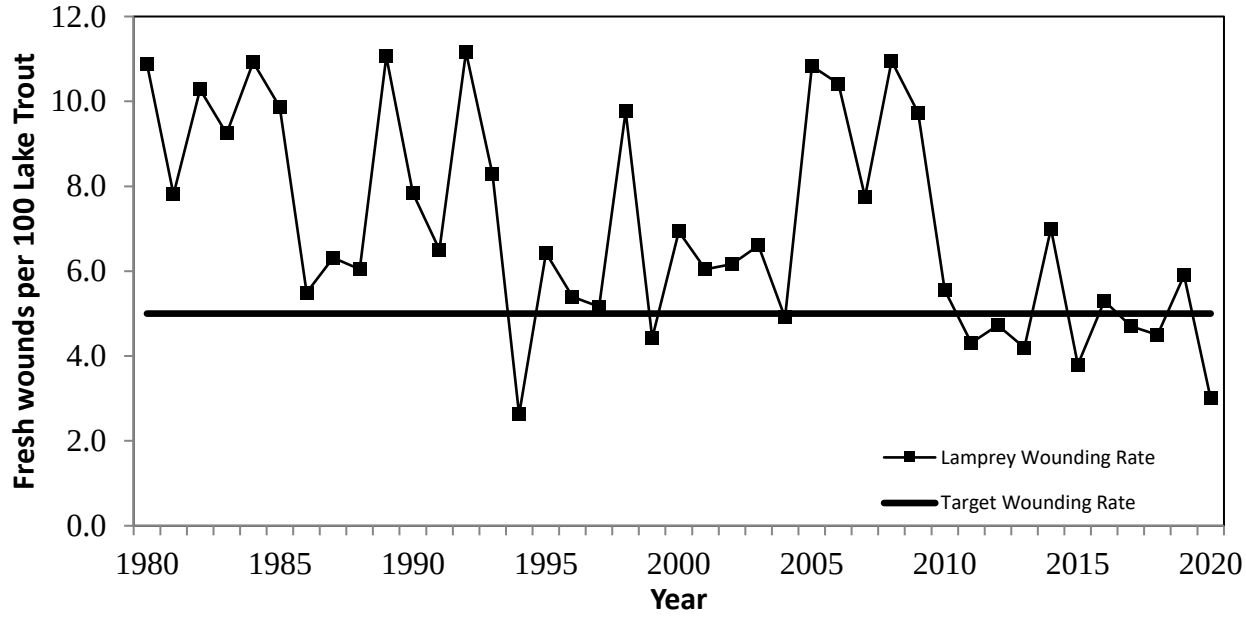

Figure 3. Shorewide number of fresh Sea Lamprey wounds per 100 Lake Trout in the May assessment, 1980-2020.

