Summary of Activities in 2023

of the

Lake Trout Suppression Program to Benefit Native Species

in

Flathead Lake

Confederated Salish and Kootenai Tribes

Fisheries Program

June 2024

Introduction

This report summarizes results of the tenth year of work conducted under the direction of the Implementation Plan for Lake Trout Suppression in Flathead Lake (2014) by the Confederated Salish and Kootenai Tribes (CSKT). The Implementation Plan is the culmination of a lengthy and often contentious process in management of the fishery of Flathead Lake. It was preceded by the Flathead Lake and River Fisheries CoManagement Plan (CoPlan) that was adopted in 2000 by CSKT and Montana Fish Wildlife and Parks (MFWP). The goals of the CoPlan are to:

1) "Increase and protect native trout populations", and

2) "Balance tradeoffs between native species conservation and nonnative species reduction to maintain a viable recreational/subsistence fishery".

The CSKT concluded in 2009 that ongoing, angler-based efforts to achieve goals of the CoPlan were unlikely to succeed without an expanded suppression program. The CSKT completed a Draft Environmental Impact Statement on June 21, 2013 that summarized impacts of all reasonable suppression methods. The Flathead Reservation Fish and Wildlife Advisory Board voted on August 21, 2013 to recommend that the Tribal Council select one of the three action alternatives rather than the No Action alternative. The Tribal Council unanimously selected Alternative D (75% reduction of Age 8+ lake trout) on September 10, 2013 as their Preferred Alternative. The Tribes released a Final Environmental Impact Statement (FEIS) on February 21, 2014 that addressed all comments received, and released the Implementation Plan for expanded lake trout suppression in March, 2014. The USFWS issued a Recovery Permit on April 1, 2014 to address incidental "take" of bull trout during suppression activities.

The approach for expanded suppression is proceeding under the same guidelines as followed in the initial suppression stages, as prescribed in the CoPlan, and restated in the Implementation Plan, which is to proceed cautiously and incrementally, employing both short-term and long-term components. The short-term strategy is based on a one-year planning horizon to best facilitate frequent review and adjustment. The long-term goal of expanded suppression is to achieve the full harvest level analyzed in the FEIS to achieve a 75% reduction in Age 8 and older lake trout. There is no requirement to meet the goal in any particular year, only to maintain annual progress toward the goal. The pace of movement could be accelerated if bull trout metrics decline below the trigger of "Secure Populations" as defined under the Co-Management agreement, or the pace could be slowed if factors (i.e. new information, excessive bycatch, etc.) indicate unacceptable impacts.

The short-term, or annual process consists of development of a harvest target for lake trout, followed by implementation of suppression activities to achieve the target, and concludes with analysis of results that facilitates setting the next annual harvest target. The purpose of this report is to gauge success and evaluate risks inherent in the suppression program, and plan for suppression in 2025. To do so, we answered six key questions. After the tenth year of expanded suppression efforts in 2023:

1) Are bull trout and westslope cutthroat trout increasing?

2) Are lake trout decreasing?

3) Is angler activity decreasing?

4) Is suppression of lake trout causing unintended consequences?

5) Is the level of risk inherent with suppression acceptable?

6) Based on the result of the first five questions; What is the best lake trout harvest target for 2025?

Implementation Activities Conducted Prior to 2023

Active suppression efforts began in autumn 2002 with the first Mack Days fishing contest. Between 2002 and 2013, anglers participating in the contests harvested 287,952 lake trout (Table 1). Average length of harvested fish was 450 mm and average weight was 850 g. Total weight harvested in these contests (2002-2013) was 244,674 kg (111,215 pounds). Expanded suppression efforts began in 2014 with initiation of gillnetting. Total harvest from contests and gillnetting from 2014 through 2022 was 702,009 lake trout with average length roughly of 432 mm and average weight of 736 g equaling a total weight of 516,678 kg (1,136,693 pounds). Total weight of fish harvested by all suppression methods from 2002 to 2022 is 728,611 kg (1,602,945 pounds).

Table 1. Harvest of lake trout by suppression method from 2002 to 2022.

Method	2002-2013	2014-2022	Cumulative 2002-2022
Spring Mack Days	177,172	289,579	466,751
Spring Gillnetting	0	194,790	194,790
Fall Mack Days	110,780	140,820	251,600
Fall Gillnetting	0	76,820	76,820
Total	287,952	702,009	989,961

Implementation Activities Conducted in 2023

Harvest during 2023 was generated from recreational angling, fishing contests, and gillnetting. The harvest target established in 2022 was 140,000 lake trout (see 2022 annual report of suppression) from these methods, based on anticipated increases in gillnetting effort. Harvest from anglers and gillnetting, resulted in a total harvest of 112,514 lake trout (Table 2 and Figure 1).

We estimated that recreational angling accounted for a harvest of 25,000 lake trout (see FEIS, Appendix 5, page 4) in 2023, based on the assumption that harvest in 2023 was similar to the average annual harvest quantified between 1998 and 2007 when extensive creel surveys were conducted. In Spring Mack Days 33,297 lake trout were harvested in 1,494 angler-trips (Figure 2), and in Fall Mack Days 17,502 lake trout were harvested in 883 angler-trips (Figure 3).

Gillnetting in spring produced 29,455 lake trout and gillnetting during fall produced 7,260 lake trout (Table 3). The total of all these activities in 2023 equaled 113,664 lake trout harvested.

Table 2. Methods, and planned and actual harvest of lake trout in 2023.

Method	Projected Lake Trout Harvest Target from Previous Year	Actual Lake Trout Harvest in 2023	Difference Between Projected and Actual Harvest
General Recreational Angling	25,000 (Estimated)	25,000 (Estimated)	?
Spring Mack Days	30,000	33,297	+3,297
Spring Gillnetting	45,000	29,455	-15,545
Fall Mack Days	15,000	17,502	+2,502
Fall Gillnetting	25,000	7,260	-17,740
Total	140,000	112,514	-27,486

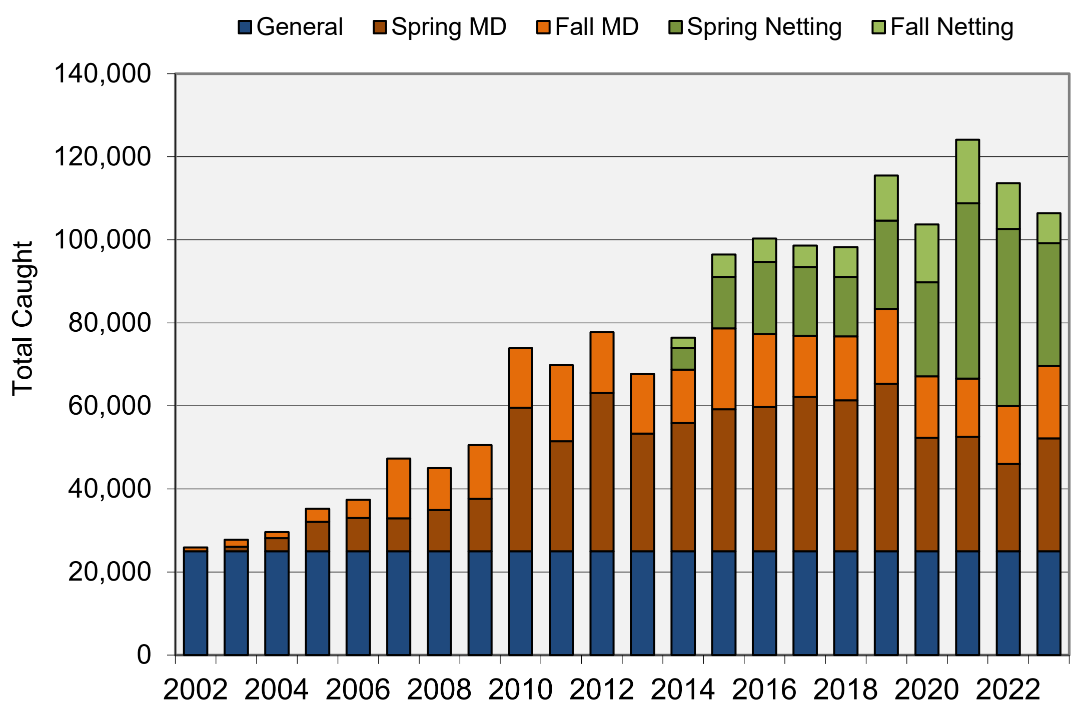

Figure 1. Total harvest of lake trout from general recreational angling, Mack Days fishing contests and gillnetting, 2002 to 2023.

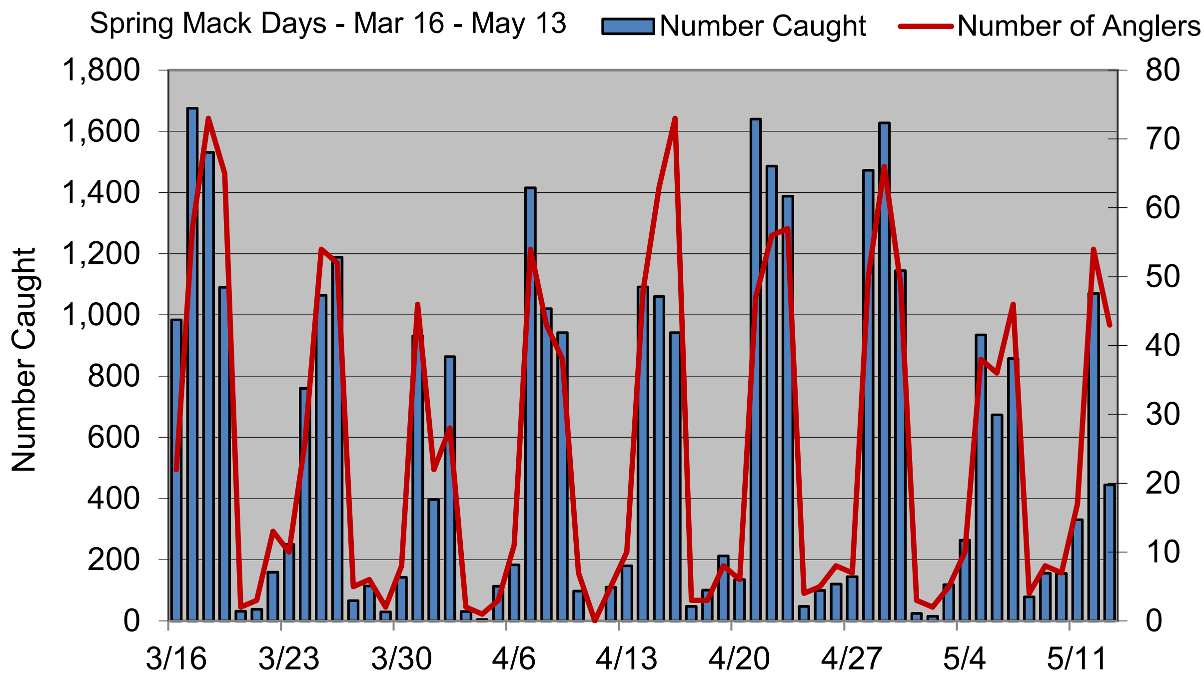

Figure 2. Number of lake trout caught (bars) and angler-days (line) expended during Spring Mack Days, 2023.

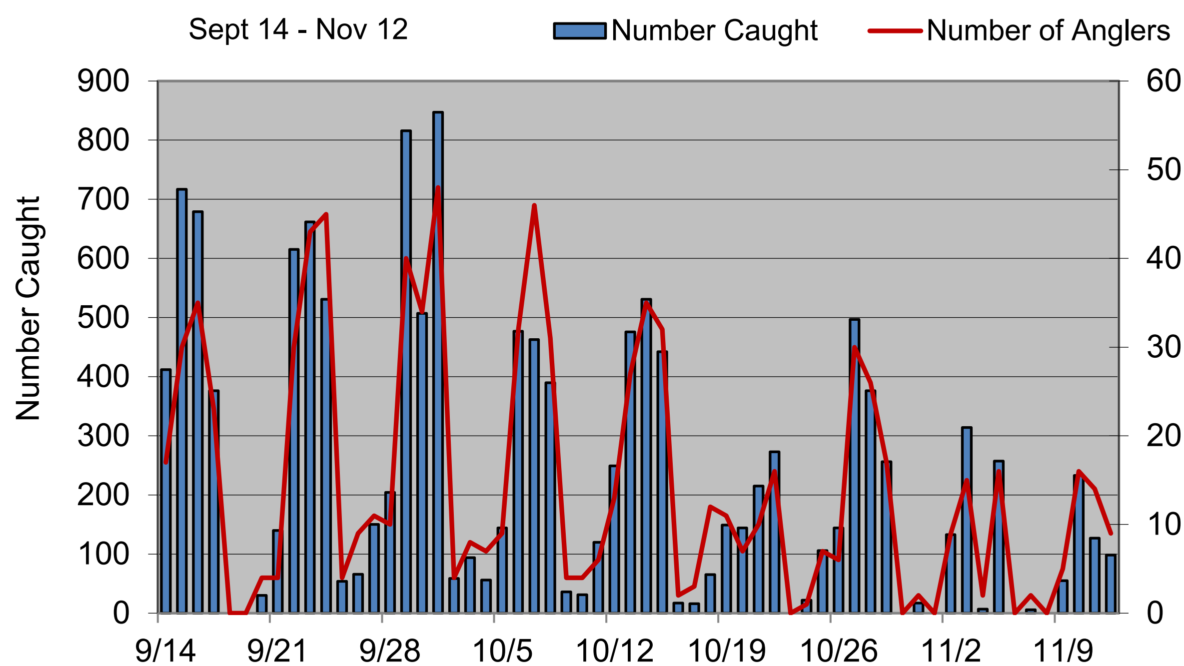

Figure 3. Number of lake trout caught (bars) and angler-days expended (line) during Fall Mack Days, 2023.

Table 3. Results of suppression gillnetting in 2023 (D = day, N = night, LT = lake trout, BT = bull trout, and x = data not collected).

Net #	Date	D/N	# Boxes	Avg Depth	Total LT Kept	Total BT Caught	BT Morts	Mesh
1	3/7	D	3	349	5	0	0	3.5
2	3/7	N	5	322	84	0	0	3.5
3	3/8	N	5	259	221	0	0	3.5
4	3/13	D	8	278	91	1	1	3.5
5	3/13	N	8	201	1042	0	0	3.5
6	3/14	N	5	224	233	0	0	3.5
7	3/14	2N	2	223	156	0	0	3.5
8	3/16	D	2	208	1	0	0	3.5
9	3/20	D	6	275	47	0	0	3.5
10	3/20	N	6	224	289	0	0	3.5
11	3/21	N	3	294	93	0	0	3.5
12	3/22	D	3	275	35	0	0	0
13	3/22	N	6	235	287	0	0	3.5
14	3/22	D	8	285	191	0	0	3.5
15	3/27	N	8	286	327	0	0	3.5
16	3/28	2N	8	258	531	1	1	3.5
17	4/3	D	8	278	149	1	1	3.5
18	4/3	N	8	290	201	0	0	3.5
19	4/4	N	8	258	368	0	0	3.5
20	4/5	N	8	279	168	0	0	3.5
21	4/10	D	8	250	86	0	0	3.5
22	4/10	2N	6	283	316	0	0	3.5
23	4/12	N	12	222	468	0	0	4
24	4/17	D	6	188	2	0	0	3.5
25	4/17	N	8	218	618	0	0	3.5
26	4/18	N	8	217	563	0	0	3.5
27	4/19	N	8	224	244	0	0	3.5
28	4/24	D	8	265	110	0	0	3.5
29	4/24	N	8	298	384	1	1	3
30	4/25	N	8	288	408	1	1	3.5
31	4/26	N	8	278	345	0	0	3.5
32	5/2	D	8	283	53	0	0	3.5
33	5/2	N	6	262	382	0	0	3.5
34	5/2	2N	4	262	191	0	0	3.5
35	5/8	N	10	303	352	0	0	3.5
36	5/9	N	10	323	331	1	1	3.5
37	3/7	D	8.9	267	332	0	0	3.5
38	3/7	N	9	267	336	0	0	3.5
39	3/8	N	9.1	267	340	0	0	3.5

