2013

Executive Summary

Draft Environmental Impact Statement

Proposed Strategies to Benefit Native Species by Reducing the Abundance of Lake Trout

Flathead Lake, Montana

Bureau of Indian Affairs
Confederated Salish and Kootenai Tribes

QUICK FACTS

What is the proposed action?

The proposed action would benefit native fish by reducing the population of non-native lake trout in Flathead Lake using a combination of fisheries population-management tools, including angling and netting. In this context, reducing the population of lake trout means that we would remove enough individuals to exceed lake trout recruitment (the increase in the population that occurs through natural reproduction) to achieve one of three target lake trout population sizes. We define benefits to native trout as increasing the population sizes of bull trout and westslope cutthroat trout to levels that could ultimately sustain harvest.

What is this document?

This is the Executive Summary of the Draft Environmental Impact Statement (EIS). It summarizes the major elements of the full Draft EIS, including the purpose and need for the proposed action, the alternatives, the affected environment, and the environmental consequences and potential cumulative effects.

Where can I get a copy of the Draft EIS?

An electronic version of the full Draft EIS and all appendices can be found on the following websites: www.mackdays.com/deis and www.flatheadlakeeis.net. Additionally, you can request a free CD-ROM by submitting a request to barry@cskt.org, or calling (406) 883-2888 ext. 7282. You can also review a printed copy at local libraries in Polson, Ronan, Kalispell, and Missoula.

How can I comment?

You can comment via regular mail, email, or online. All comments must be submitted by August 9, 2013. Send or email your comments to:

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Fisheries Program Manager
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Natural Resources Department
P.O. Box 278, Pablo, Montana 59855
(406) 883-2888
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(When emailling, please put "Flathead Lake DEIS comment" in the subject line.)

Submit online comments by clicking on the DEIS tab in the top menu of the mackdays.com website and then following the links or by clicking on the comment button on the flatheadlakeeis.net website.

Executive Summary

This Executive Summary briefly describes the contents of the Draft Environmental Impact Statement (DEIS) *Proposed Strategies to Benefit Native Species by Reducing the Abundance of Lake Trout, Flathead Lake, Montana*. The discussion of topics is brief, so we encourage readers to use the links to the Draft EIS and its appendices to explore specific topics in greater detail. Underlined blue text indicates a link. To improve the readability and conciseness of this executive summary, we have omitted citations, but they are included in the full DEIS and can be seen by clicking on the links that take you to the relevent parts of the DEIS.

What is the Proposed Action?

The project would benefit native fish by reducing the population of non-native and predacious lake trout in Flathead Lake (Figure 1) using a combination of fisheries population-management tools, including angling and netting. Reducing the population of lake trout means we would annually remove more individuals than are naturally reproduced to achieve a smaller lake trout population size. Fewer lake trout would mean reduced predation on native trout and other species. Following the successful completion of the NEPA process, the likely start date for the project would be late 2013. Project activities could then occur year-round indefinitely into the future if the program achieves its objectives based on annual assessments and adaptive changes.

Figure 1. The Project Area is Flathead Lake.

What is the Purpose of the Project?

The purpose of the action is to benefit native fish by reducing the population of non-native lake trout in Flathead Lake. The need for the action is based on over two decades of continuous regional research, management, and planning between Tribal, State, and Federal agencies. Each of our guiding documents stresses the critical importance of native species and the necessity to control non-native competitors such as lake trout. The action would play a key part in achieving several of the goals and objectives of these plans and policies, including those of the Flathead Lake and River Fisheries Co-Management Plan (Co-Management Plan) that have not been achieved to date:

Goals
- Increase and protect native trout populations (bull trout and westslope cutthroat trout).
- Balance trade-offs between native species conservation and nonnative species reduction to maintain a viable recreational/subsistence fishery.
- Protect the high quality water and habitat characteristics of Flathead Lake and its watershed.

Objectives
- Increase and protect native trout populations to at least secure levels.
- Maintain, or if needed, increase harvest of non-native fish to benefit native fish species.

- Provide a recreational fishery based on non-native and native fish, with harvest opportunities based primarily on non-native fish.

Strategies

5A: Suppress non-native fish through recreational angling.

5B. Increase suppression of nonnative fish if necessary through commercial harvest techniques.

5C. Implement agency management actions if necessary to reduce non-native fish.

What Studies and Plans Preceded the Draft EIS?

Research, joint planning efforts, and decision-making processes that direct us to control non-native competitors are described in our guidance documents (Appendix 1). We developed a bioenergetics model to quantify the trophic (food and nutrition) interactions of lake trout with the other species within Flathead Lake (Appendix 4). Changes in the age and size structure of the lake trout population in response to increasing harvest were drawn from an age-structured stochastic simulation model (Appendix 6). Changes in catch rates relative to abundance of lake trout were drawn from a model developed from lake trout populations in Ontario, Canada.

Why is the Project Needed

Current trends indicate that the implementation of the Co-Management Plan has not decreased lake trout numbers and has not increased bull trout numbers. Further, research indicates that bull trout and westslope cutthroat trout declines are the result of lake trout increases, which have cascaded through the Flathead Lake foodweb (Figures 2 through 4). In addition, bull trout were listed as a Threatened species under the Endangered Species Act in 1998. Because increases in the lake trout population have put native trout at risk, there is a need to reduce the risk through the implemenation of management actions or strategies set forth in the Co-Management Plan.

The Co-Management Plan identifies fish population management actions in Strategy 5 as follows: (A) Suppress nonnative fish through recreational angling; (B) Increase suppression of nonnative fish if necessary through commercial harvest techniques; and (C) Implement agency management actions if necessary to reduce nonnative fish. Because moving beyond Strategy 5A was controversial at the time, the management agencies made a commitment to public scoping should it be necessary to achieve the plan's goals. This document fulfills that specific need and commitment. In addition to this basic need, the DEIS affords decision makers the information they need to make a fully informed decision.

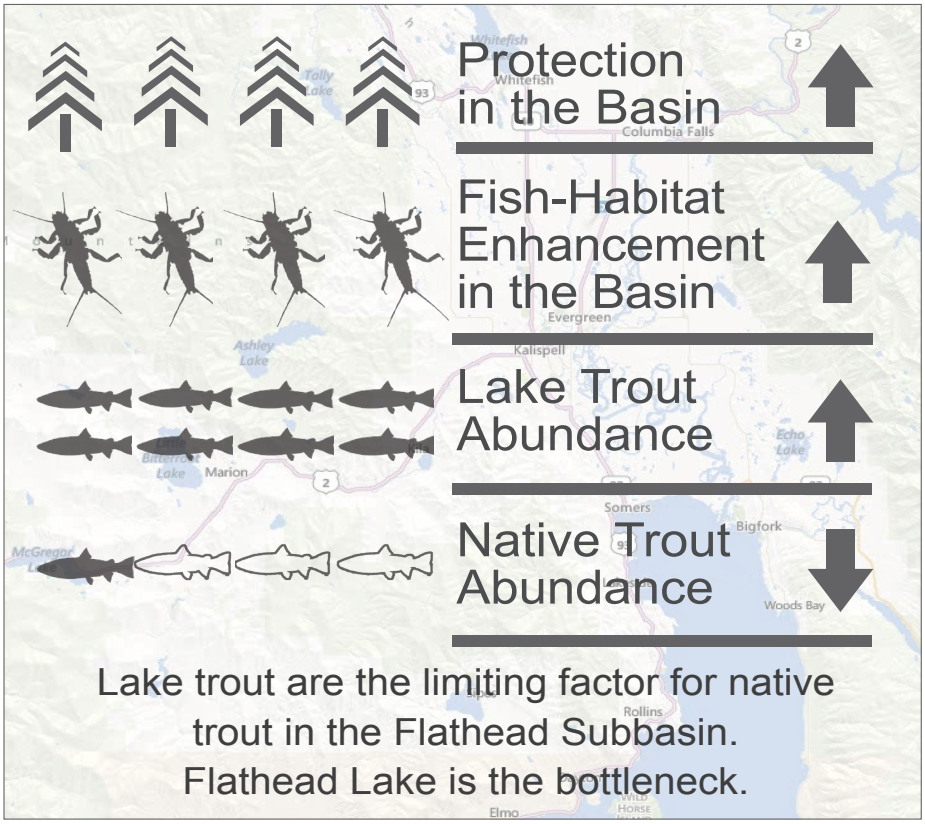

Figure 2. The project is needed because lake trout are the limiting factor for bull trout in the Flathead system.

How has the Public been Involved in the EIS Process?

The analysis of the proposed action began as an Environmental Assessment (EA), during which time we held a series of scoping meetings advertised on radio and in local newspapers. Meetings were held in Polson (April 12, 2010), Kalispell

(April 13, 2010), and Missoula (April 14, 2010). Comments from these scoping sessions are included in Appendix 3. Based on the level of public interest and the indefinite duration of the project, we decided to prepare an Environmental Impact Statement (EIS). Because the scope of the project did not change since the inception of the process, the scoping conducted during the EA applies to the EIS. The Notice of Intent (NOI) to prepare an EIS was published in the Federal Register on June 5, 2012. The NOI solicited for additional public comment on the proposal from June 5, 2012 to July 5, 2012.

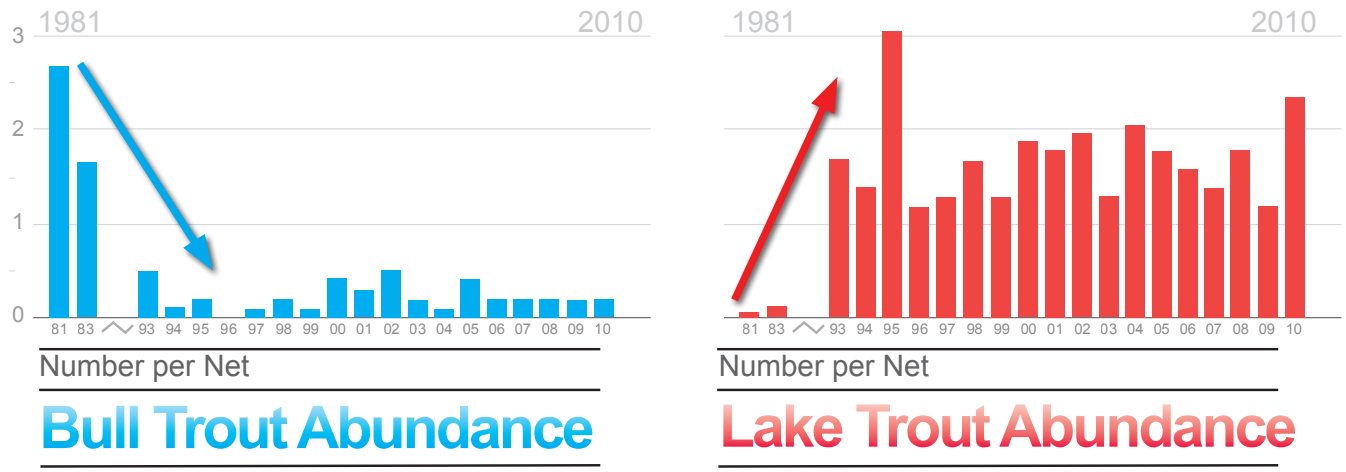

Figure 3. The relative abundances of bull trout and lake trout have reversed. Bull trout have dropped off precipitously while lake trout have increased just as dramatically (data from MFWP). (Sloped lines represent trends and are not regression lines.)

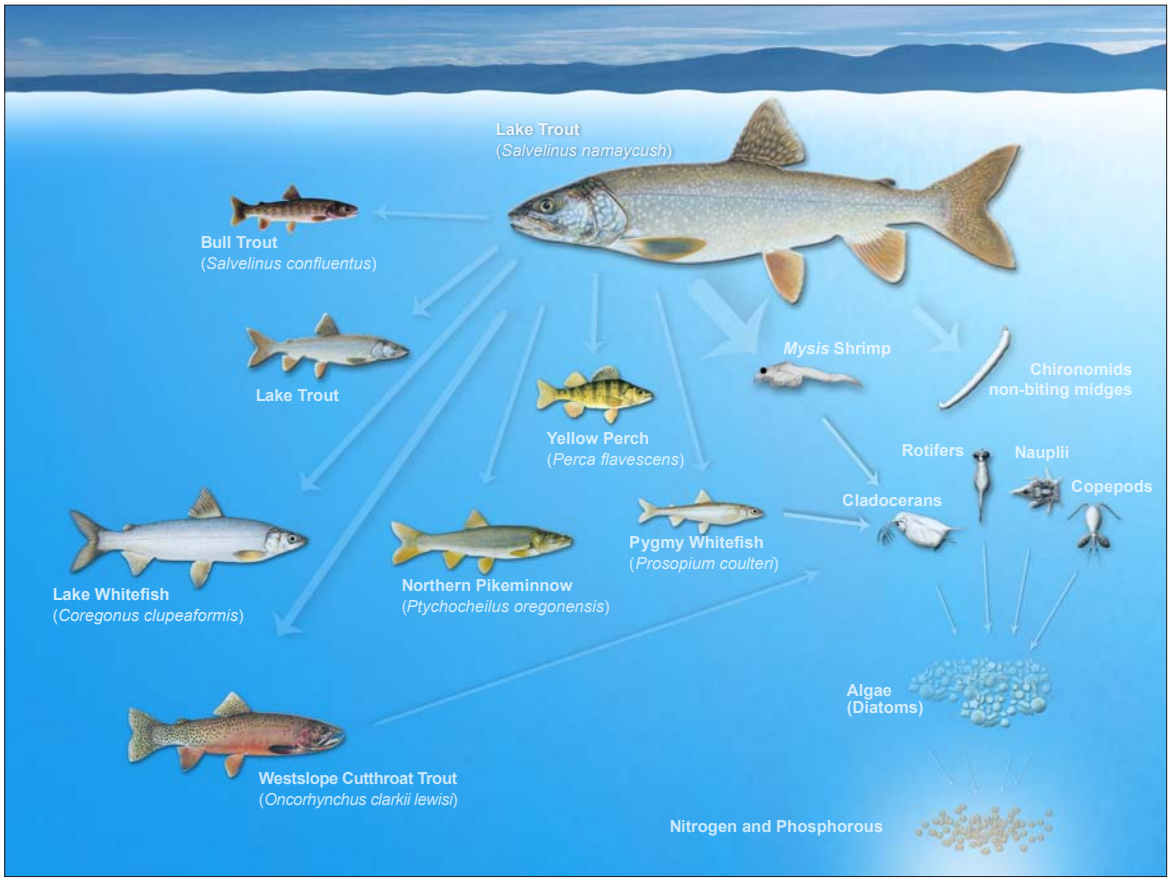

Figure 4. Simplified depiction of the Flathead Lake food web (fish illustrations by Joseph Tomelleri). Organism size does not represent abundance or relative portion of the lake trout diet.

What Significant Issues were Identified during Scoping and the Comment Period?

The public scoping process and comments received (including both significant issues and issues deemed not significant) are detailed here in the Draft EIS. See Appendix 3 for the complete list of comments and responses. The public scoping identified the following significant issues:

Issue 1: Biological and Ecological Effects of the Proposed Action

Management actions that remove lake trout, the top predator in Flathead Lake, would change the abundance and size structure of the lake trout population. In turn, all the species lake trout prey on, especially bull trout and west-slope cutthroat trout, would respond to some degree.

Issue 2: Fishing Opportunity

Many commenters expressed a desire to continue to be able to catch large numbers of lake trout and large-sized lake trout and said that having easy fishing was important for youngsters. Issue 2 includes the level of overall sport-fishing, lake trout fishing, the potential to fish for native species, and maintaining a trophy fishery for lake trout.

Issue 3: Fishing Economy

Management actions that make lake trout become more difficult to catch, could reduce angling activity and the income of local fishing businesses. Conversely, businesses could be enhanced by recreationists or anglers who want to fish for or see native species or who respond to potentially improved opportunities for yellow perch and lake whitefish.

The Alternatives

No Action Alternative: Alternative A

Alternative A is the “No Action” alternative, which means continuation of the status quo actions rather than that no actions of any kind would be taken. Specifically, Alternative A would continue the general harvest using current fishing regulations for lake trout in Flathead Lake (the slot restriction would be maintained) and continue the fishing contests known as Mack Days using the 2012 regulations.

Action Alternatives: Alternatives B - D

The Action Alternatives would reduce the population of adult lake trout (age 8 and older) relative to the 2010 levels by the following percentages: Alternative B, 25%; Alternative C, 50%; and Alternative D, 75%. All three would continue the general harvest, change the regulations to make it legal to keep lake trout from 30 to 36 inches long, continue Mack Days, and if necessary use a mix of tools such as bounties, commercial fishing, targeted gillnets and trapnets to reach and maintain their respective reductions in adult lake trout numbers. Lakewide bounties would be dependant on legislative approval.

Alternatives considered but eliminated from detailed study are here in the DEIS, and mitigation measures common to all alternatives are detailed here. Table 1 summarizes the expected effects of each alternative.

Table 1 (part 1). Summary of Predicted Effects of each alternative over the long term.

Indicator 1: Biological and ecological effects of the proposed action on fish populations over the long term									
Alt	Lake Trout			Bull Trout			Westslope Cutthroat Trout		
	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative
A	• No change in Age 8+lake trout	• 50% decrease in Age 22+lake trout from starting conditions after 50 years. • Increased growth rate, condition and decreased age at maturity.	• Dispersal beyond Flathead Lake most likely. • Possible increased competition from non-native fish and invertebrates.	• Bycatch of 163 bull trout and short-term risk of decrease in population size. • 37% reduction in losses from predation over the long term.	• Potential long-term increase of 1,875 adults.	• Additional stress from climate change and non-native competitors and predators.	• Negligible bycatch. • Moderate reduction in losses from predation by lake trout.	• Small long-term increase of population size.	• Additional stress from climate change and non-native competitors.
B	• 25% reduction in age 8+ after 50 years	• 78% decrease in Age 22+lake trout from starting conditions after 50 years. • Increased growth rate, condition and decreased age at maturity.	• Dispersal beyond Flathead Lake less likely than Alt A. • Possible increased competition from non-native fish and invertebrates.	• Bycatch of 221 bull trout and short-term risk of decrease in population size. • 65% reduction in losses from predation.	• Potential long-term increase of 3,274 adults.	• Additional stress from climate change and non-native competitors and predators.	• Negligible bycatch. • 58% reduction in losses from predation by lake trout over the long term.	• Moderate long-term increase of population size; greater than Alt. A.	• Additional stress from climate change and non-native competitors.
C	• 50% reduction in age 8+ after 50 years	• 92% decrease in Age 22+lake trout from starting conditions after 50 years. • Increased growth rate, condition and decreased age at maturity.	• Dispersal beyond Flathead Lake less likely than Alt A and B. • Possible increased competition from non-native fish and invertebrates.	• Bycatch of 338 bull trout and short-term risk of decrease in population size. • 84% reduction in losses from predation.	• Potential long-term increase of 4,184 adults.	• Additional stress from climate change and non-native competitors and predators.	• Negligible bycatch. • 77% reduction in losses from predation by lake trout over the long term.	• Moderate long-term increase of population size; greater than Alt. A and B.	• Additional stress from climate change and non-native competitors.
D	• 75% reduction in age 8+ after 50 years	• 98% decrease in Age 22+lake trout from starting conditions after 50 years. • Increased growth rate, condition and decreased age at maturity.	• Dispersal beyond Flathead Lake less likely than Alt A, B, and C. • Possible increased competition from non-native fish and invertebrates.	• Bycatch of 467 bull trout and short-term risk of decrease in population size. • 93% reduction in losses from predation.	• Potential long-term increase of 4,650 adults.	• Additional stress from climate change and non-native competitors and predators.	• Negligible bycatch. • 91% reduction in losses from predation by lake trout over the long term.	• Large long-term increase of population size; greater than Alt. A, B and C.	• Additional stress from climate change and non-native competitors.