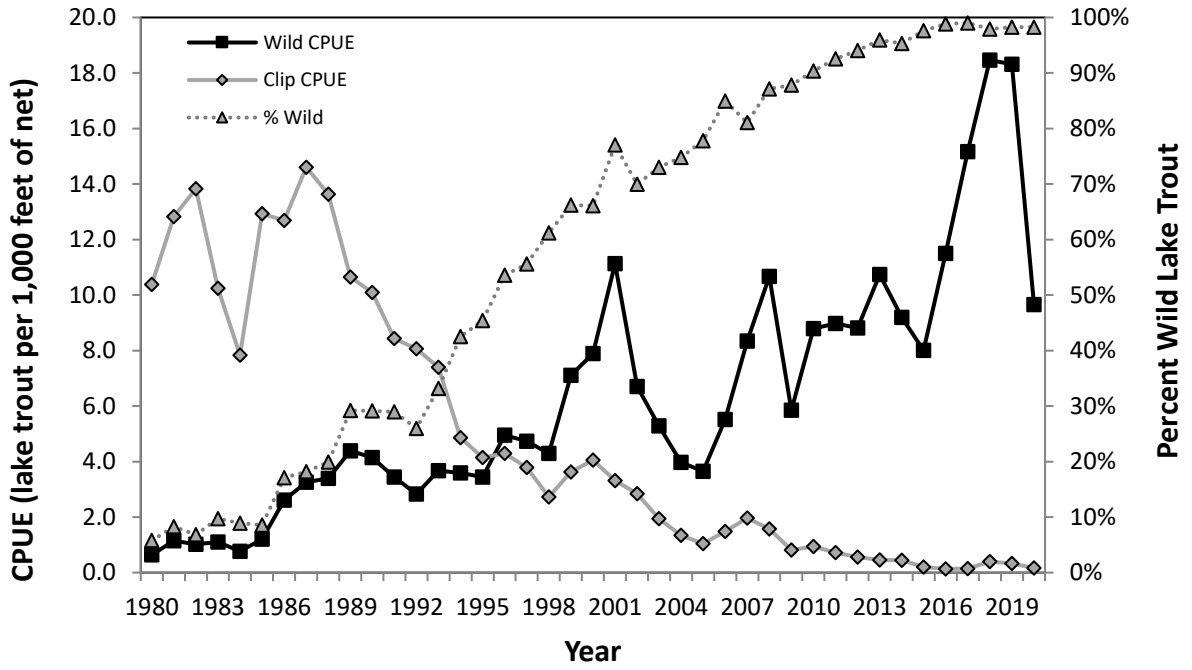

Figure 4. Catch rate (number of fish per 1,000 feet of net; CPUE) of wild and stocked Lake Trout, and percentage wild Lake Trout in the May assessment, 1980-2020.

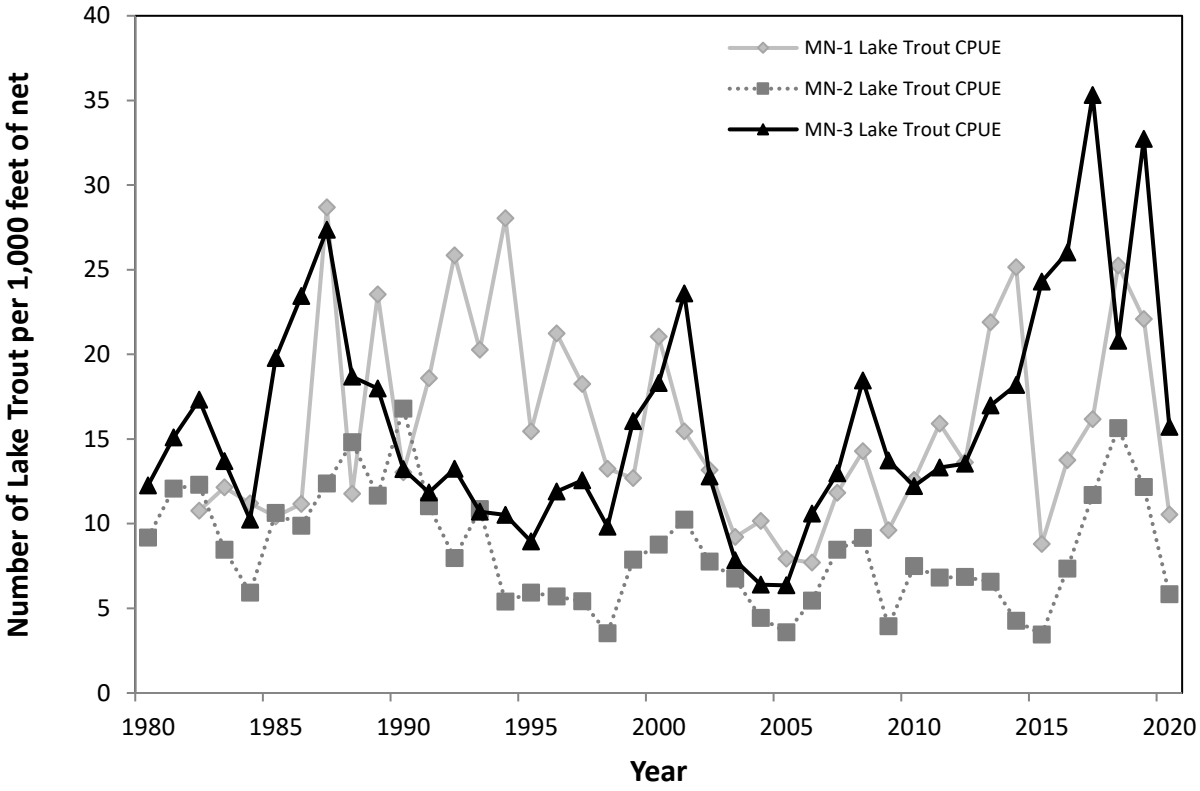

Figure 5. Lake Trout catch rate (number of fish per 1,000 feet of net; CPUE) by statistical district in the May assessment, 1980-2020.