Net #	Date	D/N	# Boxes	Avg Depth	Total LT Kept	Total BT Caught	BT Morts	Mesh
40	3/13	D	9.3	267	343	0	0	3.5
41	3/13	N	9.4	268	347	0	0	3.5
42	3/14	N	9.5	268	351	0	0	3.5
43	3/14	2N	9.6	268	355	0	0	3.5
44	3/16	D	9.7	268	359	1	1	3.5
45	3/20	D	9.8	269	363	0	0	3.5
46	3/20	N	9.9	269	367	0	0	3.5
47	3/21	N	10	269	371	0	0	3.5
48	3/22	D	10	269	374	0	0	3.5
49	3/22	N	10	269	378	0	0	3.5
50	3/22	D	10	270	382	0	0	3.5
51	3/27	N	11	270	386	0	0	3.5
52	3/28	2N	11	270	390	0	0	3.5
53	4/3	D	11	270	394	0	0	3.5
54	4/3	N	11	271	398	0	0	3.5
55	4/4	N	11	271	401	1	1	3.5
56	4/5	N	11	271	405	0	0	3.5
57	4/10	D	11	271	409	0	0	3.5
58	4/10	2N	11	271	413	0	0	3.5
59	4/12	N	11	272	417	0	0	3.5
60	4/17	D	12	272	421	0	0	3.5
61	4/17	N	12	272	425	0	0	3.5
62	4/18	N	12	272	429	0	0	3.5
63	4/19	N	12	273	432	1	1	3.5
64	4/24	D	12	273	436	0	0	3.5
65	4/24	N	12	273	440	0	0	3.5
66	4/25	N	12	273	444	0	0	3.5
67	4/26	N	12	273	448	0	0	3.5
68	5/2	D	12	274	452	0	0	3.5
69	5/2	N	13	274	456	0	0	3.5
70	5/2	2N	13	274	459	0	0	3.5
71	5/8	N	13	274	463	0	0	3.5
72	5/9	N	13	275	467	0	0	3.5
73	3/7	D	13	275	471	0	0	3.5
74	3/7	N	13	275	475	0	0	3.5
75	3/8	N	13	275	479	1	1	3.5
76	3/13	D	13	276	483	1	1	3.5
77	3/13	N	14	276	487	0	0	3.5
78	3/14	N	14	276	490	0	0	3.5
79	3/14	2N	14	276	494	1	1	3.5
80	3/16	D	14	276	498	1	1	3.5

Net #	Date	D/N	# Boxes	Avg Depth	Total LT Kept	Total BT Caught	BT Morts	Mesh
81	8/28	D	12	308	224	0	0	3.5
82	9/5	D	12	303	140	0	0	3.5
83	9/5	2N	12	298	679	1	1	3.5
84	9/11	D	12	205	146	0	0	3.5
85	9/11	N	12	183	428	0	0	3.5
86	9/12	N	12	165	369	0	0	3.5
87	9/13	N	12	196	355	2	1	3.5
88	9/18	D	12	297	154	0	0	3
89	9/18	N	12	292	332	0	0	3
90	9/19	3N	12	307	702	5	4	3
91	9/25	2N	12	120	228	1	0	3
92	9/28	D	12	150	27	0	0	3
93	10/2	D	12	143	70	0	0	4
94	10/2	N	12	143	279	0	0	4
95	10/5	D	12	113	8	0	0	4
96	10/10	D	12	88	22	0	0	4
97	10/10	N	11	87	323	0	0	4
98	10/11	N	11	85	256	2	0	4
99	10/16	D	12	97	8	0	0	4
100	10/16	N	12	299	111	0	0	4
101	10/18	N	12	135	149	0	0	4
102	10/22	D	12	113	63	0	0	4
103	10/23	N	12	101	446	0	0	4
104	10/24	N	12	108	524	0	0	4
105	10/30	D	12	108	6	0	0	4
106	10/30	N	12	105	285	0	0	4
107	11/1	N	8	111	187	0	0	4
108	11/6	D	12	115	8	0	0	4
109	11/7	N	12	110	149	0	0	4
110	11/7	N	12	118	181	1	1	4
111	11/13	N	8	92	161	0	0	4
112	11/14	N	8	195	45	0	0	4
113	11/28	N	12	293	83	0	0	3.5
114	11/29	N	12	287	138	0	0	3.5
115	12/4	N	12	288	113	1	0	3.5
116	12/5	N	12	288	85	0	0	3.5

In 2023 we placed 81 nets of varying lengths during spring and summer (Figure 4) and 35 nets during autumn (Figure 5) within the constraints prescribed by the Bull Trout Recovery Permit, following a protocol with minimal sampling in water shallower than 120 ft to avoid bycatch of bull trout.

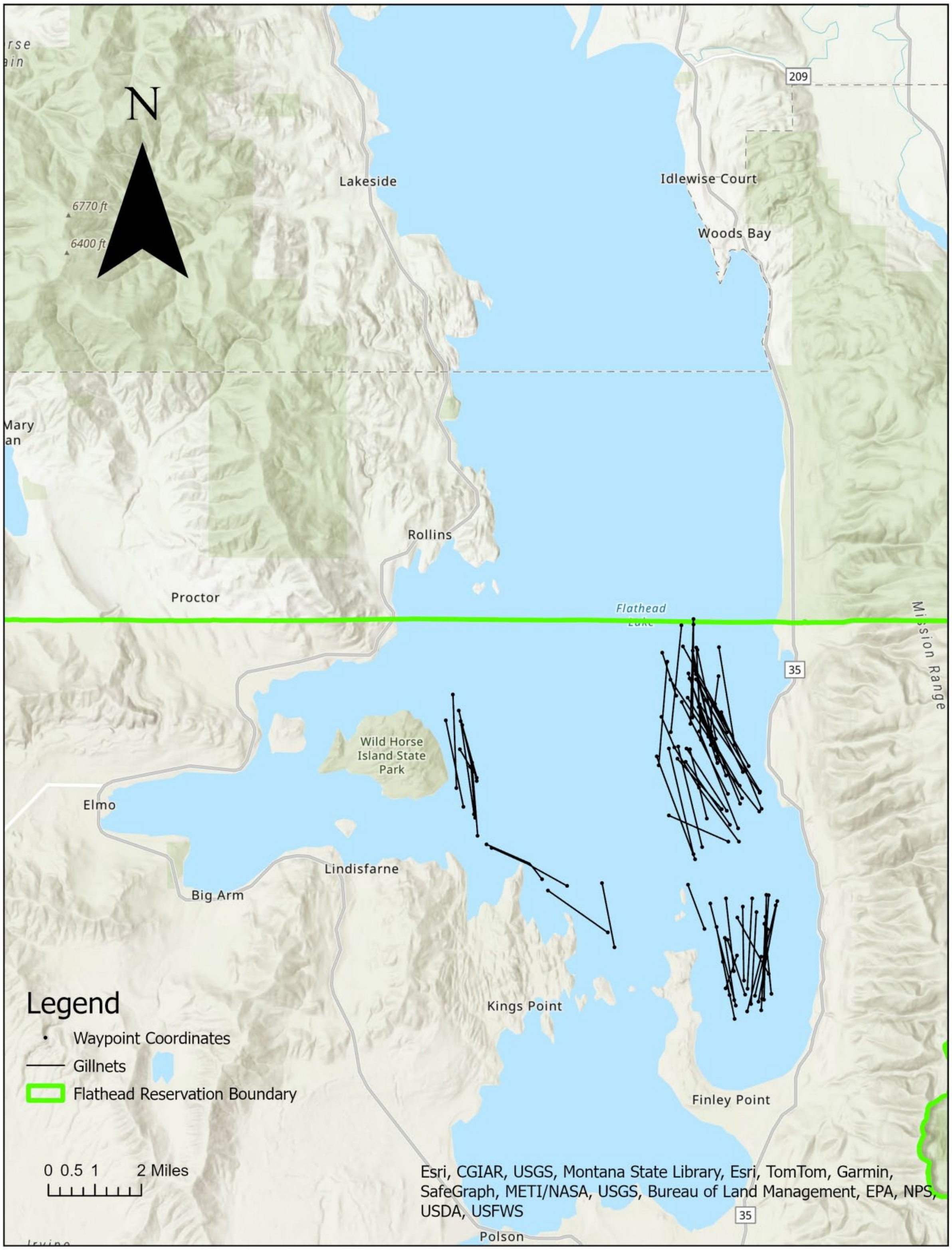

Figure 4. Locations and lengths of gillnets set during spring 2023.

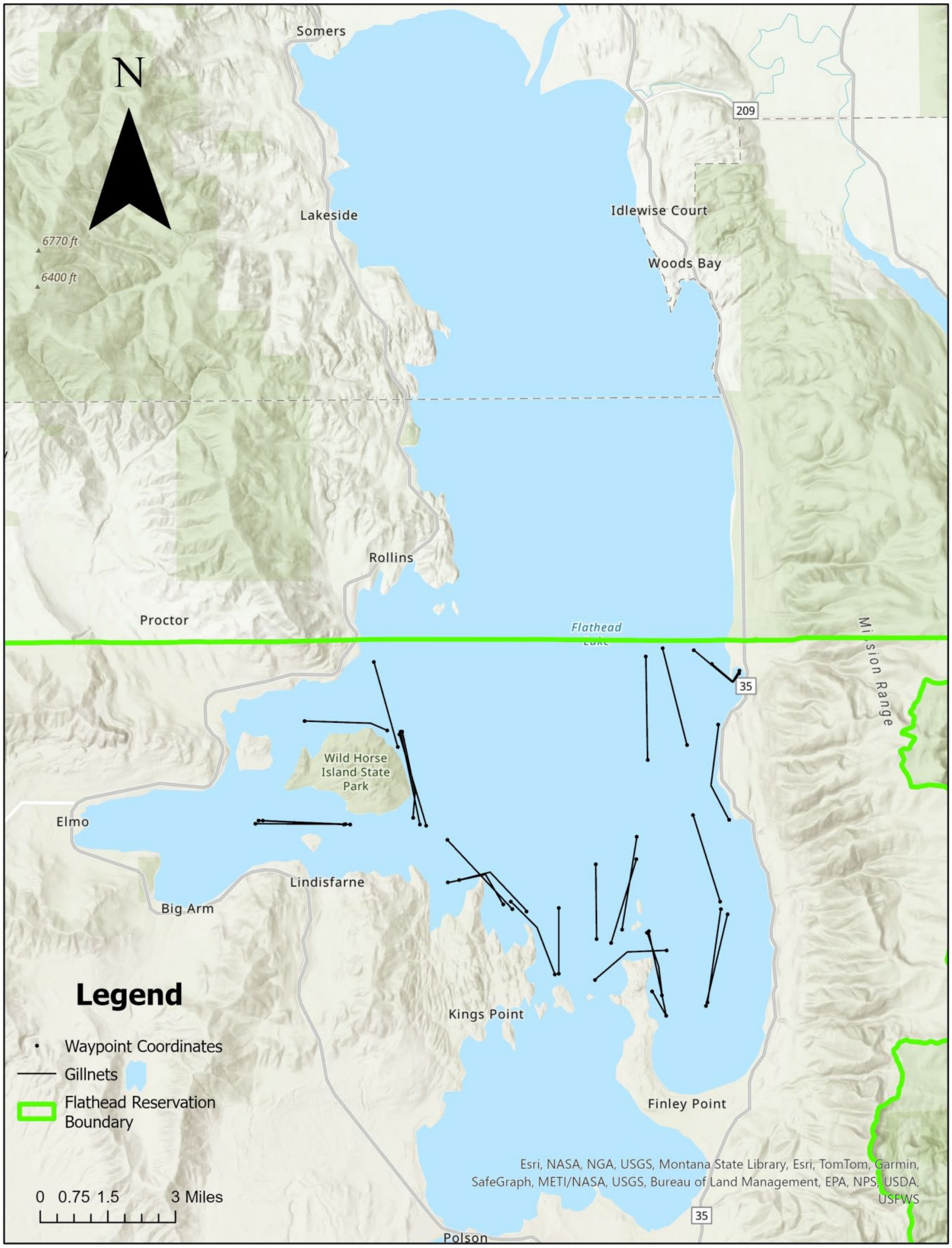

Figure 5. Locations and lengths of gillnets set during autumn 2023.

Evaluation Procedure

The purpose of this report is to answer six predetermined questions (pages 4 and 5) using the body of evidence currently available. Evidence is presented in the form of metrics derived from data collected in a consistent manner each year. Not all metrics have equal predictive value, but all are included because each one adds to the body of evidence to be weighed in the overall analysis. Rarely do all metrics indicate a consistent direction of change in abundance. Therefore this process requires subjective evaluation of the weight of evidence represented by all available metrics.

Question 1) Are bull trout increasing?

We use four metrics to track changes in bull trout abundance. The bull trout metrics focus primarily on abundance of adult bull trout, which include: 1) redd counts in index streams, 2) fixed-location (five mesh sizes) gillnetting in spring, and 3) random-location (12 mesh sizes) gillnetting in autumn. These metrics should be directly responsive to changes in abundance and therefore we expect each metric to increase if bull trout abundance increases.

1) *Redd counts*

MFWP enumerates redds in index reaches of eight Flathead tributaries annually (Figure 6). Basic assumptions of this metric are that bull trout are adfluvial, meaning the enumerated adults migrate to and from Flathead Lake, the number of adults per redd does not vary annually, and alternate-year spawning either does not occur or occurs consistently among years. None of these assumptions have been fully verified. The reliability of this metric is high because the survey is nearly a census in which experts attempt to count every redd within a fixed reach of stream. Variability in counts and distorted conclusions may result from bull trout spawning outside the boundaries of fixed index reaches, and the presence of temporary stream blockages.

The period of record for this metric spans the time from before the increase of *Mysis* to the present. The trend in total index reach redds remains low and fairly stable. Only one index reach (Granite Creek) had fewer than 10 redds, a level we consider to be dangerously low, although passage into the stream may have been blocked by beaver dams.

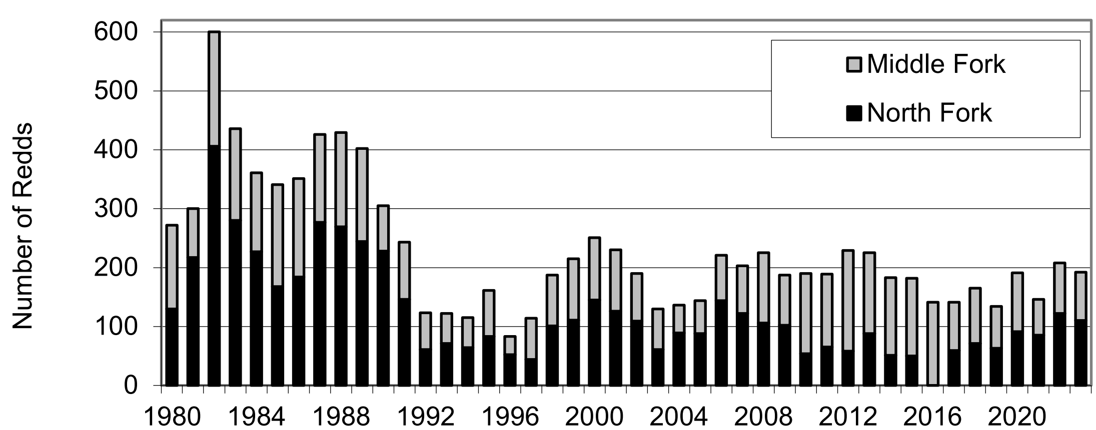

Figure 6. Bull trout redds counted in eight index streams tributary to the North and Middle Forks of the Flathead River, 1980 to 2023, although complete data were unavailable in 2016 because high flows during the spawning period obliterated some redds (data from MFWP).

2) Catch rates in spring gillnetting

Sample units for spring gillnetting consist of two sinking nets ganged together, each comprised of five panels, each 25 ft long by 6 ft high. Mesh sizes within panels range from 3/4 in to 2 in bar-measure. Fifteen ganged nets are placed in five fixed, nearshore locations. This series was developed to target bull trout in the nearshore environment. The survey has been conducted from 1981 to present, although 1984 to 1991 were not sampled. Reliability of this metric is low because of the small sample size, low capture rate, and non-random sampling design. The basic assumption of this metric is that catch rates in gillnets are proportional to fish density. Capture rates have been highly variable (Figure 7). The absence of bull trout in the 2018 sample is misleading because six bull trout were captured in the associated floating nets but are not included in this measure because it is based on sinking nets. This netting series was not conducted in 2020 because of concerns for worker-safety during the COVID19 pandemic. The trend in catches remains very low.

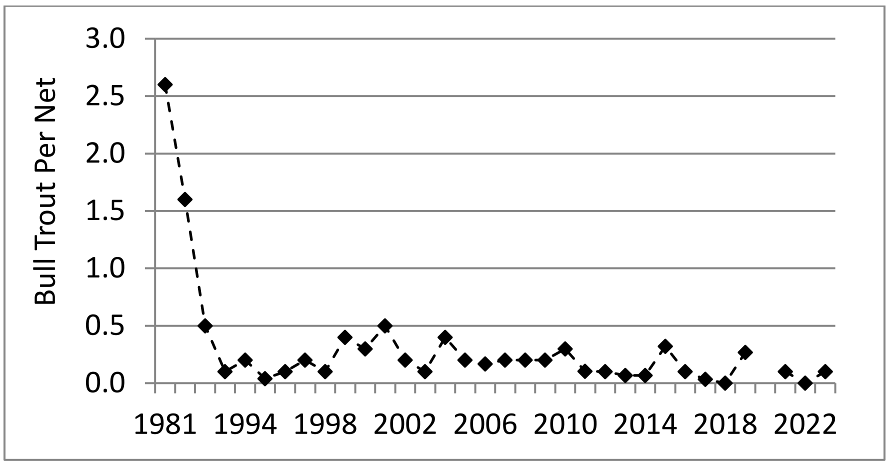

Figure 7. Average annual catches of bull trout in 30 fixed-location sinking gillnets set in spring, 1992 to 2023 (data from MFWP, no nets were set in 2020 because of COVID 19).

