Summary of Activities in 2015

of the

Lake Trout Suppression Program to Benefit Native Species

in

Flathead Lake

Confederated Salish and Kootenai Tribes

and

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Introduction

This report summarizes results of the second 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 timeline to meet that 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 process begins with development of an annual harvest target for lake trout, followed by implementation of suppression activities to achieve the target, and finally analysis of results for setting the next annual harvest target. The purpose of this report is to gauge success and evaluate risks of the suppression program, and to lay the groundwork for suppression in 2016. To do so, we answered the following questions. After the second year of expanded suppression efforts in 2015:

1) Are native 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 2016?

Implementation Activities Conducted in 2015

Harvest during 2015 was generated from recreational angling, fishing contests, gillnetting and trap-netting. The Implementation Plan set a total harvest target of 98,000 lake trout from these methods, but we were only able to achieve a harvest of 96,477 lake trout (Table 1 and Figures 1 and 2).

Table 1. Methods, and planned and actual harvest of lake trout in 2015.

Method	Projected Lake Trout Harvest Target	Actual Lake Trout Harvest	Difference in Projections
General Recreational Angling	25,000 (Estimated)	25,000 (Estimated)	0
Spring Mack Days	40,000	34,179	-5,821
Spring Gillnetting	15,000	12,406	-2,594
Fall Mack Days	13,000	19,525	+6,525
Fall Gillnetting	5,000	5,367	+367
Total	98,000	96,477	-1,523

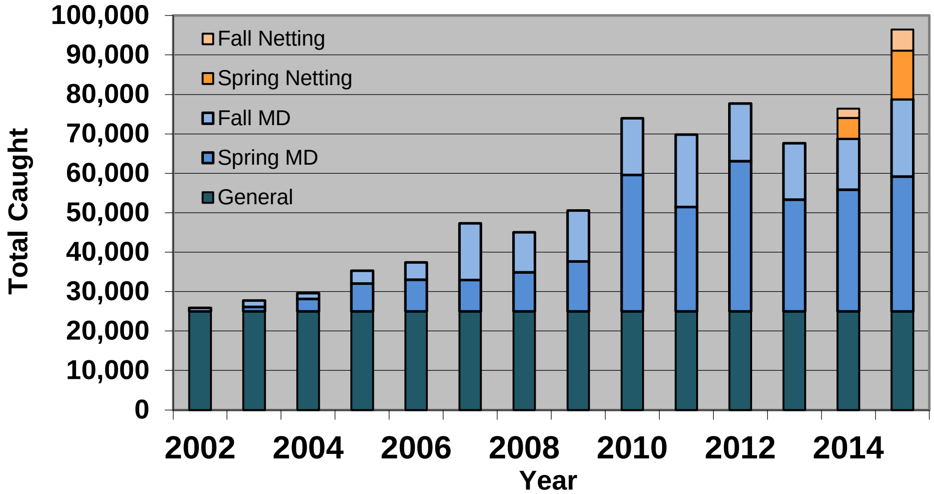

Figure 1. Components of lake trout harvest including netting, Mack Days fishing contests and general recreational angling, 2002 to 2015.

We estimated that recreational angling accounted for a harvest of 25,000 lake trout in 2015, based on the assumption that harvest rates in 2015 were similar to the rates between 1998 and 2007 when extensive creel surveys were conducted. In Spring Mack Days 34,175 lake trout were harvested in 1,968 angler-trips (Figure 2), and in Fall Mack Days 19,525 lake trout were harvested in 1,239 angler-trips (Figure 3). Gillnetting in spring produced 12,406 lake trout and gillnetting during fall produced 5,367 lake trout. The total of all these activities equaled 96,477 lake trout harvested in 2015.

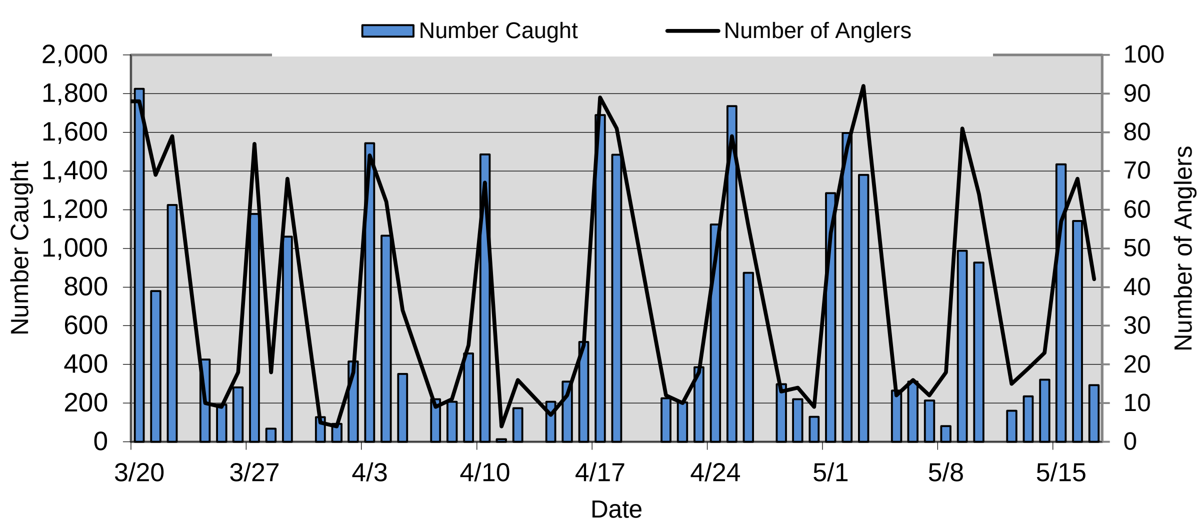

Figure 2. Number of lake trout caught and number of angler-days expended during Spring Mack Days, 2015.

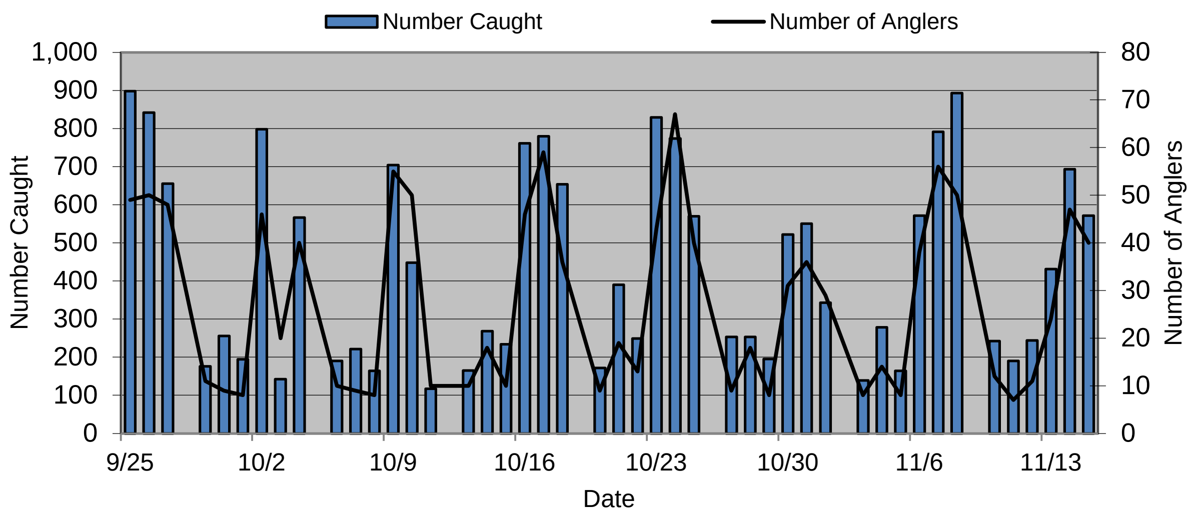

Figure 3. Number of lake trout caught and number of angler-days expended during Fall Mack Days, 2015.

Table 2. Results of suppression gillnetting in 2015.

Net #	Set Date	Location	Day Night	Total Net Length	Mesh Stretch	Depth (ft)	# LT Caught	# LT Kept	# Bull Trout
1	3/4/2015	Blue Bay	N	3600	4	285-302	75	60	0
2	3/9/2015	W. Blue Bay	D	4500	3.5	257-305	269	208	0
3	3/9/2015	W. Blue Bay	N	2700	4	255-260	132	114	0
4	3/10/2015	Blue Bay	N	5400	3.5	261-267	269	156	0
5	3/11/2015	Blue Bay	N	5400	4	265-272	244	217	0
6	3/17/2015	Mid Lake	N	5400	4	198-246	267	193	0
7	3/17/2015	Blue Bay	D	3600	4	291-298	132	132	0
8	3/18/2015	Mid Lake	N	5400	4	202-227	281	206	0
9	3/22/2015	E. Bird Island	N	5400	3.5	257-295	311	264	0
10	3/22/2015	Blue Bay	N	4500	4	255-262	125	107	0
11	3/23/2015	N. Frgy's Hump	N	4500	4	263-310	132	118	0
12	3/23/2015	N. Frgy's Hump	N	5400	3.5	257-260	227	190	0
13	3/23/2015	Blue Bay	D	4500	4	252-255	210	193	0
14	3/24/2015	W. Blue Bay	D	5400	3.5	260-268	10	10	0
15	3/24/2015	Mid Lake	N	4500	4	183-253	160	132	0
16	3/24/2015	NW Blue Bay	N	5400	3.5	250-253	68	49	0
17	3/25/2015	Mid Lake	N	5400	4	188-325	244	244	0
18	3/25/2015	W Yellow Bay	N	4500	3.5	232-252	133	105	0
19	3/30/2015	Mid Lake	N	4500	4	298-301	209	209	0
20	3/30/2015	Mid Lake	N	5400	3.5	240-296	129	129	0
21	3/31/2015	Mid Lake	N	5400	3.5	227-253	408	398	0
22	3/31/2015	Mid Lake	N	4500	4	241-297	158	158	0