Table 1 (part 2). Summary of Predicted Effects of each alternative.

Indicator 1 (cont.): Biological and ecological effects of the proposed action on fish populations over the long term						
Alt	Lake Whitefish			Mysis and other Invertebrates		
	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative
A	• Negligible Bycatch. • Moderate reduction in losses from predation by lake trout.	• Small long-term increase in population size.	• Additional stress from climate change and non-native competitors.	• Small increase in losses from predation by lake trout.	• Decrease to 34/m^2	• Additional stress from climate change and non-native competitors.
B	• Bycatch of 35,000 lake whitefish. • 60% reduction in losses from predation by lake trout.	• No measurable change in population size.	• Additional stress from climate change and non-native competitors.	• Moderate increase in losses from predation by lake trout.	• Increase to 51/m^2	• Additional stress from climate change and non-native competitors.
C	• Bycatch of 105,000 lake whitefish. • 79% reduction in losses from predation by lake trout.	• No measurable change in population size.	• Additional stress from climate change and non-native competitors.	• Moderate increase in losses from predation by lake trout.	• Increase to 81/m^2	• Additional stress from climate change and non-native competitors.
D	• Bycatch of 182,500 lake whitefish. • 88% reduction in losses from predation by lake trout.	• No measurable change in population size.	• Additional stress from climate change and non-native competitors.	• Moderate increase in losses from predation by lake trout.	• Increase to 130/m^2	• Additional stress from climate change and non-native competitors.

Indicator 2: Fishing opportunity—average catch rates over the long term									
Alt	Lake Trout			Bull Trout			Westslope Cutthroat Trout		
	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative
A	• No change 0.59 / hr.	• Reduced opportunity for large fish.	• None	• Low opportunity, currently unquantified.	• None	• Climate change and non-natives may reduce catch rates	• Low opportunity, currently unquantified	• None	• Climate change and non-natives may reduce catch rates
B	• Decrease to 0.54 / hr.	• Moderately reduced opportunity for large fish.	• Improved angler expertise from education	• Slightly greater opportunity than A.	• Improved catch rates in river	• Climate change and non-natives may reduce catch rates	• Slightly greater opportunity than A	• Improved catch rates in river	• Climate change and non-natives may reduce catch rates
C	• Decrease to 0.47 / hr.	• Greatly reduced opportunity for large fish.	• Improved angler expertise from education.	• Moderately greater opportunity than A.	• Improved catch rates in river; greater than Alt. B.	• Climate change and non-natives may reduce catch rates	• Moderately greater opportunity than A	• Improved catch rates in river; greater than Alt. B	• Climate change and non-natives may reduce catch rates
D	• Decrease to 0.34 / hr.	• Greatly reduced opportunity for large fish.	• Improved angler expertise from education.	• Moderately greater opportunity than A.	• Improved catch rates in river; greater than Alt. B and C.	• Climate change and non-natives may reduce catch rates	• Moderately greater opportunity than A	• Improved catch rates in river; greater than Alt. B & C	• Climate change and non-natives may reduce catch rates

Table 1 (part 3). Summary of Predicted Effects of each alternative.

Indicator 2 (cont.): Fishing opportunity—average catch rates over the long term			
Alt	Lake Whitefish		
	Direct	Indirect	Cumulative
A	• High during specific periods.	• Changes in perch may change catch rates.	• Climate change and other non-natives may affect catch rates.
B	• No change.	• Changes in perch may change catch rates.	• Climate change and other non-natives may affect catch rates.
C	• No change.	• Changes in perch may change catch rates.	• Climate change and other non-natives may affect catch rates.
D	• No change.	• Changes in perch may change catch rates.	• Climate change and other non-natives may affect catch rates.

Indicator 3: Fishing Economy									
Alt	Angler Days			Effects on the Economy			Cost to Implement the Action		
	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative
A	• Flathead Lake: unlikely to change.	• Flathead River system: unlikely to change.	• Many factors affect angler visits to Flathead Lake and insulate the economy from changes in angling.	• Total annual angler spending of $20,108,000.	• Continued fishing for other species and in other water bodies	• Future economic and social changes are likely. Climate change affects unknown.	• $350,000	• Future changes in wages, fuel, etc.	• Future economic changes could inflate costs.
B	• Flathead Lake: comparable number of lake trout fishing days as Alt. A.	• Flathead River system: slightly more fishing days than Alt. A.	• Many factors affect angler visits to Flathead Lake and insulate the economy from changes in angling.	• 5.3% reduction in angler spending on lake trout fishing.	• Unquantified increase in fishing for other species and in other water bodies	• Future economic and social changes are likely. Climate change affects unknown.	• $462,000	• Future changes in wages, fuel, etc.	• Future economic changes could inflate costs.
C	• Flathead Lake: moderately fewer lake trout fishing days than Alt. A.	• Flathead River system: slightly more fishing days than Alt. A.	• Many factors affect angler visits to Flathead Lake and insulate the economy from changes in angling.	• 8.2% reduction in angler spending on lake trout fishing.	• Unquantified increase in fishing for other species and in other water bodies	• Future economic and social changes are likely. Climate change affects unknown.	• $686,000	• Future changes in wages, fuel, etc.	• Future economic changes could inflate costs.
D	• Flathead Lake: much fewer lake trout fishing days than Alt. A.	• Flathead River system: moderately more fishing days than Alt. A.	• Many factors affect angler visits to Flathead Lake and insulate the economy from changes in angling.	• 11.6% reduction in angler spending on lake trout fishing.	• Unquantified increase in fishing for other species and in other water bodies	• Future economic and social changes are likely. Climate change affects unknown.	• $934,000	• Future changes in wages, fuel, etc.	• Future economic changes could inflate costs.

The Affected Environment and Environmental Consequences

Lake Trout

Affected Environment

Lake trout were introduced into Flathead Lake in 1905. The population grew slowly for the first 50 years because of poor juvenile survival, the result of low prey abundance and cannibalizing of juveniles by adults. After the invasion of *Mysis*, juvenile lake trout survival increased, greatly expanding the population. It has now stabilized at near carrying capacity. Lake trout density in the lake is high relative to other lake trout lakes in North America. The number harvested by anglers is also high but sustainable because of Flathead Lake's high productivity. The exploitation rate is very low despite the high harvest per acre because the population is so large. Some studied populations of lake trout have been shown to sustain their numbers under harvest rates nearly twice the level currently experienced by the Flathead Lake population. The harvest of fish between 30 to 36 inches has been prohibited since 1994, and that protection has resulted in an unusually high percentage of large lake trout in the population.

High density populations experience proportionally high levels of competition between individuals. Biological parameters of lake trout have changed in response to increases in the lake trout population. For example, following the invasion of *Mysis*, individual lake trout growth has slowed, body condition has declined, and age at maturity has increased.

Fish represent about one-third of the total energy budget of the lake trout population. *Mysis* and other invertebrates make up the remaining two-thirds. While native fish represent smaller portions of lake trout diets, the effect of lake trout predation on them is large because their populations are relatively small. There are many examples of introduced lake trout populations negatively influencing native trout. Lake trout eliminated bull trout in Hector Lake, Bow Lake, and Spray Lakes in Canada not long after they were introduced. In Glacier Park where lake trout have increased greatly, bull trout have decreased dramatically over the same period. Bull trout also declined to near extirpation following an increase of lake trout in Priest Lake, Idaho. Introduced lake trout populations have similar negative effects on cutthroat trout, best exemplified by Yellowstone Lake.

Environmental Consequences

We used a population model (Appendix 6) to predict harvest levels needed to achieve the reduction goals (expressed as percentages of Age 8+) identified for each alternative (Figure 5). The status quo harvest (Alternative A) is 70,000 lake trout, and the modeled harvests are 84,000 for Alternative B, 113,000 for Alternative C and 143,000 for Alternative D. The size structure of the lake trout population will shift over the long term under increased harvest to greater percentages of younger fish (Figures 6 and 7).

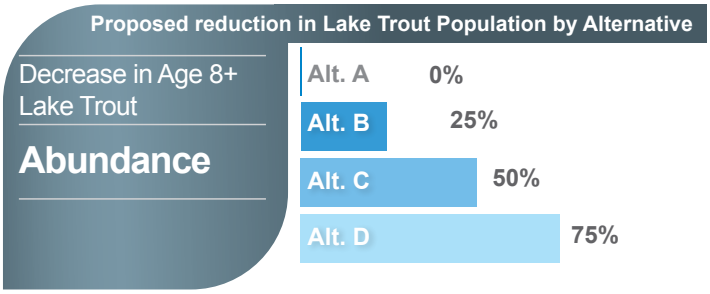

Figure 5. Population reduction goals for lake trout age 8+ in each alternative.

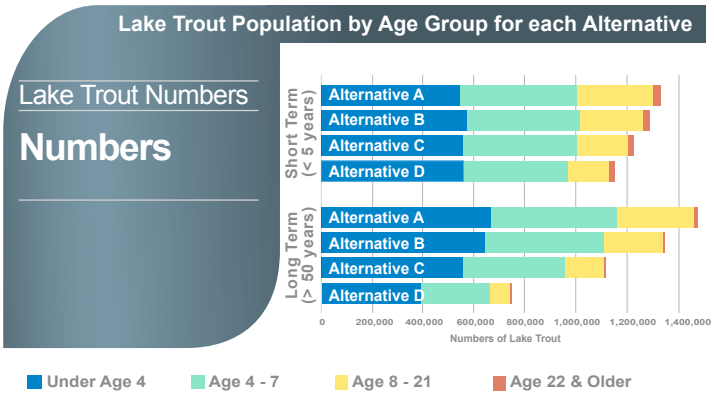

Figure 6. Predicted changes in four age groups of lake trout over the short and long term for each alternative.

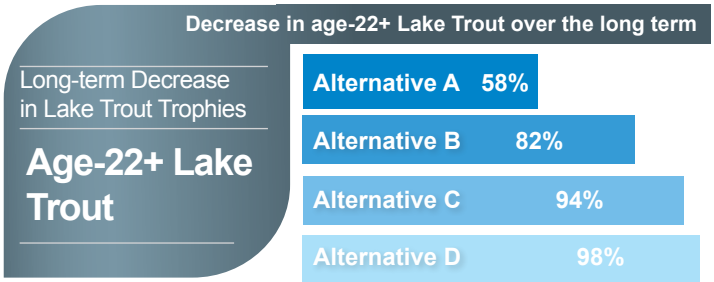

Figure 7. Predicted long-term reductions in age-22+ lake trout expected under each action alternative.

Bull Trout

Affected Environment

Bull trout are native to the Flathead Lake and River system. Migratory bull trout grow to maturity in the lake and then travel up to 130 miles upriver to spawn in their birth-streams. Juveniles stay in those streams for 1 to 4 years and then move downriver to Flathead Lake where they grow to maturity and complete their life cycle. Fishing for bull trout in the Flathead system was closed in 1992 after redd counts had declined for five consecutive years. Redd counts did not increase following the fishing closure, suggesting that harvest was not the primary factor controlling bull trout abundance at that time. In 1998, the US Fish and Wildlife Service listed bull trout as Threatened under the Endangered Species Act. The total abundance of adult bull trout in the interconnected Flathead system is now about 3,000. Past estimates using the same method have ranged from a high of 8,100 fish in 1982 to a low of 1,300 in 1996.

The conservation of bull trout depends on maintaining as many local populations as possible within the larger core area. The total numbers of redds (spawning nests) counted have declined by over 50% since the highest counts in the early 1980s. The decline in the North Fork Flathead system has been greater than the decline in the Middle Fork. Three of four spawning streams inventoried in 2011 had less than 10 redds each in index reaches. These populations are indicative of subpopulations at risk. Research indicates that many Flathead bull trout subpopulations are currently at such low levels that stochastic extinction is a foreseeable threat. Gillnet catches and creel surveys, which are focused on Flathead Lake, show even more dramatic declines than redd counts in the river system. The losses of bull trout to predation by lake trout are estimated to be at least 19,000 bull trout annually, equating to over half the lowest estimated annual production of bull trout outmigrants. The possibility of further declines of bull trout has ramifications beyond the primary issue of biodiversity in the Flathead system. Further declines or even perpetuation of the status quo precludes attainment of recovery objectives for the crucially important Flathead Lake Core Area.

Environmental Consequences

Reduced predation by lake trout should allow greater survival of juvenile bull trout, eventually increasing the number of adults (Figure 8). Bycatch of bull trout is inevitable, regardless the method of harvest employed for lake trout, so is a consequence of suppression. Predicted bycatch increases from 147 in Alternative A to 457 in Alternative D (Figure 9). One measure of benefit and risk of lake trout suppression is the ratio of bull trout lost through bycatch mortality to bull trout potentially gained through reduced predation (Figure 10).

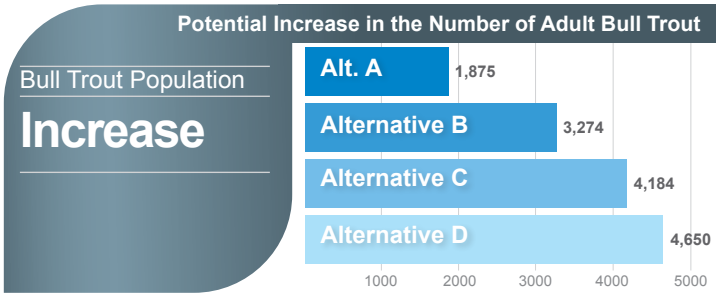

Figure 8. Potential increase in adult bull trout numbers by alternative.

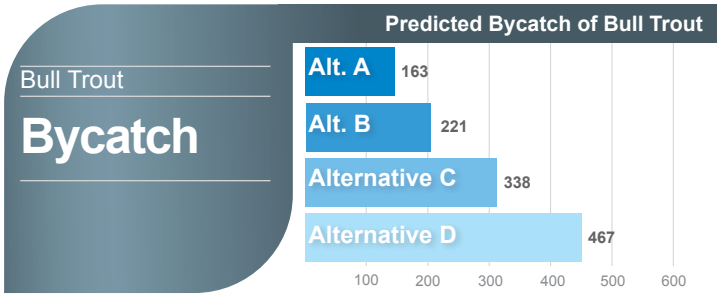

Figure 9. Predicted annual bycatch mortality for bull trout.

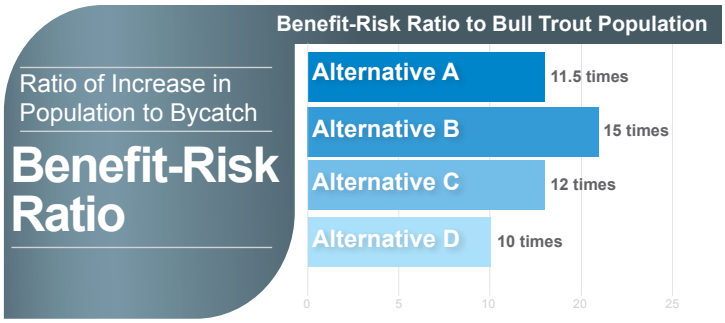

Figure 10. Benefit-risk ratio to bull trout population by alternative.

Westslope Cutthroat Trout

Affected Environment

Westslope cutthroat trout are native to the Flathead Lake and River system. Both migratory and resident forms spawn in tributaries of the North and Middle Forks of the Flathead River and are the most abundant fish in those tributaries. Juveniles rear in both forks until a portion migrate to the Flathead River or Flathead Lake to reach full size and maturity.

Westslope cutthroat trout are well represented in the diet of lake trout in Flathead Lake. Lake trout are estimated to consume 177,000 westslope cutthroat trout annually in Flathead Lake (Appendix 4). Catches in gillnets indicate a decline of roughly two thirds since monitoring began in 1981.

Environmental Consequences

Each alternative is estimated to decrease predation on westslope cutthroat trout in proportion to the reduction in abundance of lake trout based on average predation rates quantified in the bioenergetics study (Figure 11).

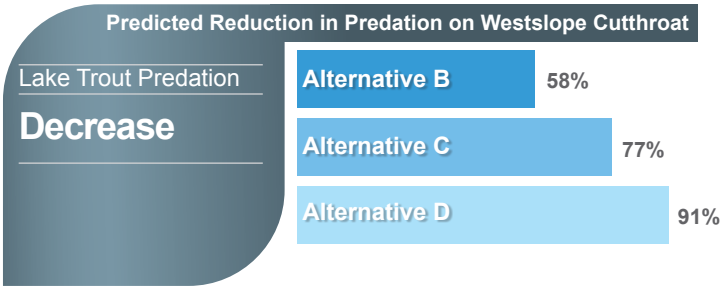

Figure 11. Predicted percent reduction in predation on westslope cutthroat trout by alternative relative to Alternative A.

Lake Whitefish

Affected Environment

Lake whitefish were introduced into Flathead Lake in the late 1800s. Like lake trout, they have benefited from the introduction of *Mysis* and greatly expanded in abundance since the 1980s. Annual angler exploitation of lake whitefish is extremely low, which has allowed “stockpiling” of older, larger fish in the population despite a creel limit of over 100 fish. Abundance of lake whitefish vulnerable to gillnetting is estimated at 959,496 fish, nearly two-times higher than the same parameter for lake trout.

The diet of lake whitefish in Flathead Lake is dominated by chironomids (midges), *Mysis,* and clams. Lake whitefish also prey heavily on juvenile yellow perch during some years.

Environmental Consequences

Each alternative is estimated to decrease predation on lake whitefish based on average predation rates quantified in the bioenergetics study (Figure 12).

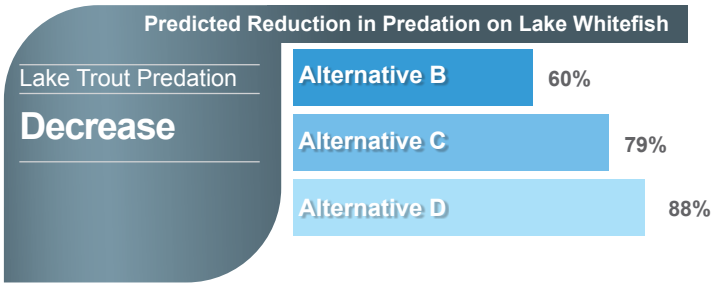

Figure 12. Predicted percent reduction in predation on lake whitefish by alternative relative to Alternative A.

Invertebrates (including *Mysis*), Zooplankton, and Phytoplankton

Affected Environment

Flathead Lake is characterized by relatively low nutrient levels and high water clarity. Large diatoms and golden algae dominate the spring algal bloom. Small organisms adapted to low nutrient availability make up the phytoplankton community present during summer.

In Flathead Lake, the three main groups of zooplankton are rotifers, copepods, and cladocerans. Although cladocerans are numerically only two percent of the zooplankton community, they play a substantial role because of their high productivity, large size and biomass, and importance to both vertebrate and invertebrate consumers.