3) Catch rates in autumn gillnetting

Autumn gillnetting consists of individual sinking nets constructed from 12 panels, each 25 ft long by 8 ft high for a total net length of 300 ft. Mesh sizes within panels range from 3/8 in to 3 in bar-measure. Nets are placed randomly within five area-strata and five depth-strata at densities proportional to the lake-wide occurrence of those conditions. Numbers of nets within the series have ranged from 44 to 96, while maintaining constant proportionality between strata. All habitats within the lake are included in the survey. This series has been conducted from 1998 to present (Figure 8). The basic assumption of this metric is that catch rates in gillnets are proportional to fish density. Strengths of this metric are that it is derived from a large number of sample units (nets), all identified strata within the lake are sampled, and sample sites are randomly selected. A weakness of this metric for monitoring bull trout is that catch rates are very low.

Catch rates in the autumn series have ranged from 0.06 to 0.3 bull trout per net. The average catch since 2004 is 0.12 bull trout per net. Large variability in catches is the result of patchy distribution of bull trout in which up to five bull trout have been caught in one net, while most nets catch zero bull trout. In 2007, four bull trout were caught in one net, which accounted for 67% of the bull trout caught that year. The overall trend since 2000 has been downward.

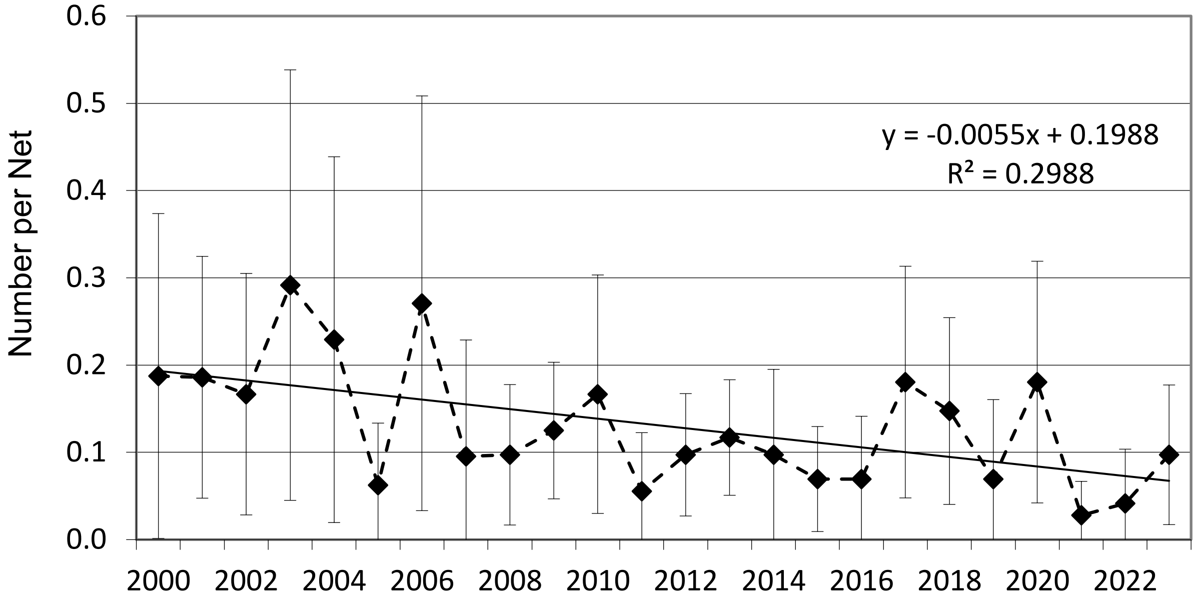

Figure 8. Average annual catches (95% confidence intervals) of bull trout in stratified random gillnets (44 to 96 nets annually) set in autumn in Flathead Lake, 2000 to 2023.

4) Catch rates in suppression nets

Catch rates of bull trout in suppression nets are not ideal indicators of bull trout abundance because we place suppression nets in locations chosen to avoid bull trout. Nonetheless, because the sample size of suppression nets is so large (greater than one million feet per year), the potential exists for meaningful trends to develop (Table 4). One confounding factor in these data is that catches are inflated by the use of smaller mesh sizes which catch bull trout at a far greater rate than larger meshes, and the percentage of smaller mesh nets used each year is variable. In 2020 we used 3" mesh in over 300 ft of water during August and had large catches of bull trout. The 3" mesh represented about 10% of the total nets set, but caught about 50% of the total bull trout. Therefore, at this time these data are of little value as a surrogate indicator of bull trout abundance.

Table 4. Catch rates of bull trout in suppression nets, 2014 to 2023.

Year	Number of	Feet of	Number of Bull trout	Bull trout per 1,000
2014	37	135,000	8	0.059
2015	68	405,900	12	0.030
2016	98	677,700	22	0.032
2017	127	1,034,100	23	0.022
2018	192	1,218,900	24	0.020
2019	186	1,443,600	19	0.013
2020	99	740,700	65	0.088
2021	194	1,262,700	62	0.049
2022	125	1,062,000	53	0.05
2023	116	1,041,300	26	0.025

Summary conclusion: Are bull trout increasing?

We track four metrics of bull trout abundance. Catches in the spring gill-netting series and the autumn series both remain very low. Number of redds in the North Fork Flathead tributaries are trending upward while Middle Fork tributaries are low and without trend. Based on these metrics (Table 5), we conclude bull trout abundance remains low, but fairly stable, with some recent increases in key tributaries.

Table 5. Summary of metrics describing trends in bull trout abundance and interpretations of their meaning.

Metric	Direction of Change	Value of Metric	Comments
1) Redd Counts	No Trend, but encouraging increases in North Fork tributaries	High, accurate and reliable	Recent increases are encouraging
2) Catch rates in spring fixed location gillnetting	No Recent Trend, but remains low	Low	Difficult interpretation because of small samples
3) Catch rates in autumn random-location gillnetting	No Recent Trend, but remains low	Moderate	High variability and low capture rates reduce predictability
4) Catch rates in suppression nets	No Trend	Low	Large sample size, but non-random sampling

Are westslope cutthroat trout increasing?

The primary index of westslope cutthroat abundance is derived from annual catches in floating gillnets set in Flathead Lake during spring. Sample units for spring gillnetting consist of two floating nets ganged together, each comprised of five 25 ft long by 6 ft high panels. Mesh sizes within panels range from 3/4 in to 2 in bar-measure. Fifteen ganged nets are placed in five fixed, nearshore locations. The survey has been conducted from 1981 to present, although 1984 to 1991 were not sampled. The basic assumption of this metric is that catch rates in gillnets are proportional to fish density. A weakness in this metric is the small number of nets (30) in the series, sample locations are fixed rather than random, and average catches are often fewer than one cutthroat trout per net. Captures since 1992 vary by over 100% around an average catch of 0.9 cutthroat trout per net (Figure 9), and catches in the last ten years were among the highest and lowest in the period of record. This metric provides no clear evidence of an upward or downward trend in abundance of westslope cutthroat trout in Flathead Lake, although low numbers since 2014 are very concerning. This netting series was not conducted in 2020 because of concerns for safety during the COVID19 pandemic.

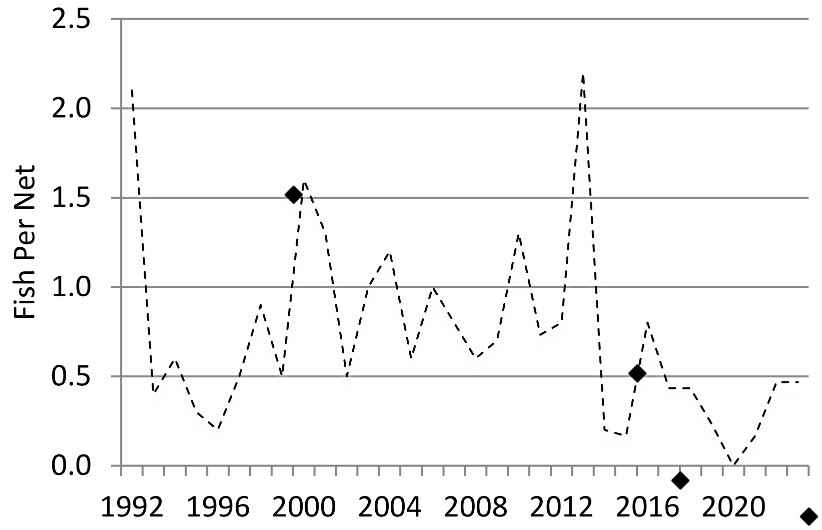

Figure 9. Average annual catches of westslope cutthroat trout in 30 standardized gillnets set in spring, 1992 to 2023 (data from MFWP, no nets were set in 2020).

Question 2) Are Lake Trout Decreasing?

Total harvest in 2023 was 112,514 lake trout (see Table 2). We use 16 metrics that directly or indirectly indicate abundance of lake trout. Lake trout were captured by numerous methods and under a variety of sample designs to generate metrics of absolute and relative abundance, as well as metrics reflective of density-dependent changes in lake trout growth.

The first two metrics address population abundance as estimated by mark and recapture techniques. For these estimates we capture lake trout by angling and by gillnetting throughout the year, mark them with PIT tags placed in the left cheek, clip the adipose fins for permanent marks, and release them. Lake trout are recaptured during Mack Days fishing contests in which each fish submitted to the contest is examined for a mark. The marking period spans the full year prior to the first day of each contest, and the recapture period spans the duration of the contest, usually 9 weeks. This estimate is restricted to lake trout within the size limits targeted in the contests which range from 175 mm to 762 mm TL. Approximately 1,000 fish are marked prior to each contest, and the recapture sample has ranged from 12,000 to 38,000 fish. Numbers of lake trout previously marked and recaptured for each estimate have ranged from 26 to 82 individuals. Population estimates are generated from standard mark and recapture protocols. A shortcoming of this method has been uneven distribution of tags, as the north half of the lake receives less angling and fewer tags are placed there than the south half, and deep fish are difficult to capture and release in healthy condition because of barotrauma.

We consider these population estimates to have a moderate level of reliability because they: 1) are conducted uniformly each year, 2) are the product of a very large sample of the population, 3) have low variability between years, and 4) monitoring indicates that marked fish have low levels of tag loss and high post-release survival. With the exception of the estimate generated in spring 2010, the estimates since fall 2010 have not varied by more than 20% of the mean of the 12 estimates. We assume tag loss to be low based on an ongoing test of double-tagged fish in which nearly all recaptured fish have retained both tags. Survival tests of variable time spans following tagging have indicated very low post-tagging mortality. A final indicator of reliability is that recapture rates have been consistently proportional to the size of the harvest (Figure 10). These estimates have not been robust enough to indicate relative changes in abundance of separate age groups, and they only refer to the segment of the population less than 30 inches in length. We have not generated estimates since 2019 because we have been unable to tag a reasonable number of fish.

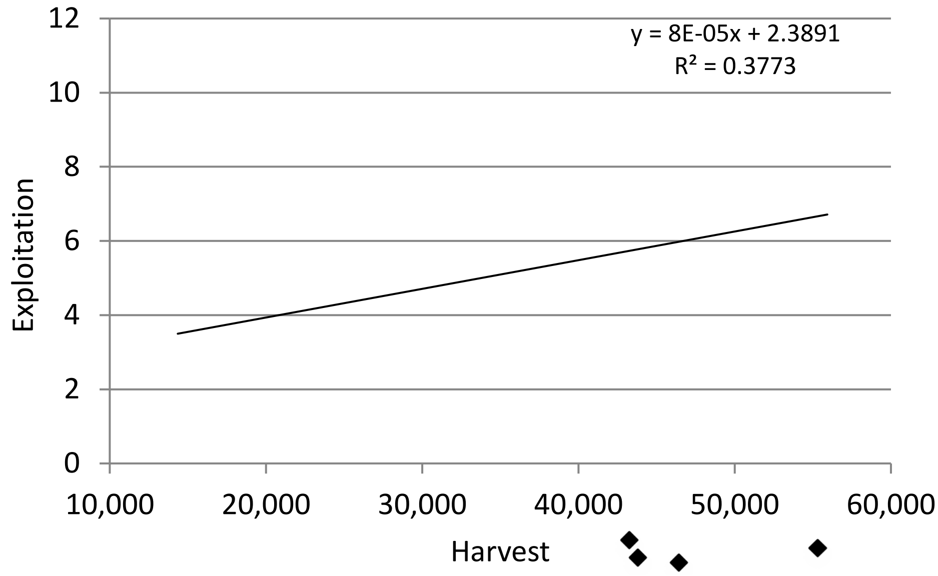

Figure 10. Exploitation of lake trout, as the percentage of marked fish recaptured, during spring and autumn fishing contests and gillnetting, 2010 to 2019.

1) ***Mark/Recapture Population Estimates in Spring***

We generated ten mark and recapture estimates during spring between 2010 and 2019. Excluding the 2010 estimate that was likely inflated by disproportionately high catches in deep water, the estimates are non-trending (Figure 11). In recent years we have not tagged enough lake trout to generate helpful estimates of abundance.

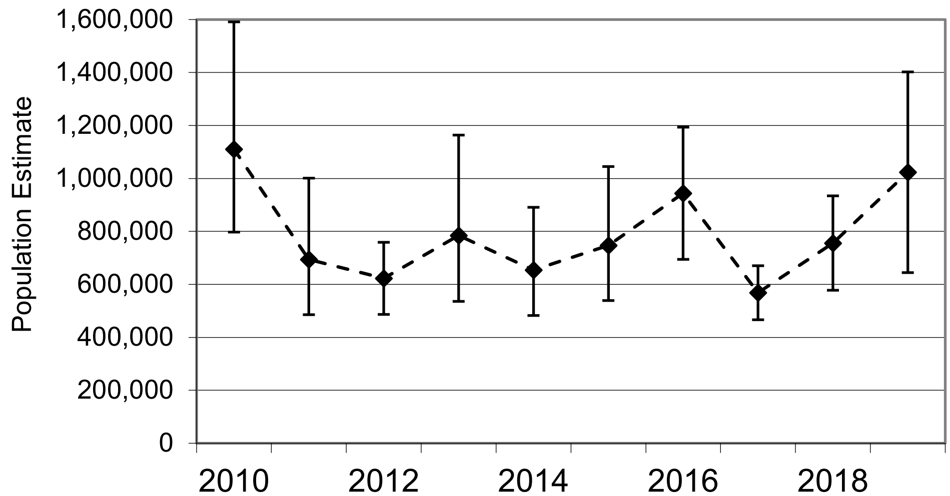

Figure 11. Mark-and-recapture population estimates ($\pm$ 95% confidence limits) for lake trout, completed during spring, 2010 to 2019.

2) ***Mark/Recapture Population Estimates in Autumn***

We generated ten mark and recapture estimates during autumn between 2010 and 2019. The estimates are non-trending, so give no indication that total population size has changed over this time period (Figure 12). In recent years we have not tagged enough lake trout to generate helpful estimates of abundance.

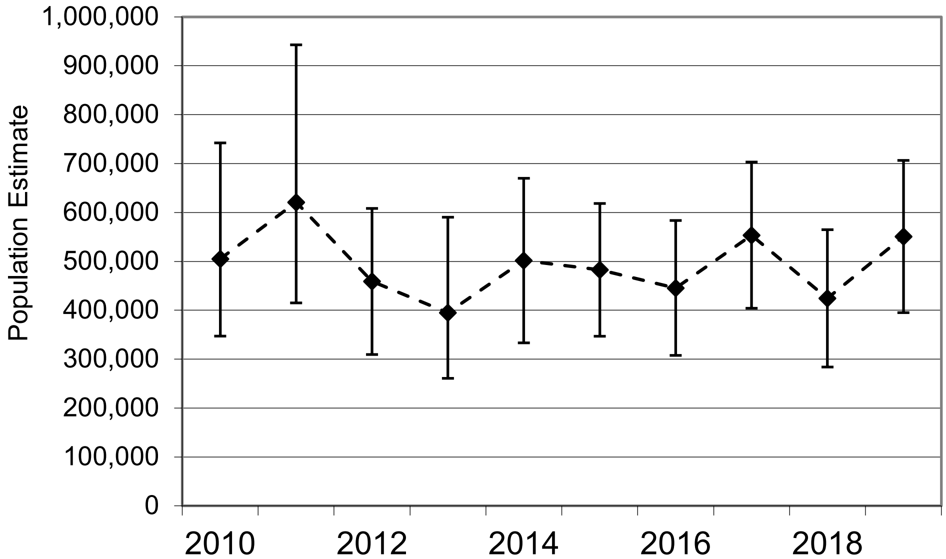

Figure 12. Mark-and-recapture population estimates (± 95% confidence limits) for lake trout, completed during autumn 2010 to 2019.