Net #	Set Date	Location	Day Night	Total Net Length	Mesh Stretch	Depth (ft)	# LT Caught	# LT Kept	# Bull Trout
23	4/1/2015	Skidoo Bay	N	5400	4	244-265	573	573	0
24	4/6/2015	Mac Alley	D	2700	4	166-199	35	35	0
25	4/6/2015	Mid Lake	N	9000	4, 3.5	247-252	571	571	0
26	4/9/2015	W. Blue Bay	D	5400	4	257-305	107	107	0
27	4/13/2015	Skidoo Bay	N	7200	3.5, 4	268-274	651	651	0
28	4/15/2015	NE Wildhorse	N	7200	4	205-216	444	427	0
29	4/15/2015	Skidoo Bay	D	5400	4, 3.5	280-289	109	109	0
30	4/20/2015	N. of Rocky Pt.	N	7200	4	231-259	879	863	0
31	4/27/2015	N. of Bird Is	N	7200	4	260-265	604	586	0
32	4/28/2015	Skidoo Bay	N	7200	4	189-271	362	362	0
33	5/4/2015	Mid Lake	N	2700	3.5	254-299	186	172	0
34	5/5/2015	N Black Pt	N	4500	3.5	262-288	328	320	0
35	5/6/2015	Blue Bay	N	4500	3.5	263-267	119	119	0
36	5/11/2015	Skidoo Bay	N	7200	3.5	259-289	525	513	0
37	5/12/2015	Skidoo Bay	N	7200	3.5	274-302	806	803	0
38	5/12/2015	Skidoo Bay	N	1800	3.5	274-302	278	266	0
39	5/13/2015	Skidoo Bay	N	4500	3.5	266-291	260	260	0
40	5/19/2015	Mid Lake	N	5400	3.5	259-320	376	376	0
41	6/9/2015	Mid Lake	N	7200	4	220-257	102	97	0
42	6/10/2015	Mid Lake	N	7200	4	267-282	276	276	0
43	6/15/2015	Skidoo Bay	N	9000	4	294-299	700	696	0
44	6/16/2015	Blue Bay	N	9000	4	288-320	617	617	0
45	10/5/2015	Blue Bay	N	8100	4	260-294	201	196	2
46	10/6/2015	E Wildhorse Is	D	8100	4	251-267	53	51	1
47	10/12/2015	Skidoo Bay	N	7200	4	279-282	556	556	0
48	10/12/2015	Skidoo Bay	N	3600	3.5	279-282	354	354	0
49	10/14/2015	Skidoo Bay	N	3600	3.5	299-300	70	70	0
50	10/19/2015	W. of Blue Bay	N	8100	4	289-315	73	73	0
51	10/20/2015	Mid Lake	N	8100	4	223-308	320	320	3
52	10/21/2015	N. of Narrows	N	4500	4	263-265	44	44	0
53	10/26/2015	Mid Lake	N	4500	3.5, 4	293-300	97	97	0
54	10/27/2015	W. of Bird Is	N	10800	3.5, 4	180-210	171	171	0
55	10/28/2015	SE Skidoo Bay	N	10800	3.5, 4	124-275	280	280	0
56	11/1/2015	SE of Bird Is	N	9000	3.5, 4	260-280	176	176	0
57	11/2/2015	Rocky Pt	D	8100	3.5, 4	260-280	104	104	0
58	11/2/2015	E Wildhorse Is	N	12600	3.5, 4	180-220	479	433	0
59	11/3/2015	N Wildhorse Is	N	6300	3.5, 4	180-220	499	499	1
60	11/4/2015	SE Wildhorse Is	D	6300	3.5, 4	180-200	180	180	0
61	11/4/2015	N. Rocky Pt.	N	12600	3.5, 4	180-220	489	489	1
62	11/12/2015	Gravel Bay	D	1800	3.5	95-187	70	52	0
63	11/16/2015	Skidoo Bay	D	1800	3.5	138-195	30	16	0
64	11/16/2015	Skidoo Bay	N	5400	3.5, 4	222-250	90	90	0
65	11/18/2015	Skidoo Bay	N	4500	3.5, 4	286-300	131	131	2

Net #	Set Date	Location	Day Night	Total Net Length	Mesh Stretch	Depth (ft)	# LT Caught	# LT Kept	# Bull Trout
66	12/7/2015	Blue Bay	N	8100	3.5, 4	125-260	142	134	2
67	12/8/2015	Skidoo	N	6300	3.5, 4	147-155	156	156	0
68	12/8/2015	Skidoo	N	6300	3.5, 4	147-155	254	254	0

LT=lake trout

We conducted gillnetting according to a protocol that precluded sampling in water shallower than 120 ft to avoid bycatch of bull trout. We placed 68 nets of varying lengths during 2015 within the constraints of the Bull Trout Recovery Permit (Figure 4).

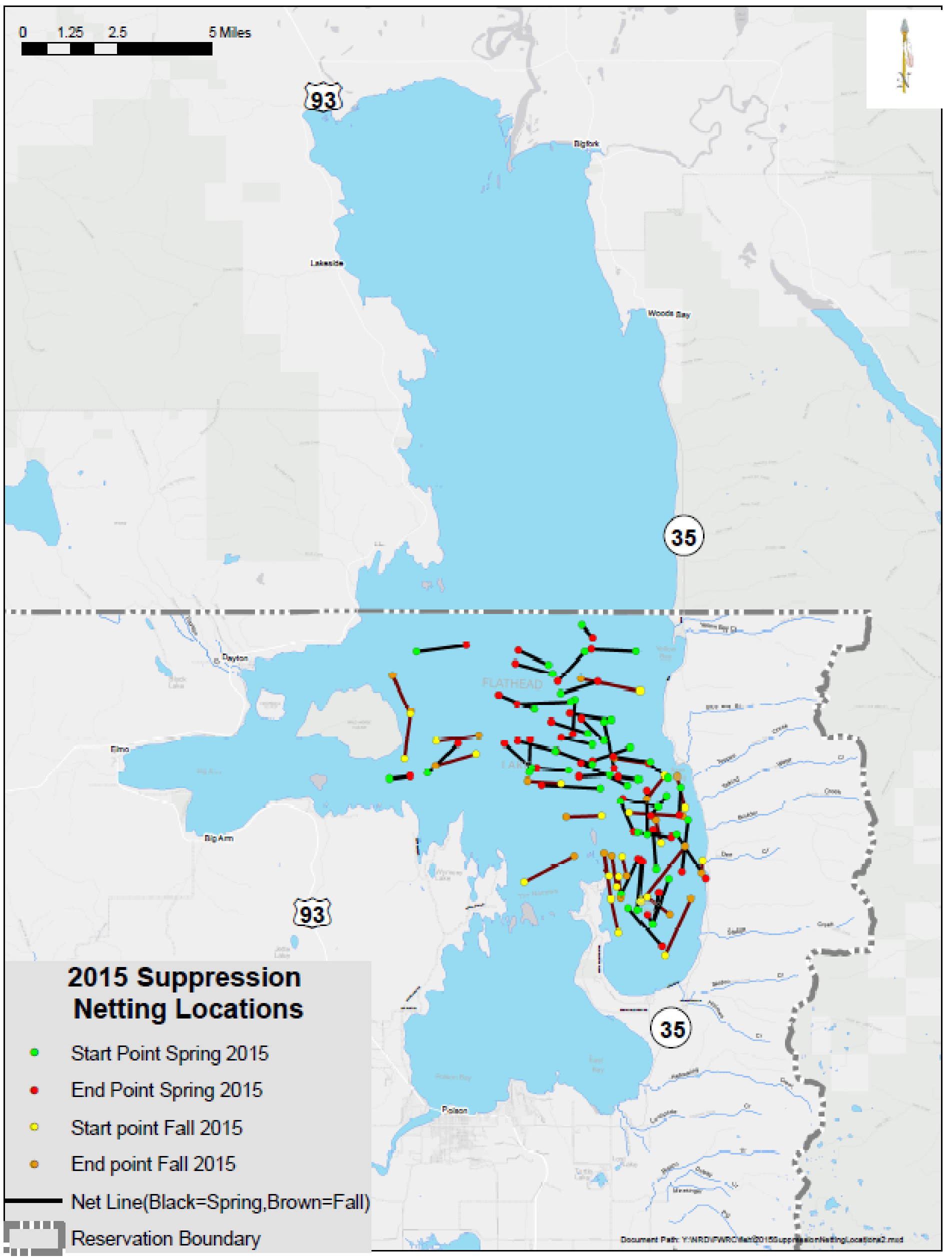

Figure 4. Gillnetting locations and lengths of nets set during 2015.

Evaluation Procedure

The purpose of this report is to answer the six predetermined questions 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. Some of the metrics have low predictive value because of some intrinsic weaknesses, but are included because they add 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.

1) Are bull trout increasing?

We use three metrics to track changes in bull trout. The bull trout metrics focus primarily on adult bull trout abundance; 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.

a) *Redd counts*

MFWP enumerates redds in index reaches of eight Flathead tributaries annually (Figure 5). Basic assumptions of this metric are that the enumerated adults migrate to 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 may result from bull trout spawning outside the boundaries of the fixed index reaches. The period of record for this metric spans the time before the increase of *Mysis* to the present.