The primary consumers of pelagic (open water) zooplankton in Flathead Lake are opossum shrimp known as *Mysis* (from the species name *Mysis diluviana*). Mysis (about .5 inches long) were first detected in Flathead Lake in 1981 and reached maximum abundance by 1986. The increase in *Mysis* caused: (1) cascading effects up and down the food chain,(2) the decline of several zooplankton species, and (3) the increase in lake trout and lake whitefish. Mysids hide on the lake bottom during the day to avoid predators and migrate vertically at night to the upper water column where they feed on large zooplankton. In Flathead Lake, mysids prey primarily on the algae-eating zooplankter, *Daphnia thorata*. In turn, *Mysis* are preyed on predominantly by lake trout and lake whitefish, and also by bull trout.

Because their abundance in Flathead Lake peaked and dropped over a short span of years, and the decline was coincident with decreases in zooplankton, it might appear that *Mysis* in Flathead Lake were regulated by the availability of their prey. But *Mysis* probably declined because of increasingly intense predation by lake trout and lake whitefish in the late 1980s. Modeling indicates that if there were no fish predators in Flathead Lake there would be sufficient forage for *Mysis* to increase four-fold. Beauchamp and others (2006) drew similar conclusions and estimated that lake trout consumed about 30% of the annual Mysid production.

Environmental Consequences

Reducing lake trout numbers would create a cascade of effects through the foodweb. Juvenile lake trout are highly effective predators of *Mysis*. Reducing lake trout numbers would likely cause *Mysis* numbers to increase (Figure 13), cascading to decreases in zooplankton and increases in phytoplankton, although the changes are not predicted to be large. The likely changes in *Mysis* density do not exceed densities measured in Flathead Lake since 1986.

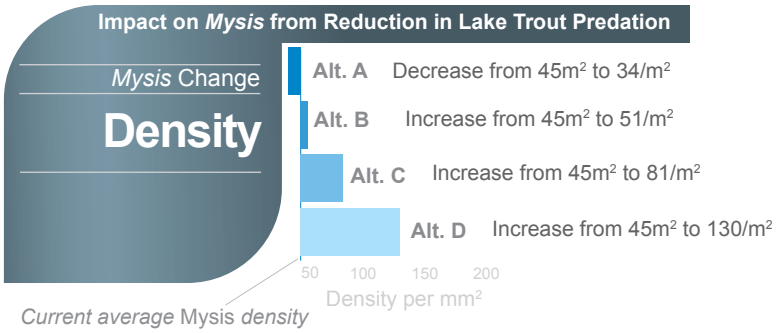

Figure 13. Anticipated change in Mysis *density resulting from reduction in predation on* Mysis *by lake trout by alternative. The long-term average density is 45/m² (2006-2012). While uncertainty about the extent of change exists for each of the alternatives, we do not anticipate that implementation of any of them would cause zooplankton or phytoplankton densities to increase substantially beyond the range that has existed in Flathead Lake over the last 27 years.*

Issue 2: Fishing Opportunity

Affected Environment in the Project Area

A state-wide angler survey ranked Flathead Lake fifth in the state for use by anglers. Total angler activity on Flathead Lake is measured with bi-annual mail surveys which have averaged about 51,000 angler-days per year since 1992. Between 2000 and 2008, the average annual angler use was below 50,000 angler-days, the target prescribed in the Co-Management Plan, on three of six years measured. The intensity of use on Flathead Lake is low, averaging about 0.4 angler-hours per acre, in part because it is large and intimidating to many anglers. Canyon Ferry Reservoir typically supports 2.4 angler-hours per acre, and Lake Mary Ronan supports over 13 angler-hours per acre.

General angler use on Flathead Lake has declined substantially since the 1980s when kokanee were present. Current activity has been fairly stable at about one-half or less the level that occurred when kokanee were present.

Lake trout have been the species most commonly targeted by anglers in Flathead Lake since the collapse of kokanee in 1987. However, between 2000 and 2008, the percent of anglers targeting lake trout declined from 88% to 52% as many anglers focused on yellow perch and lake whitefish. Summer months are typically the most active on Flathead Lake, despite the fact that catch rates for lake trout during summer are much lower than in spring or autumn. Nearly half of all lake trout harvested by anglers are between 19 and 22 inches long.

Angler catch rates for lake trout in Flathead Lake are much higher than for most other lakes, averaging about 0.6 lake trout per angler-hour between 2000 and 2008. Anglers on average keep about 70% of the lake trout they catch. The annual lake trout harvest has varied from 28,000 to 46,000 between 2000 and 2009. Harvest since then has averaged about 70,000 lake trout, whcih includes the contribution to harvest from Mack Days. The current harvest represents very low exploitation: only 3.8% of the number of age 1–30 lake trout, 9.0% of the number of age 4–30 lake trout, and 13.1% of the number of age 8–30 lake trout (adults).

Yellow perch and lake whitefish also support important fisheries in Flathead Lake. Each fishery is typically seasonal and dependent on suitable weather conditions and prey concentrations. When those conditions are met, popular fisheries result, especially during spring and winter for yellow perch and summer and fall for lake whitefish.

Environmental Consequences

A standard model relating angling success to lake trout abundance was applied to predict future catch rates under declining abundance. The model predicted that catch rates for lake trout would decline much slower than abundance, dropping from 0.59 lake trout per hour in Alternative A to 0.34 lake trout per hour in Alternative D (Figure 14).

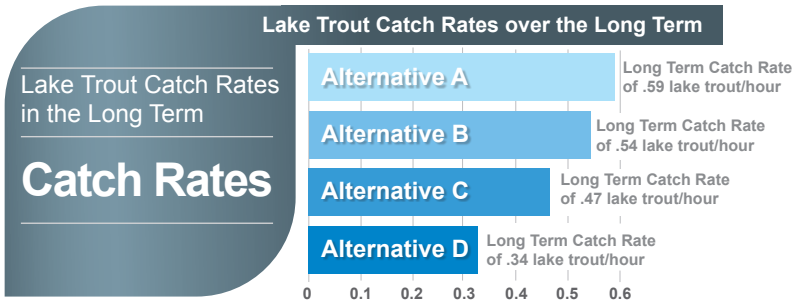

Figure 14. Anticipated long-term lake trout catch rates by alternative.

Issue 3: Fishing Economy

Affected Environment

The Lake and Flathead County area grew substantially in population, employment, and personal income between 1970 and 2008. Between 2001 and 2008, the area saw a 23% increase in total employment due primarily to employment increases in the services and construction sectors. Total personal income in the analysis area grew substantially between 1970 and 2008. In 1970, labor earnings accounted for 71.4% of total personal income. By 2008, labor income as a share of total income had shrunk to 57%.

The issue of lake trout management within Flathead Lake necessarily affects fishing opportunities and economic activity associated with those opportunities. In 2008, 19% of employment in the two-county analysis area was directly tied to travel and tourism-related economic sectors, though the sectors tied to travel and tourism do not necessarily service only those activities. The most obvious link between fish populations in the Flathead system and economic values is through angler use of the river and lake. Two distinct components of economic values associated with angler use are the money fishermen spend on their trips to the river and lake and the additional value they derive from their fishing trips over and above the amount they actually spend. Estimated total annual angler expenditures associated with fishing the North Fork, Middle Fork, and main-stem Flathead down to and including Flathead Lake is about 20,000,000 dollars. Overall, based on 2007 angler use, Montana resident anglers spent 6.4 million dollars and non-residents spent 13.78 million dollars while fishing these waters. Estimated net economic value per trip for fishing in Montana is based on MFWP estimates of 2007 angler trips and the estimated net economic value per trip. Flathead waters provided an estimated 8.8 million dollars in net economic value to anglers in 2007. This value represents the amount anglers would be willing to spend over and above what they actually spent on their fishing trips.

The CSKT sponsor “Mack Days” competitons that attract large numbers of anglers that spend money on fishing within the local economy. During Spring and Fall Mack Days in 2010, 1,807 people signed up to fish and caught-about 49,000 lake trout. Anglers can donate their fish to the event, which are then packaged by CSKT and distributed to local food banks. During 2010, about 42,000 lake trout were processed by Tribal members who were paid $62,000 in wages.

Environmental Consequences

Estimated costs for labor, materials and prizes (in contests) increase proportionally to the target level of suppression for each alternative (Figure 15). Changes in abundance of lake trout would likely reduce fishing activity based on reductions in average catch rates, which would likely cause a decline in total fishing trips to Flathead Lake to fish for lake trout (Figure 16). Some of the predicted reduction in trips might be negated by increases in trips to target other species in Flathead Lake or increases in trips to the Flathead River system.

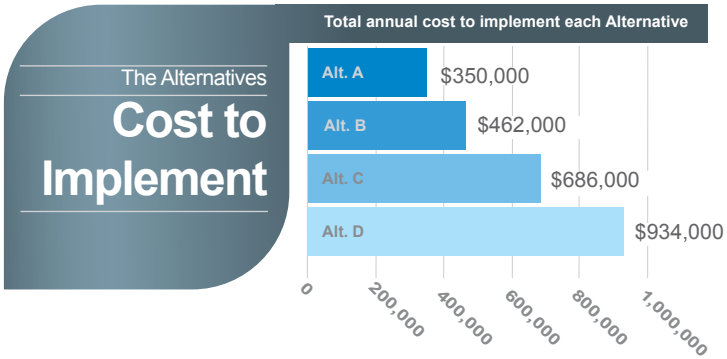

Figure 15. Anticipated cost of each alternative.

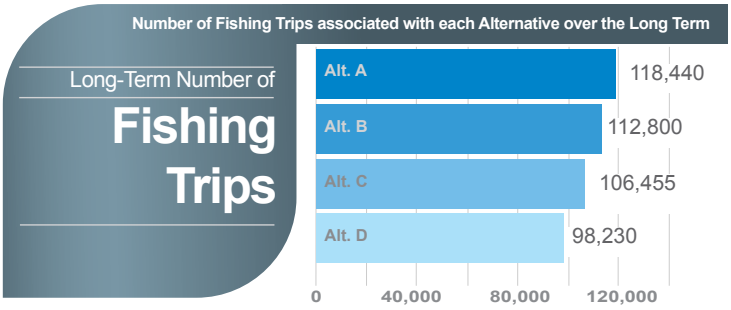

Figure 16. Predicted long-term number of fishing trips under each alternative.

Cumulative Effects

Affected Environment

In recent decades, multiple governmental and non-governmental agencies have focused on protecting the interconnected Flathead River system. Since 1998, over 10,000 acres of wetlands, riparian lands, and near-river lands have received protections through purchase or easements. The Flathead National Forest has made substantial investments to improve water quality and aquatic habitat. The Montana Department of Natural Resources and Conservation manages 18,370 acres of forested state trust lands under the guidance of a Habitat Conservation Plan designed to ensure the continued protection of habitats for bull trout and westslope cutthroat trout. Levels of fine sediment in spawning areas in both the North and Middle Fork drainages are generally lower today than they were in the early 1990s when the highest levels were measured. Current operations at Hungry Horse Dam best resemble the natural-flow conditions of all post-dam periods, improving the chances of protecting bull trout and key ecosystem processes in the main stem. In addition, the United States and Canada have jointly moved to protect the North Fork watershed and have chosen to elevate the area's biological importance above the values derived from mineral extraction.

On the other hand, the Flathead is likely to undergo changes related to global climate change that will be detrimental to native fish. Increased fire frequency and intensity will likely remove riparian vegetation at a greater rate than is currently occurring. Increases in ambient air temperatures in concert with reduced shade would contribute substantially to stream warming. More frequent droughts and increased evapotranspiration will likely reduce baseflow conditions, degrading in-stream habitat quality and reducing the ability of autumn-spawning bull trout to access some stream segments. Climate change will likely increase the importance of Flathead Lake to the adfluvial life history of native trout. With a warming climate, the cool-water refuge provided by Flathead Lake, with optimal temperatures below the thermocline, will be increasingly important as the shallower waters of the spawning streams and mainstem river system continue to warm. The advantage of this temperature refuge in Flathead Lake will be minimized or negated if the lake includes the increased risk of predation by lake trout.

Several non-native species are present in Flathead Lake that have the potential to compound the existing negative effect of non-native lake trout. For example, smallmouth bass and walleye have the potential to increase and exert additional predation pressure on native trout, and rainbow trout will continue to hybridize with native westslope cutthroat trout.

Environmental Consequences

Populations of native trout, especially the migratory component, would likely increase in the Flathead River system as a result of reductions in lake trout abundance in Flathead Lake. We anticipate that habitat conditions will remain stable or improve in the future, while climate change will probably continue and worsen in the future. Benefits to native fishes resulting from reduced predation by lake trout will probably be partially offset by the detrimental effects of climate change. Conversely, the effects of climate change when combined with the chronic effects of predation by lake trout could drive the abundance of native fishes lower than currently exists.

Protections given to the North Fork Flathead River watershed contribute greatly to supporting a long-term stable environment for migratory native fishes. These protections would help to ensure that the full benefits of reduced predation on native fishes are realized by maintaining suitable conditions within the spawning and rearing streams of the North Fork.

Predation by introduced aquatic predators (namely, northern pike, walleye, and smallmouth bass) will probably increase in the future. If these nonnative species were to become highly abundant and prey heavily on native fishes, they could negate the benefits of a reduced lake trout population.

It is likely that nonnative aquatic competitors, especially rainbow trout, will increase in the future. Nonnative aquatic competitors drive down the abundance of native fishes through hybridization and reduced survival rates. If they become highly abundant, they could completely negate any benefits to westslope cutthroat trout derived from reducing lake trout predation. The risk of additional introductions of aquatic predators and competitors is high. If prevented and even if controlled after an introduction, the impact on native fishes would be low.

Environmental Justice (Executive Order 12898)

None of the action alternatives will have disproportionate adverse human health or environmental effects on the Tribes or on low-income or minority populations living within the area. Indeed, reducing the population of nonnative lake trout in Flathead Lake to benefit native fishes would help to protect the Tribes' treaty rights and, over the long term, has the potential to increase opportunities for subsistence consumption of bull trout and westslope cutthroat trout and the cultural practices distinct to the Tribes that are tied to harvest and consumption of these native fishes. Under the No Action Alternative (Alternative A) the removal of 70,000 lake trout annually would be insufficient to drive an increase in bull trout numbers in a way that would improve opportunities for Tribal member subsistence consumption or practice of cultural fishing activities. Opportunities for Tribal member subsistence consumption of westslope cutthroat trout would increase over the long term under Alternative A but would be substantially less than under any of the action alternatives.

Short-term Uses and Long-term Productivity

Extensive research and monitoring has determined that lake trout threaten the persistence of native trout in the Flathead Lake and River system. This proposed action addresses that threat. All action alternatives are specifically intended to maintain the long-term productivity of the Flathead watershed by ensuring that the critical component species—native bull trout and westslope cutthroat trout—are increased to a point that their likelihood of persistence is greatly improved.

Unavoidable Adverse Effects

Alternatives have been designed to minimize bycatch and have been evaluated based on the level of bycatch. Adaptive measures would be employed to reduce bycatch based on knowledge gained while implementing a particular harvest method.

Irreversible and Irretrievable Commitments of Resources

Each alternative would cause the irretrievable loss of the monetary costs required to implement the alternative. The costs vary by alternative, with even the No Action Alternative incurring substantial costs. Most projects requiring NEPA compliance have the risk of causing an irreversible impact that might result from implementation of the proposed action. In contrast, there may be the irreversible extinction of bull trout within the Flathead Lake and River system if one of the action alternatives is not implemented. Therefore the proposed actions are intended to prevent the irretrievable loss of a species. Each alternative is intended to reduce the threat from lake trout and in turn reduce the risk of irreversible extinction of bull trout.

2013

Draft Environmental Impact Statement

Proposed Strategies to Benefit Native Species by Reducing the Abundance of Lake Trout

Flathead Lake, Montana

Bureau of Indian Affairs
Confederated Salish and Kootenai Tribes

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CONTRIBUTORS

Lead Agency

The Department of the Interior, Bureau of Indian Affairs (BIA) is the lead agency in this EIS. The co-operating agency is the Confederated Salish and Kootenai Tribes (Tribes or CSKT). Representatives from the following agencies have been involved throughout the entire NEPA compliance process as part of the Interdisciplinary Team:

- US Forest Service
- Montana Dept Natural Resources & Conservation
- US Fish and Wildlife Service
- US Geological Survey
- University of Montana Biological Station
- Confederated Salish and Kootenai Tribes
- National Park Service
- Montana Fish, Wildlife & Parks

In addition, a Citizen Ad Hoc Group has also participated. Members include:

- Trout Unlimited
- Flathead Lakers
- Flathead Lake Outfitter
- Flathead Wildlife, Inc.
- Flathead River Outfitter

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Related Documents

- Flathead Lake and River Fisheries Co-Management Plan (2000)
- Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin (2000)
- Cutthroat Memorandum of Understanding and Conservation Agreement (2007)
- Flathead Subbasin Plan (2004)
- CSKT Comprehensive Resources Plan (1996)
- CSKT Fisheries Management Plan (1993)

SUMMARY

The paragraph below briefly summarizes the content of the Draft Environmental Impact Statement (DEIS). A more lengthy and detailed **Executive Summary** is included as pages iii - xviii of this document.

The DEIS analyzes the environmental consequences of a proposal to benefit native fish populations by reducing the abundance of non-native lake trout in Flathead Lake. Because of the migratory nature of fish in the system, areas north or upstream of the lake—specifically, the Flathead River and its tributaries—are included in the analysis. The proposed action would use a combination of fisheries population-management tools, including angling and netting, to reduce the population of lake trout. The need for the project is based on over two decades of continuous and cooperative regional research, management, and planning by Tribal, State, and Federal agencies. The research, joint planning efforts, and decision-making processes are recorded in our guidance documents, which include: the Flathead Lake and River Fisheries Co-Management Plan (2000), the Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin (2000), the Cutthroat Memorandum of Understanding and Conservation Agreement (2007), the Flathead Subbasin Plan, Part III (2004), the CSKT Comprehensive Resources Plan (1996), and the CSKT Fisheries Management Plan (1993). The EIS includes four alternatives:

- **Alternative A**
  NEPA-defined, no action alternative (maintain the status quo).

- **Alternative B**
  Reduce the population of adult lake trout (age 8 and older) by **25%** using Mack Days contests, targeted gillnets, trapnets, and by allowing anglers to legally keep fish of all sizes (there would be no “slot” limit).

- **Alternative C**
  Reduce the population of adult lake trout (age 8 and older) by **50%** using Mack Days contests, targeted gillnets, trapnets, and by allowing anglers to legally keep fish of all sizes (there would be no “slot” limit).

- **Alternative D**
  Reduce the population of adult lake trout (age 8 and older) by **75%** using Mack Days contests, targeted gillnets, trapnets, and by allowing anglers to legally keep fish of all sizes (there would be no “slot” limit).

The management agencies have intentionally not chosen a preferred alternative. The selection of a preferred alternative will come after giving full consideration to public comments.

List of Preparers

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David Rockwell, Graphic Design and Editing

Important Note to the Reviewing Public

Reviewers have an obligation to structure their participation in the National Environmental Policy Act (NEPA) process so that it is meaningful and alerts the Bureau of Indian Affairs to their position and contentions. Environmental objections that could have been raised at the draft stage may be waived if not raised until after completion of the Final Environmental Impact Statement. Comments on the Draft Environmental Impact Statement should be specific and should address the adequacy of the statement and the merits of the alternatives discussed. Please send your comments to:

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All comments concerning this Draft EIS must be submitted by August 9, 2013.