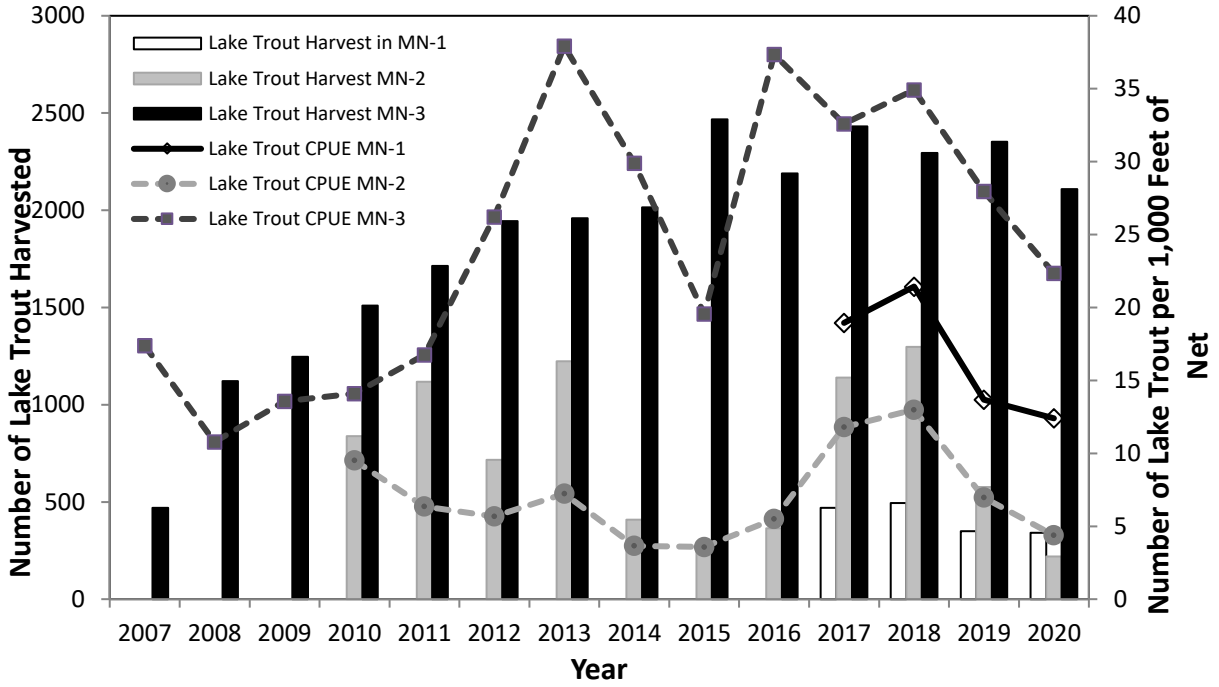

Figure 6. Lake Trout harvest and catch rate (number of fish per 1,000 feet of net; CPUE) in the summer commercial assessment, 2007-2020.