3) Catch rates in assessment gillnetting in spring

This metric is derived from lake trout sampled in fixed-location gillnetting in spring. Sample units for spring gillnetting consist of two sinking nets ganged together, each consisting of five 25 ft long by 6 ft high panels. Mesh sizes within panels range from 3/4 in to 2 in bar measure. Thirty ganged nets are placed in five fixed, nearshore locations. This series was developed to target bull trout and therefore only samples a portion of available lake trout habitat near shore, and likely represents trends in abundance specifically of the lean stock of lake trout. This series has been conducted from 1981 to present, although 1984 to 1991 were not sampled. Weaknesses of this metric for indexing changes in lake trout abundance are that it is produced from samples of only the nearshore environment, and from a small number of gillnets. We therefore consider the reliability of this metric to be low. This netting series was not conducted in 2020 because of concerns for safety during the COVID19 pandemic. Catch rates have been variable but trending downward, with a nearly 50% reduction in average catches between 2003 and present (Figure 13).

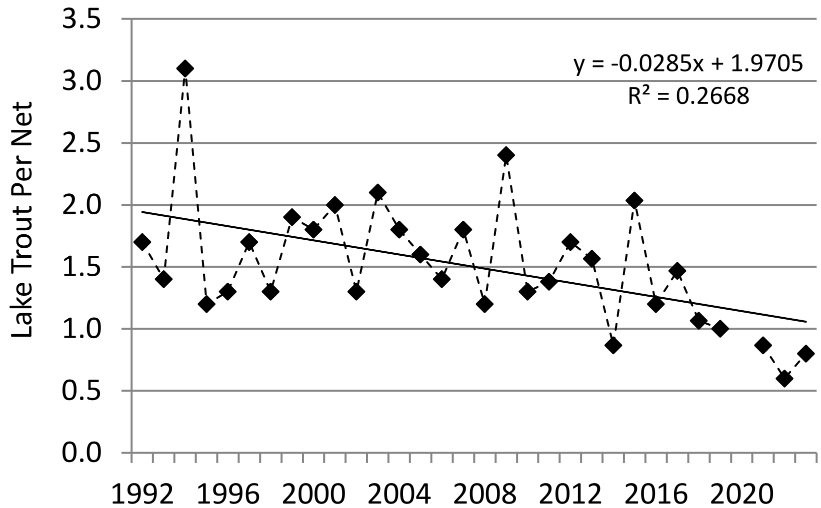

Figure 13. Mean catch rates of lake trout in 30 fixed-location sinking gillnets set during spring in Flathead Lake, 1992-2023 (data from MFWP).

4) Catch rates in assessment gillnetting in autumn

Several metrics are derived from lake trout sampled in stratified random gillnetting in autumn. Autumn sampling consists of individual sinking nets made of 12 panels, each 25 ft long by 8 ft high with one meter space between, for a total net length of 300 ft. Mesh sizes within panels range from 3/8 in to 3 in bar measure. Nets are placed randomly within five area-strata and five depth-strata at densities proportional to the lake-wide occurrence of those conditions. Numbers of nets set each year have ranged from 44 to 96. This series has been conducted from 1998 to present.

Strengths of this metric are: 1) the large number of sample units (nets), 2) all habitats are sampled in proportion to their availability, 3) all sizes of fish are sampled, and 4) the sample locations are randomized.

Catch rates have been highly variable over the period of record (Figure 14), ranging between four and 11 mean captures per net. Reliability of this metric should be high because it is based on a rigid stratified random sampling design, although large variability in capture rates among years is a concern. A downward trend in catches is evident since sampling began in 1998. In 12 of 16 (75%) years prior to 2013, catches exceeded six per net. Since 2013, in 10 of 11 (91%) years, catches were less than six per net.

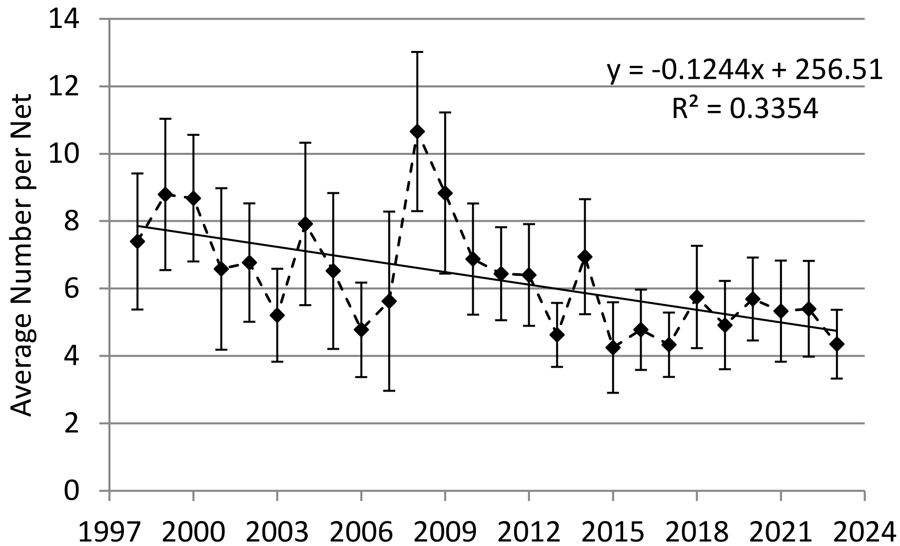

Figure 14. Mean catch rate (+ 95% confidence limits) of lake trout in stratified random gillnets in Flathead Lake, 1998-2023.

5) Catch rates in suppression-gillnetting

Catch rates of lake trout in suppression nets provide a surrogate, but imprecise, index of lake trout abundance. Factors confounding these data include: 1) an inconsistent variety of mesh sizes are used each year and smaller meshes tend to catch substantially larger numbers of fish, 2) fish may develop net-avoidance behavior, 3) locations for netting are not chosen randomly, 4) a variable number of nets are set each day, and 5) nets are soaked for a variable number of days. Nevertheless, suppression netting represents an enormous amount of sampling effort that may shed some light on trends in lake trout abundance. For example, in 2019 a total of 1,291,500 ft of net were set, although in 2020 under COVID19 restrictions the distance fell to 740,700 ft. Netting effort peaked in 2019 (Figure 15). Catch rates decreased annually from 2014 until 2019 and increased until 2022 and declined in 2013 (Figure 16).

The inconsistency in catch rates renders this metric of marginal use as an index of lake trout abundance. Increases in catch rates since 2019 are most likely the result of increasing expertise in gillnetting. Although compensatory responses to past harvest may be increasing recruitment, that may only partially explain the increase in catch rates. Changes made, especially in 2020, that increased effectiveness were: 1) setting smaller mesh sizes (3”), 2) soaking nets for up to three days, and 3) fishing over 300’ deep during August when the thermocline was fully developed and the epilimnion was warmer than preferred temperatures for lake trout.

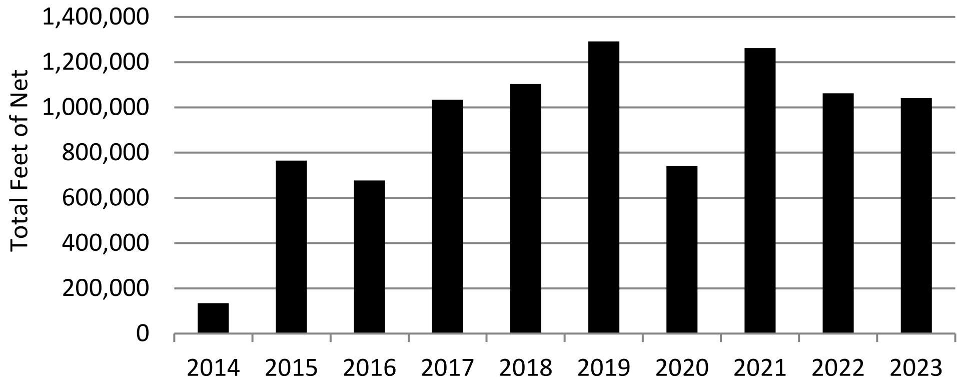

Figure 15. Total length of suppression gillnets set in Flathead Lake, 2014 to 2023.

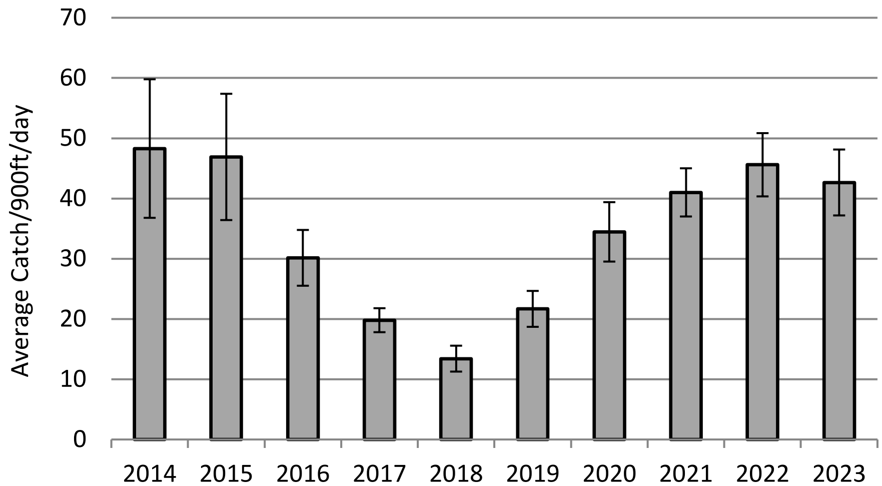

Figure 16. Average catches (± 95% confidence limits) of lake trout in 900 ft segments of suppression nets of three different mesh sizes set overnight during spring and autumn, 2014 through 2023.

6) Relative weight

Relative weight is a measure of body condition relative to a standard for lake trout across their range. Typically, relative weight increases as density decreases, serving as a potential surrogate indicator of abundance. An exception occurs when changes in condition result from changes in the density or type of prey base available, although no such change has occurred in Flathead Lake in recent years. Weights are taken from both male and female lake trout collected in the autumn gillnetting survey. Trends in relative weights over the period of record have been variable, but upward (Figure 17), indicative of declining density of lake trout.

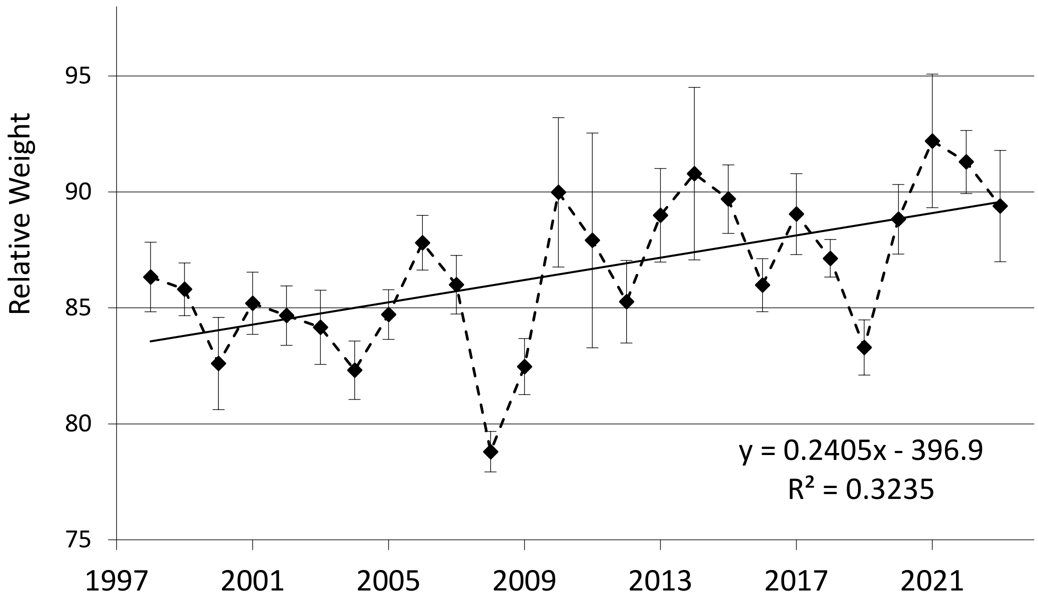

Figure 17. Mean annual relative weight (± 95% confidence limits) of lake trout caught in standardized-gillnet surveys in the fall, 1998–2023.

7) Mortality rate

Mortality rate is a function of the decline in relative abundance of progressively older year classes starting from the youngest year class with full vulnerability to the sampling gear. Annual mortality (A) has been computed from the descending limb of the age frequency distribution of lake trout collected in assessment netting during autumn (catch-curve method of Ricker 1975) and ages calculated from an age-length relationship developed from an aged sample of 457 lake trout collected in 2014. We are currently employing a more direct method of computing mortality rate by assigning an age to every fish in the sample based on a predictive model of otolith weights.

This series has ranged from 48 to 96 randomly placed nets in a stratified design throughout the lake and incorporates 12 mesh sizes. The presence of separate stocks of lean and dwarf lake trout that have differing average rates of exploitation and natural mortality, complicates the reliability of this metric because the relative percentage of each stock in the sample likely varies from year to year.

All otoliths collected from 1998 to 2023 have been weighed and the process of applying the model to generate age structure and mortality rate is underway and will be used for the 2024 report.

Figure not currently available, will be completed in 2024

Figure 18. Mean annual mortality (± 95% confidence limits) estimated from age frequency samples of age-10 to 25 year old lake trout caught in standardized-gillnet surveys, 1998 to 2023.

8) Length at 50% maturity

Maturity is determined by visual examination of gonads and this metric is computed as the length at which half the individuals of that length are mature. Decreasing density typically results in improved condition and faster growth, so maturity is reached at younger ages. Because some research indicates that length at maturity occurs at a fixed percentage of asymptotic length, it is not clear how reduced density will affect length at maturity, except that it will likely change. Length at maturity has changed little or slightly trended upward since 1998 (Figure 19).

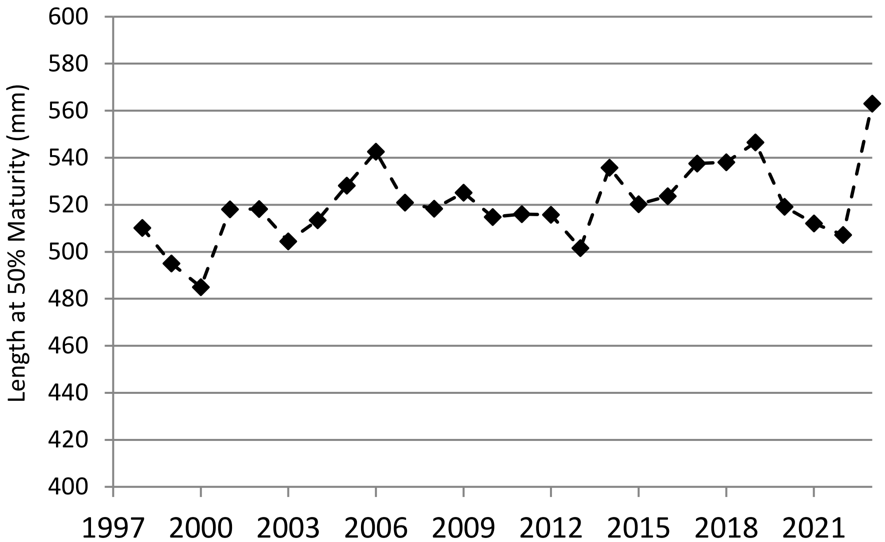

Figure 19. Length at which 50% of lake trout (± 95% confidence limits) from standardized-gillnet surveys were mature, 1998–2023.

9) Relative abundance of size groups

Increases in exploitation by angling and netting cause decreases in size classes vulnerable to those methods. Compensatory responses to exploitation typically result in increases in recruitment and increased abundance of smaller, less vulnerable size classes. Annual changes in size groups have been minimal despite substantial harvest (Figure 20). The <300 mm size group peaked in 2023, likely an indication of compensation in response to overall population reduction.