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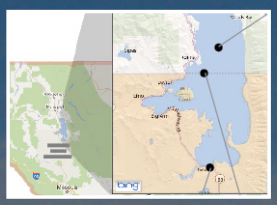

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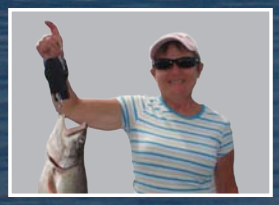

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12: Glossary
13 Expert Panel Assessment

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1

Purpose, Need, and Project Development

Document Structure

The Bureau of Indian Affairs (BIA) and the Confederated Salish and Kootenai Tribes (Tribes or CSKT) have prepared this Draft Environmental Impact Statement in compliance with the National Environmental Policy Act (NEPA) and other relevant laws and regulations. It discloses the direct, indirect, and cumulative environmental impacts that would result from each of the alternatives. The document is organized into four chapters:

- **Chapter 1: Purpose and Need for Action**
  Chapter 1 includes information on the purpose of and need for the project, ways of achieving that purpose and need, and issues considered in the analysis. It also details how the BIA and the Tribes informed the public of the proposal and how the public responded.
- **Chapter 2: Alternatives, including the Proposed Action**
  Chapter 2 provides a more detailed description of the alternatives for achieving the stated purpose. These alternatives were developed based on significant issues raised by the public and other agencies. The management agencies have intentionally not chosen a preferred alternative at this time. The selection of a preferred alternative will come after giving full consideration to public and agency comments.
- **Chapter 3: Affected Environment and Environmental Consequences**
  Chapter 3 describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by species or species group.
- **Chapter 4: Consultation and Coordination**
  Chapter 4 provides a list of preparers and agencies consulted during the development of the environmental impact statement.
- **Appendices**
  The appendices provide more detailed information and basic research used in the analyses presented in the environmental impact statement.

Location

The project area is Flathead Lake, located in Lake and Flathead Counties, Montana (Figure 1.1). The Flathead Lake and Flathead River System are managed as one entity because of the migratory nature of fish in the system. Therefore the following areas north (or upstream) of the lake are included in this analysis: the Flathead River upstream from Flathead Lake and the Middle and North Fork Flathead River watersheds (Figure 1.2).

Description of Proposed Action

The project would benefit native fish through the use a combination of conventional management tools, including angling and netting, to reduce the population of non-native, predacious lake trout in Flathead Lake. In this context, reducing the population means we would annually remove more individuals than are naturally reproduced to achieve a smaller lake trout population size. Following the successful completion of the NEPA process, the likely start date for the project would be late 2013. Project activities could then occur year-round indefinitely into the future if the program achieves its objectives based on continuing annual assessments and adaptive changes. The process of adaptive management is described in Appendix 8.

Purpose of the Project

The purpose of the action, which is supported by over two decades of continuous and cooperative regional research, management, and planning between Tribal, State, and Federal agencies, is to benefit native fish by reducing the population of non-native lake trout in Flathead Lake. The research, joint planning efforts, and decision-making processes are described in our guidance documents, which include: the Flathead Lake and River Fisheries Co-Management Plan (2000), the Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin (2000), the Cutthroat Memorandum of Understanding and Conservation Agreement (2007), the Flathead Subbasin Plan, Part III (2004), the CSKT Comprehensive Resources Plan (1996), and the CSKT Fisheries Management Plan (1993). Each of these plans stresses the critical importance of native species and the necessity to remove non-native competitors such as lake trout. The action would play a critical part in achieving several of the goals and objectives of these plans and policies (Appendix 1), including the following goals, objectives, and strategies from the Flathead Lake and River Fisheries Co-Management Plan:

Goals
- Increase and protect native trout populations (bull trout and westslope cutthroat trout).
- Balance trade-offs between native species conservation and non-native species reduction to maintain a viable recreational/subsistence fishery.
- Protect the high quality water and habitat characteristics of Flathead Lake and its watershed.

Objectives
- Increase and protect native trout populations to at least secure levels.
- Maintain, or if needed, increase harvest of non-native fish to benefit native fish species.
- Provide a recreational fishery based on non-native and native fish with harvest opportunities based primarily on non-native fish.

Strategies
- 5A: Suppress non-native fish through recreational angling.
- 5B. Increase suppression of non-native fish if necessary through commercial harvest techniques.
- 5C. Implement agency management actions if necessary to reduce non-native fish.

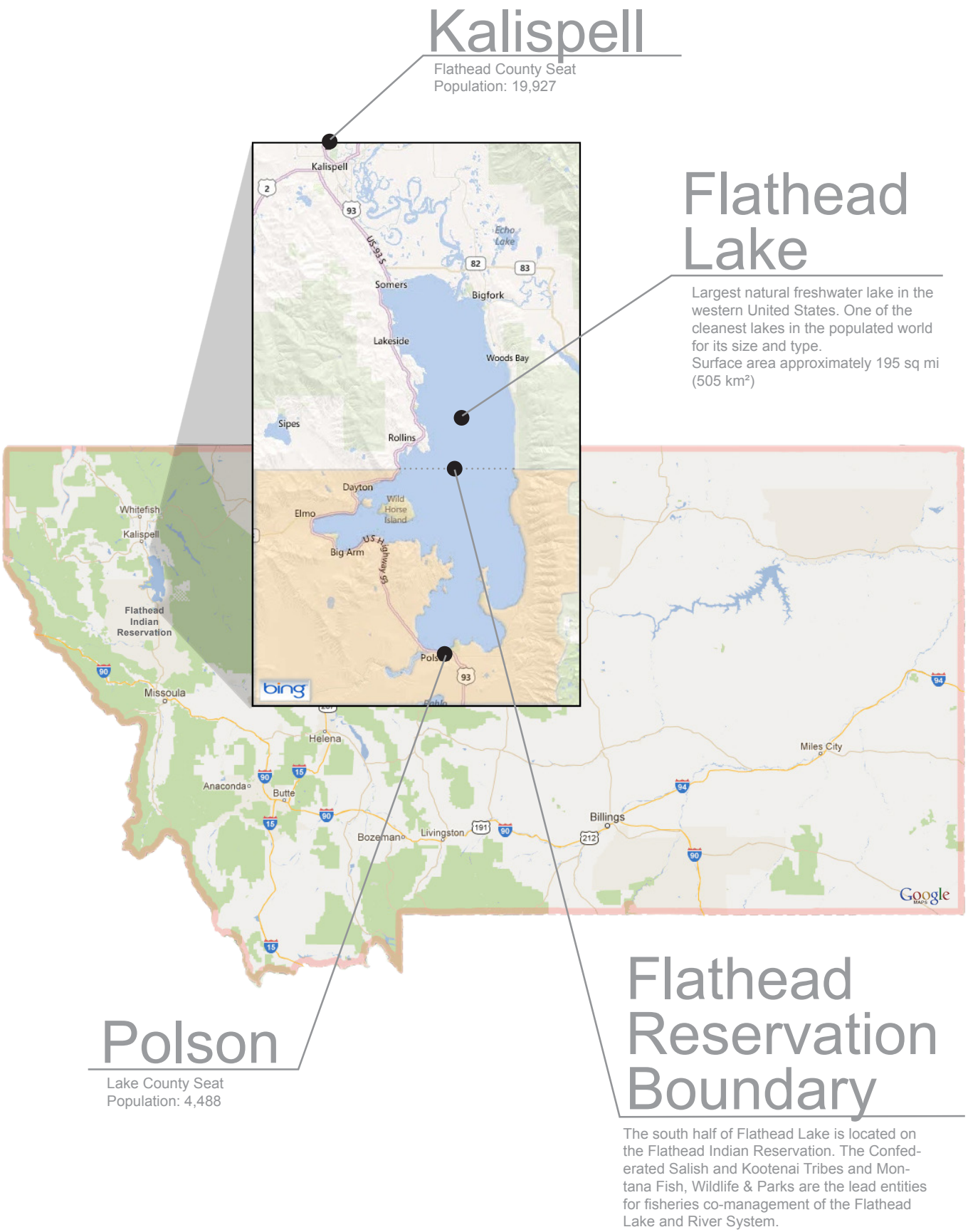


Figure 1.1. The Project Area is Flathead Lake.

NORTH FORK FLATHEAD

153-mile (246 km) river flowing through British Columbia (BC), Canada south into Montana. Basin area: 1,548 miles^2
Discharge (acre-feet x 10^6): 2.16

FLATHEAD RIVER, BC

North of the border, in British Columbia (BC), the North Fork is called the Flathead River.

BORDER

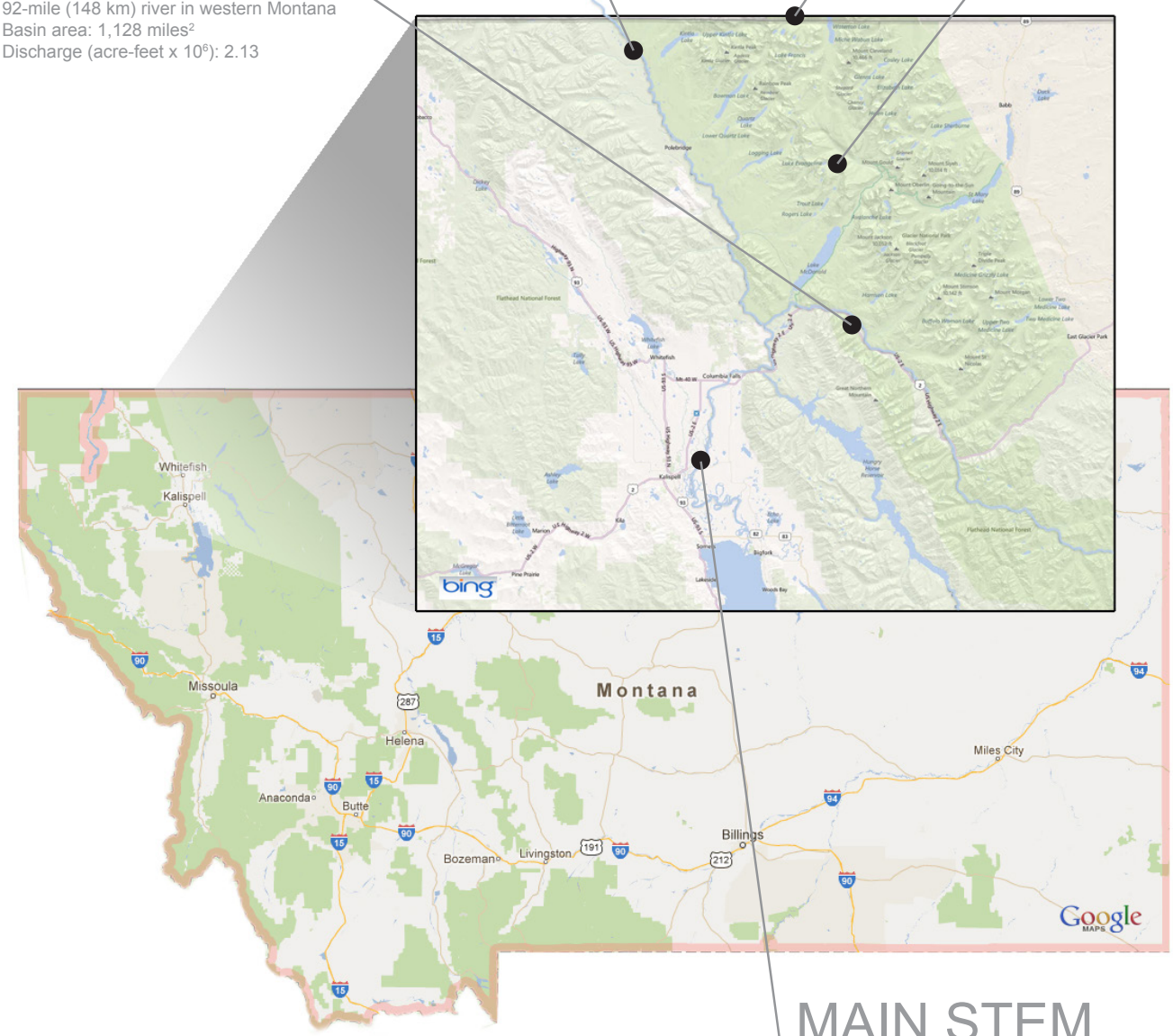
Canada-US International Boundary

GLACIER PARK

Darker green north of the Middle Fork is Glacier National Park
1,013,594 acres

MIDDLE FORK FLATHEAD

92-mile (148 km) river in western Montana
Basin area: 1,128 miles^2
Discharge (acre-feet x 10^6): 2.13



MAIN STEM FLATHEAD RIVER

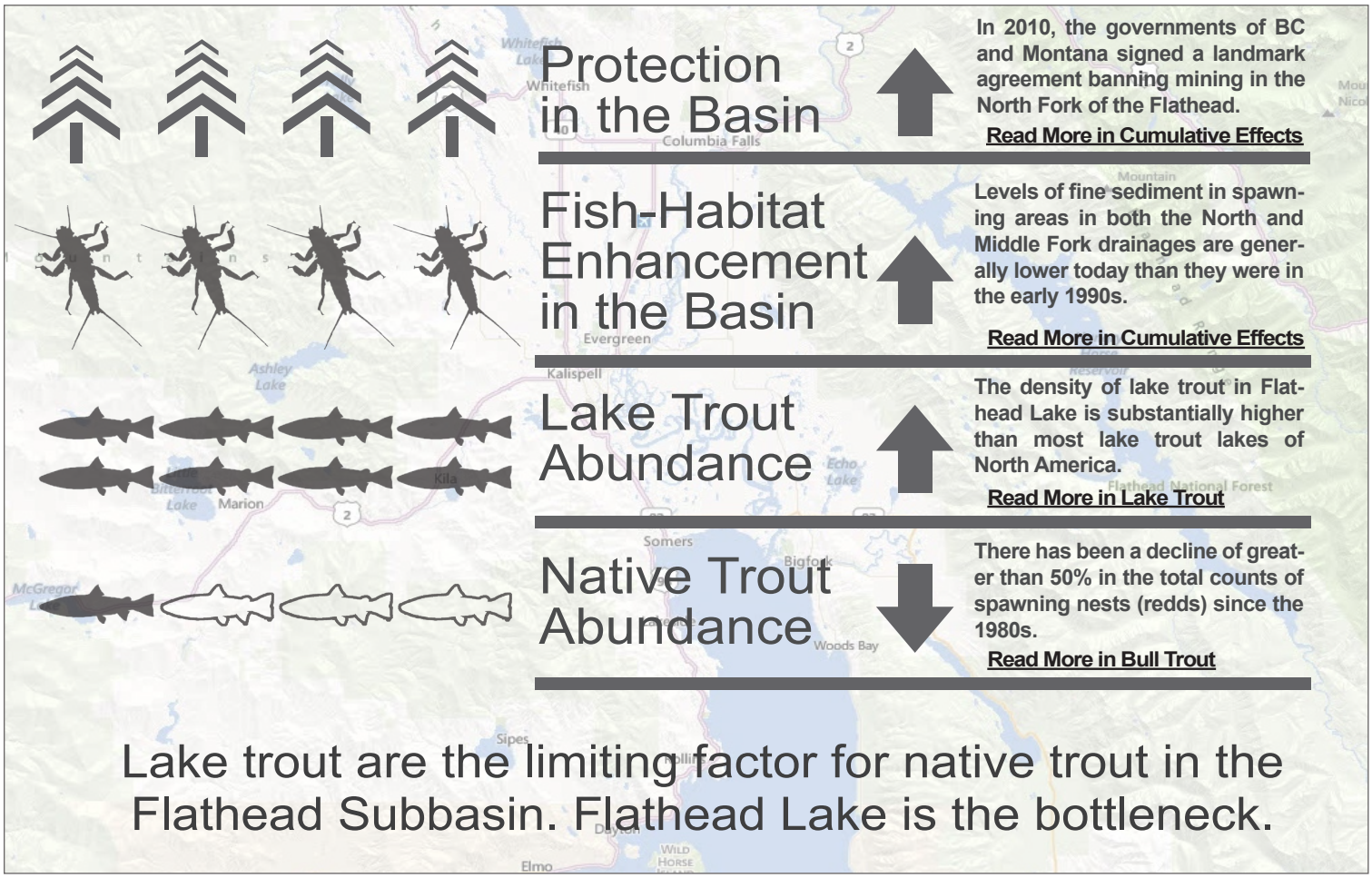
Main stem of the Flathead River is slower and more meandering above Flathead Lake than any of the three forks.

Figure 1.2. The Flathead Lake and River System are managed as one entity because of the migratory nature of fish in the system. Therefore areas upstream of the lake are also relevant to this analysis.

Need for the Project

A goal of the Flathead Lake and River Fisheries Co-Management Plan (2000) is to increase and protect native trout populations (bull trout and westslope cutthroat trout) while balancing trade-offs between native species conservation and non-native species reduction to maintain a viable recreational/subsistence fishery. Current trends indicate that implementation of the Co-Management Plan has not decreased lake trout populations and has not increased bull trout population from 2000-2010 (Co-Management Plan Mid-term Review 2006). Further, research indicates that bull trout and westslope cutthroat trout declines in the Flathead system are the result of lake trout increases that have cascaded through the Flathead Lake foodweb (Figures 1.3 through 1.6) (Bull Trout Study Group 1997; Beauchamp 2006; Flathead Lake Co-Management Plan Expert Panel 1998). In addition, bull trout were listed as a Federally Threatened species under the Endangered Species Act in 1998, and the Tribes are committed to improving conditions for Threatened and Endangered Species (Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin, 2000). Because increases in the lake trout population have put native trout at risk, there is a need to reduce the risk through implementation of management actions or strategies set forth in the Co-Management Plan. Although the Co-Management Plan expired in 2010, its goals and direction remain in effect. Because lake trout greater than 24 inches are the most effective predators in the population, disproportionate gains to prey species are gained from reducing numbers of larger lake trout.

Figure 1.3. The project is needed because lake trout are the limiting factor for bull trout in the system. Adequate habitat exists for bull trout spawning and rearing, but lake trout in Flathead Lake are preventing native trout from increasing.



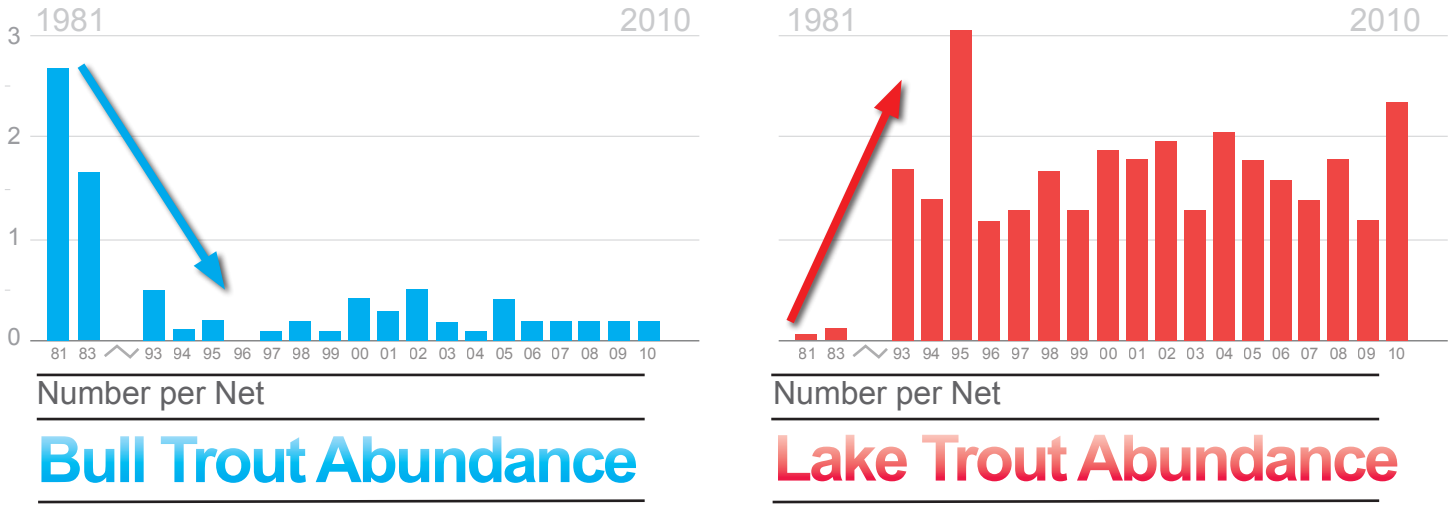


Figure 1.4. The relative abundances of bull trout and lake trout have reversed. Bull trout have dropped off precipitously while lake trout have increased just as dramatically (data from MFWP). (Sloped lines represent trends and are not regression lines.)