In 2015, 182 redds were counted. Average number of redds in index streams since 1992, when counts were the lowest recorded, is 176.6. Average redds since 2005, the first year that harvest in fishing contests exceeded 10,000 lake trout, is 198. Numbers of redds counted over the last several years have been consistent, not trending in either an upward or downward direction. The total 2015 count was the lowest in the last 10 years, and was the second lowest on record in North Fork tributaries, indicating that some subpopulations may be at dangerously low levels.

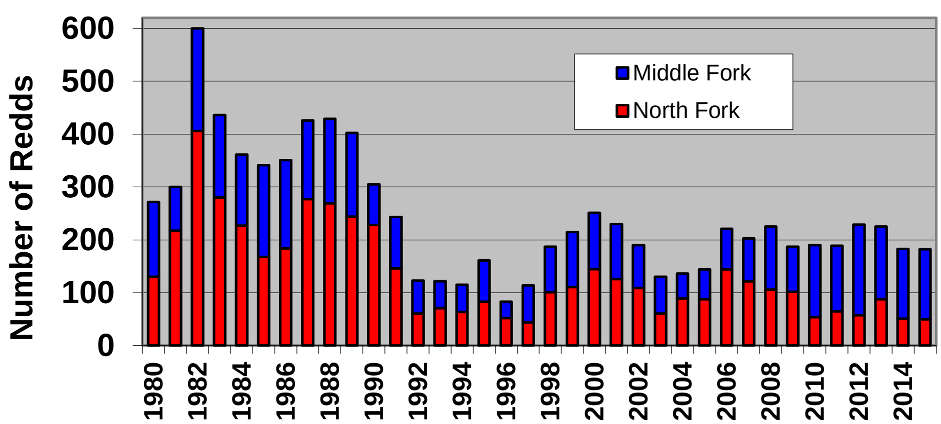

Figure 5. Bull trout redd counts in eight index streams tributary to the North and Middle Forks of the Flathead River, 1980 to 2015 (data from MFWP).

b) 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.

Captures since 2004 have trended downward and these were among the lowest in the period of record (Figure 6). Catches in 2015 markedly increased.

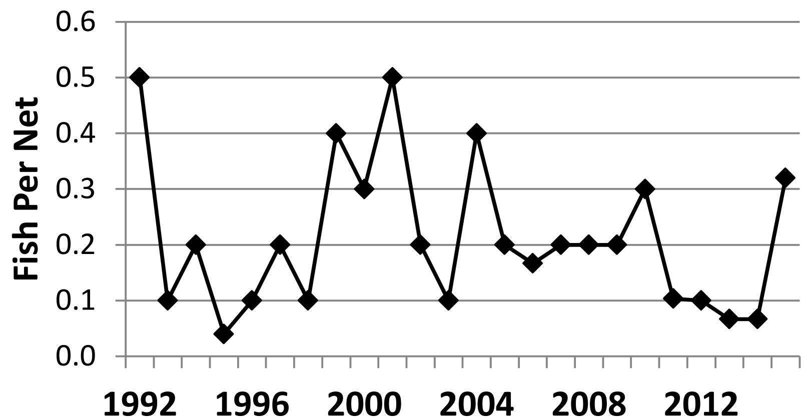

Figure 6. Average annual catches of bull trout in 15 standardized gillnets set in spring, 1992 to 2015 (data from MFWP).

c) 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 94, while maintaining constant proportionality within strata. All habitats within the lake are included in the survey. This series has been conducted from 1998 to present (Figure 7). 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 0.5 bull trout per net. The average catch since 2004 was 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 stable and low catch rate indicates a low level of abundance of bull trout in Flathead Lake, but does not indicate any clear change in abundance of bull trout in Flathead Lake over the last 10 years.

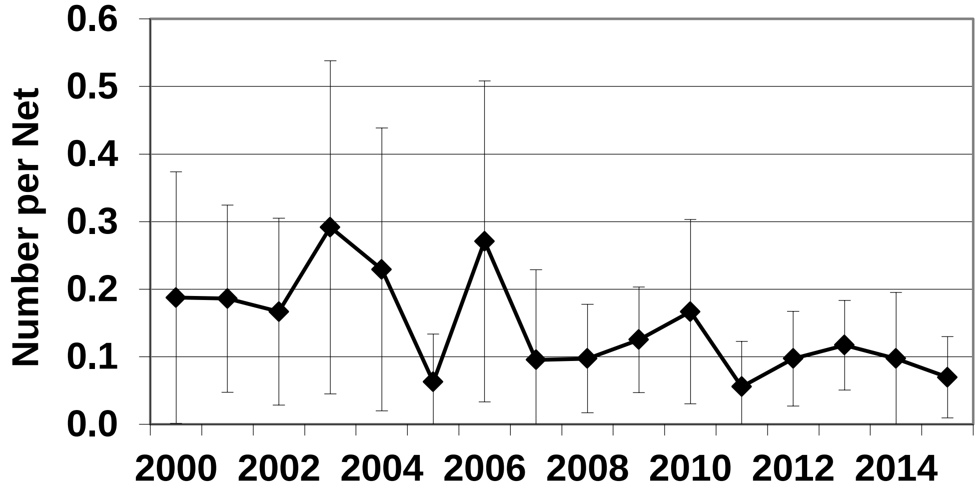

Figure 7. Average annual catches (95% confidence intervals) of bull trout in stratified random gillnets (44 to 94 nets annually) set in autumn, 2000 to 2015.

Summary conclusion: Are bull trout increasing?

None of the indices of bull trout abundance indicate a change in abundance over the last ten years. Catches in spring gill-netting series over the last 10 years appear to be declining, but are still within the range of variability over the last 20 years. While redd counts in the North Fork Flathead tributaries in 2015 were the second lowest on record, no downward trend in abundance is evident for the metapopulation. The catch in spring gillnetting during 2015 increased substantially. Based on these three metrics (Table 3), we conclude that there is no downward trend in abundance of bull trout since 2015, or over the last 10 years. The increase in spring 2015 catches may be anomalous, and will require additional years of sampling before a trend can be confirmed. Despite the absence of a discernible trend, abundance of several subpopulations is dangerously low.

Table 3. Summary of metrics describing trends in bull trout abundance and interpretations of their meaning.

Metric	Direction of Change	Value of Metric	Comments
a) Redd Counts	No Trend	High, accurate and reliable	Low counts, especially in North Fork tributaries, are a large concern
b) Catch rates in autumn gillnetting	No Trend	Moderate	High variability in catches undermines predictability
c) Catch rates in spring gillnetting	Downward trend since 2004, except upward in 2015	Low	Small sample size, small capture rate, encouraging result in 2015

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 (15) 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 8), and counts in the last two years were among the highest and lowest in the period of record. This metric provides no evidence of an upward or downward trend in abundance of westslope cutthroat trout in Flathead Lake.

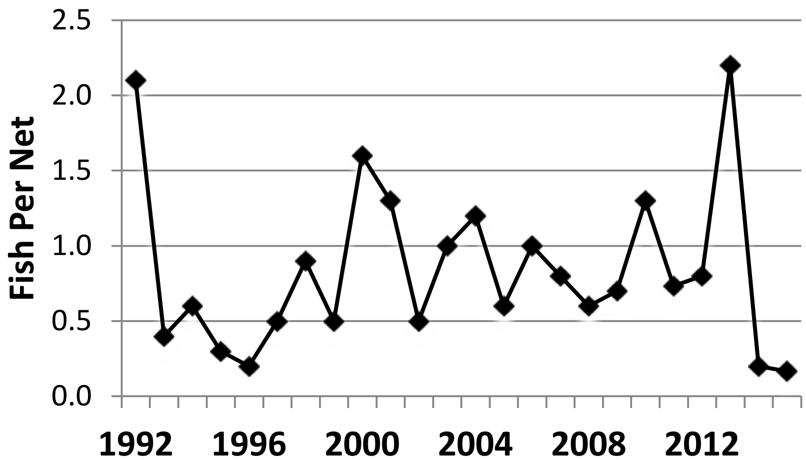

Figure 8. Average annual catches of westslope cutthroat trout in 15 standardized gillnets set in spring, 1992 to 2015 (data from MFWP).

2) Are Lake Trout Decreasing?

The total harvest in 2015 was 96,477 lake trout (see Table 1). We use 13 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 where 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, ranging from 7 to 11 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 high level of reliability because they: 1) are conducted uniformly each year, 2) are the product of a very large sample of the population, 3) the variability of the estimates is low, and 4) monitoring indicates that marked fish have low levels of tag loss and high 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 nine estimates. We assume tag loss to be low based on an ongoing test in which 140 have been double-tagged fish, 26 of which have been recaptured and all 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 consistently been proportional to the size of the harvest (Figure 9). 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.

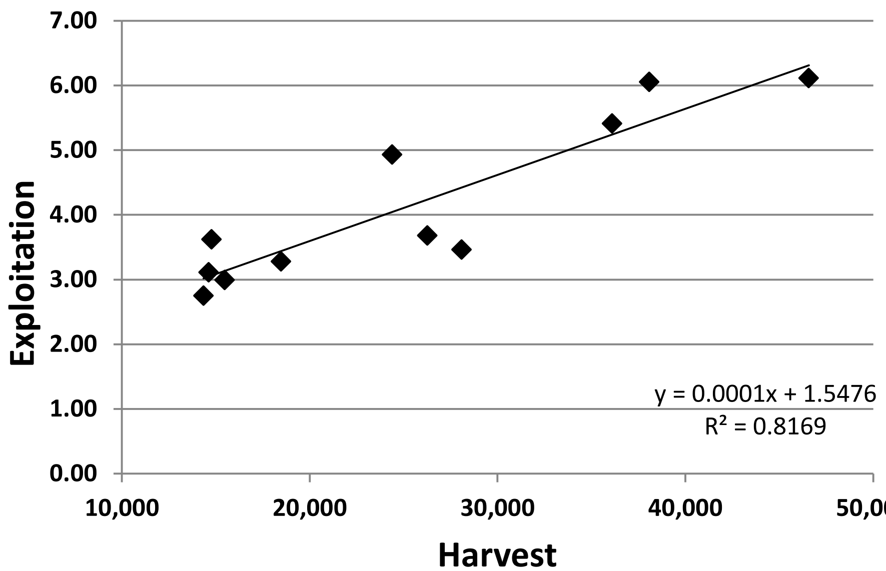

Figure 9. Exploitation, as percentage of marked fish recaptured, in relation to harvest during spring and autumn, 2010 to 2015 (excluding spring 2010).