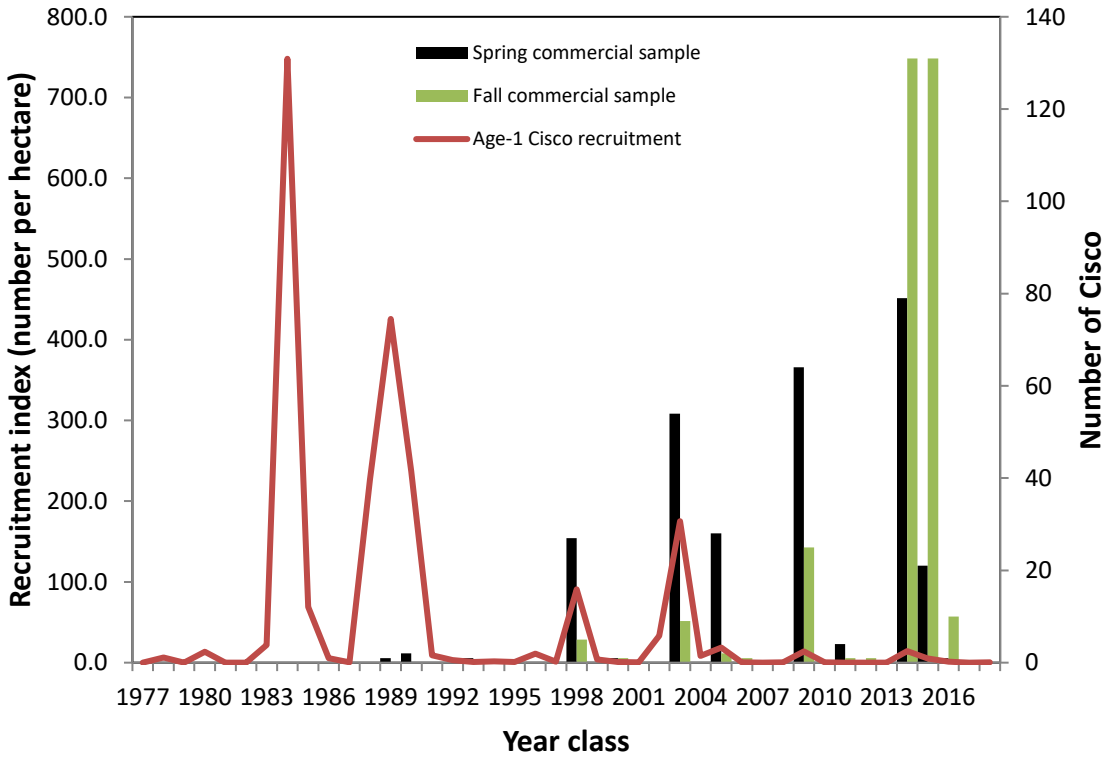

Figure 7. Cisco year-class strength, 1977-2019, as measured by the relative density of age-1 Cisco that were caught during USGS bottom trawl surveys, and the number of Cisco caught by year-class from commercial fishermen samples (spring and fall), 2019.

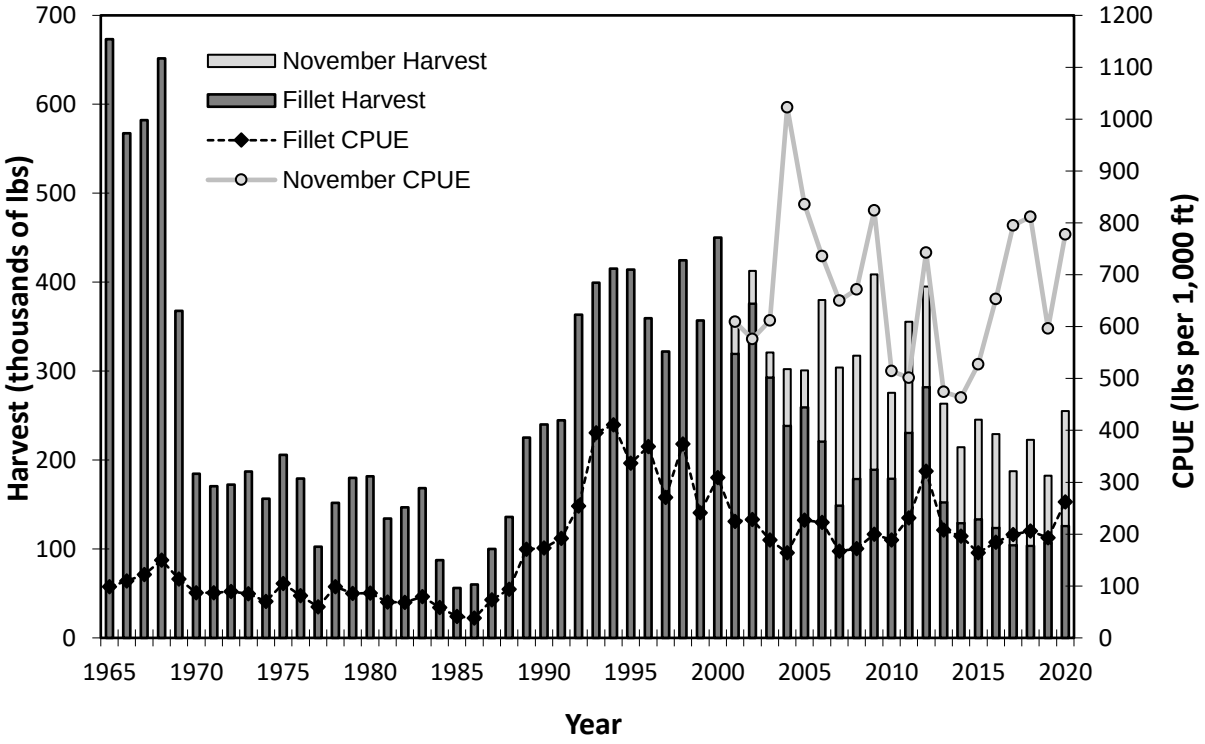

Figure 8. Cisco harvest (thousands of pounds) and catch rate (pounds per 1,000 feet of net; CPUE) in the commercial gill net fishery in Minnesota waters of Lake Superior, 1965-2020.