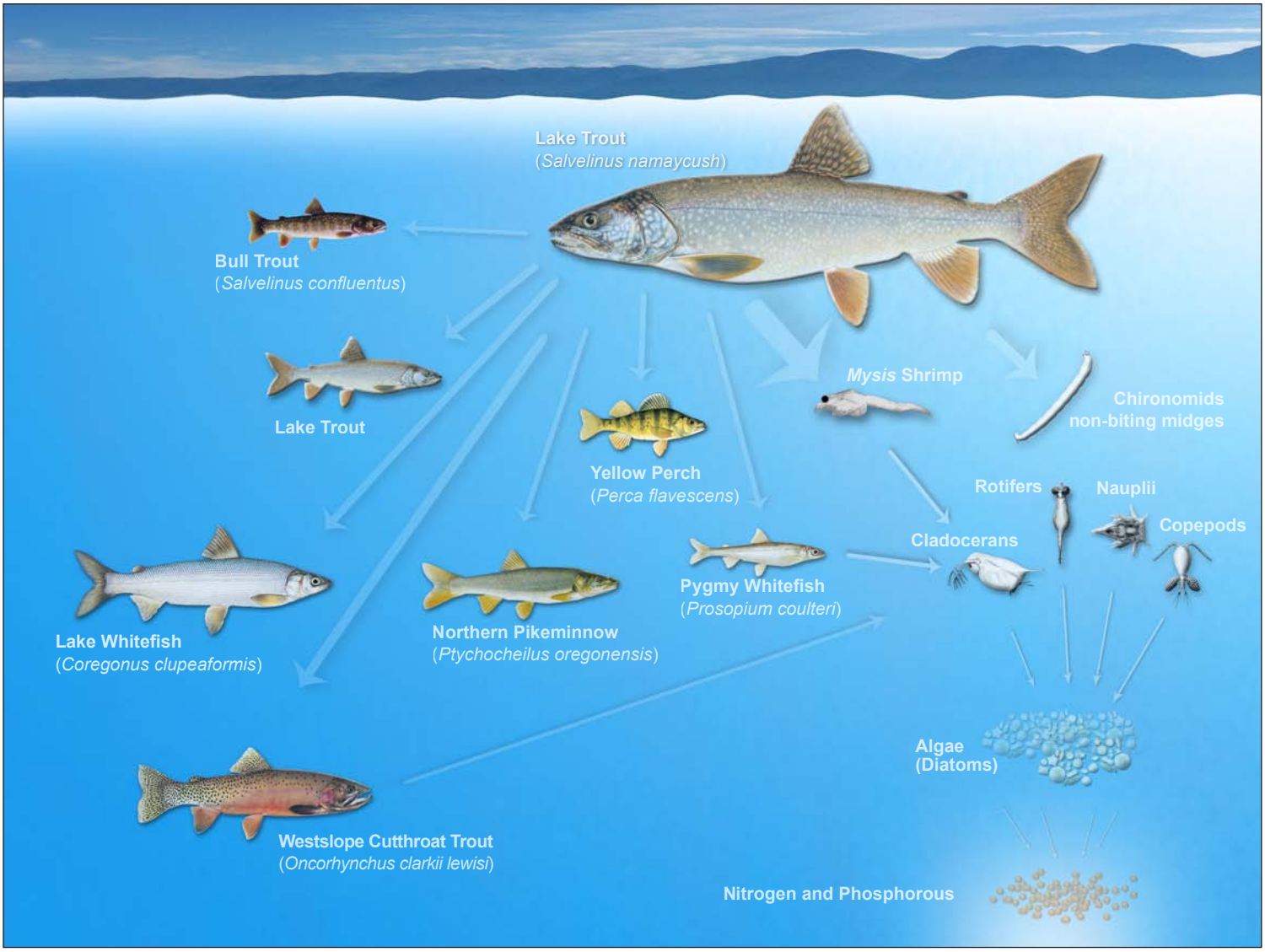


Figure 1.5. Simplified depiction of the Flathead Lake food web (fish illustrations by Joseph Tomelleri). Organism size does not represent abundance or relative portion of the lake trout diet.

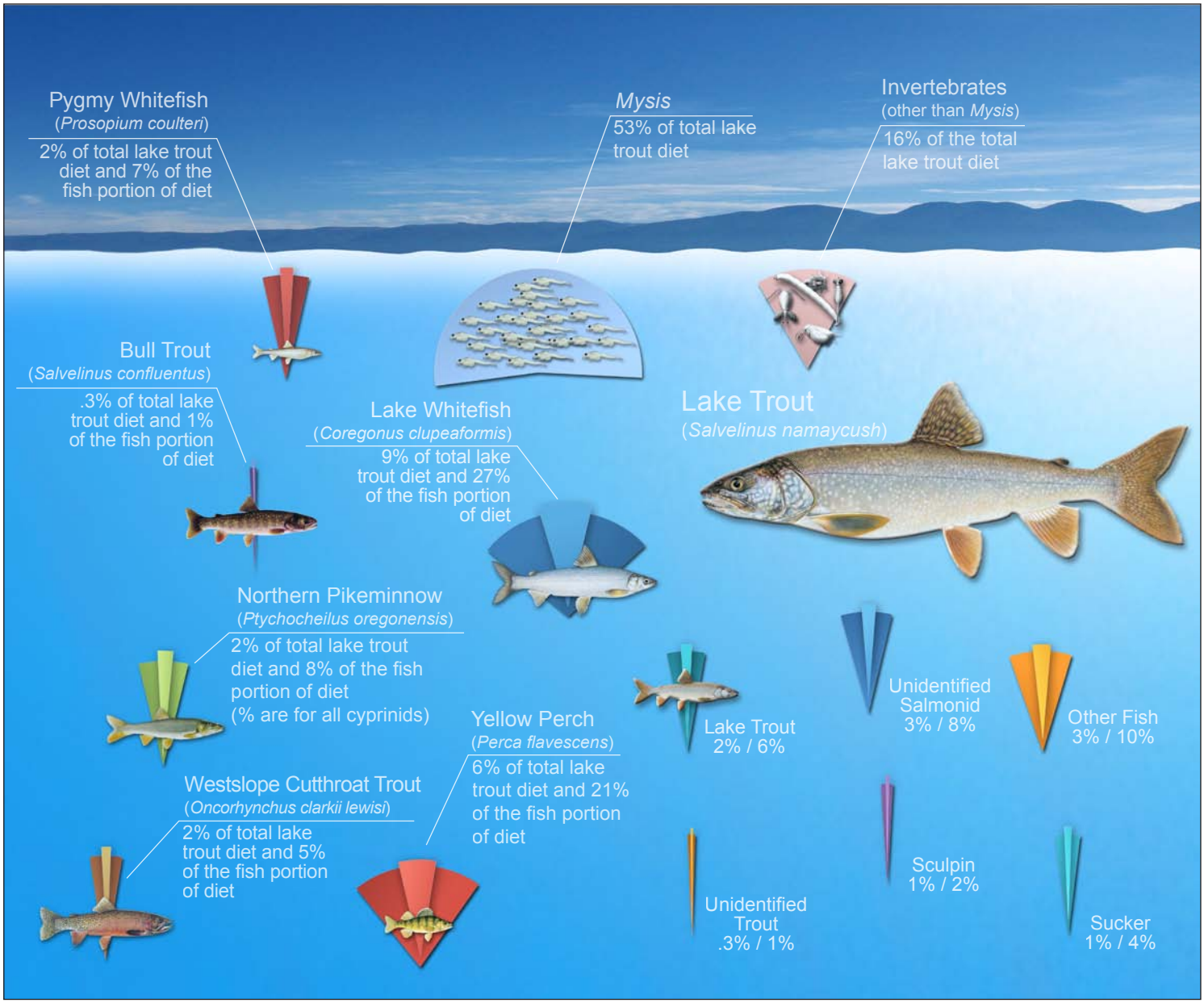


Figure 1.6. Percentage of prey organisms in the diet of lake trout in Flathead Lake during 1998 to 2001 (Appendix 4). For fish species with two pie slices, the larger piece represents the percentage of that species relative to all fish in the lake trout diet and the smaller piece represents the percentage relative to all the items in the diet. The low percentage for bull trout is largely due to their low population density. Note that lake trout have a substantial impact on westslope cutthroat trout populations, which is often overlooked (fish illustrations by Joseph Tomelleri).

The Co-Management Plan identifies fish population management actions in Strategy 5 as follows: (A) Suppress non-native fish through recreational angling; (B) Increase suppression of non-native fish if necessary through commercial harvest techniques; and (C) Implement agency management action if necessary to reduce non-native fish. Because moving beyond Strategy 5A was controversial at the time, the management agencies made a commitment to public scoping should it be necessary to achieve the plan's goals. This document fulfills that specific need and commitment. The Co-Management Plan was originally written for the period of 2000 to 2010, but it continues to serve as the planning and goal-setting document for decision makers to make fully informed decisions.

Desired Future Condition

The Desired Future Condition is defined primarily by the Flathead Lake and River Fisheries Co-Management Plan (MFWP and CSKT 2000). Key components are the desire to: (1) increase populations of native fish, (2) decrease numbers of lake trout, (3) maintain clean water, (4) improve angler-access, and (5) sustain 40,000 angler days in the river and 50,000 angler days in the lake.

It is assumed that by restoring a greater balance to the Flathead Lake fishery, the long-term viability of native adfluvial fish will be improved. The desired future condition would include: (1) a reduced role for lake trout, an introduced apex predator that has changed the entire fishery; (2) the restoration of at least 50% of the population levels of westslope cutthroat and bull trout lost since the population of lake trout greatly expanded in the 1980s; and (3) annually sustaining 40,000 angler days in the river and 50,000 angler days in the lake.

We established this threshold level of native trout populations (and initiated this NEPA process) because of the circumstances present in 2010 in which fisheries managers were faced with the need to make a decision on future actions. The large expense of ongoing efforts (i.e. fishing contests) was unsupportable due to: (1) the absence of gains in native fish abundance, (2) the continued bycatch of bull trout, and (3) harvest levels too low to reduce lake trout numbers. Further delay in additional meaningful action was considered to be neglectful of critically important native fish in the Flathead system. We determined, therefore, that achieving the goals of the Co-Management Plan would require consideration of the additional tools outlined in the plan.

Monitoring and Adaptive Management

Alternatives are designed to be implemented for an indefinite period into the future because the lake trout population and its effects on native fishes will likely persist indefinitely. The lengthy period of implementation makes it imperative that there be extensive monitoring to verify the predicted effects. There must also be flexibility to adapt to unforeseen effects. Adaptive management would proceed with the benefit of monitoring data collected annually and analyzed by CSKT and a team of experts to be convened when necessary (Appendix 8). The alternatives were designed with the best available information and population modeling, but it is not reasonable to expect the system to behave precisely as has been predicted in this document. Monitoring of effects is equally or more important than the prediction of effects that has been made in this stage of the process (Appendix 8). Monitoring will ultimately determine the fate of this project. If monitoring indicates that success is not being achieved, primarily in the form of increases in native fish numbers, and further that the potential for success is low, the suppression activity would be terminated. After termination, the lake trout population would likely rebound to a level similar to the level present in 2010. At that point the future of native bull and westslope cutthroat trout in the Flathead system would remain uncertain.

Relationship to Laws and Other Projects

For a summary of how this project relates to federal laws (such as the Endangered Species Act), Tribal regulations, and other ongoing projects, see Appendix 2.

Decision Framework

Because NEPA is a federal law, the lead agency in a NEPA document is always a federal agency. In this EIS, it is the Department of the Interior, Bureau of Indian Affairs (BIA). The Confederated Salish and Koo-

tenai Tribes are a cooperating agency. Montana Fish, Wildlife & Parks was a cooperating agency until they withdrew from the process in March 2012.

The decision to be made by the Superintendent of the BIA, in cooperation with the Tribal Council of the Tribes is to choose from one of the following:

1. Select the No Action Alternative, which would mean maintaining current management;

2. Select one of the three Action Alternatives;

3. Select a combination of elements from the action alternatives and package them into a new alternative, which would then require further analysis by the Interdisciplinary Team (IDT); or

4. Select none of the alternatives and reconvene the management-planning team.

If one of the proposed alternatives from this document is selected, the BIA would then prepare a Record of Decision (ROD), which would summarize the action and effects and would be signed by the BIA.

Permits Needed

If an action alternative is selected, an implementation plan would be written to more precisely identifly the components of suppression, such as specific dates, locations, and durations. The proposal would need review for compliance with the Endangered Species Act by the USFWS before an action alternative could be implemented.

The proposal would also require cultural clearance from the CSKT Tribal Preservation Office (TPO). The Tribal Fisheries Management Program would submit a request for clearance through the NEPA office. No work would occur until a clearance or other notification from the TPO is received.

Public Involvement

The analysis of the proposed action began as an Environmental Assessment (EA), during which time we held a series of scoping meetings. Based on the level of public interest surrounding the proposed action, we decided in February 2012 to prepare an Environmental Impact Statement (EIS). Under such circumstances, a federal agency may choose to prepare an EIS without having first completed an EA. Because the scope of the project did not change from the EA to the EIS, the scoping conducted during the EA continues to apply. In other words, the increased level of analysis required to move from an Environmental Assessment to an Environmental Impact Statement does not nullify the scoping conducted as part of the EA process. Indeed, according the Council on Environmental Quality the "…scoping process [can] be used in connection with preparation of an environmental assessment, i.e., before both the decision to proceed with an EIS and publication of a notice of intent…The regulations state that the scoping process is to be preceded by a Notice of Intent (NOI) to prepare an EIS. But that is only the minimum requirement. Scoping may be initiated earlier, as long as there is appropriate public notice and enough information available on the proposal so that the public and relevant agencies can participate effectively" (http://ceq.hss.doe.gov/nepa/regs/40/40p3.htm).

During the EA process, scoping meetings (advertised on radio and in local newspapers) were held at Polson (April 12, 2010), Kalispell (April 13, 2010), and Missoula (April 14, 2010). At the meetings, the Tribes

presented the history of Flathead Lake management and lake trout and bull trout biology. Montana Fish, Wildlife & Parks participated as a cooperating agency. We also included consultants and stakeholder groups in the information portion of meetings. Several hundred people attended and provided comments before, during, and after the sessions. We also presented information to the Flathead Reservation Fish and Wildlife Advisory Board from 2010 to 2013. The results of all these EA-scoping sessions are included in Appendix 3 and summarized in Figure 1.7.

The Notice of Intent (NOI) to prepare an EIS was published in the Federal Register on June 5, 2012. The NOI asked for public comment on the proposal from June 5, 2012 to July 5, 2012. In addition, the Tribes solicited review and comment in July 2012 from a group of independent scientists associated with Bonneville Power Administration (BPA). This group—the Independent Scientific Review Panel— routinely reviews proposals from agencies that solicit funds from BPA. We held Interdisciplinary Team (IDT) Meetings from 2010 through 2013 to craft alternatives and analyze effects. IDT members included staff from Tribal, Federal, and State natural resource agencies.

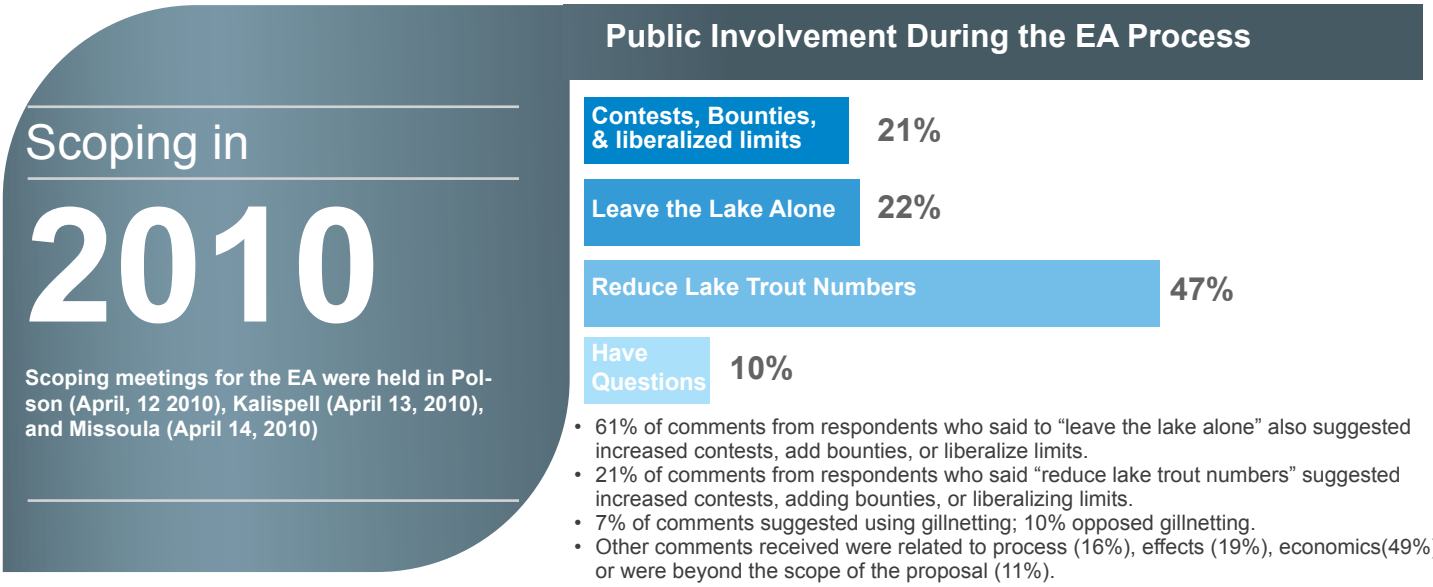


Figure 1.7. Scoping during the Environmental Assessment showed 68% favored reducing lake trout numbers.

Issues

We have separated the issues into two groups: significant and not significant. (See Appendix 3 for our complete list of comments, issues, suggested actions, and responses and for more information on issues considered but eliminated from further analysis.)