1) *Mark/Recapture Population Estimates in Spring*

We generated six mark and recapture estimates during spring over the last six years. Excluding the 2010 estimate that was likely inflated by disproportionately high catches in deep water, the estimates are non-trending, so give no indication that total population size has changed over this time period (Figure 10).

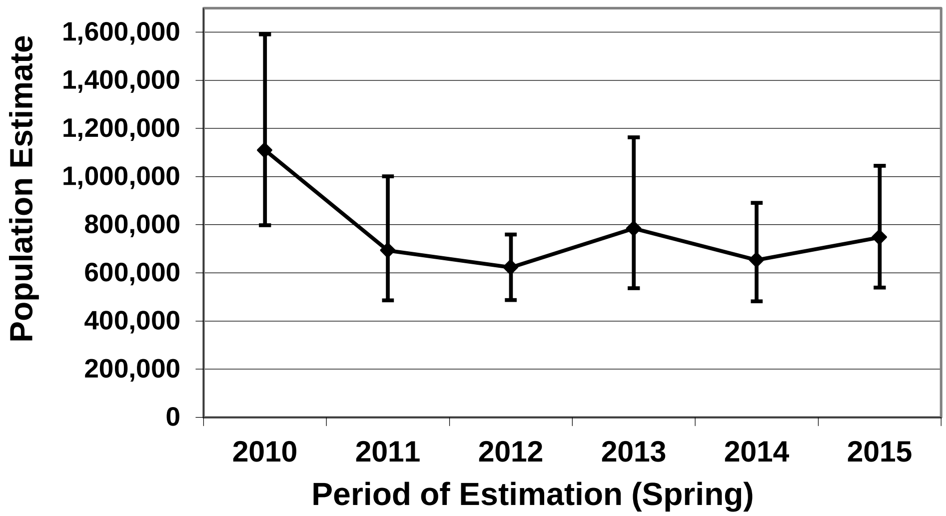

Figure 10. Mark-and-recapture population estimates for lake trout, completed during spring 2010 to 2015.

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

We generated six mark and recapture estimates during autumn over the last six years. The estimates are non-trending, so give no indication that total population size has changed over this time period (Figure 11).

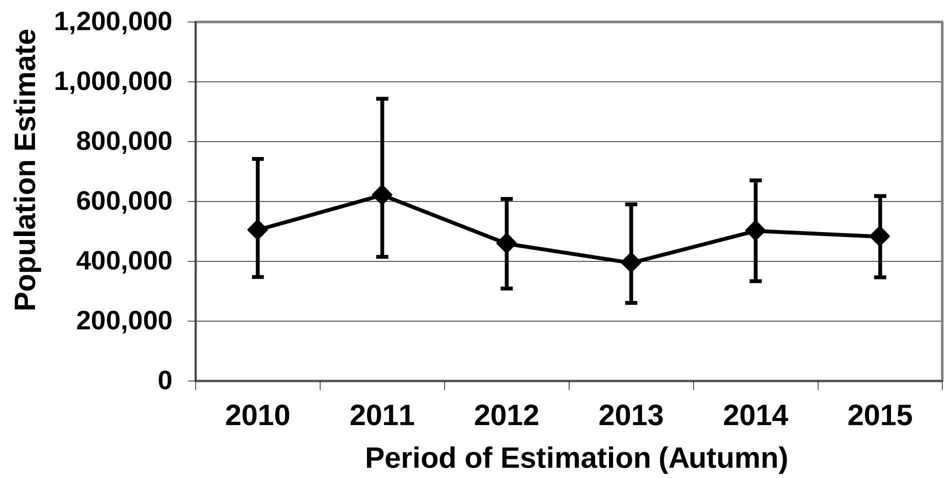

Figure 11. Mark-and-recapture population estimates for lake trout, completed during autumn 2010 to 2015.

3) Catch rates in spring gillnetting

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. Fifteen 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 therefore 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.

Catch rates have been variable, but non-trending over the period of record (Figure 10).

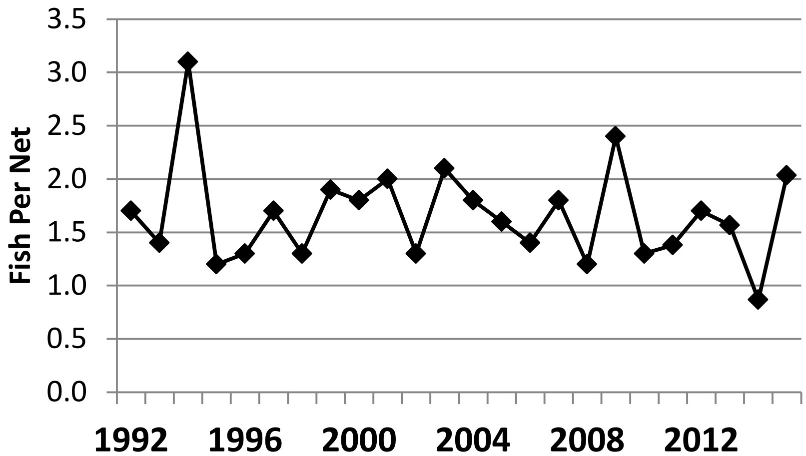

Figure 12. Mean catch rates of lake trout in fixed location sinking gillnets set during spring in Flathead Lake, 1992-2015 (data from MFWP).

4) Catch rates in autumn gillnetting

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 94. This series has been conducted from 1998 to present. Strengths of this metric are: 1) the large number of sample units (nets), 2) all available habitats are sampled, 3) all sizes of fish are sampled, and 4) the sample locations are randomized. A potential problem with this metric is that two stocks of lake trout, lean and dwarf, are being sampled and seasonal movements may cause some disproportionate catches of one or the other.

Catch rates have been highly variable over the period of record (Figure 13), ranging between 2 and 6 geometric 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 over the last 16 years of record. The increase in catch rate that occurred from 2013 to 2014 was likely a sampling anomaly. The capture rate in 2015 was the lowest in the 17 years of record.

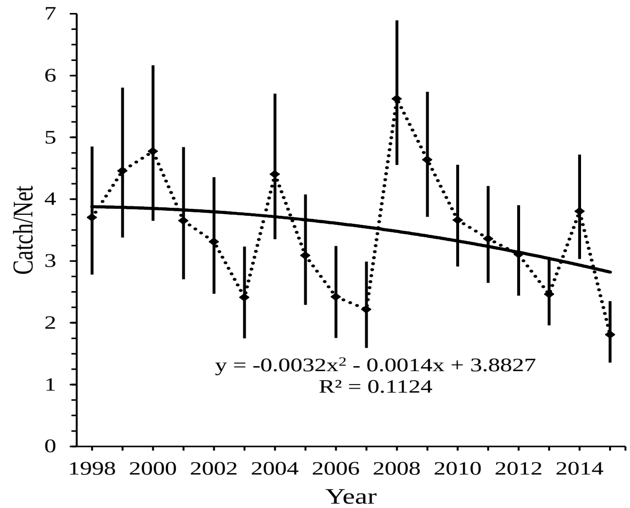

Figure 13. Geometric mean catch rate of all lake trout in stratified random gillnet sampling in Flathead Lake, 1998-2015. The dashed line and equation depict the linear trend through time of geometric mean catch/net during 1998–2015.

5) 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 is when changes in condition result from changes in the density or type of prey base that is available. 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, with an upward trend evident from 2008 to 2014 (Figure 14). A small decline in relative weight was measured in 2015.

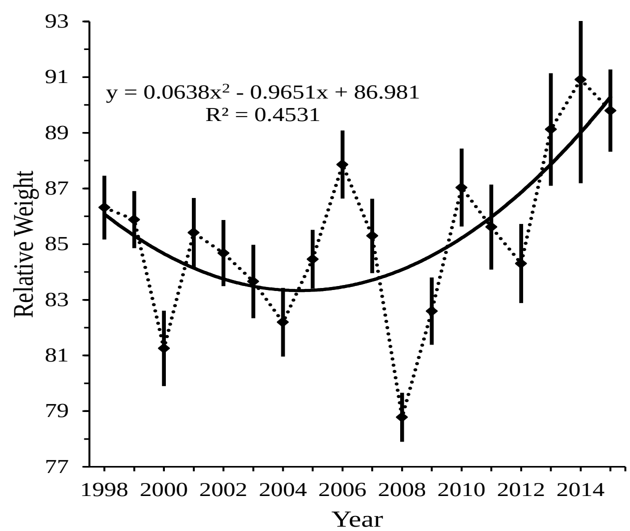

Figure 14. Mean annual relative weight (± 95% confidence limits) of lake trout (N = 5,065; 179–500 per year) caught in standardized-gillnet surveys in Flathead Lake, Montana during 1998–2015. The dashed line and equation depict the nonlinear trend through time of mean annual relative weight from 1998 to 2015.

6) Mortality rate

Mortality rate is measured as the decline in relative abundance of progressively older year classes starting from the youngest year class with full vulnerability to the sampling gear. This metric is derived from lake trout collected in the autumn gillnetting survey which 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.