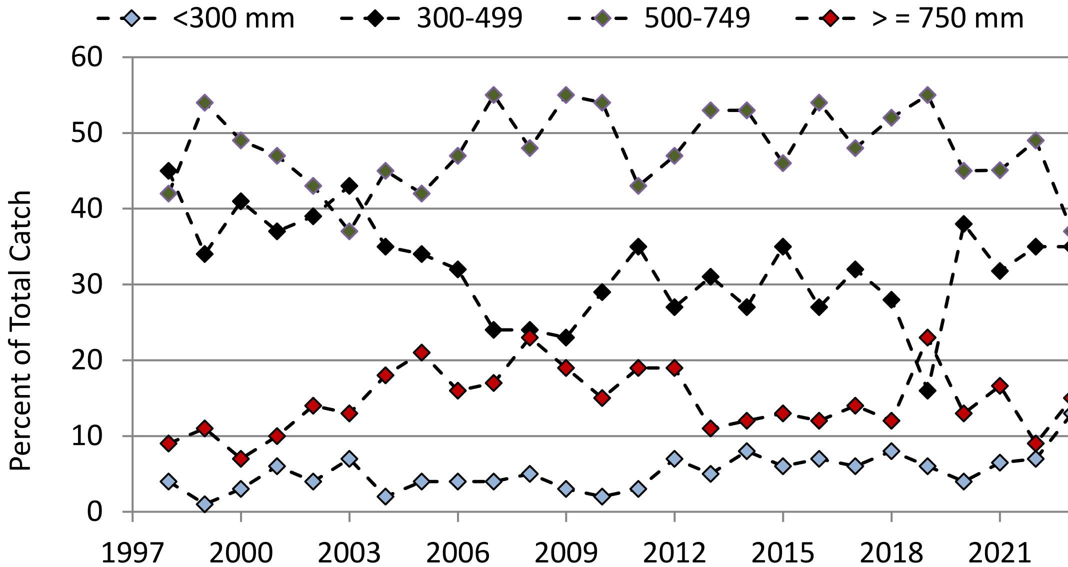

Figure 20. Percent of lake trout <300 mm, 300-499 mm, 500-749 mm and ≥750 mm total length caught in standardized-gillnet surveys, 1998–2023.

The following three metrics are opportunistically derived from a subsample of angler-caught lake trout submitted to Mack Days contests, and therefore are not generated from of a specifically designed study. Interpretation of these metrics can be confounded by undocumented changes in angler behavior such as changes in locations targeted (deep vs. shallow) and methods used (jigging vs. trolling). Sample sizes collected in each contest range from 500 to 2,000 fish.

10) ***Length of fish captured by angling in spring***

Angling in spring is dominated by jigging in deep water for lake trout that are typically shorter than fish caught in autumn because dwarf lake trout and juveniles of both stocks predominate in deep water fish. Average lengths have consistently trended downward since 2010 (Figure 21).

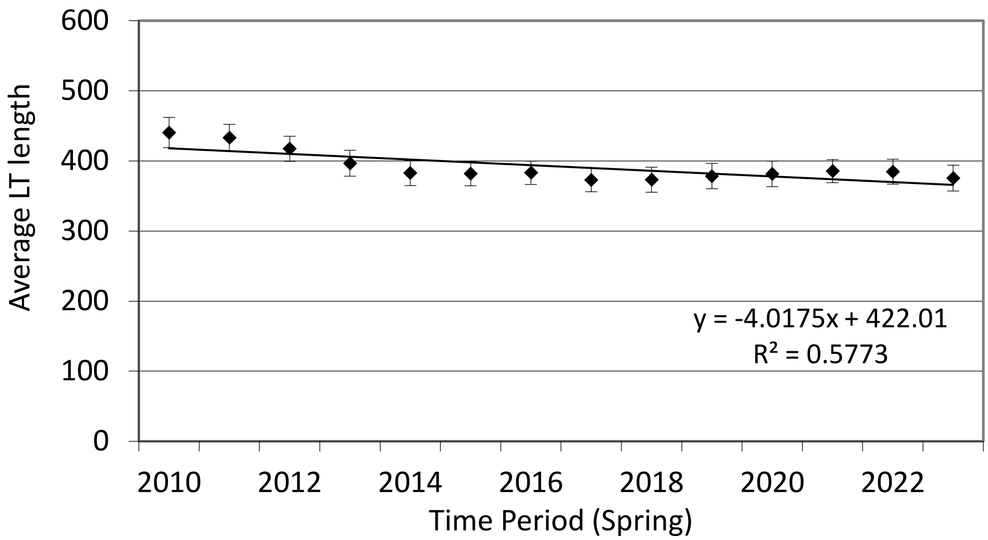

Figure 21. Average lengths (± 95% confidence limits) of lake trout submitted to the Spring Mack Days contests, 2010-2023.

11) *Length of fish captured by angling in autumn*

Angling in autumn includes more trolling and casting in shallow water than typically occurs in spring, resulting in catches of longer lake trout relative to the spring period. Average lengths have trended downward since 2010 (Figure 22).

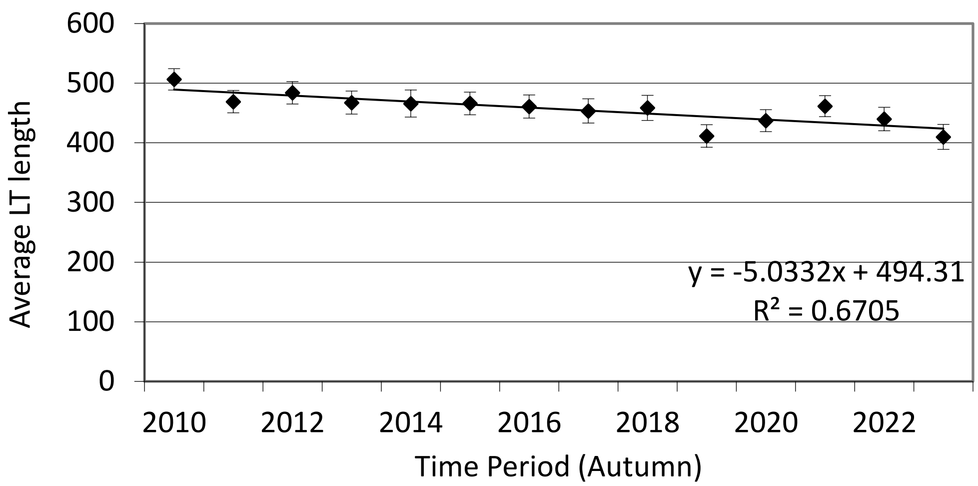

Figure 22. Average lengths (± 95% confidence limits) of lake trout submitted to the Fall Mack Days contests, 2010-2023.

Angling catch rates are typically correlated with density of fish being targeted. An assumption of angling metrics is that catch rates are directly correlated with changes in abundance. Additionally, this metric is meant to indicate changes in the quality of the fishery over time, in the absence of targeted creel surveys, which are not currently being conducted. Data from Mack Days contests provide a readily available surrogate for tracking trends in abundance. Problems with use of this metric are that catch rates increase with improvements in angling technology under conditions of constant or even decreasing abundance, and trends in the competitive anglers group may not be representative of trends in the larger angling public.

The top anglers in Mack Days have clearly improved their effectiveness by making large investments in high-tech gear. One of the most effective new tools is the anchorless boat-positioning system with integrated GPS, which is used by all top anglers. This tool facilitates pinpoint positioning and allows anglers to spend more time fishing and less time positioning their boats, translating into higher catch rates.

12) Average catch rate of top 25 anglers in Spring Mack Days

These catch rates are based on number of fish caught per fishing trip. We do not know the length of each trip, and therefore cannot compute standard hourly catch rates. Instead we use the number of fishing trips (or days) and assume that trip-length is consistent between years and compute the average catches per day. Daily catch rates increased significantly from 2010 to 2020, fell abruptly in 2021 and 2022, and partially rebounded in 2023 (Figure 23). Although we consider it more likely that the increase between 2010 and 2020 is the result of improvements in angler skills and in fishing technology. The large decline in catch rate in 2021and 2022 may have been partially driven by extreme weather, but is also likely an indication that angler effectiveness has peaked and the overall population has decreased. It is possible that the increased catch rate in 2023 is the result of compensation in which juvenile abundance increases due to over-exploitation.

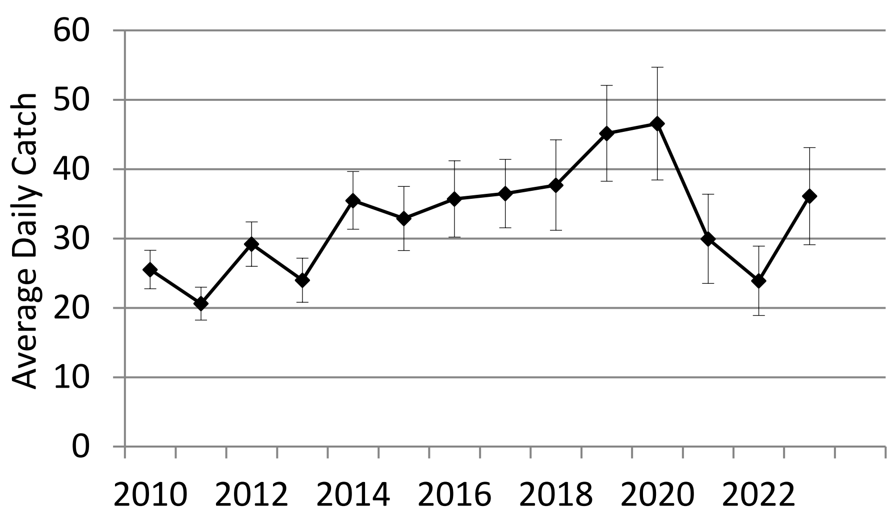

Figure 23. Average daily catch (± 95% confidence limits) of the “top 25 anglers group” in Spring Mack Days, 2010 to 2023.

13) Average catch rate of top 25 anglers in Fall Mack Days

As with the spring event, these catch rates are based on number of fish caught per fishing trip. No clear trend in daily catch rates exists for Fall Mack Days (Figure 24), and therefore this metric gives no indication of change in abundance.

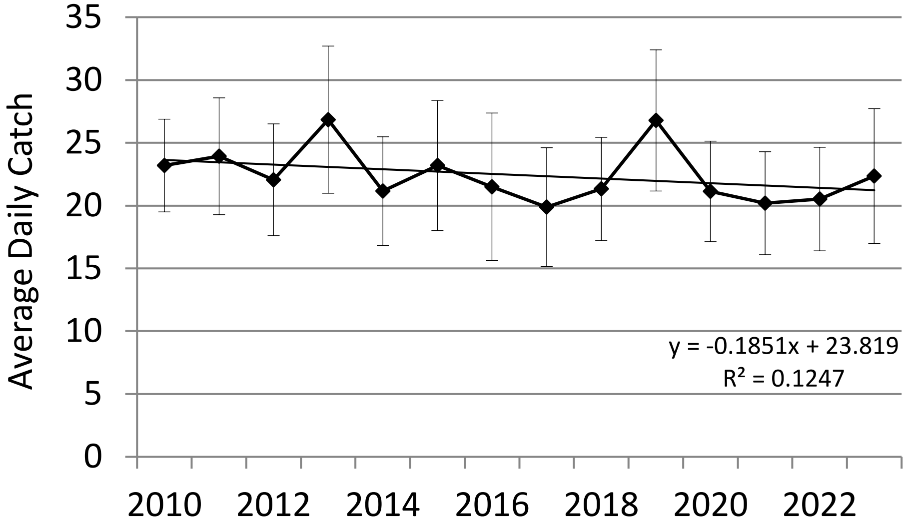

Figure 24. Average daily catch (± 95% confidence limits) of the "top 25 anglers" group in Fall Mack Days, 2010 to 2023.

14) Changes in growth rate

As density of lake trout declines and the relative proportion of resources available to each individual increases, growth rate will increase unless a confounding factor is present. All lake trout captured in autumn assessment-netting in 2014 were aged by enumeration of annuli on otoliths. Individuals were assigned to either dwarf or lean stocks based on characteristic growth patterns. The analysis indicated that 35% of the lake-wide random sample of individuals were of the dwarf stock, a life history form assumed to be the product of intense competition for prey. The presence of dwarfs in a lake trout population is indicative of high density. The combination of high density and intense competition result in very little growth in the dwarf stock following maturity, as evidenced by the flattened growth trajectory after age 10 (Figure 25). The minimal growth of adult dwarf lake trout is reinforced by a tagging study in which growth of 39 recaptured lake trout averaged 4.2 mm per year over the average of 15.7 years between marking and recapture (Figure 26). The conclusion is that the lake trout population as of at least 2014, sustained a density likely exceeding carrying capacity and resulting in substantial stock-piling of biomass.

Sufficient exploitation will reduce biomass resulting in increased growth rate and a reduction in the percentage of dwarfs in the population. Growth rates increased between 2009 and 2021 indicating that exploitation has been sufficient to reduce population density (Figure 27).

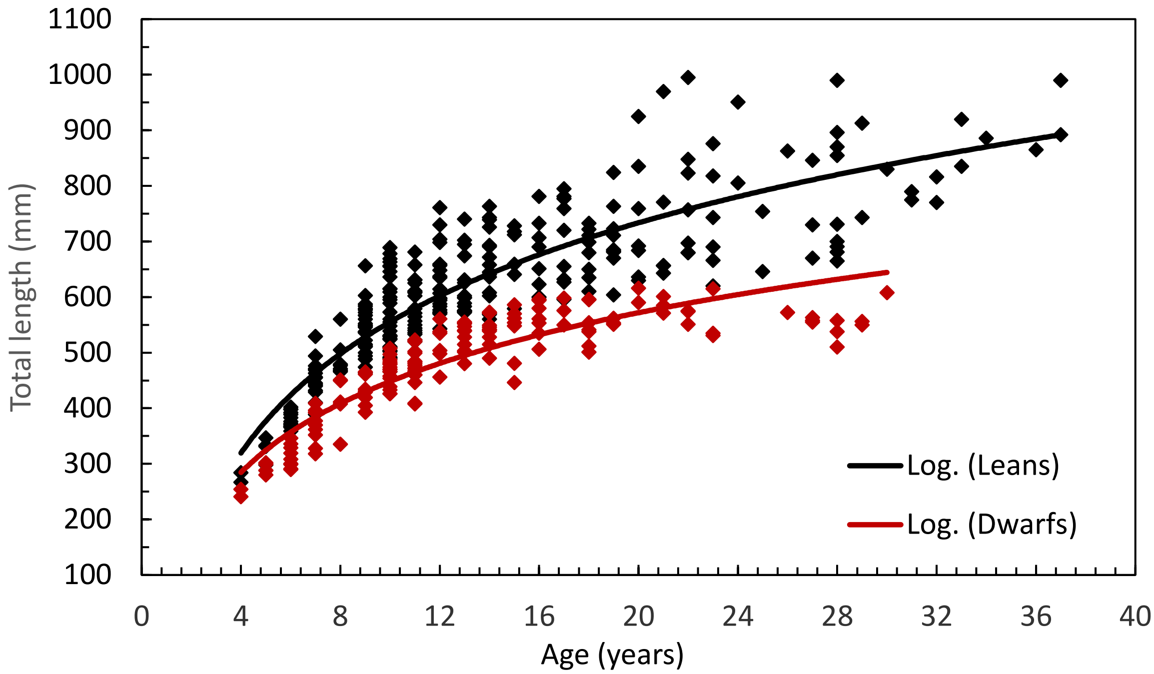

Figure 25. Ages of lake trout collected in a lake-wide stratified random sample in 2014. Black points represent individuals of the lean stock and red points represent individuals of the dwarf stock.

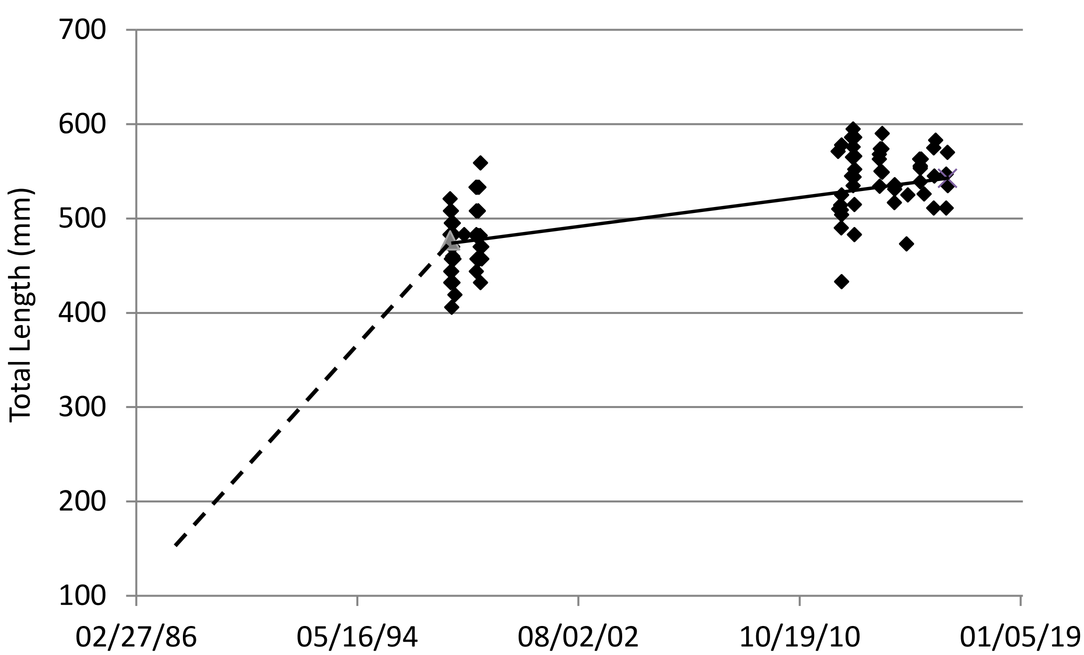

Figure 26. Lengths of 39 tagged lake trout when marked and released (left) and when recaptured (right), Flathead Lake, 1996 to 2017.