Issues Considered but Eliminated from Further Analysis (Not Significant)

These are issues that: (1) fall outside the scope of the proposed action; (2) are already decided by law, regulation, other plans, or are higher-level decisions; (3) are not relevant to the decision to be made; or (4) are conjectural and not supported by scientific or factual evidence. The following issues presented during scoping were considered but eliminated from further analysis:

- **Hatchery: "Why not just use a hatchery to plant more bull trout?"**
  The Bull Trout Restoration Plan (2000) states, on page 102: "…restoration stocking [is an approved recovery strategy] only if the actual cause of extirpation is identified and corrected first." Hatchery solutions to fish population problems tend to result in "put-and-take" scenarios that are not sustainable. The sustainable solution is to remedy the underlying reason for low population numbers. Because we know the habitat is suitable and indeed has produced at least twice the number of redds in the 1980s than are present today, we know that if the bottleneck to bull trout recruitment is removed this area can produce higher numbers of native fish. For these reasons, hatcheries were not included in our Co-Management Plan and are therefore beyond the scope of this analysis. In addition, hatchery fish compete with and dilute the unique genetic make up of wild fish thereby compromising the purpose of a hatchery.

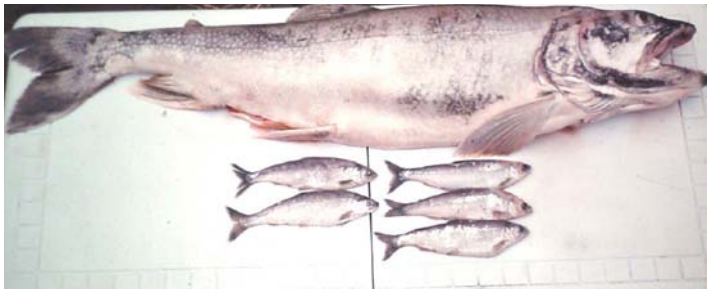


Figure 1.8. Small hatchery-raised kokanee salmon found in the stomach of a single adult lake trout.

- **Dams: "Why manage when dams affect bull trout?"**
  While Hungry Horse Dam cuts off some Flathead Lake bull trout from spawning habitat in the South Fork of the Flathead River, there remains abundant suitable habitat in the Flathead River and the North and Middle Fork drainages. Overall, redd counts decreased from 1980s levels in the North and Middle Forks, 35 years after construction of Hungry Horse Dam.

  Swan River Dam near Bigfork had little affect on the Flathead Lake population because the Swan Lake population of bull trout was naturally isolated from Flathead Lake, and uses the Swan River tributaries for spawning.

- **Genetics**
  Genetic engineering and changing the reproductive rate of lake trout are promising ideas but currently we do not have the technology to implement them.

- **Bring back kokanee**
  The management agencies tried to bring back kokanee during the 1990s through a large-scale, multi-year stocking program, but we were unsuccessful due to high predation rates by lake trout (Figure 1.8).

- **Control northern pike**
  While northern pike do prey on bull trout, pike are not the bottleneck for bull trout populations in Flathead Lake. Bioenergetic estimates of predation on native trout by northern pike is less than 10% of the amount attributed to lake trout. Nevertheless, incentives to harvest more northern pike can be implemented by the CSKT and MFWP through fishing regulations and do not need to be addressed in a separate NEPA document. Northern pike are also discussed in the "Cumulative Effects to Bull Trout" section of this document.

- **Poison lake trout**
  While some piscicides (fish poisons) can be used effectively in smaller lakes that do not contain Endangered or Threatened species, it would not be feasible, practical, or responsible to do so in Flathead Lake.

- **Introduce other fish**
  Introducing other fish is not an appropriate action because it is not consistent with our Co-Management Plan. Moreover, introduction often results in unintended and severe negative consequences, two examples of which are the stocking of *Mysis* shrimp into the Flathead system and the stocking of lake trout into Flathead Lake.

- **Drought: Why manage when drought is the problem?**
  Drought is not something we can control. We can address it, however, by maintaining the upper reaches of streams in good-to-excellent habitat condition. The Forest Service, DNRC, and MFWP have worked diligently to do that in the Flathead Basin. Thus, while drought can affect water temperatures in streams with low flows and low amounts of shade, this effect will be minimized in the Flathead Basin. Decreases in recent redd counts relative to counts in the 1980s are due to factors other than drought. Drought and climate change are discussed in the "Cumulative Effects" section of this document.

- **Wildlife Issues, including Threatened and Endangered Species.**
  Potential direct and indirect effects would occur in the Project Area (Figure 1.1) and cumulative effects would occur in the Analysis Area (Figure 3.1).

  - **Grizzly Bear**
    Grizzly bears are listed as a Threatened species under the federal Endangered Species Act. Grizzly bears occur in the Mission Range to the east of Flathead Lake, and they have been observed occasionally at lower elevations near the east and southeast side of the lake. They do not usually occur in the lake itself, although a grizzly bear swam across the lake from a point east of Rollins to the northeastern side of Wildhorse Island in 2010. The same bear then swam across the lake from the south side of Wildhorse Island to the south shore near Drift (Bootlegger Island), and then crossed the lake again between Rocky Point and the east side of Skidoo Bay.

    Based on decades of observing bear movements by the Tribal Wildlife Management Program, there is no evidence that the fishery in Flathead Lake has provided a substantial food source to area grizzly bears in recent times. Therefore, we do not anticipate that the proposed activity will threaten the survival of grizzly bears in the area. It is possible that increasing migratory fish, which includes most native fish (lake trout are not migratory), would provide a food source for bears that use the rivers and tributaries in the Flathead Basin.

  - **Canada Lynx**
    Canada lynx do not use habitats that overlap the area of the proposed activity. As a result, no impact upon Canada lynx or their habitat is anticipated.

- **Bald Eagles**

  The Tribal Wildlife Program inventories nesting bald eagles on the Reservation, and the birds are common on the southern half of Flathead Lake. Other pairs nest on the north end of the lake. Winter surveys of bald eagles conducted in January of each year indicate that both adult and subadult birds are relatively common during that time.

  Bald eagles that nest on Flathead Lake feed heavily on fish. Native fish such as suckers and pikeminnows comprise the primary prey, although other species are captured as well. Nesting bald eagles on the lake do not use salmonids regularly but tend to feed more on non-game fish that frequent shallower habitats and are thus more available to eagles. During winter, bald eagles feed more on waterfowl (primarily American coots and mallard ducks) than fish. Waterfowl are often concentrated on the lake and can be caught in ice build-ups near shore where they are readily available to bald eagles.

  To date, there have been no instances of bald eagles (or any other bird species) becoming entangled in nets, and there has been no mortality from the netting conducted annually by the Tribal Fisheries Program. We do not anticipate adverse population impacts on bald eagles due to direct mortality from any of the proposed alternatives. The possibility, although slight, exists that eagles might become tangled in nets near the water surface and those birds could be injured or drown. The potential is small, however, because the nets are located in water deeper than that used by bald eagles. Any change in the Flathead Lake fishery composition (and therefore prey to bald eagles) is not anticipated to adversely affect either nesting or wintering bald eagles because bald eagles prey most often on other, more readily available fish species and because of the overall inaccessibility of salmonids to bald eagles that forage in Flathead Lake.

- **Trumpeter Swan**

  Trumpeter swans are present on Flathead Lake primarily during two migration periods—in late March and late November. Resident trumpeter swans are occasionally found on Flathead Lake throughout the year, but they do not utilize the lake extensively. Nearly all swan observations on the lake are of swans using shallow bays, such as East Bay, the west shore, and the north shore for foraging due to the availability of aquatic plants in those areas.

  We do not anticipate any measurable negative direct, indirect, or cumulative effects to individual trumpeter swans or their populations because of how swans forage; swans forage by swimming slowly in water less than 5-to-6 feet deep where they tip their hind-ends up and reach underwater with their necks and bills to find vegetation growing on the lake bottom. Gill and trapnetting activities would occur in much deeper habitats than those where swans forage.

- **Common Loon**

  Common loons are present on Flathead Lake during the summer, autumn, and spring. They are a diving bird that captures and feeds on small fish. They utilize deep water habitats, as well as other, more shallow areas of the lake. They apparently do not nest on the lake probably because of the limited availability of adequate nesting habitat and the significant amount of recreational-boat disturbance during the summer. Loons are observed regularly in the shallow bays as well as in deep water areas during autumn and spring months when they are migrating through the area.

The proposed activity has limited potential to either capture and injure or kill common loons. Loons often become entangled in discarded fishing line below the water surface and then drown when they are unable to get free. To date, there have been no instances of any bird species becoming entangled in nets or mortality from netting conducted annually by the Tribal Fisheries Program. We anticipate that the potential for entanglement from any of the proposed alternatives would be small due to the timing of the netting activity. Loons would generally not be foraging at night when the proposed gillnetting would occur.

- **Osprey**

  Ospreys are common on Flathead Lake. They nest along most shoreline areas and feed exclusively upon fish. Ospreys on Flathead Lake feed primarily on nongame fish species, which are generally found in shallow waters, although foraging ospreys are opportunistic and will take any fish near the surface that is of catchable size. Most foraging takes place in shallower water, but it may also occur in deeper waters.

  The proposed action could adversely affect osprey if they were to become entangled in fishing nets. However, to date there have been no instances of any bird species becoming entangled in nets, and there has been no mortality from the netting conducted annually by the Tribal Fisheries Program. We anticipate that the potential for entanglement from any of the proposed alternatives would be small due to the depth of the net placement and the timing of the netting activity.

- **Grebes**

  Six species of grebes (horned, eared, pied-bill, red-necked, Clark's, and western) are found at Flathead Lake. All are diving birds that feed on small fish, freshwater invertebrates, and crustaceans. The proposed action is not anticipated to result in substantial adverse effects to prey resources of grebes. It could result in the entanglement of grebes in nets, but the possibility is very small due to the timing and depth of the netting activity, and the fact that fish caught in the nets would be larger than grebes could consume.

- **Mergansers**

  Two species of mergansers (common and hooded) are found on Flathead Lake. Similar to grebes, mergansers are diving bids that feed on small fish, freshwater invertebrates, and crustaceans. The proposed action is not anticipated to result in substantial adverse effects to the prey of mergansers. Mergansers might become entangled in nets, but the possibility is limited due to the timing of the netting activity.

- **Other species of waterfowl and water birds**

  Several other species of migratory waterfowl and waterbirds are present on Flathead Lake during various seasons. Most use other foraging habitats that do not bring them into contact with areas proposed for netting. In addition, their foraging habitats and the manner and timing of foraging would generally ensure that they would be safe from netting activities. To date, there have been no instances of any bird species becoming entangled in nets, and there has been no mortality from the netting conducted annually by the Tribal Fisheries Program.

Significant Issues

Significant issues are questions, concerns, or problems directly or indirectly caused by implementing the proposed action. All alternatives strive for a stable but reduced lake trout population size in the future. While harvest levels needed to maintain a stable but smaller lake trout population would decline over time as the population declines, harvest would still need to be maintained indefinitely. Actions to reduce lake trout numbers must be implemented indefinitely to be successful. If harvest is stopped, the lake trout population would immediately begin to expand.

Issue 1: Biological and ecological effects of the proposed action

Management actions that remove lake trout, the top predator in Flathead Lake, would change the abundance and size structure of the lake trout population. In turn, all the species lake trout they prey on, especially bull trout and westslope cutthroat trout, would respond to some degree.

- **Indicators for Issue 1**
  We have evaluated abundance, growth rate, and condition of lake trout. Parameters we measured to assess lake trout include:
  1. Numbers of lake trout in total and by size class (current and post action)
  2. Population structure of lake trout (current and post-action), specifically the change in abundance from one age class to the next. This would indicate if the population has been measurably decreased and is starting on a downward trend.
  3. Growth rate of individual lake trout
  4. Body condition of individual lake trout
  5. Stochastic age-structured lake trout simulation modeling

  We have evaluated the abundance, distribution, and condition of bull trout and westslope cutthroat trout. Parameters we measure to assess bull trout and westslope cutthroat trout include:
  1. Number of bull trout redds
  2. Number of bull trout killed during angling and management actions
  3. Number of stream reaches that produce bull trout redds
  4. Diet of lake trout (Appendix 4)
  5. Number in spring and autumn standardized gillnetting

  We evaluated the abundance and distribution of lake whitefish and the abundance and role of phytoplankton, zooplankton, and invertebrates.

Issue 2: Fishing opportunity

Many commenters expressed a desire to continue to be able to catch large numbers of lake trout and large-sized lake trout and said that having easy fishing was important for youngsters. Issue 2 includes the level of overall sport-fishing, lake trout fishing, the potential to fish for native species, and maintaining a trophy fishery for lake trout.

- **Indicator for Issue 2**
  1. Average catch rate
     Methods used to determine the average catch rate include:
     - Lakewide creel surveys

- Seasonal species-specific surveys to address fisheries for yellow perch, lake whitefish and westslope cutthroat trout
- Tallying the results of Mack Days

Issue 3: Fishing economy

Management actions that make lake trout become more difficult to catch, could reduce angling activity and the income of local fishing businesses. Conversely, businesses could be enhanced by recreationists or anglers who want to fish for or see native species, or respond to potentially improved opportunities for yellow perch and lake whitefish.

- **Indicators for Issue 3:**
  1. Angler days
     The Co-Management plan goal for Flathead Lake is 50,000 angler-days (one person found using Flathead Lake on one day, regardless of the length of time spent equals one angler day). The Co-Management plan goal for the Flathead River upstream from Flathead Lake is year-2000 levels, which is nearly 40,000 angler-days. Methods used to count anglers include:
     - Aerial counts of angler activity
     - Mail-in surveys of angler activity
  2. Effects on the economy. Parameters include:
     - Population, employment, and personal income within Lake and Flathead Counties
     - Seasonal unemployment rate for Lake and Flathead Counties
     - Employment in travel and tourism sectors in Lake and Flathead Counties
     - Total annual expenditures by Flathead-system anglers
     - Net economic value per year of Flathead Lake and Flathead River fishing
  3. Flathead Lake and Fisheries Co-Management Plan Costs to implement the action. Parameters include:
     - Cost to remove lake trout for each method (relative cost per effort)

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Alternatives

Introduction

This chapter describes and compares the alternatives—how the alternatives meet the objectives and the differences in the effects of the alternatives on the significant issues identified in Chapter 1. The management agencies have intentionally not chosen a preferred alternative at this time. The selection of a preferred alternative will come after giving full consideration to public comments. The alternatives include:

- **Alternative A**
  NEPA-defined no action (maintain the status quo actions, including Mack Days fishing contests, and the slot-length limit).

- **Alternative B**
  Reduce the population of adult lake trout (age 8 and older) by 25% using Mack Days, targeted gillnets, trapnets, and by allowing anglers to legally keep fish of all sizes (there would be no “slot” limit).

- **Alternative C**
  Reduce the population of adult lake trout (age 8 and older) by 50% using Mack Days, targeted gillnets, trapnets, and by allowing anglers to legally keep fish of all sizes (there would be no “slot” limit).

- **Alternative D**
  Reduce the population of adult lake trout (age 8 and older) by 75% using Mack Days, targeted gillnets, trapnets, and by allowing anglers to legally keep fish of all sizes (there would be no “slot” limit).

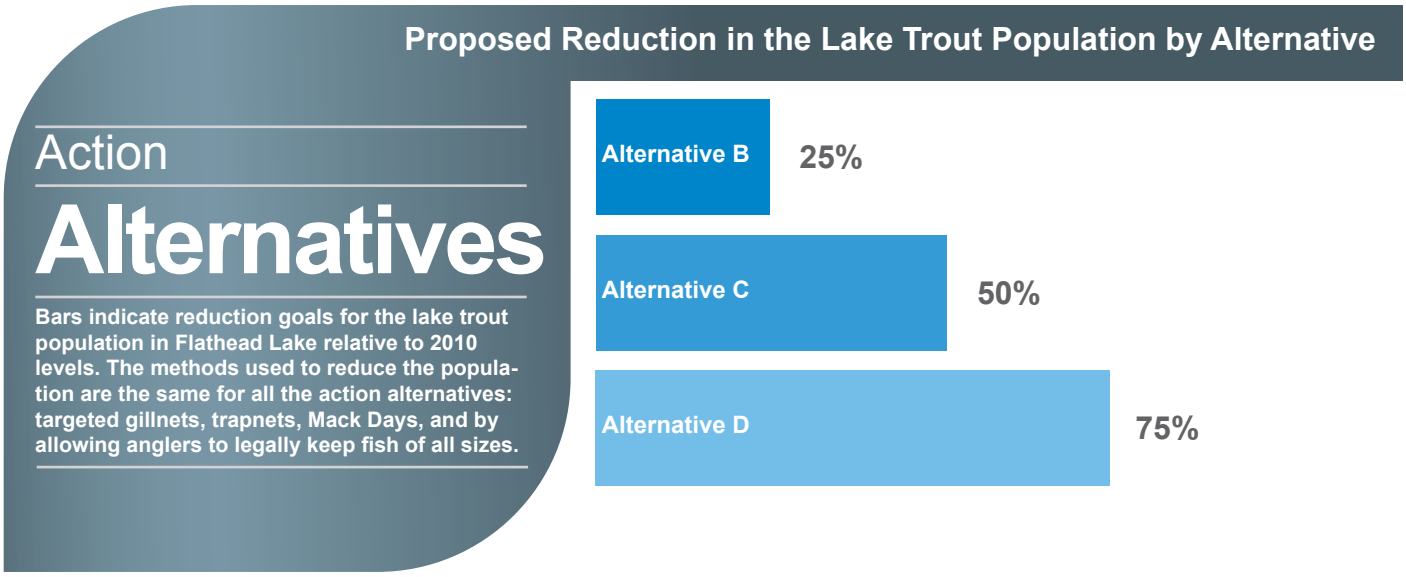

Figure 2.1. Bars show the goal of each action alternative for reducing the lake trout population relative to 2010 levels. Action alternatives would supplement the current management strategies and techniques to reduce lake trout, whereas the "no action alternative" (Alternative A) would continue the present course of action, which is to use recreational angling (including Mack Days) to reduce the lake trout population.

The Alternatives

Alternative A

Alternative A is the "No Action" alternative. A No Action Alternative is included in every EIS in order to provide a baseline to compare the environmental consequences of the action alternatives against existing management. The phrase "no action" does not mean "do nothing"; rather, it means maintaining the status quo actions.

No Action

Current management would continue unchanged.

Specifically, Alternative A would:

- **Continue the General Harvest using current fishing regulations for lake trout in Flathead Lake, which includes:**

  - A Daily Creel Limit of 100 lake trout less than 30 inches.

  - No lake trout may be kept that are between 30 and 36 inches (Slot Limit).

  - Of the daily creel limit, one fish may be greater than 36 inches.

  - Possession Limit: no more than two times the daily limit of any species in possession at any location at any time.

  - Exceptions to standard limits for Flathead Lake: two lines with up to two hooks each allowed.

- Fishing regulations may change during the future implementation of this proposed action. For analysis purposes, we have assessed the current or 2012 fishing regulations because we have no way of knowing what the future regulations will be.

- **Continue the fishing contest known as Mack Days using the 2011 regulations. See www.mackdays.com for details.**

Alternative B

The goal of Alternative B is to reduce the population of adult lake trout (age 8 and older) in Flathead Lake by 25% relative to the 2010 levels, which means an annual harvest target of 84,000 lake trout age 4 and above (the actual harvest could range between 79,000 and 100,000 fish). Alternative B, like all of the action alternatives, would accomplish this by continuing Mack Days and when necessary adding a mix of tools such as bounties, commercial fishing, targeted gillnets, and trapnets to reach and maintain their respective reductions in adult lake trout numbers. Bounties would be dependant on legislative approval. Specifically, Alternative B would:

25%
reduction
Annual target of 84,000 (between 79,000 & 97,000) fish. Method: Adding the option of targeted gillnets and trapnets to existing strategies.