Mortality rate has been trending upward since 2008 (Figure 15), although small decreases occurred in 2014 and 2015. The degree of change has been relatively small and the variance in the estimates has been large, and therefore it is difficult to conclude whether these are real changes in abundance or measurement error.

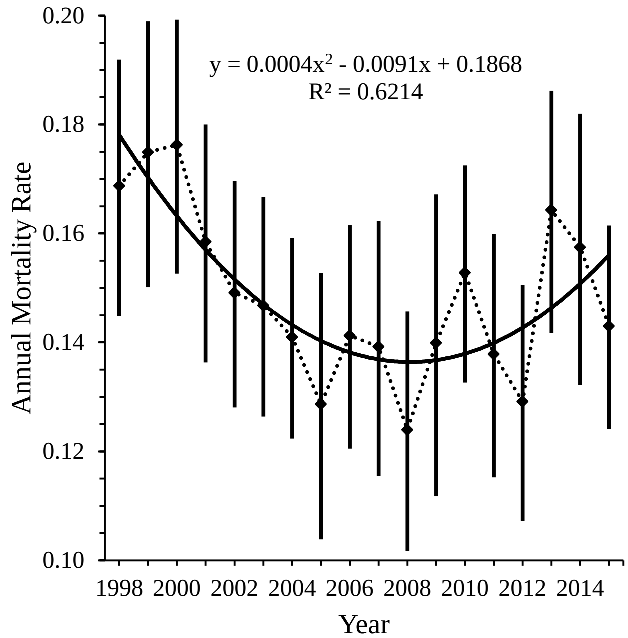

Figure 15. Mean annual mortality (+ 95% confidence limits) estimated from age frequency samples of age-8 and older lake trout caught in standardized-gillnet surveys in Flathead Lake, Montana during 1998–2015. The dashed line and equation depict the nonlinear trend through time of annual mortality from 1998 to 2015.

7) Length at 50% maturity

Maturity is determined by visual examination of gonads and this metric is computed as the length at which half of 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 trended downward since 2006 (Figure 16).

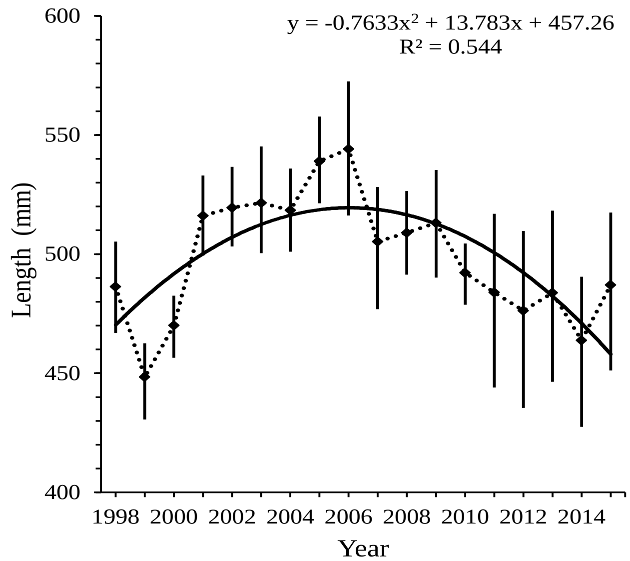

Figure 16. Length at which 50% of lake trout were mature (+ 95% confidence limits) from standardized-gillnet surveys in Flathead Lake, Montana during 1998–2015. The dashed line depicts the nonlinear trend through time in length at 50% maturity.

8) 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. The catch rates of lake trout >500 mm and lake trout ≥750 mm in standardized gillnet surveys are trending downward over the last 10 years, while the catch rate of lake trout in the <300 mm group is trending slightly upward (Figure 17).

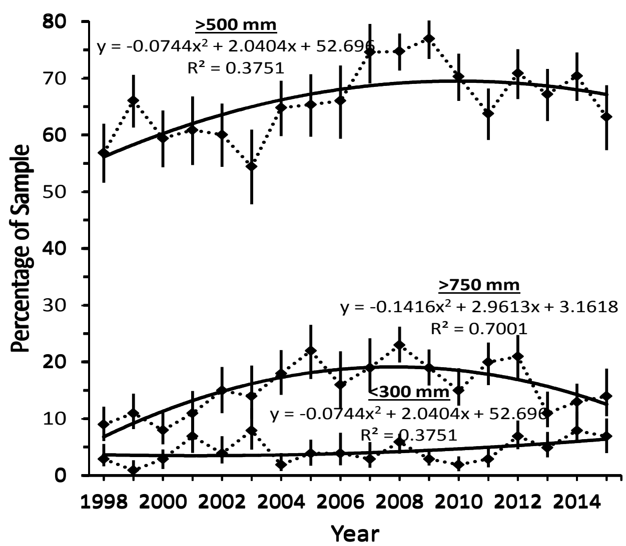

Figure 17. Percent of lake trout <300 mm, >500 mm and >750 mm in standardized-gillnet surveys in Flathead Lake, Montana during 1998–2015. Dashed lines and equations depict nonlinear trends through time in the percent of lake trout <300 mm, >500 mm and >750 mm.

The following three metrics are derived from a subsample of angler-caught lake trout submitted to Mack Days contests, and therefore are not derived 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.

9) ***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 18).

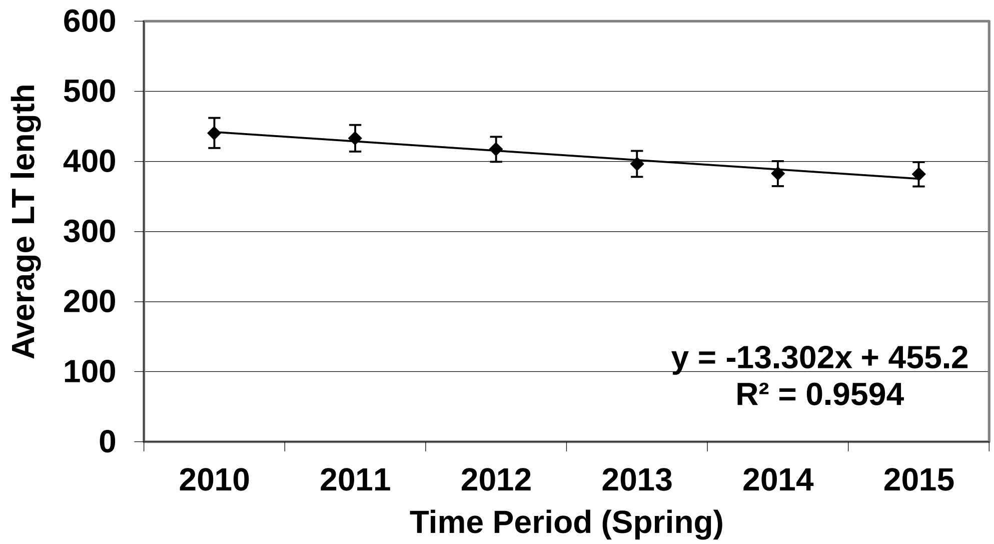

Figure 18. Average lengths of lake trout submitted to the Spring Mack Days contests, 2010-2015.

10) ***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 slightly downward since 2010 (Figure 19).

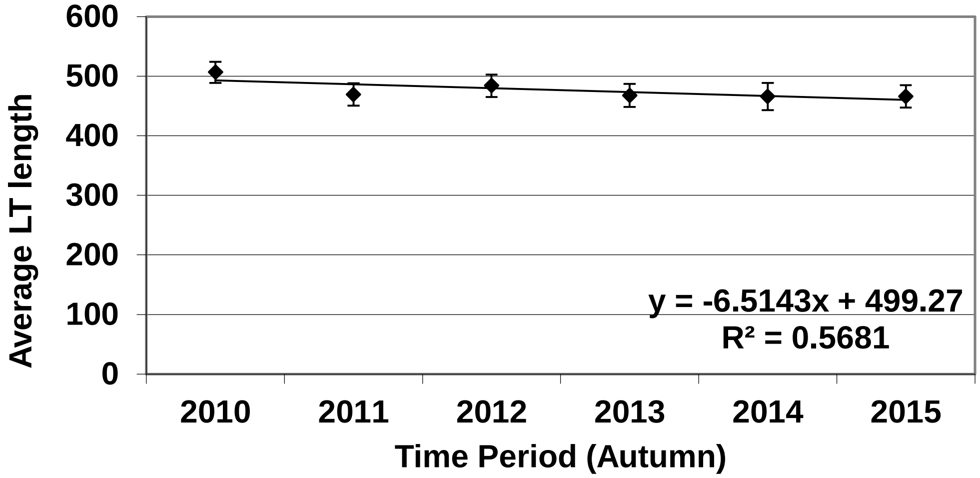

Figure 19. Average lengths of lake trout submitted to the Fall Mack Days contests, 2010-2015.

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 made large investments in gear to increase their competitiveness. One of the most effective new tools is the anchorless boat positioning system with integrated GPS, which most top anglers have been acquiring over the last several years. This tool facilitates pinpoint positioning and allows anglers to spend more time fishing and less time positioning their boats. Many, but not all, of these anglers occupy this category in all six years examined.

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

Catch rates increased from 2010 to 2015 (Figure 20). We consider it more likely that this increase is the result of improvements in angler skills, and in fishing gear, than increases in abundance.