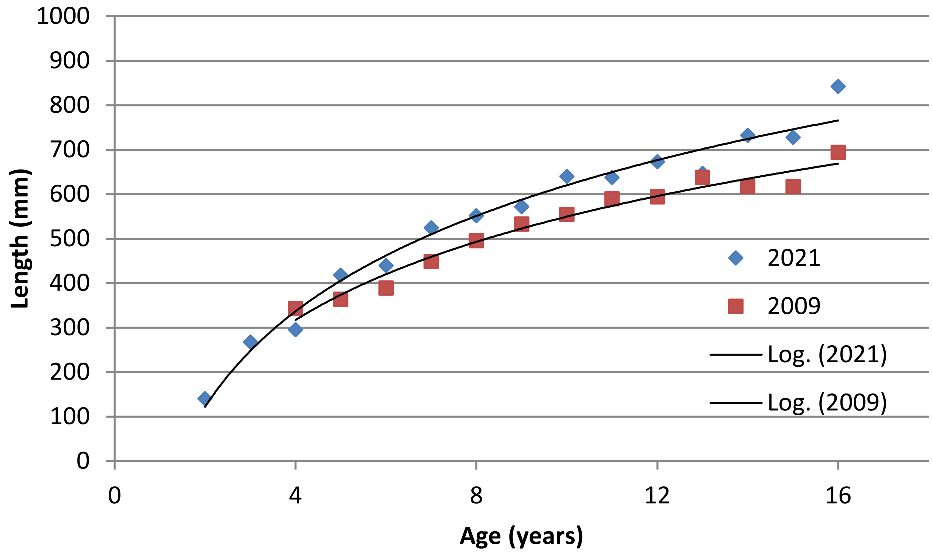

Figure 27. Changes in growth rate of lake trout, 2009 and 2021.

15) Annual yield and comparison to indices of sustainability

As a long-lived, slow growing species with moderate fecundity, lake trout are highly vulnerable to over-exploitation. But introduced populations in western lakes, especially in the presence of *Mysis*, seem able to withstand higher levels of exploitation. Healey (1995) concluded after studying native lake trout populations in Canada that annual yield above 0.5 kg/ha was unsustainable. We estimated that recreational harvest in Flathead Lake was roughly equivalent to Healey's 0.5 kg/ha threshold prior to initiating active suppression measures. Since active suppression began in 2002 yield has gradually increased to the current level of 2.4 kg/ha, or roughly five times the level considered to be sustainable (Figure 28).

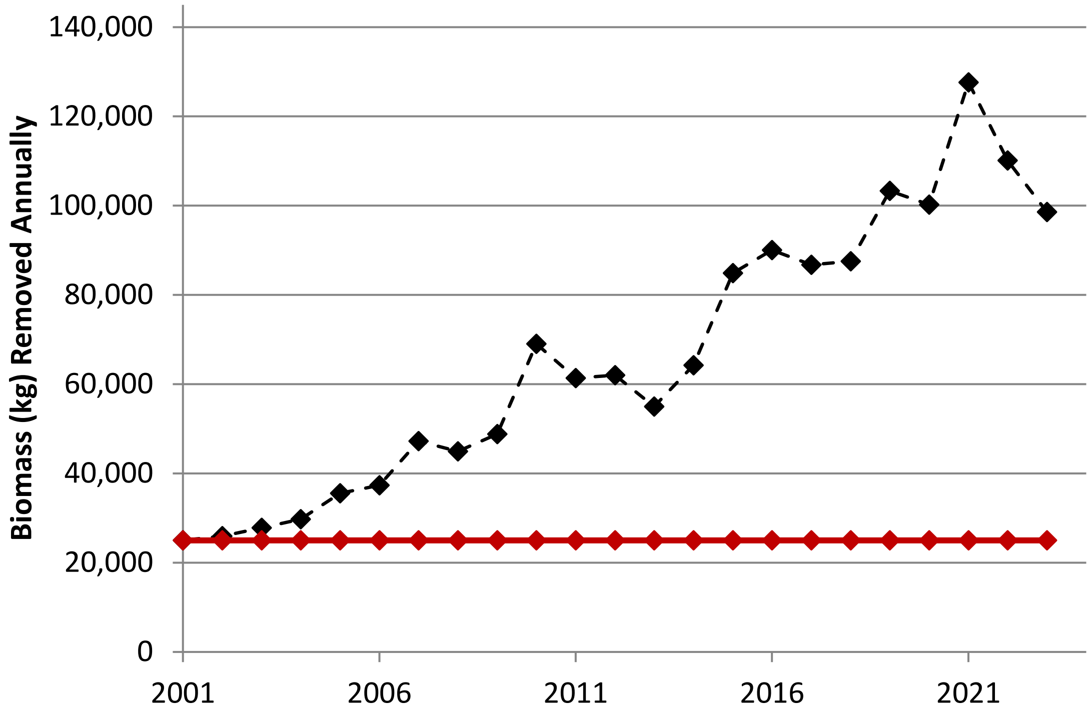

Figure 28. Annual biomass (kg) of lake trout removed by suppression programs in Flathead Lake (black) and the 0.5 kg/ha index of sustainability (red).

16) Distribution throughout the lake

Competition within highly dense populations of fish forces individuals to fill all available habitats, including the most marginal. Even though prey-rich habitat is most preferable, excessive competition in those habitats likely forces many individuals to utilize prey-limited habitats where reduced competition facilitates more effective foraging despite reduced availability of prey. As population density declines, so too will competition, allowing a larger percentage of the population to utilize preferred habitats and forcing fewer individuals into marginal habitats. Stratified random sampling draws proportionately from all available habitats in the lake, including marginal ones. As the population declines, the likelihood increases that a habitat absent of lake trout will be sampled. Over the period of sampling the percentage of nets set each autumn in which zero lake trout were captured has trended upward from zero to about 12% (Figure 29).

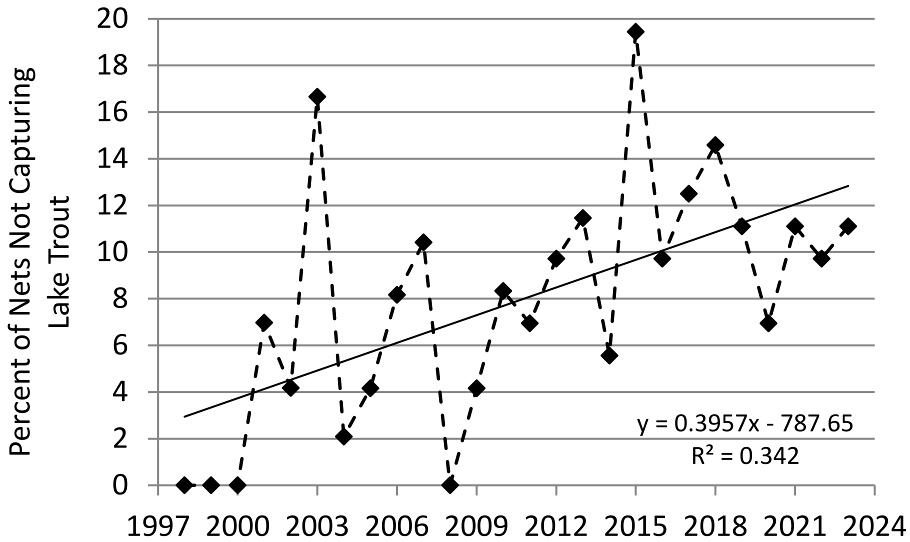

Figure 29. Percent of nets in fall random sampling that captured zero lake trout, 1998 to 2023.

Summary conclusion: Are lake trout decreasing?

The 16 metrics used to answer this question are either non-indicative or trending in a direction indicating declining abundance of lake trout (Table 6). Four metrics (1, 2, 5, and 9) are non-trending, indicating neither an increase nor decrease in abundance over the last decade. Twelve metrics (3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, and 16) are trending in a direction indicating a decrease in abundance of lake trout. Collectively, the 12 metrics indicate a density-dependent response to stress from exploitation. The biological indices, body condition, maturity, mortality and size structure, are most indicative of population change. Not all abundance indices (mark-recapture estimates or gill-net catch rates) indicate changes in abundance, which may be the result of slower time lags, lower power to detect changes, and less precision than biological indices. We conclude that the current harvest level has reduced the abundance of adult lake trout to an extent sufficient for biological adjustments to be taking place.

Table 6. Summary of metrics of lake trout abundance, and interpretations of their meaning.

	Metric	*Direction of Change*	*Value of Metric*	*Comments*
1	Mark/Recapture Spring Estimates	No Trend	Moderate	Low precision, very difficult to mark enough fish
2	Mark/Recapture Autumn Estimates	No Trend	Moderate	Low precision, very difficult to mark enough fish
3	Catch rates in assessment gillnetting	Downward	High	Moderate precision
4	Catch rates in spring gillnetting	Downward	Moderate	High variability in catches
5	Catch rates in suppression netting	No Trend	Low	Biased downward, high sampling variability
6	Relative weight	Upward	Moderate	Sensitive to density changes
7	Mortality rate	Upward	High	Does not address younger year classes
8	Length at 50% maturity	Downward	Moderate	Potentially biased by two stocks of lake trout
9	Abundance of size groups	Upward for smallest size group	High	Little change with high sampling variability
10	Length of angled lake trout in Spring Mack Days	Downward	Moderate	Small, consistent change over time
11	Length of angled lake trout in Fall Mack Days	Downward	Moderate	Small change
12	Average catch rate of top 25 anglers in Spring Mack Days	Downward trend	Moderate	Driven in part by improving angler skill and increasingly effective use of technology
13	Average catch rate of top 25 anglers in Fall Mack Days	Slight downward trend	Moderate	Driven in part by improving angler skill and increasingly effective use of technology
14	Changes in growth rate	Up	High	Very responsive to changes in density
15	Annual yield	Four times sustainable harvest	Moderate	Based on estimate within native range
16	Distribution	Downward	Moderate	Results fairly subject to random sampling variability

Question 3) Is Angler Activity Decreasing?

The Flathead Lake and River Fisheries CoManagement Plan directs managers to maintain a viable recreational fishery while reducing lake trout abundance. The CoManagement Plan identified 50,000 angler-days on Flathead Lake as the definition of a viable fishery. This metric has exceeded 50,000 angler-days in only five of the last 13 years it has been monitored. Further, in at least one of those years, fishing for lake whitefish was at peak levels.

1) statewide angler mail-in survey of pressure on Flathead Lake

This metric is typically generated every other year from mail-in surveys of licensed anglers. This metric is likely not as accurate as on-site creel surveys with direct counts of anglers, but represents a useful long-term trend indicator of angler activity on Flathead Lake. This metric assumes that changes in pressure are directly related to the quality of angling which in turn is related to the abundance of the fishery, although several other social and economic factors influence pressure. Biennial estimates since 1962 indicate a large decline in pressure and contrast the kokanee-dominated fishery (up until 1987) with the current lake trout-dominated fishery. Pressure since 2000, when the Flathead Lake and River Fisheries CoManagement Plan was adopted, has been variable with a slight downward trend (Figure 30). These data likely indicate the comparatively small interest in lake trout fishing and have little value in determining the effect of lake trout reduction efforts on pressure. Of the nine surveys conducted since 2000, only five have exceeded the threshold of 50,000 angler-days per year established in the Plan.

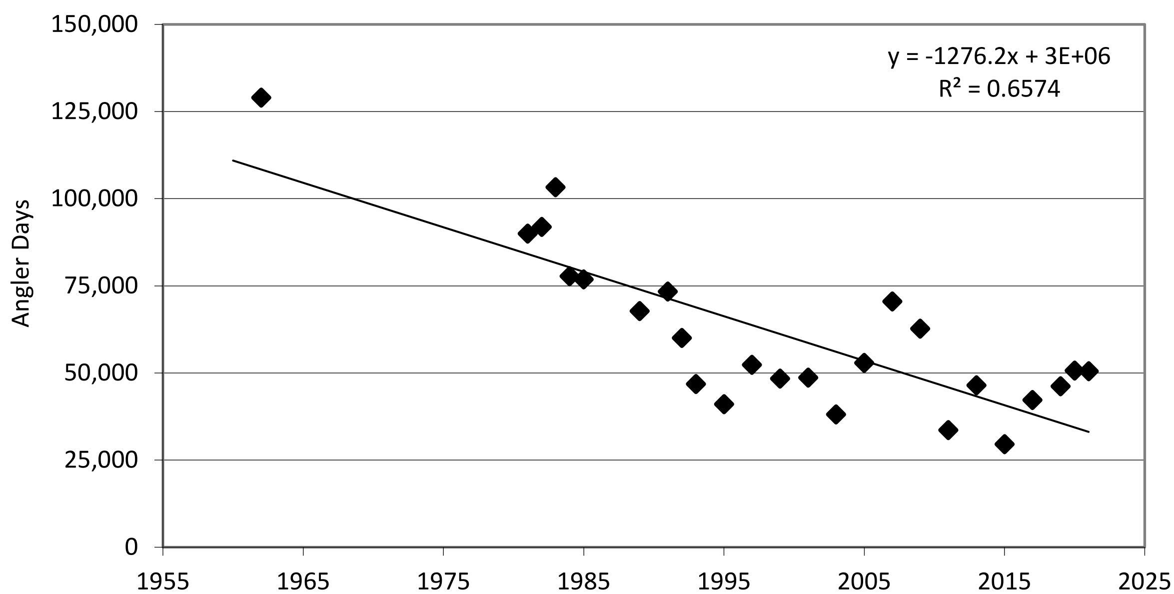

Figure 30. Total angler pressure on Flathead Lake derived from mail-in surveys by MFWP, 1999 to 2021.

2) statewide angler mail-in survey of pressure on the Flathead River system

The river system is divided into three different segments. Angler pressure in the Forks of the Flathead is trending substantially upward since 2011, while pressure on the mainstem segment of Flathead River is up over the last 30 years although variable (Figure 31).

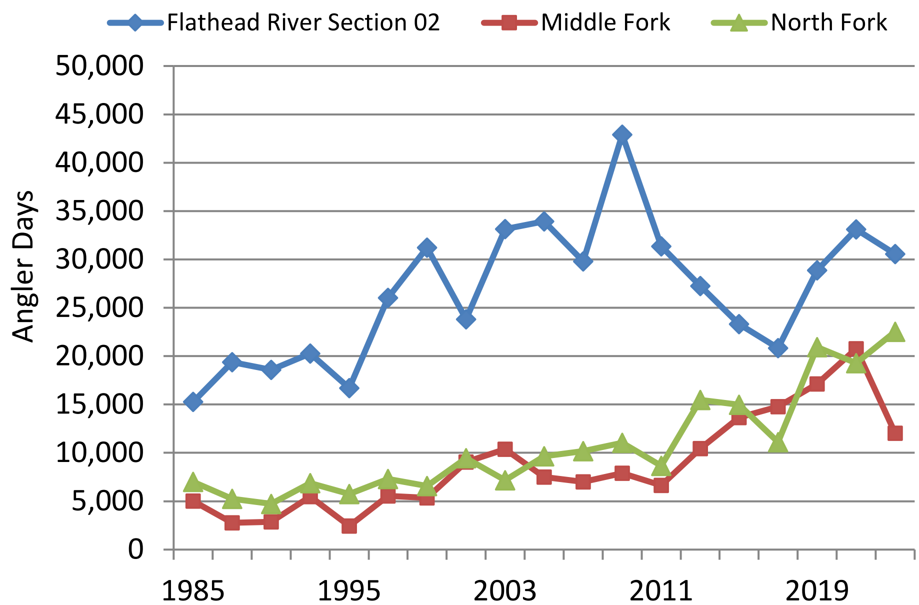

Figure 31. Total angler pressure on segments of the Flathead River system derived from mail-in surveys by MFWP, 1985 to 2021.

3) participation in fishing contests

The number of participants in Mack Days contests represents an index of a portion of angling activity on Flathead Lake (Figure 32). Interpretation of these data requires some caution because contestants represent a unique group of anglers, and their behavior can be influenced by factors that may not influence the larger angling public. For example, some anglers may choose to boycott the contests but continue to fish Flathead Lake at other times. Participation in both spring and fall events decreased rapidly over the period from 2010 to 2014, and decreased more slowly since 2014.