- **Continue the general harvest.**

- **Change the regulations to make it legal to keep lake trout from 30 to 36 inches long.**

- **Continue Mack Days and expand it if possible.**

- **If we do not reach the annual harvest target of 84,000 fish with angling, we could use bounties, targeted gillnets, and trapnets to reach and maintain a 25% reduction in adult lake trout numbers. The use of lakewide bounties in the future would require legislative approval.** Because trapnetting is labor intensive and expensive, we anticipate that we would, at least initially, only be able to capture a small percentage of lake trout with trapnetting. We estimate we would need approximately 120,000 feet of gillnet to reach the target (Appendix 5).

- **Potential Future Action**
  To achieve and maintain the lake trout population at 25% below current abundance, we would need to initiate an annual harvest of 84,000 lake trout age 4 and above that would gradually decline over the next 50 years to 62,000 (Appendix 6).

Alternative C

The goal of Alternative C is to reduce the population of adult lake trout (age 8 and older) in Flathead Lake by 50% relative to the 2010 levels, which means an annual harvest target of 112,000 lake trout age 4 and above (the actual harvest could range between 101,000 and 125,000 fish). Alternative C, like all of the action alternatives, would accomplish this goal by continuing Mack Days and when necessary adding a mix of tools such as bounties, commercial fishing, targeted gillnets, and trapnets to reach and maintain their respective reductions in adult lake trout numbers. Bounties would be dependant on legislative approval. Specifically, Alternative C would:

50%
reduction
Annual target of 112,000 (between 101,000 & 125,000) fish. Method: Adding the option of targeted gillnets and trapnets to existing strategies.

- **Continue the general harvest.**
- **Change the regulations to make it legal to keep lake trout from 30 to 36 inches long.**
- **Continue Mack Days and expand if possible .**
- **If we do not reach the annual harvest target of 112,000 fish with angling, we could use bounties, targeted gillnets, and trapnets to reach and maintain a 50% reduction in adult lake trout numbers. The use of bounties in the future would require legislative approval.**
  Because trapnetting is labor intensive and expensive, we anticipate that we would, at least initially, only be able to capture a small percentage of lake trout with trapnetting. We estimate we would need approximately 286,700 feet of gillnet to reach this target (Appendix 5).
- **Potential Future Action**
  To achieve and maintain the lake trout population at 50% below current abundance, we would need to initiate an annual harvest of 112,000 lake trout age 4 and above that would gradually decline over the next 50 years to 64,000 (Appendix 6).

Alternative D

The goal of Alternative D is to reduce the population of adult lake trout (age 8 and older) in Flathead Lake by 75% relative to the 2010 levels, which means an annual harvest target of 143,000 lake trout age 4 and above (the actual harvest could range between 129,000 and 157,000 fish). Alternative D, like all of the action alternatives, would accomplish this goal by continuing Mack Days and when necessary adding a mix of tools such as bounties, commercial fishing, targeted gillnets, and trapnets to reach and maintain their respective reductions in adult lake trout numbers. Bounties would be dependant on legislative approval. Specifically, Alternative D would:

75%
reduction
Annual target of 143,000 (between 129,000 & 157,000) fish. Method: Adding the option of targeted gillnets and trapnets to existing strategies.

- **Continue the general harvest.**
- **Change the regulations to make it legal to keep lake trout from 30 to 36 inches long.**

- **Continue Mack Days and expand if possible.**

- **If we do not reach the annual harvest target of 143,000 fish with angling, we could use bounties, targeted gillnets, and trapnets to reach and maintain a 75% reduction in adult lake trout numbers. The use of bounties in the future would require legislative approval.** Because trapnetting is labor intensive and expensive, we anticipate that we would, at least initially, only be able to capture a small percentage of lake trout with trapnetting. We estimate we would need approximately 486,700 feet of gillnet to reach this target (Appendix 5).

- **Potential Future Action**
  To achieve and maintain the lake trout population at 75% below current abundance, we would need to initiate an annual harvest of 143,000 lake trout age 4 and above that would gradually decline over the next 50 years to 20,000 (Appendix 6).

Comparison of Alternatives

Table 2.1 lists the effects of each alternative as measured by indicators.

Table 2.1 (Part 1). Summary of Predicted Effects of each alternative.

Indicator 1: Biological and ecological effects of the proposed action on fish populations over the long term

Alt	Lake Trout			Bull Trout			Westslope Cutthroat Trout		
	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative
A	• No change in Age 8+	•50% decrease in Age 22+lake trout from starting conditions after 50 years relative to the baseline. •Increased growth rate, condition and decreased age at maturity.	•Dispersal beyond Flathead Lake most likely. •Possible increased competition from non-native fish and invertebrates.	•Bycatch of 163 bull trout and short-term risk of decrease in population size. •37% reduction in losses from predation.	•Potential long-term increase of 1,875 adults.	•Additional stress from climate change and non-native competitors and predators.	•Negligible bycatch. •Moderate reduction in losses from predation by lake trout.	•Small long-term increase of population size.	•Additional stress from climate change and non-native competitors.
B	•25% reduction in age 8+ after 50 years	•78% decrease in Age 22+lake trout from starting conditions after 50 years. •Increased growth rate, condition and decreased age at maturity.	•Dispersal beyond Flathead Lake less likely than Alt A. •Possible increased competition from non-native fish and invertebrates.	•Bycatch of 221 bull trout and short-term risk of decrease in population size. •65% reduction in losses from predation.	•Potential long-term increase of 3,274 adults.	•Additional stress from climate change and non-native competitors and predators.	•Negligible bycatch. •58% reduction in losses from predation by lake trout over the long term.	•Moderate long-term increase of population size; greater than Alt. A.	•Additional stress from climate change and non-native competitors.
C	•50% reduction in age 8+ after 50 years	•92% decrease in Age 22+lake trout from starting conditions after 50 years. •Increased growth rate, condition and decreased age at maturity.	•Dispersal beyond Flathead Lake less likely than Alt A and B. •Possible increased competition from non-native fish and invertebrates.	•Bycatch of 338 bull trout and short-term risk of decrease in population size. •84% reduction in losses from predation.	•Potential long-term increase of 4,184 adults.	•Additional stress from climate change and non-native competitors and predators.	•Negligible bycatch. •77% reduction in losses from predation by lake trout over the long term.	•Moderate long-term increase of population size; greater than Alt. A and B.	•Additional stress from climate change and non-native competitors.
D	•75% reduction in age 8+ after 50 years	•98% decrease in Age 22+lake trout from starting conditions after 50 years. •Increased growth rate, condition and decreased age at maturity.	•Dispersal beyond Flathead Lake less likely than Alt A, B, and C. •Possible increased competition from non-native fish and invertebrates.	•Bycatch of 467 bull trout and short-term risk of decrease in population size. •93% reduction in losses from predation.	•Potential long-term increase of 4,650 adults.	•Additional stress from climate change and non-native competitors and predators.	•Negligible bycatch. •91% reduction in losses from predation by lake trout over the long term.	•Large long-term increase of population size; greater than Alt. A, B and C.	•Additional stress from climate change and non-native competitors.

Table 2.1 (Part 2). Summary of Predicted Effects of each alternative.

Indicator 1 (cont.): Biological and ecological effects of the proposed action on fish populations over the long term						
Alt	Lake Whitefish			Mysis and other Invertebrates		
	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative
A	• Negligible Bycatch. • Moderate reduction in losses from predation by lake trout.	• Small long-term increase in population size.	• Additional stress from climate change and non-native competitors.	• Small increase in losses from predation by lake trout.	• Decrease to 34/m^2	• Additional stress from climate change and non-native competitors.
B	• Bycatch of 35,000 lake whitefish. • 60% reduction in losses from predation by lake trout.	• No measurable change in population size.	• Additional stress from climate change and non-native competitors.	• Moderate increase in losses from predation by lake trout.	• Increase to 51/m^2	• Additional stress from climate change and non-native competitors.
C	• Bycatch of 105,000 lake whitefish. • 79% reduction in losses from predation by lake trout.	• No measurable change in population size.	• Additional stress from climate change and non-native competitors.	• Moderate increase in losses from predation by lake trout.	• Increase to 81/m^2	• Additional stress from climate change and non-native competitors.
D	• Bycatch of 182,500 lake whitefish. • 88% reduction in losses from predation by lake trout.	• No measurable change in population size.	• Additional stress from climate change and non-native competitors.	• Moderate increase in losses from predation by lake trout.	• Increase to 130/m^2	• Additional stress from climate change and non-native competitors.

Table 2.1 (Part 3). Summary of Predicted Effects of each alternative.

Indicator 2: Fishing opportunity—average catch rates over the long term

Alt	Lake Trout			Bull Trout			Westslope Cutthroat Trout		
	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative
A	•No change 0.59 / hr.	•Reduced opportunity for large fish.	•None.	•Low opportunity, currently unquantified.	•None.	•Climate change and non-natives may reduce catch rates	•Low opportunity, currently unquantified	•None	•Climate change and non-natives may reduce catch rates
B	•Decrease to 0.54 / hr.	•Reduced opportunity for large fish.	•Improved angler expertise from education .	•Slightly greater opportunity than A.	•Improved catch rates in river	•Climate change and non-natives may reduce catch rates	•Slightly greater opportunity than A	•Improved catch rates in river	•Climate change and non-natives may reduce catch rates
C	•Decrease to 0.47 / hr.	•Reduced opportunity for large fish.	•Improved angler expertise from education.	•Moderately greater opportunity than A.	•Improved catch rates in river; greater than Alt. B.	•Climate change and non-natives may reduce catch rates	•Moderately greater opportunity than A	•Improved catch rates in river; greater than Alt. B	•Climate change and non-natives may reduce catch rates
D	•Decrease to 0.34 / hr.	•Reduced opportunity for large fish.	•Improved angler expertise from education.	•Moderately greater opportunity than A.	•Improved catch rates in river; greater than Alt. B and C.	•Climate change and non-natives may reduce catch rates	•Moderately greater opportunity than A	•Improved catch rates in river; greater than Alt. B & C	•Climate change and non-natives may reduce catch rates

Table 2.1 (Part 4). Summary of Predicted Effects of each alternative.

Indicator 2 (cont.): Fishing opportunity—average catch rates over the long term			
Alt	Lake Whitefish		
	Direct	Indirect	Cumulative
A	•High during specific periods.	•Changes in perch may change catch rates.	•Climate change and other non-natives may affect catch rates.
B	•No change.	•Changes in perch may change catch rates.	•Climate change and other non-natives may affect catch rates.
C	•No change.	•Changes in perch may change catch rates.	•Climate change and other non-natives may affect catch rates.
D	•No change.	•Changes in perch may change catch rates.	•Climate change and other non-natives may affect catch rates.

Table 2.1 (Part 5). Summary of Predicted Effects of each alternative.

Indicator 3: Fishing Economy

Alt	Angler Days			Effects on the Economy			Cost to Implement the Action		
	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative	Direct	Indirect	Cumulative
A	•Flathead Lake: unlikely to change.	•Flathead River system: unlikely to change.	•Many factors affect angler visits to Flathead Lake and insulate the economy from changes in angling.	•Total annual angler spending of $20,108,000.	• Continued fishing for other species and in other water bodies	•Future economic and social changes are likely. Climate change affects unknown.	•$350,000	•Future changes in wages, fuel, etc.	•Future economic changes could inflate costs.
B	•Flathead Lake: comparable number of lake trout fishing days as Alt. A.	•Flathead River system: slightly more fishing days than Alt. A.	•Many factors affect angler visits to Flathead Lake and insulate the economy from changes in angling.	•5.3% reduction in angler spending on lake trout fishing.	•Unquantified increase in fishing for other species and in other water bodies	•Future economic and social changes are likely. Climate change affects unknown.	•$462,000	•Future changes in wages, fuel, etc.	•Future economic changes could inflate costs.
C	•Flathead Lake: moderately fewer lake trout fishing days than Alt. A.	•Flathead River system: slightly more fishing days than Alt. A.	•Many factors affect angler visits to Flathead Lake and insulate the economy from changes in angling.	•8.2% reduction in angler spending on lake trout fishing.	•Unquantified increase in fishing for other species and in other water bodies	•Future economic and social changes are likely. Climate change affects unknown.	•$686,000	•Future changes in wages, fuel, etc.	•Future economic changes could inflate costs.
D	•Flathead Lake: much fewer lake trout fishing days than Alt. A.	•Flathead River system: moderately more fishing days than Alt. A.	•Many factors affect angler visits to Flathead Lake and insulate the economy from changes in angling.	•11.6% reduction in angler spending on lake trout fishing.	•Unquantified increase in fishing for other species and in other water bodies	•Future economic and social changes are likely. Climate change affects unknown.	•$934,000	•Future changes in wages, fuel, etc.	•Future economic changes could inflate costs.

Alternatives Considered But Eliminated From Detailed Study

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and briefly discuss the reasons for eliminating any alternatives that were not developed in detail. Public comments received during Scoping provided suggestions for alternative methods to achieve the purpose and need. Some were outside the scope or duplicative of the alternatives considered in detail, or they would cause unnecessary environmental harm if implemented. We considered and dismissed the following alternatives from detailed consideration.

- **Increase harvest to the point of sustaining a maximum of 50,000 angler-days**
  This alternative did not set a specific reduction goal for the lake trout population. Rather, lake trout removal would continue as long as the 50,000 angler-days threshold was maintained. Methods would include the full range of options—general harvest, fishing contests, trapnets, and gillnets. We estimate the percent reduction would be at least 60%, but this is an estimate; the actual percentage is unknown. Because it does not include a goal for an actual percentage reduction, this action would be difficult to analyze relative to the other alternatives. In addition, all of the proposed alternatives need to maintain 50,000 angler-days. The team felt we would still have a range of alternatives by keeping the other proposed alternatives and dropping this alternative.

- **Do nothing except general harvest**
  Because this alternative did not meet the purpose and need to reduce lake trout numbers, it was dropped from further consideration. If the Tribes wanted to implement only the General Harvest in the future, they would not need a NEPA analysis to do so. However, because the analysis of the effects of this alternative was of interest to team members, we have included this information in Appendix 7, Draft Analysis of Two Alternatives Considered but Eliminated.

- **Reduce lake trout using mostly trapnets rather than gillnets**
  The IDT considered emphasizing trapnets for several lake trout reduction alternatives. However, because trapnets can only be used in specific and restricted areas of Flathead Lake (Appendix 5), and because it takes considerable time to become efficient with trapnets, we decided it was not feasible to rely on them to harvest the targeted numbers of lake trout. Instead, we combined targeted gillnetting and trapnetting so we could use both methods. Trapnetting, regardless of the action alternative selected, will likely be maximized in the future based on the tradeoffs between costs and bycatch.

- **Expand Mack Days**
  The IDT initially considered an alternative that would attempt to increase harvest from Mack Days contests. Results from the 2011 contests indicated that harvest did not increase despite increased prize money. Without unreasonable changes in duration and prize money, the contests seem to have reached their capacity. We therefore considered this alternative to not be feasible. See Appendix 5 for more information on future potential of contests.

  In addition, under all of the action alternatives, if total harvest increases during Mack Days or the General Harvest, harvest by netting will be reduced proportionally.

- **Reduce lake trout by 50% while retaining the slot limit**
  The IDT initially considered reduction alternatives that retained the slot limit (the provision that makes it illegal for anglers to keep lake trout sized 30-36 inches long), a provision intended to maintain trophy-sized lake trout. The IDT members concluded that the slot limit was inconsistent with the purpose and need statement, which is to reduce lake trout to benefit native fish species. Other members suggested that retaining the slot provision as part of Alternative C would be misleading because our analysis showed that over time, trophy-sized fish would still become rare-to-absent, even with the slot limit. This is because with increased harvest levels, fewer intermediate-sized fish would survive to grow into the trophy size-class. This phenomenon occurred at the 50% lake trout reduction level, although the trophy-sized fish were able to persist longer under this scenario than in the other reduction alternatives. Still, the Interdisciplinary Team thought retaining the slot limit might make it appear that trophy-sized fish would be retained, even though our analysis shows that trophy-sized fish would essentially be lost over time. Therefore, the alternative that would retain the slot limit was eliminated.

- **Test trapnets and gillnets on a limited basis to prepare for future action**
  This alternative would have used the current General Harvest regulations, the Mack Days fishing contests (estimated at 35,000 lake trout annually), and limited gillnetting and trapnetting that would not exceed 5,000 lake trout. MFWP estimated that under this alternative, the total annual lake trout harvest would be 60,000 fish. This alternative was dropped from further analysis because it did not meet the purpose and need to reduce lake trout numbers and because it did not differ appreciably from Alternative A. In addition, because the alternative does not meet the purpose and need, the Tribes could no longer justify funding the Mack Days contests.

- **Reduce the population of adult lake trout (age 8 and older) in Flathead Lake by 90%**
  The goal of this alternative would have been to reduce the population of adult lake trout (age 8 and older) in Flathead Lake by 90% relative to the 2010 levels, which means an annual harvest target of 188,000 lake trout age 4 and above (the actual harvest could range between 169,000 and 207,000 fish). This would have been accomplished by changing management strategies to add the option of using targeted gillnets and trapnets. Specifically, the alternative would have continued the General Harvest; changed the regulations to make it legal to keep lake trout from 30 to 36 inches long; continued Mack Days (with the slot limit removed). Under this alternative, if we had not reached our annual harvest target of 188,000 fish, we would have used targeted gillnets and trapnets to reach and maintain a 90% reduction in adult lake trout numbers. This alternative would have virtually eliminated the lake trout fishery over the long term (>50 years) and because this is inconsistent with the goals of the Co-Management Plan, the alternative was dropped. However, because the analysis of the effects of this alternative was of interest to team members, we have included this information in Appendix 7, Draft Analysis of Two Alternatives Considered but Eliminated.

Mitigation Measures Common to All Alternatives

The following mitigation measures would be used as part of all the action alternatives:

- **Bull trout mortality**
  Under all the alternatives, bull trout mortality would be limited to the levels identified in predeter-

mined bycatch tables and would have to be permitted under ESA by the U.S. Fish and Wildlife Service (USFWS). Adaptive management strategies (Appendix 8) would be implemented to respond to changing circumstances especially if the permitted bycatch amounts were being approached.

In addition, under all the alternatives, the USFWS would be involved in tracking each year's activities and would require action (including potential termination of certain activities) if bull trout mortalities reached an unacceptable point (as determined by the USFWS). In addition, the USFWS would be required to issue a permit for implementation of any action alternatives.

Education efforts would continue both online and directly with anglers to improve identification of bull trout, especially juvenile characteristics.

- **Gillnetting mitigation measures to minimize non-target species bycatch**
  - Use of recovery (revival) methods, such as oxygen infusion in cold water.
  - Gillnets would be deployed to minimize bycatch by establishing the most optimal:
    - Net locations: Gillnet locations would avoid established high-use bull trout sites, such as Somers Bay, south and west of Wildhorse Island, etc.
    - Net depths: Gillnets would typically be set at 80 feet or deeper (bull trout and westslope cutthroat are typically shallower) and more than 0.25 miles from shore.
    - Season of Use (bull trout are typically in the upper watershed in summer)
    - Use of restricted mesh sizes and filament sizes least likely to capture bull trout

  For more information on strategies, see Appendix 5.

- **Grizzly bears**
  - Grizzly bear sightings and bear-human conflicts would be reported to the Tribal Fish and Wildlife Department within 24 hours, as would mountain lion conflicts.
  - Food items would be stored in closed vehicles.
  - Garbage would be stored in bear-proof areas and removed from the site daily.
  - Firearms, whether on a person or in a vehicle, would not be allowed in the work area.