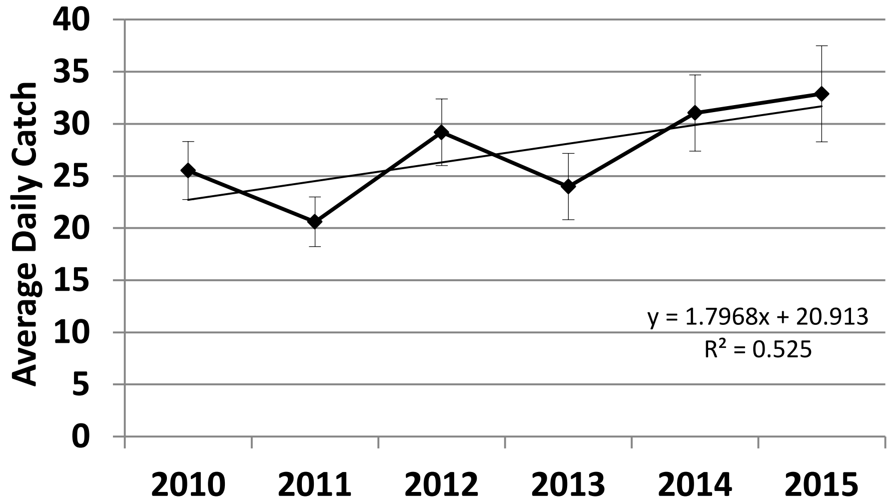

Figure 20. Average daily catch of the "top 25 anglers group" in Spring Mack Days, 2010 to 2015.

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

No clear trend in catch rate exists for Fall Mack Days (Figure 21), and therefore this metric gives no indication of change in abundance.

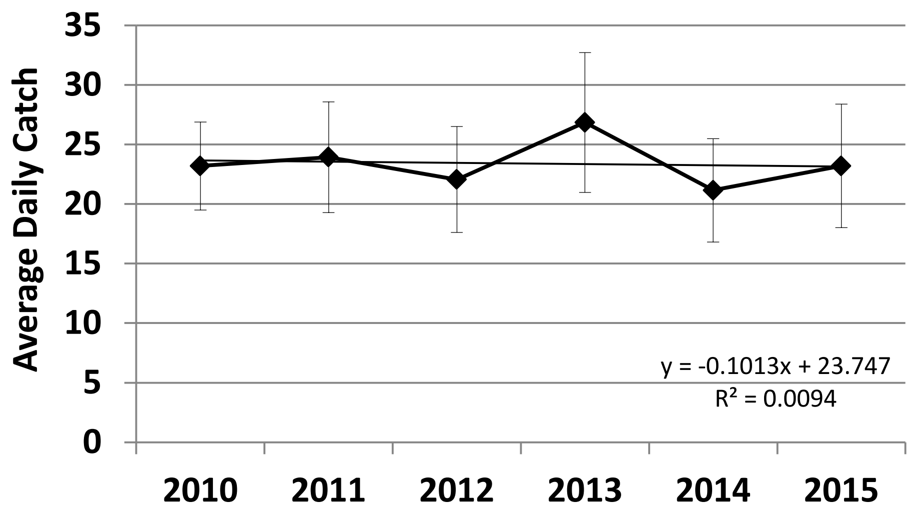

Figure 21. Average daily catch of the "top 25 anglers" group in Fall Mack Days, 2010 to 2015.

Summary conclusion: Are lake trout decreasing?

The 12 metrics used to answer this question do not provide uniformly consistent indications of change in the lake trout population (Table 4). Four metrics (1, 2, 3, and 12) are non-trending, indicating no increase or decrease in abundance over the last decade. One metric (11) is trending upward, suggesting an increase in abundance, although we contend the increase is the result of increasing angler expertise. Seven metrics (4, 5, 6, 7, 8, 9 and 10) are trending downward, indicating a decrease in abundance of lake trout. Collectively, the 12 metrics suggest the early stages of a density-dependent response to exploitation stress. The biological indices, body condition, maturity, mortality and size structure, are most indicative of population change. The abundance indices (mark-recapture estimates or gill-net catch rates) do not 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, primarily among lake trout age 8 and older.

Table 4. Summary of metrics of lake trout abundance and interpretations of their meaning.

Metric	*Direction of Change*	*Value of Metric*	*Comments*
1) Mark/Recapture Spring Population Estimates	No Trend	Moderate	Low precision
2) Mark/Recapture Autumn Population Estimates	No Trend	Moderate	Low precision
3) Catch rates in autumn gillnetting	Downward	High	Low precision
4) Catch rates in spring gillnetting	No Trend	Low	High variability in catches
5) Relative weight	Upward	Moderate	Down in 2015
6) Mortality rate	Upward	High	Ambiguous trend
7) Length at 50% maturity	Downward	Moderate	Potentially biased by two stocks of lake trout
8) Abundance of size groups	Downward for larger sizes	High	Decline in capture of the >500 & >750 mm groups
9) Length of angled lake trout in spring	Downward	Moderate	Small change
10) Length of angled lake trout in autumn	Downward	Moderate	Small change
11) Average catch rate of top 25 anglers in Spring Mack Days	Upward	Moderate	Driven in part by improving angler skill and increasingly effective use of technology
12) Average catch rate of top 25 anglers in Fall Mack Days	No Trend	Moderate	Driven in part by improving angler skill and increasingly effective use of technology

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 CoPlan 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 three of the last eight years it has been monitored. Further in at least one of those three years, fishing for lake whitefish was at peak levels.

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

This metric is generated every other year from mail-in surveys of licensed anglers, although data from 2015 are not currently available. It 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 also influence pressure. Biennial estimates have been variable and are trending neither upward or downward (Figure 22).

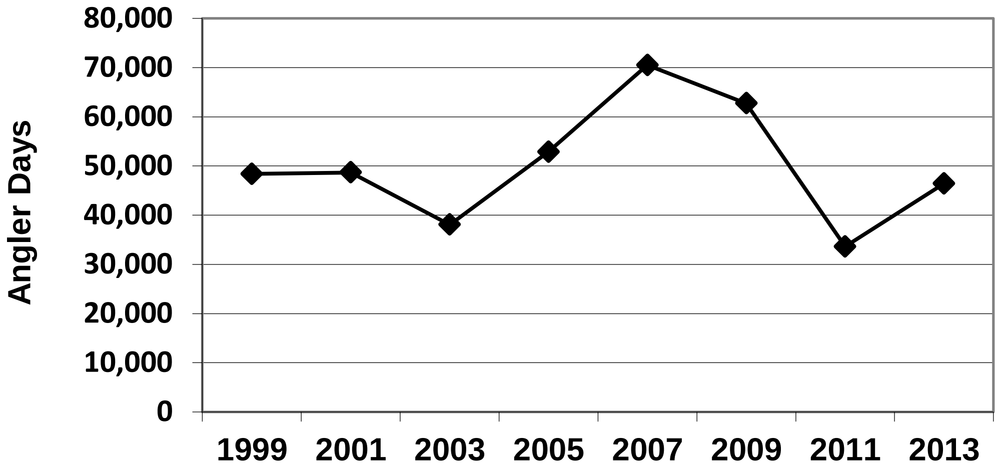

Figure 22. Total angler pressure on Flathead Lake derived from mail-in surveys by MFWP, 1999 to 2013.

b) 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 non-trending, while pressure on the mainstem segment of Flathead River increased substantially since 1995, and decreased over the last two cycles (Figure 23).

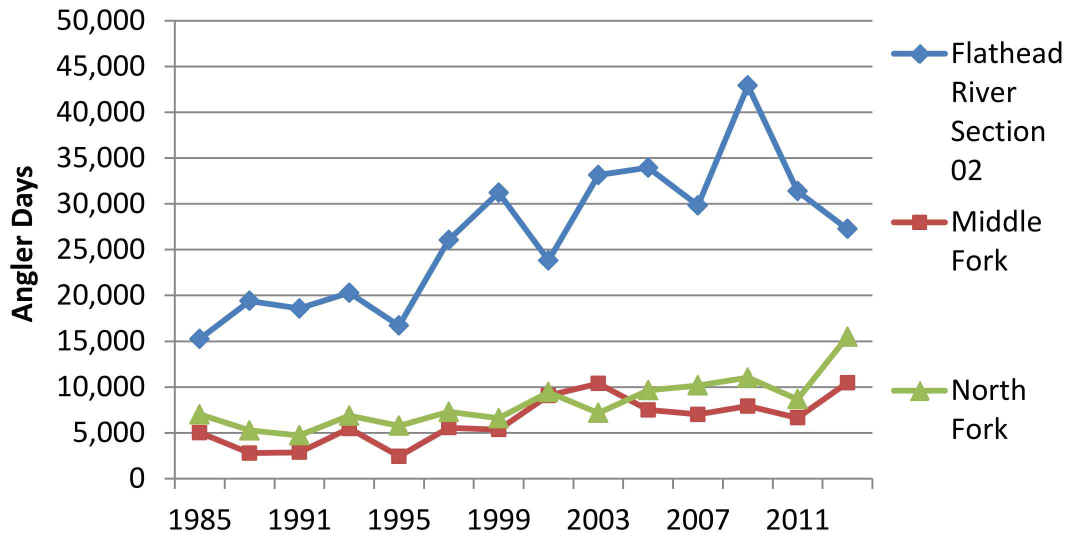

Figure 23. Total angler pressure on segments of the Flathead River system derived from mail-in surveys by MFWP, 1985 to 2013.

c) 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 24). 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 continuing to fish Flathead Lake at other times. Participation in both spring and fall events decreased from 2010 to 2014, but increased slightly in both contests in 2015.