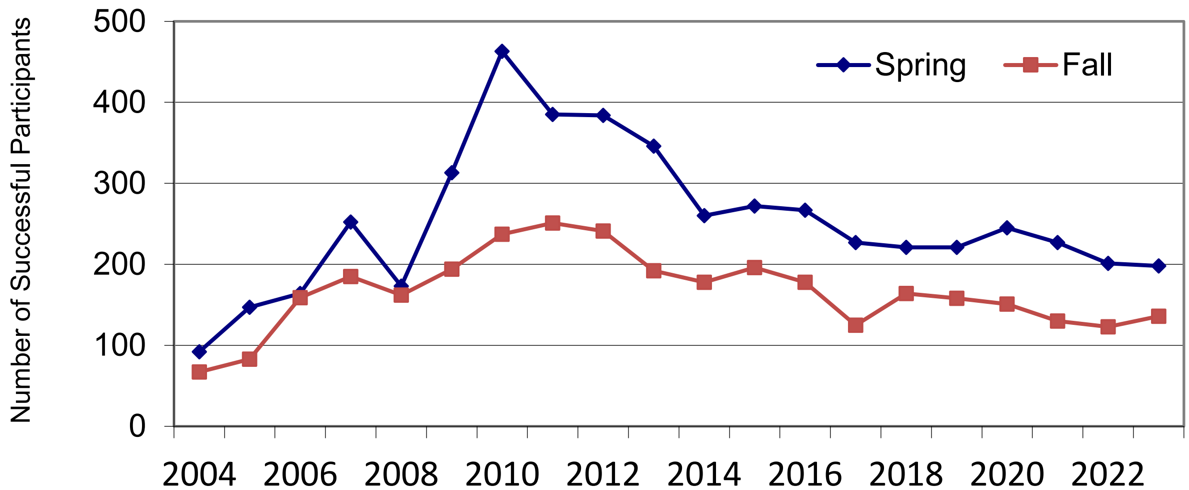

Figure 32. Number of successful participants in Spring Mack Days (blue) and Fall Mack Days (red), 2004-2023.

Summary conclusion: Is angler activity decreasing?

The metric available for evaluating pressure on Flathead Lake indicates relative stability since the collapse of kokanee (Table 7). The mail-in survey has produced highly variable estimates, and the reduced participation in Mack Days may not reflect changes in overall pressure on the lake. We conclude insufficient evidence is available to indicate any change in angler activity on Flathead Lake since the early 1990s. Angler pressure on the Forks of the Flathead has been upward trending over the last decade, while activity on the mainstem increased since 2004, but recently decreased.

Table 7. Summary of metrics of angler activity and interpretations of their meaning.

Metric	Direction of Change	Value of Metric	Comments
1) statewide mail-in survey of angler pressure on Flathead Lake	Upward, more rapidly recently	Moderate	Problems with small sample size and recall of anglers
2) statewide angler mail-in survey of pressure on the Flathead River system	Recently up in Mainstem and in Forks	Moderate	Problems with small sample size and accuracy of recall of anglers
3) participation in fishing contests	Downward since 2010, stable last four years	High	Non-biological factors also influence participation

Question 4) Is suppression of lake trout causing unintended consequences?

We have identified three specific concerns for unintended consequences of suppression. They are bycatch of bull trout and of lake whitefish, and increases in *Mysis* that could cause cascading ecological changes.

1) Is bycatch of bull trout too high?

Bycatch of bull trout impedes progress toward the goal of increasing bull trout abundance. To date, we have not defined a threshold of bycatch that would be unacceptable and likely to preclude success of the program. Nor have we defined a maximum level of mortality that is sustainable. In the absence of these analyses, the Tribes have taken a conservative approach and made it a priority to minimize bycatch at the expense of expanded harvest of lake trout. One reference level of acceptable bycatch is the level permitted by USFWS in the Recovery Permit, which allows a total of 165 bull trout mortalities from Mack Days and from gillnetting.

Netting and angling result in some mortality of bull trout. During Mack Days contests mortality has resulted from anglers mistaking bull trout as lake trout. In 2023 anglers submitted one bull trout to the contests, mistakenly thinking it was a lake trout (Table 8). An additional source of mortality occurs when Mack Days anglers catch bull trout, correctly identify and release them, but a percentage die from injuries. We estimate bycatch during 2023 contests of 1,067 bull trout (21 bull trout for every 1,000 lake trout caught based on previous creel surveys). Of those, we estimate that 5%, or 53 died from hooking and handling injuries.

Bull trout bycatch in suppression nets has been low, and the resulting mortality has been even lower as roughly half of the bycatch survives and is released. In 2023, we caught 26 bull trout in 116 nets, 17 of which were known to have died (Table 9). Therefore total bull trout mortality, known and estimated that we attribute to suppression, was 71 (53 post-release from angling, 1 mistaken identity from angling, and 17 from netting).

Table 8. Bull trout mistaken for lake trout and submitted in Mack Days contests, 2010 to 2022.

Year	Annual Harvest	Spring Mack Days	Fall Mack Days	Total Known Bull Trout Mortalities from Angling	Bull Trout as Percent of Lake Trout Harvest	Ratio of LT:BT
2010	48,914	6	0	6	0.01	8,152
2011	44,847	12	13	25	0.06	1,794
2012	52,717	10	6	16	0.03	3,295
2013	42,676	11	2	13	0.03	3,283
2014	43,763	16	2	18	0.04	2,431
2015	53,704	8	2	10	0.02	5,370
2016	52,259	1	3	4	0.008	13,065
2017	51,923	2	1	3	0.006	17,308
2018	51,726	1	2	3	0.006	17,242
2019	58,351	10	1	11	0.019	5,305
2020	42,152	0	1	1	0.000	42,152
2021	41,597	2	0	2	0.005	20,799
2022	34,924	1	0	1	0.003	34,924
2023	44,696	0	1	1	0.002	44,696

Table 9. Catch and mortality of bull trout in suppression nets, 2014 to 2023.

Year	Feet of Net	Number of Bull trout captured	Number of Bull trout released	Number of Bull Trout per 1000 ft of net	Number of Bull trout Mortalities	Ratio of LT:BT Mortalities
2014	135,000	8	7	0.007	1	7,657
2015	405,900	12	4	0.030	8	2,222
2016	677,700	22	10	0.032	12	1,920
2017	1,034,100	23	14	0.022	9	2,411
2018	1,218,900	24	16	0.020	8	2,689
2019	1,443,600	32	13	0.022	19	1,691
2020	740,700	65	19	0.088	46	794
2021	1,262,700	62	22	0.049	40	1,439
2022	1,062,000	53	23	0.050	30	1,791
2023	1,041,300	26	9	0.025	17	2,160

Most of the known bull trout mortalities were juvenile or subadult individuals (Figure 33). Additionally, we estimate that 25% of the Mack Days bycatch of bull trout would continue in the absence of Mack Days (because not all Mack Days activity is additive to general angling pressure). Therefore, total known and estimated bull trout mortality that is attributable to suppression activities is 58 (40 post-release from angling, 1 mistaken identity from angling, and 17 from netting). We assume that the loss of 58 subadult and juvenile bull trout is unlikely to cause a decline in the Flathead metapopulation of bull trout.

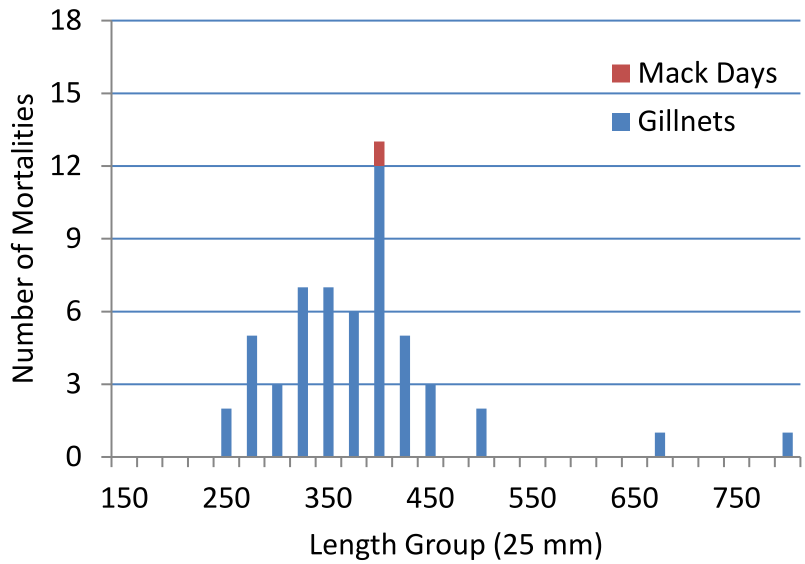

Figure 33. Length frequency distribution of known bull trout mortalities from Mack Days contests (red), and both bull trout mortalities and live-releases from gillnets (blue), 2023.

In 2023 we caught bull trout in gillnets across all areas and depths (Figures 34 and 35), indicating that bull trout are occupying most habitats within the lake. This broad distribution of predominantly immature fish may be an indicator of gradual increases in abundance.

Small bull trout are concentrated in deep waters, preying on Mysis, while the largest bull trout are preying on fish near shore in shallower water, and some intermediate sized bull trout expand into intermediate depths (Figure 33).

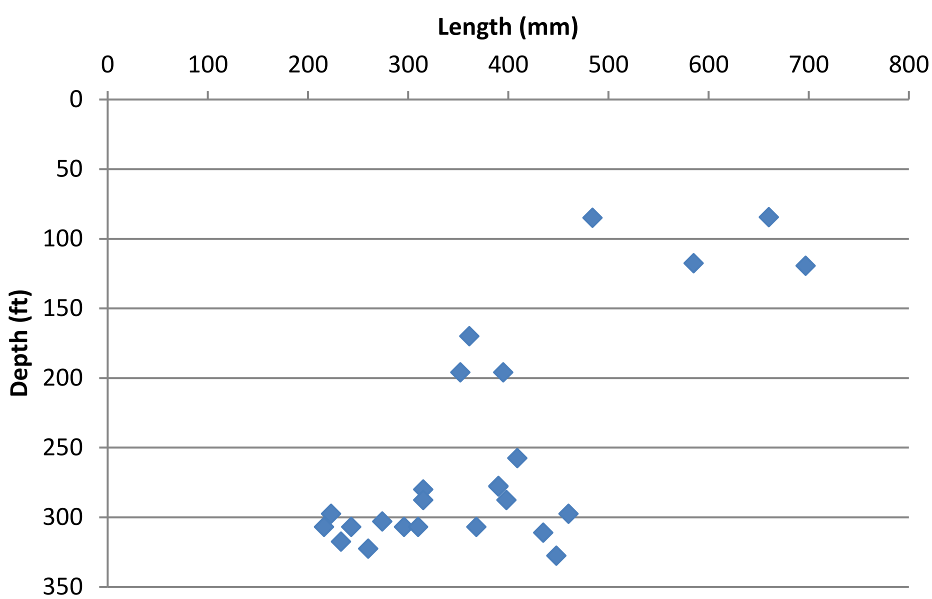

Figure 34. Lengths of bull trout and depths at which they were captured in gillnets, 2023.

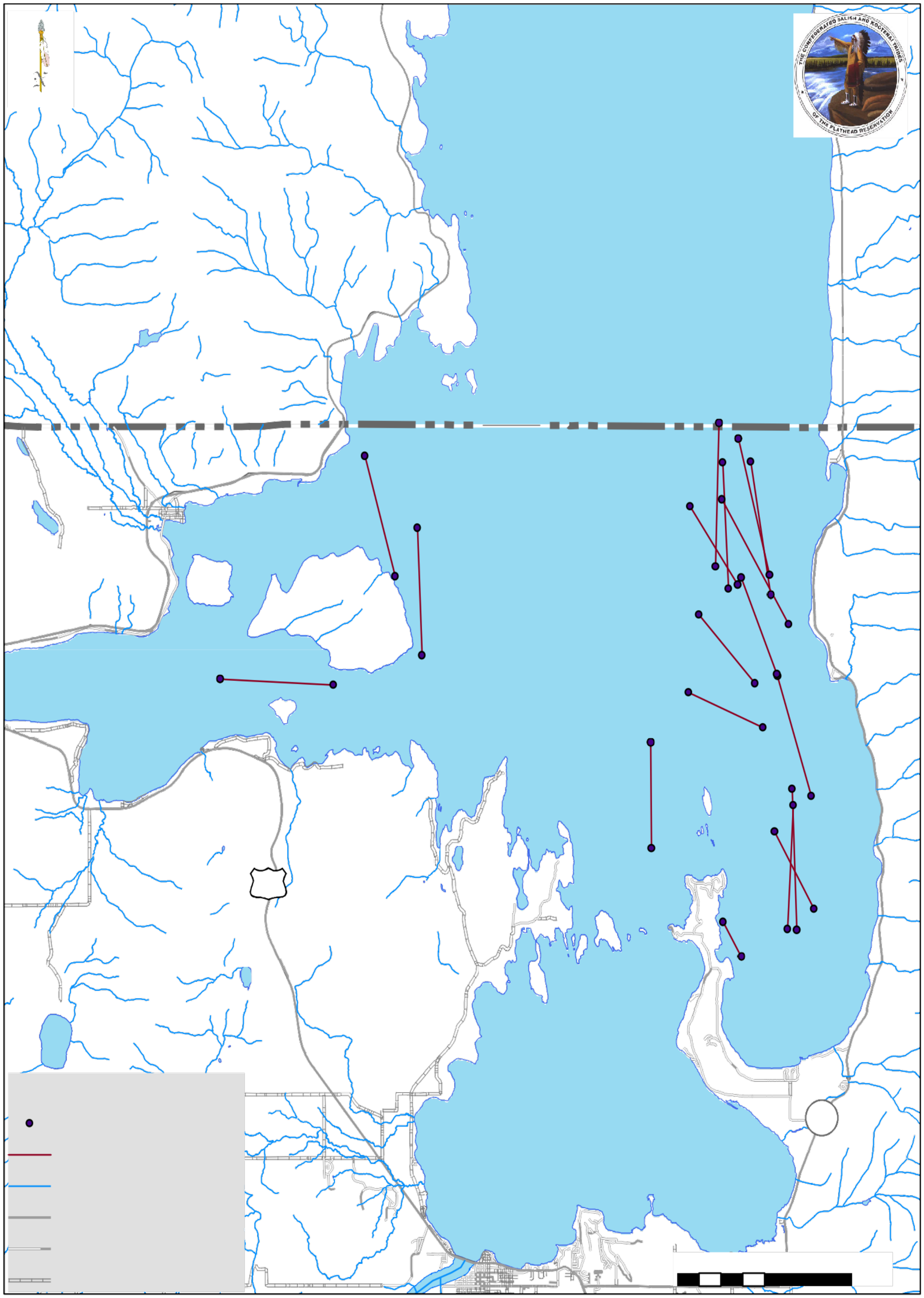

Figure 35. Locations of bull trout captured in nets during 2023.

2) Is bycatch of lake whitefish too high?

CSKT set a total of 1,041,300 ft of suppression gillnets in 116 locations during 2023, resulting in a bycatch of 24,459 lake whitefish, or over one percent of estimated standing stock. The spring gillnetting survey indicates a recent downward trend (Figure 36) and the autumn survey indicates a long downward trend (Figure 37). The abundance of lake whitefish has been very high in Flathead Lake (estimated at greater than two million), exploitation is very low, and they exhibit high fecundity and high resiliency to exploitation. Because the capture data are so variable, we cannot conclude that the declining trends in abundance reflect reality.

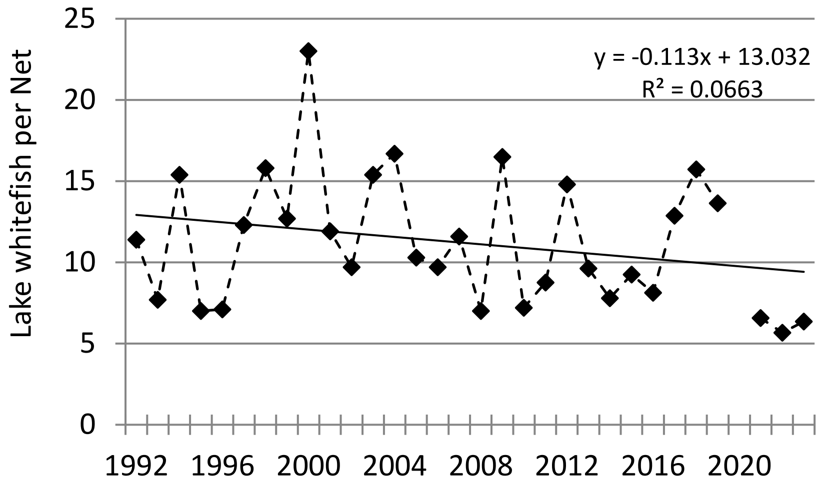

Figure 36. Average annual catches of lake whitefish in 30 fixed-location sinking gillnets set in spring in Flathead Lake, 1992 to 2023 (data from MFWP).