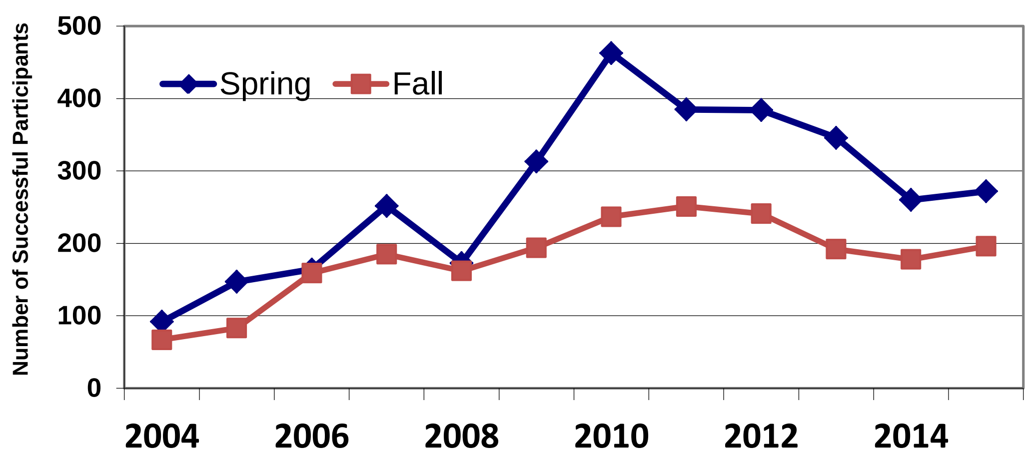

Figure 24. Number of successful participants in the Spring Mack Days (blue) and Fall Mack Days (red), 2004-2015.

Summary conclusion: Is angler activity decreasing?

The two metrics available for evaluating pressure on Flathead Lake do not provide strong evidence to indicate any change in total angler activity (Table 5), although recent data are not yet available. 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. We further conclude from the mail-in survey that 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 5. Summary of metrics of angler activity and interpretations of their meaning.

Metric	Direction of Change	Value of Metric	Comments
1) statewide angler mail-in survey of pressure on Flathead Lake	No Trend	Moderate	Problems with small sample size and recall of anglers
2) statewide angler mail-in survey of pressure on the Flathead River system	Up and down in Mainstem Upward in Forks	Moderate	Problems with small sample size and accuracy of recall of anglers
3) participation in fishing contests	Downward since 2010, but up in 2015	High	Non-biological factors also influence participation

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 lake whitefish, and increases in *Mysis* that could cause cascading ecological changes.

a) Is bycatch of bull trout too high?

Bycatch of bull trout impedes progress toward the goal of increasing bull trout numbers. 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 113 bull trout mortalities from Mack Days and 40 mortalities from gillnetting.

The largest source of known mortality of bull trout occurs during Mack Days contests and is the result of anglers mistaking bull trout as lake trout. In 2015 anglers submitted 10 bull trout to the contests, mistakenly thinking they were lake trout (Table 6). 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 2015 contests of 1128 bull trout (21 bull trout for every 1,000 lake trout caught based on previous creel surveys). Of those, we estimate that 5%, or 56 die from hooking and handling injures. In addition, 12 bull trout were caught in the 68 nets set in 2015, eight of which died. Therefore total bull trout mortality, known and estimated that we attribute to suppression, was 74 (56 post-release from angling, 10 mistaken identity from angling, and 8 from netting).

Table 6. Bull trout mistaken for lake trout and submitted in Mack Days contests, 2010 to 2015.

Year	Annual Harvest	Spring Mack Days	Fall Mack Days	Total Known Bull Trout Mortalities	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

The total known and estimated mortality of bull trout is 79 fewer than the 153 allowed in the Recovery Permit. Nearly all of the known mortalities are juvenile or subadult individuals (Figure 25). Additionally, we estimate that 25% of the Mack Days bycatch 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 66 (42 post-release from angling, 8 mistaken identify from angling, and 8 from netting). We asume that the loss of 66 subadult and juvenile bull trout is unlikely to cause a decline in the Flathead metapopulation of bull trout.

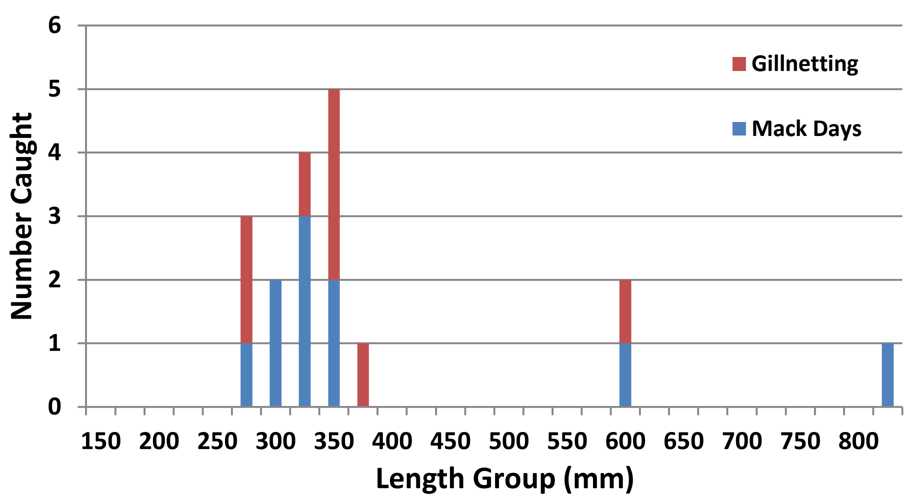

Figure 25. Length frequency distribution of known bull trout mortalities from Mack Days contests (blue) and live captures in gillnets and released (red), 2015.

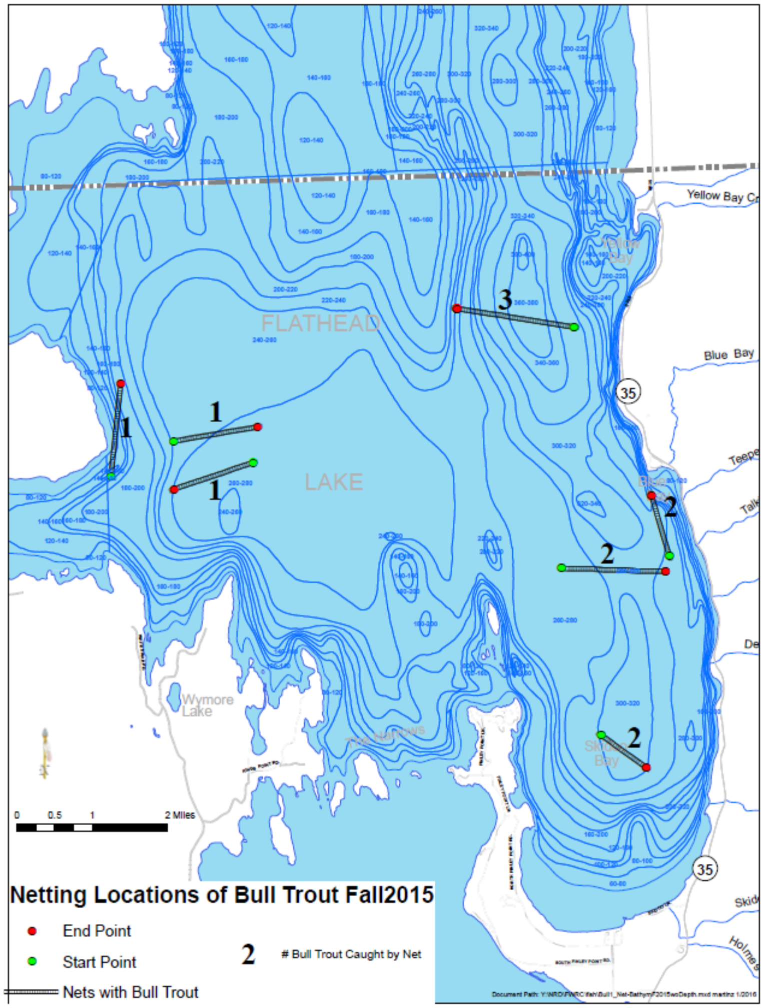

Figure 26. Locations, depths and numbers of bull trout were captured in nets during 2015.

b) Is bycatch of lake whitefish too high?

CSKT set a total of 405,900 ft of suppression gillnets in 68 locations during 2015, resulting in a bycatch of 5,902 lake whitefish, or less than one percent of estimated standing stock. Both spring and fall gillnetting surveys indicate declines in catch rates of lake whitefish since 2004 (Figures 27 and 28). 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 resiliency and high fecundity. We therefore conclude that if lake whitefish have declined since 2004, that factors other than suppression or general angling are the cause. Additional monitoring of these metrics is important to evaluate the validity of the apparent trends.

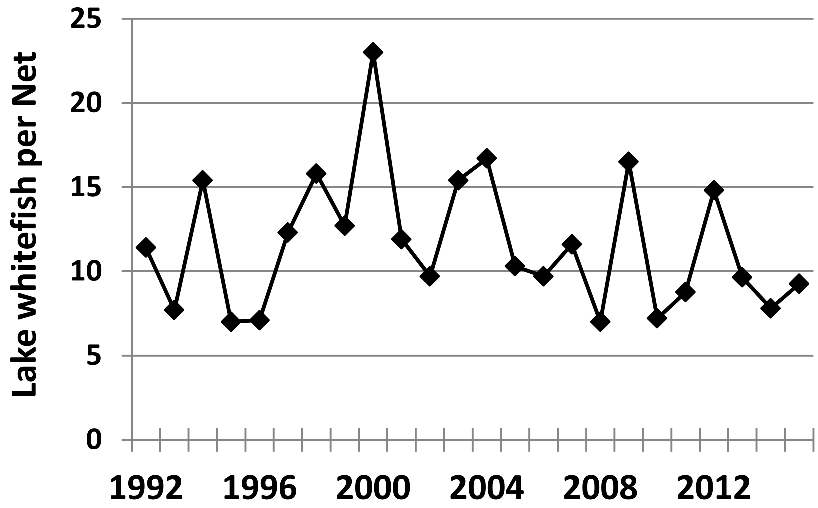

Figure 27. Average annual catches of lake whitefish in 30 standardized gillnets set in spring, 1992 to 2015 (data from MFWP).