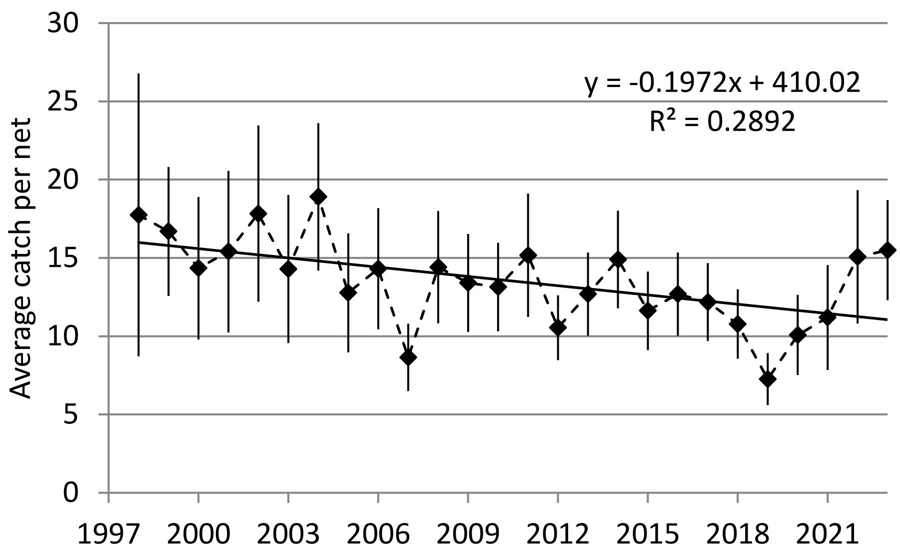

Figure 37. Average catches of lake whitefish (± 95% confidence limits) in stratified random gillnets (from 48 to 96 nets) set in autumn in Flathead Lake, 1998 to 2023.

3) Is abundance of species, not harvested by suppression activities, changing?

a) Pygmy Whitefish

Pygmy Whitefish feed largely on invertebrates, reside in deep water, and are commonly preyed upon by lake trout. Decreased abundance of lake trout would likely result in decreased predation on pygmy whitefish and increases in their abundance. Pygmy whitefish catches have been stable or slightly increasing since sampling began in 1999 (Figure 38).

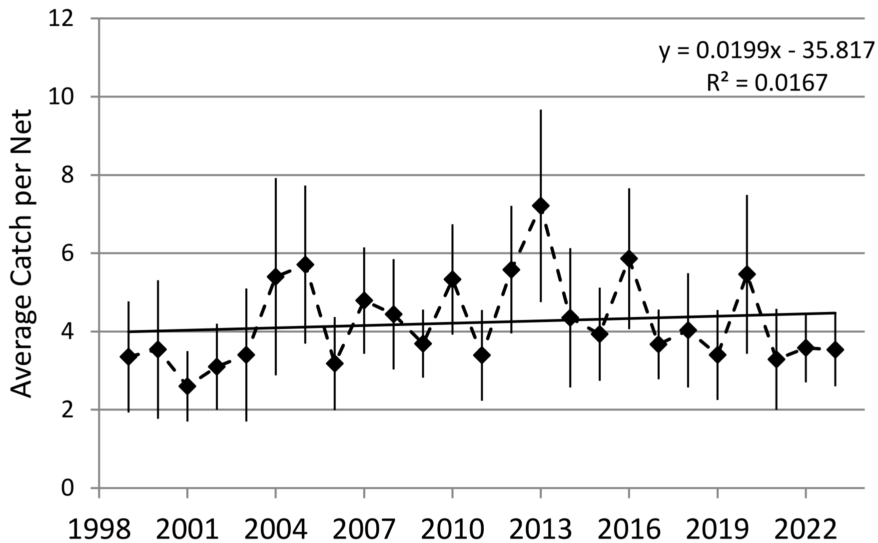

Figure 38. Average catches of Pygmy Whitefish (± 95% confidence limits) in stratified random gillnets (from 48 to 96 nets) set in autumn in Flathead Lake, 1999 to 2023.

b) Northern Pikeminnow

Northern pikeminnow are piscivorous and reside near shore in depths generally less than 50 ft. A possible downward trend has occurred since 1998, although high variability in catches confuses the conclusion (Figure 39).

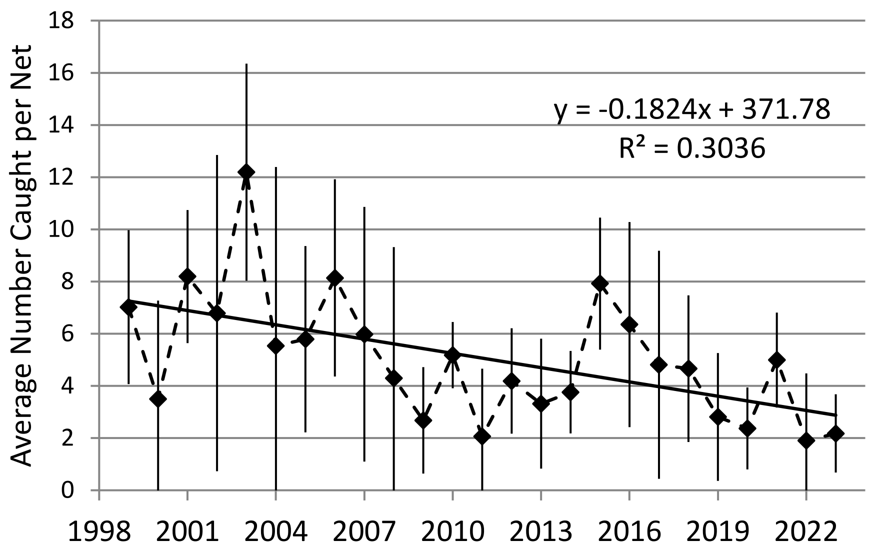

Figure 39. Average catches of Northern Pikeminnow (± 95% confidence limits) in stratified random gillnets (from 48 to 96 nets) set in autumn in Flathead Lake, 1999 to 2023.

4) Is abundance of Mysis diluviana increasing?

Mysis diluviana are the primary prey of juvenile lake trout of both lean and dwarf stocks. Suppression of either of these stocks would reduce predation on *Mysis* and likely result in increases in abundance of *Mysis*. This cascading effect is complicated by the presence of two stocks of lake trout, one more dependent on *Mysis* than the other, and compensatory recruitment potentially causing a near-term increase in juvenile, *Mysis*-eating lake trout.

Mysis abundance is driven both by bottom-up and top-down factors. Nutrient availability varies with the magnitude of runoff, partially explaining the inter-annual variability in *Mysis* abundance, and may also overwhelm the effect of changes in predation pressure by lake trout in recent years. Also confounding the effects of the suppression program is that as lake trout decline their predation pressure on *Mysis* may simply be replaced by increased predation pressure from lake whitefish. Some evidence exists that abundance of juvenile lake trout is increasing possibly adding pressure on *Mysis* and explaining their decline over the last three years. Abundance of *Mysis* over the last eight years has varied by 150%, while total lake trout biomass has decreased. Either there is little influence of lake trout on *Mysis* abundance or increases in juvenile lake trout may be increasing the predation pressure on *Mysis* (Figure 40.)

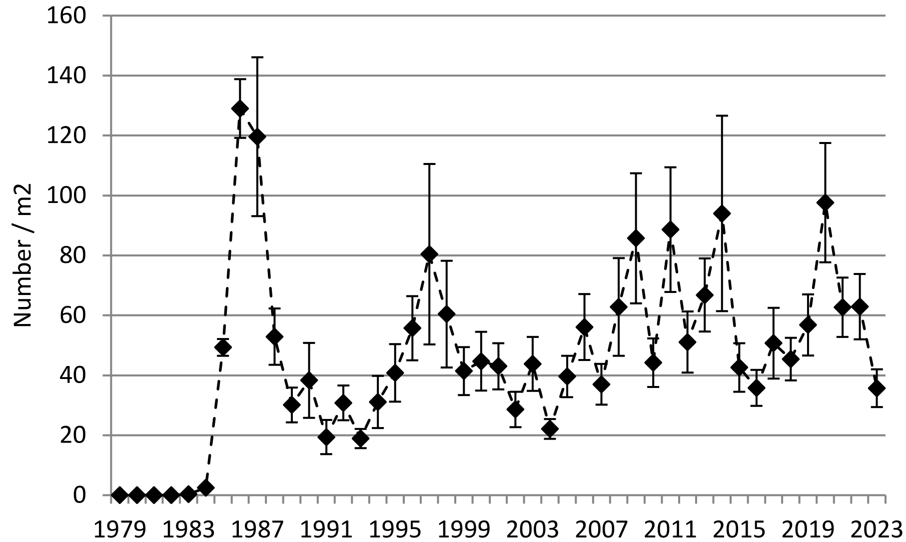

Figure 40. Number of *Mysis diluviana* per square meter (+ 95% confidence limits) averaged across 40 sampling locations in Flathead Lake, 1979 to 2023 (data from Flathead Lake Biological Station).

Mysis prey on cladocerans (primarily Daphnia sp.) who in turn consume algae. If *Mysids* increase, then cladocerans are expected to decrease, leading to an increase in algae. The production or density of phytoplankton is measured by several methods, which include annual primary production in grams of carbon and weight per liter of Chlorophyll a. Primary production has been stable and non-trending (Figure 41), although recent data are not currently available.

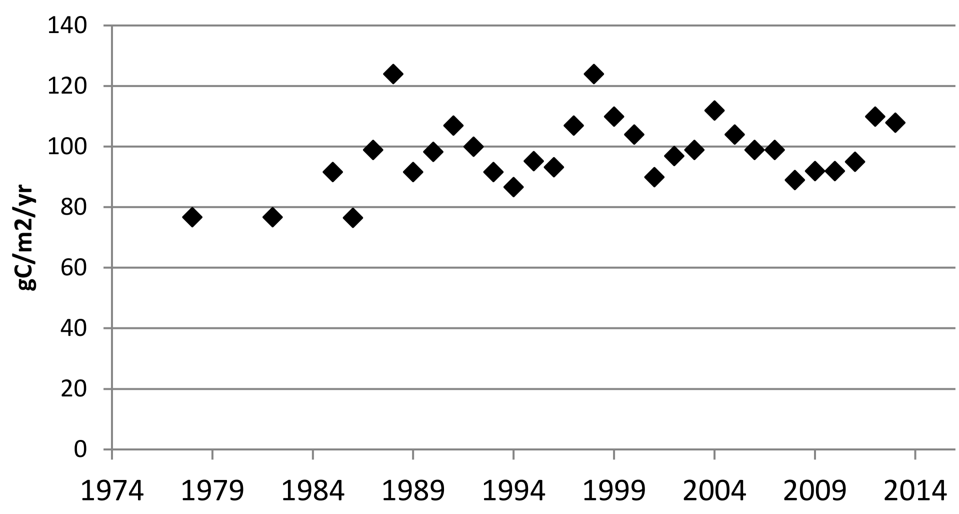

Figure 41. Average annual primary productivity (gC/m2/yr) in Flathead Lake, 1978-2013 (data from Flathead Lake Biological Station).

Density of chlorophyll a has been trending upward, although the recent peak is within the range of variability observed over the last 20 years (Figure 42).

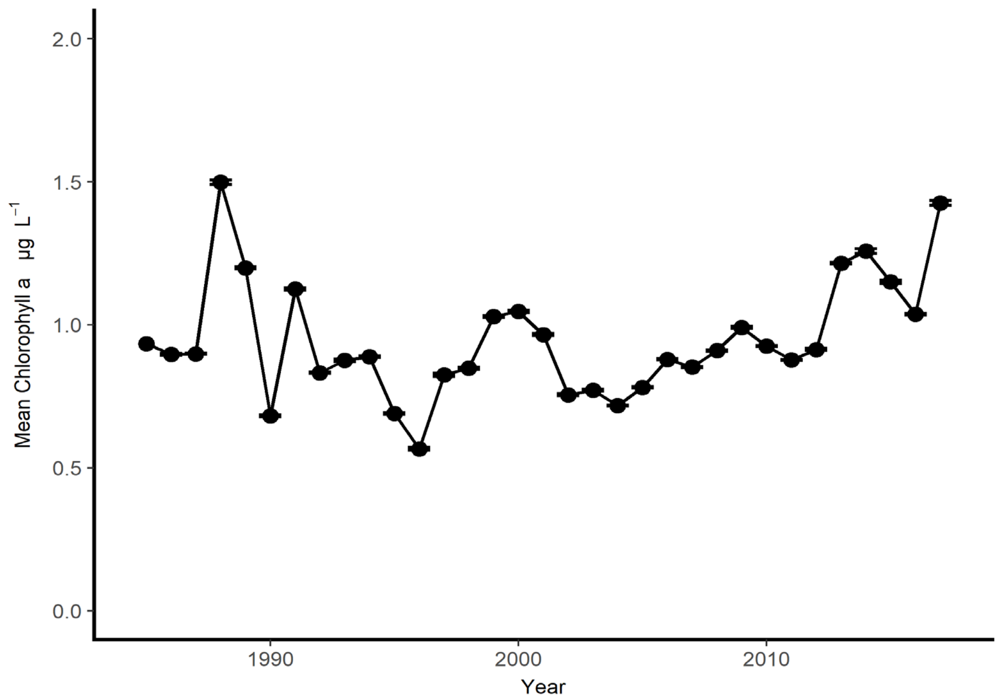

Figure 42. Average annual chlorophyll a (ug/L) in Flathead Lake, 1978-2017 (data from Flathead Lake Biological Station).

Secchi disk readings provide a visual indication of water clarity and are non-trending through the period of record (Figure 43).

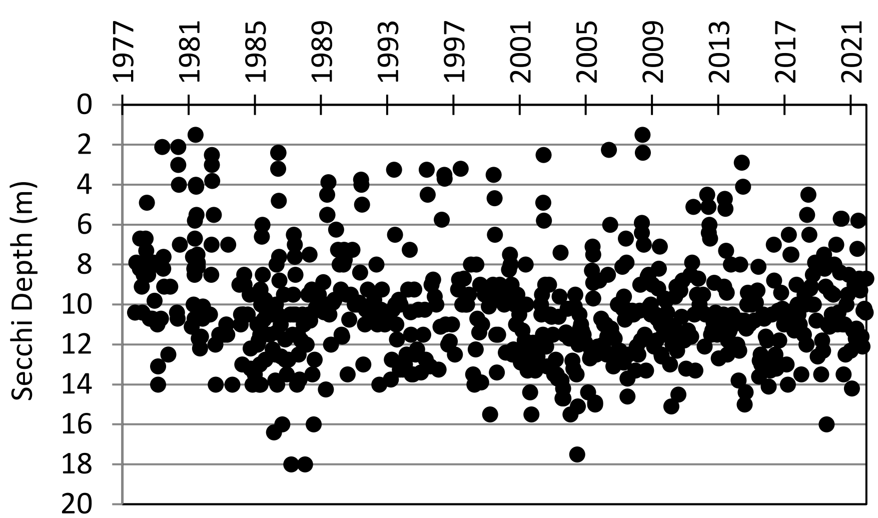

Figure 43. Secchi depth readings, 1977 to 2021 (Data from Flathead Lake Biological Station).

Summary conclusion: Is suppression of lake trout causing unintended consequences?

After 10 years of expanded suppression we have detected no indication of unintended consequences. Bycatch mortality of both bull trout and lake whitefish has been very small, and therefore bycatch is extremely unlikely to have measurably affected their abundance. *Mysis* abundance has varied widely, and without an strong upward trend, and therefore not consequential at this time.

Question 5) Is the level of risk inherent with suppression acceptable?

None of the risks that have been identified to date are at a level that is unacceptable. Mortality of bull trout has been low, and bycatch of lake whitefish has been small relative to their population size. Increases in *Mysis* and Chlorophyll a are noteworthy, but below levels present in Flathead Lake in 1986. Therefore risk of continued suppression is considered to be low.

Question 6) Based on the results of the first five questions; What is the best lake trout harvest target for 2024?

In 2024, the eleventh year of expanded suppression efforts, our primary objective is to exceed the harvest achieved in the previous year. Mack Days contests will be conducted as they were in previous years because we think we have arrived at the optimal format leaving no additional opportunity for cost-effectively increasing harvest. We will attempt to exceed the largest netting effort to date, which is 1,262,700 ft of net.

Assuming constant angling catch and reduced catch from netting, we project that it is feasible in 2024 to harvest 126,000 lake trout (Table 10). We consider this target to be a realistic one to achieve, unless catch rates decline substantially in 2024. Current indications are that suppression is effectively reducing adult lake trout abundance at harvest levels well below modeled targets. We will continue to evaluate this seeming contradiction and the need to make additional adaptive changes.

Table 10. Methods of suppression, harvest achieved in 2023, harvest projected for 2024, and projected bull trout bycatch for 2024.

Method	Lake Trout Harvest 2023	Projected Lake Trout Harvest Target for 2024	Projected Bull Trout Bycatch / Mortality
General Recreational Angling	25,000 (Estimated)	25,000 (Estimated)	525/26
Spring Mack Days	33,297	32,000	672/34
Spring Gillnetting	29,455	30,000	20/10*
Fall Mack Days	17,502	18,000	378/19
Fall Gillnetting	7,260	14,000	9/5*
Total	112,514	119,000	1,604/94

*based on the assumption of 1 bull trout per 1,500 lake trout caught in gillnetting and 50% mortality

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