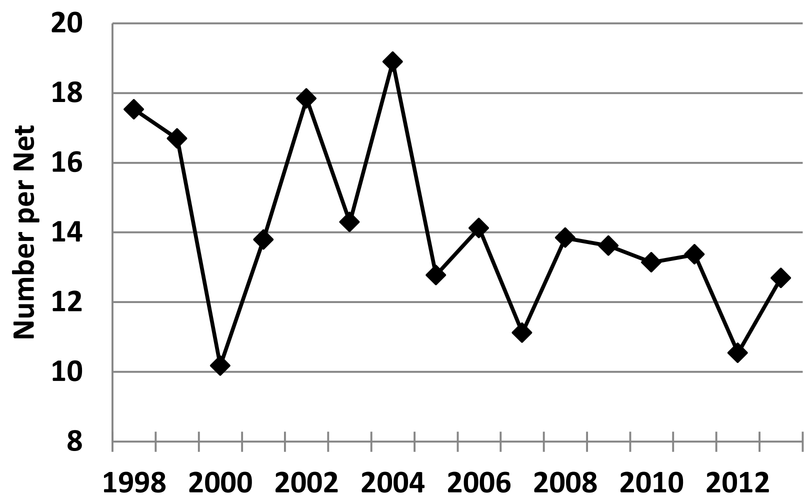

Figure 28. Average annual catches of lake whitefish in stratified random gillnets (from 48 to 94 nets) set in autumn, 1998 to 2015.

c) 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.

An increasing trend in Mysis density is evident from 2004 to present (Figure 29), although data are not yet available for 2015. Despite substantial variability in the data, the upward trend is convincing. None of the indices of lake trout abundance suggest a decline to be sufficient in extent or duration to explain the upward trend in Mysis density.

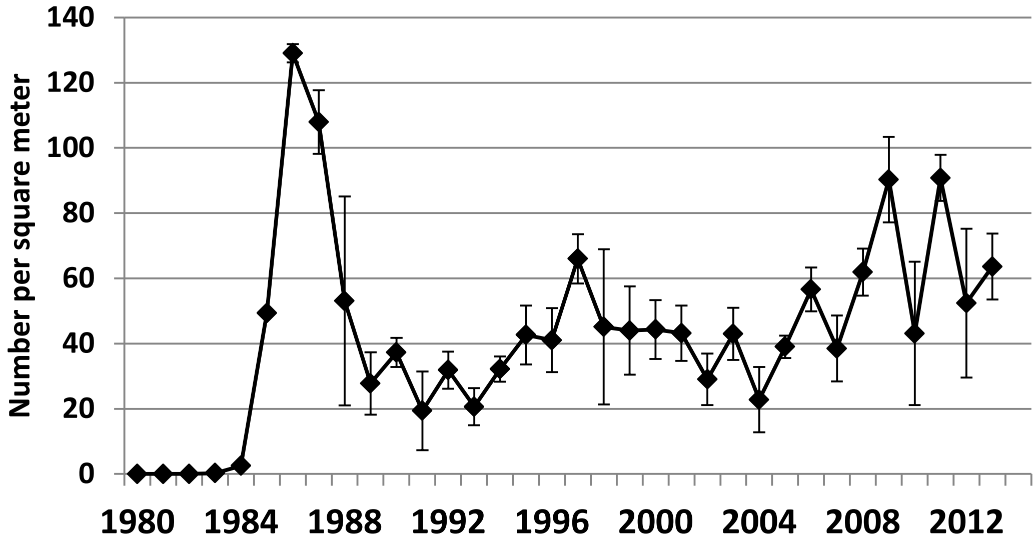

Figure 29. Number of Mysis diluviana per square meter averaged across 40 sampling locations in Flathead Lake, 1980 to 2014 (data from Flathead Lake Biological Station).

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 (Figure 30) and weight per liter of Chlorophyll a (Figure 31).

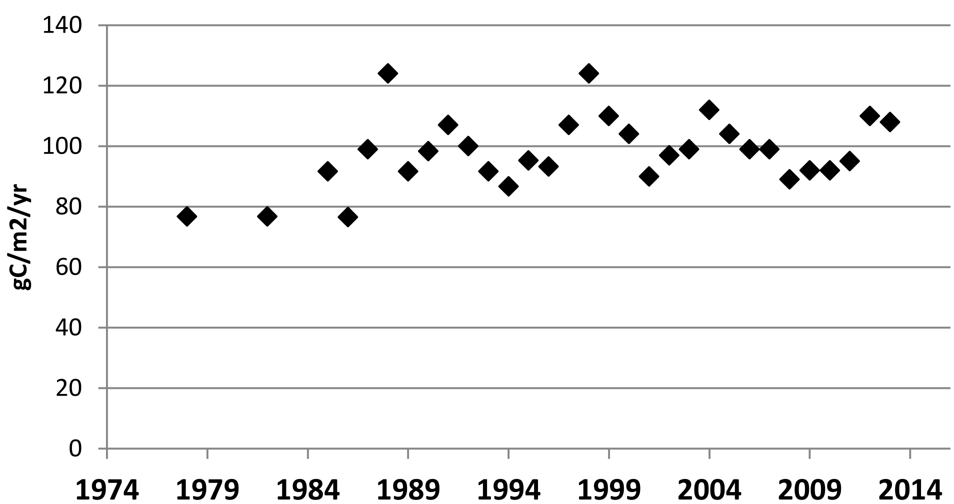

Figure 30. Average annual primary productivity (gC/m2/yr) in Flathead Lake, 1978-2013 (data from Flathead Lake Biological Station).

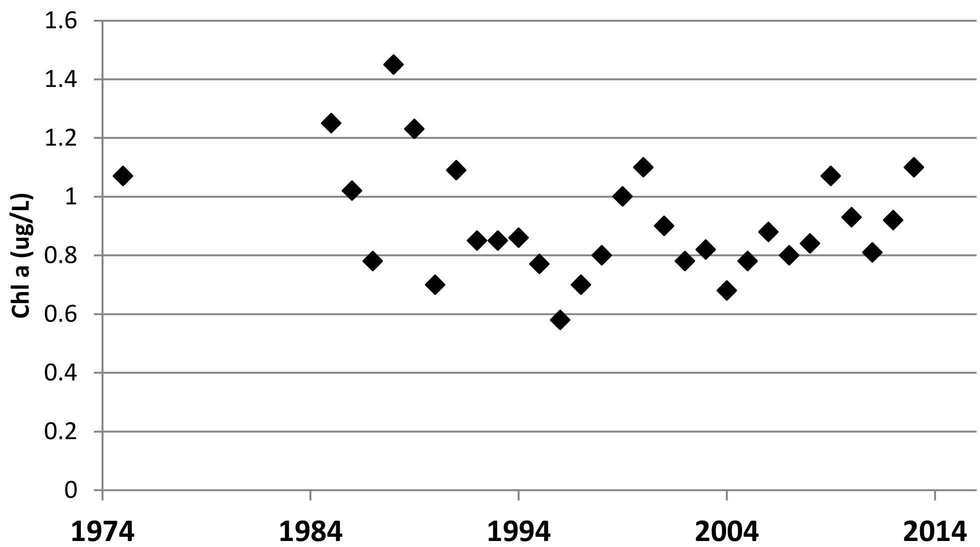

Figure 31. Chlorophyll a (ug/L) in Flathead Lake, 1978-2013 (data from Flathead Lake Biological Station).

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

We assume that it is too early in the suppression process, and the scale of harvest is too small to reasonably expect to identify unintended consequences. Nonetheless, we evaluated three metrics to determine if early signs of suppression are evident. Regarding bycatch, the incidental mortality of both bull trout and lake whitefish has been very small, and therefore bycatch is extremely unlikely to have measurably affected their abundance.

An increase in *Mysis* since 2004 is apparent, but is unlikely attributable to changes in lake trout abundance. In summary, we conclude there is no discernible evidence of unintended consequences at this time.

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 very small, especially relative to their population size. Increases in *Mysis* abundance are noteworthy, but well below levels present in 1986, and we cannot attribute those increases to decreases in lake trout abundance at this time.

6) Based on the results of the first five questions; What is the best lake trout harvest target for 2016?

The third year of expanded suppression will continue to be constrained by ongoing efforts to expand the program and build infrastructure, and therefore the harvest target is more the result of practical considerations than what is "best". The primary objective is to exceed the harvest achieved in 2015. We project harvest for 2016 based on use of similar equipment as employed in 2015, but with an increase in personnel by about 15%. Mack Days contests will be conducted as they were in 2015 because we think we have arrived at the optimal format leaving no additional opportunity for cost-effectively increasing harvest. We will attempt to increase netting effort from 50 days expended in 2015 to 70 days in 2016, and likely increase harvest by at least 6,000 fish. We project therefore that it is feasible in 2016 to harvest 104,000 lake trout (Table 9).

Table 9. Methods of suppression, harvest achieved in 2015, harvest projected for 2016, and projected bull trout and lake whitefish bycatch for 2016.

Method	Lake Trout Harvest 2015	Projected Lake Trout Harvest Target for 2016	Projected Bull Trout Bycatch / Mortality	Projected Lake Whitefish Bycatch
General Recreational Angling	25,000 (Estimated)	25,000 (Estimated)	525/57	Small
Spring Mack Days	34,179	34,000	714/36	0
Spring Gillnetting	12,406	22,000	<5/1	7,500
Fall Mack Days	19,525	18,000	378/19	0
Fall Gillnetting	5,367	5,000	<15/5	5,000
Total	96,477	104,000	1,635/61	12,500