- **Hazardous Material**
  Contractors would be required to properly maintain equipment and provide spill-containment materials with all equipment.

- **Weeds and Aquatic Invasive Species**
  All equipment would be pressure washed prior to use to remove or reduce the potential for noxious plant, animal, disease, or invertebrate dispersal.

Monitoring and Adaptive Management

Alternatives are designed to be implemented for an indefinite period into the future because the lake trout population and its effects on native fishes will likely persist indefinitely. The lengthy period of implementation makes it imperative that there be extensive monitoring to verify the predicted effects. There must also be flexibility to adapt to unforeseen effects. The alternatives were designed with the best available information and population modeling, but it is not reasonable to expect the system to behave precisely as

has been predicted in this document. Monitoring of effects is equally or more important than the prediction of effects that has been made in this stage of the process. Monitoring will ultimately determine the fate of this project. If monitoring indicates that success is not being achieved, primarily in the form of increases in native fish numbers, and further that the potential for success is low, the activity would be terminated. After termination, the lake trout population would likely rebound to a level similar to the level present in 2010. At that point the future of native bull and westslope cutthroat trout in the Flathead system would remain uncertain.

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Affected Environment & Environmental Consequences

Introduction

This chapter summarizes the environment and affected species of the project area (Figure 3.1) and the effects of implementing each alternative on that environment and those species. It also presents the scientific and analytical basis for comparing alternatives. It is arranged by the significant issues identified in Chapter 1:

- **Issue 1: Biological and ecological effects of the proposed action on fish populations (lake trout, bull trout, westslope cutthroat trout, lake whitefish, and yellow perch) and invertebrates (including *Mysis*), zooplankton, and phytoplankton**
- **Issue 2: Fishing Opportunity**
- **Issue 3: Fishing Economy**

Methods to determine Environmental Consequences of Removing Lake Trout

We used a bioenergetics model developed specifically for Flathead Lake (Beauchamp et al. 2006) and drew comparisons from similar systems to predict impacts on other species from reduction in lake trout numbers. The model is based on empirically derived rates of predation by specific size groups of lake trout. Large lake trout were determined to have higher rates of predation than smaller lake trout, and therefore changes in predation are influenced by the changes in the size structure of the predators. The bioenergetics modeling work was conducted by Dr. David Beauchamp (University of Washington) and others (Appendix 4).

Changes in the age and size structure of the lake trout population in response to increasing harvest were drawn from age-structured stochastic simulation modeling done by Dr. Michael Hansen (University of Wisconsin, Stevens Point) (Appendix 6). Simulation modeling requires that current population conditions be quantified to establish accurate starting conditions. The current status (growth rate, size structure, abundance, etc.) of lake trout in Flathead Lake was developed from extensive empirical data collected by CSKT and MFWP. These conditions are described in multiple reports and appendices (Appendix 6).

Simulation modeling was chosen because it is useful for understanding the likely effect of a change in system conditions, such as mortality rates changing as harvest rates change. Random variation in recruitment greatly complicates the modeling of future abundance. Variation in recruitment ranges from zero to about eight potential juveniles surviving to adulthood from each adult female, allowing for great differences in annual recruitment. Stochastic modeling identifies the most likely new state that will develop in response to a specific change after many generations. Stochastic modeling is not able to predict specific fish abundance in specific years. Instead, it informs us of the future potential states of the lake trout population relative to specific actions that might be taken.

We predict changes in growth rates and body condition of lake trout in response to increasing harvest based on extensive literature describing biological responses to changing density (Evans et al. 1991; Ferreri and Taylor 1996; Matusek et al. 1990). Conclusions about potential secondary effects from reducing lake trout numbers were also supported by other research. For example, Stapp and Hayward (2002) used demographic modeling to estimate progressively smaller population declines of Yellowstone cutthroat trout in Yellowstone Lake with progressively larger reductions in lake trout numbers. A similar process was used to predict substantial decreases in predation by northern pikeminnow on salmon in the Columbia River as northern pikeminnow abundance decreased (Rieman et al. 1990).

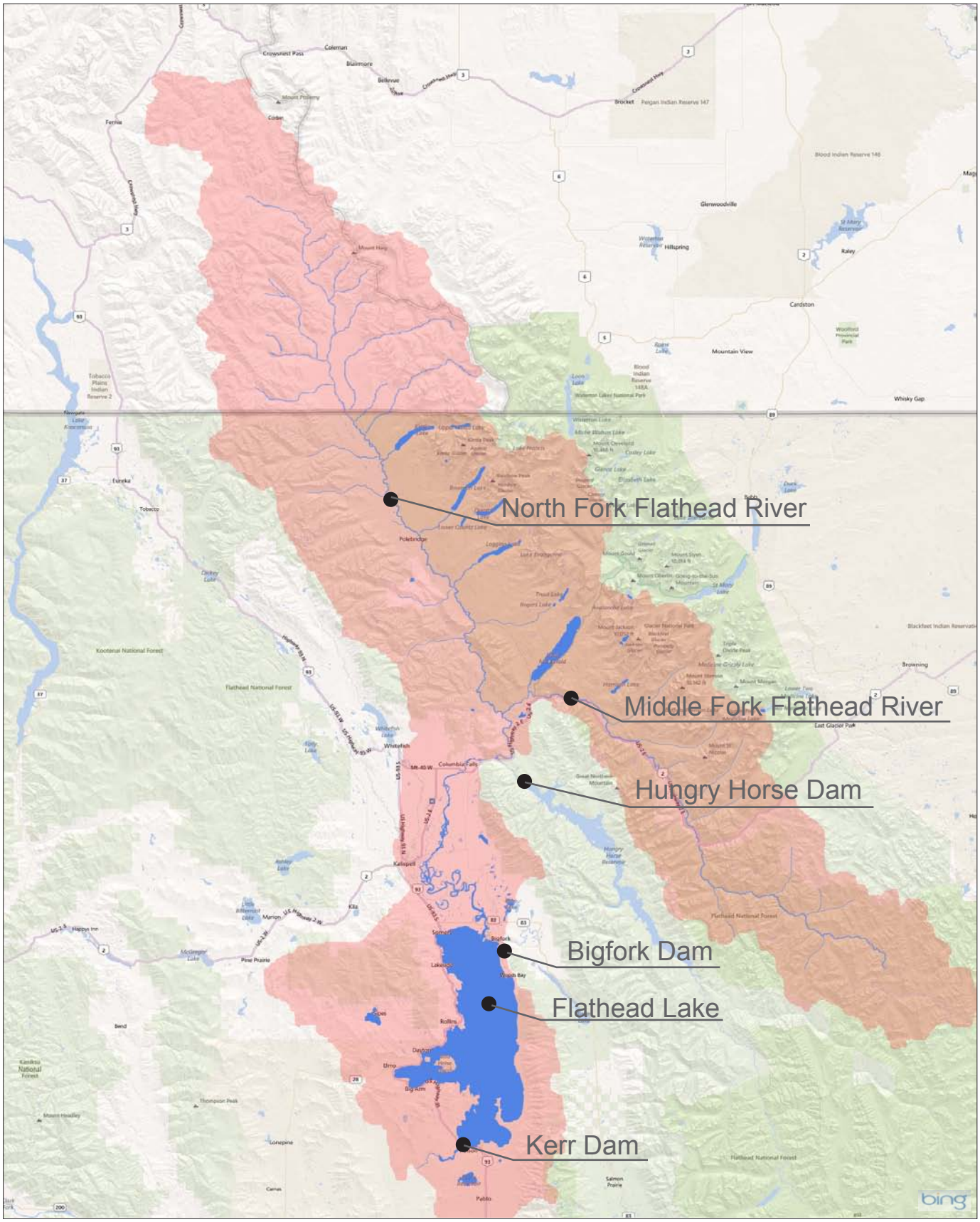


Figure 3.1. Project area (Flathead Lake) and cumulative effects analysis area (highlighted in red).

Issue 1: Biological and Ecological Effects

Affected Environment in the Project Area: Lake Trout

This section describes the affected environment or the current conditions for lake trout in Flathead Lake and the area delineated in red in Figure 3.1.

History

Lake trout were introduced into Flathead Lake in 1905, but substantial catches were not recorded until the 1940s (Elrod 1929, Schultz 1941). For the next 50 years, the population probably grew slowly because of poor juvenile survival, primarily the result of low prey abundance and the cannibalizing of juveniles by adults. The resulting population consisted mostly of older, larger individuals. A shift in the population occurred in the mid-1980s after the invasion of Flathead Lake by *Mysis* (or opossum shrimp), which had been planted in three upstream lakes: Ashley, Swan, and Whitefish (Spencer et al. 1991, Ellis et al. 2011). The shrimp provided abundant benthic prey (deep and associated with the lake bottom), thereby increasing juvenile lake trout survival and greatly expanding the lake trout population.

Habitat and Distribution

Habitat within Flathead Lake is optimal for lake trout. Lake trout prefer temperatures between 44 and 58°F (Martin and Olver 1980), which generally limits their distribution to depths greater than 50 feet during summer. Thermal habitat volume—the quantity of the water column within their preferred temperature range during summer—is limiting in many lakes but is very large in Flathead Lake (Payne et al. 1990).

Based on observations during autumn gillnet sampling, it appears spawning tends to occur in nearshore areas in depths of less than 50 feet. Juveniles typically move to the deepest portions of the lake to avoid predation by adult lake trout (Bronte et al. 1995).

Much of our information about lake trout in Flathead Lake comes from sampling with gillnets. Based on captures in gillnets, they utilize all areas and depths of the lake (Figures 3.2 through 3.4).

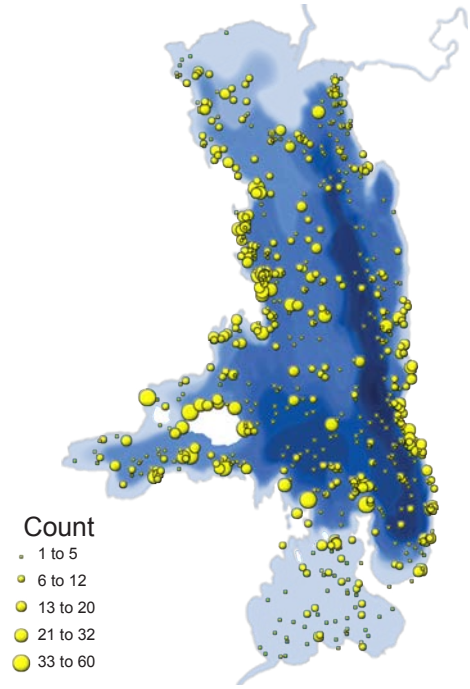
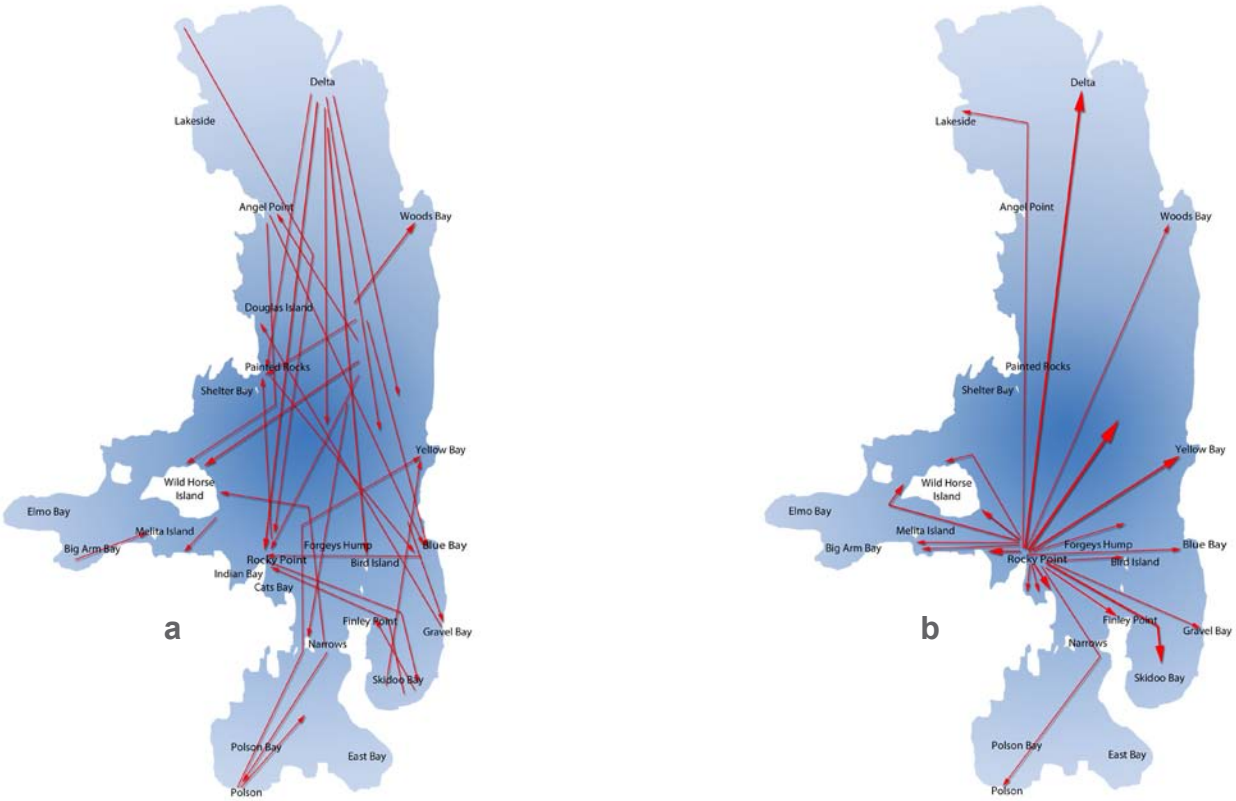


Figure 3.2. Lake trout capture locations in gillnets set predominantly during autumn, 1998 - 2010. Each circle represents a gillnet location; the circle size indicates the number of lake trout caught in each net.



Figures 3.3a and b. The lake map on the left (a) shows lake trout movements in Flathead Lake between 2007 and 2010 and recaptured during Spring Mack Days, 2010. Each line indicates at least a single fish that was marked in a location approximated by the open end of the line and recaptured in a location indicated by the arrow. The lake map on the right (b) shows movements of lake trout marked at Rocky Point between 2007 and 2012 and recaptured between 2008 and 2012. Each line indicates a single fish that was marked in a location approximated by the open end of the line and recaptured in a location indicated by the arrow. Heavier lines indicate multiple fish.

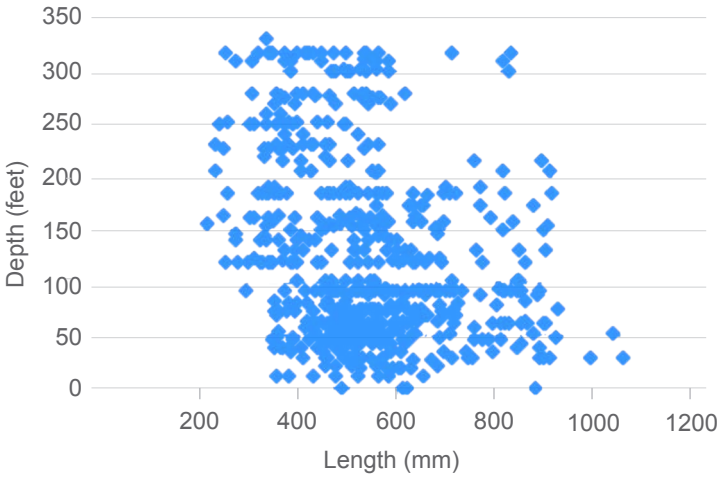


Figure 3.4. Lake trout length and depth of capture in gillnets set predominantly during autumn, Flathead Lake, 1998 to 2010.

Lake trout effectively utilize all habitats within Flathead Lake and likely move throughout the lake rather than remain solely in specific habitats. Over 5,000 lake trout have been tagged in Flathead Lake since 2007, and over 500 of them have been recaptured. Roughly 12% of the recaptured fish were recaptured in the locations where they were originally caught and marked, suggesting those individuals either had a fidelity to that location or had returned to the same location. The remaining 88% were recaptured at least two miles from the marking location (Figure 3.3a). The longest movement (23 miles) was by one individual that was captured and marked near the Flathead River delta and recaptured in Polson Bay. The most rapid and directed movement was by one individual that

was marked at Rocky Point and recaptured near the Flathead River delta (17 miles) three days later. Another individual was marked in Blue Bay and recaptured at Swan Point (7 miles) three days later. Seasonal movements of lake trout away from areas of at least temporary high density have also been documented. Rocky Point is one of the most popular fishing locations on the lake. It supports intensive angling pressure, especially during spring (Figure 1, Appendix 9) indicating the presence of high densities of lake trout. Despite these high densities there is extensive evidence that lake trout move away from Rocky Point after spring (Figure 3.3b).

A group of lake trout in Flathead Lake referred to as dwarf lake trout (because they do not exceed 24 inches in length) have restricted movements based on depth. Isotopic signatures of dwarfs indicate they remain consistently in deep-water habitats (Stafford et al. 2009). Dwarf lake trout likely remain deep because they feed predominantly on *Mysis* throughout their lives (Stafford et al. 2009). Although dwarfs are restricted to deep-water habitats, we assume they move freely throughout the deep-water zone. In contrast, the original stock introduced into Flathead Lake, called the "lean" form, utilizes *Mysis* primarily during juvenile years, and switches to fish prey as adults. Being piscivores, they grow to large size and generally utilize shallower water than used by the dwarf form.

The yield of lake trout (total weight of lake trout harvested by anglers) in Flathead Lake between 2005 and 2008 was about 0.9 pounds per acre, which is above the average for North America (Healey 1978). While high, this yield is sustainable because of Flathead Lake's relatively high productivity. These favorable growing conditions include: (1) the availability of *Mysis*, a widespread and productive food source; (2) moderate depth that retains *Mysis* within reach of lake trout; (3) abundant water volume at suitable temperatures and oxygen levels; and (4) optimal spawning habitat.

Abundance and Density

Lake trout became very abundant in Flathead Lake after *Mysis* became established. The expansion of the lake trout population following the introduction of *Mysis* has stabilized at near carrying capacity (Appendix 6). The prevailing mortality rate (the sum of natural and fishing mortality) over the last decade has been low (24%), despite increased harvest from fishing contests. This is the result of high juvenile survival and low levels of harvest by anglers. For example, modeling indicates that if all fishing mortality were removed from this population, there would only be a 6% increase in abundance (Appendix 6).

Estimates of the abundance of lake trout in Flathead Lake have been conducted frequently in the last four years. We have employed a combination of methods utilizing mark-and-recapture techniques, length distributions derived from samples obtained from gillnets and from anglers, and the application of advanced modeling tools to simulate the most accurate estimates. These methods are described in Appendix 9. The current estimate of total lake trout abundance from age 1 through age 30 is about 1.5 million fish (Figure 3.5).

Total annual mortality of lake trout in Flathead Lake (which is the combination of mortality from natural causes and harvest by anglers) is presently about 26% (Appendix 6). Anglers have been harvesting 4.1% of the age 1 and older population, 7.4% of the age 4 and older population, and 10.3% of the age 8 and older population in Flathead Lake. These exploitation rates are low, and well within the level considered sustainable. Some studied populations of lake trout have been shown to sustain their numbers under harvest rates nearly twice the level currently experienced by the Flathead Lake population (Healey 1978; Shuter 1998; Appendix 6).

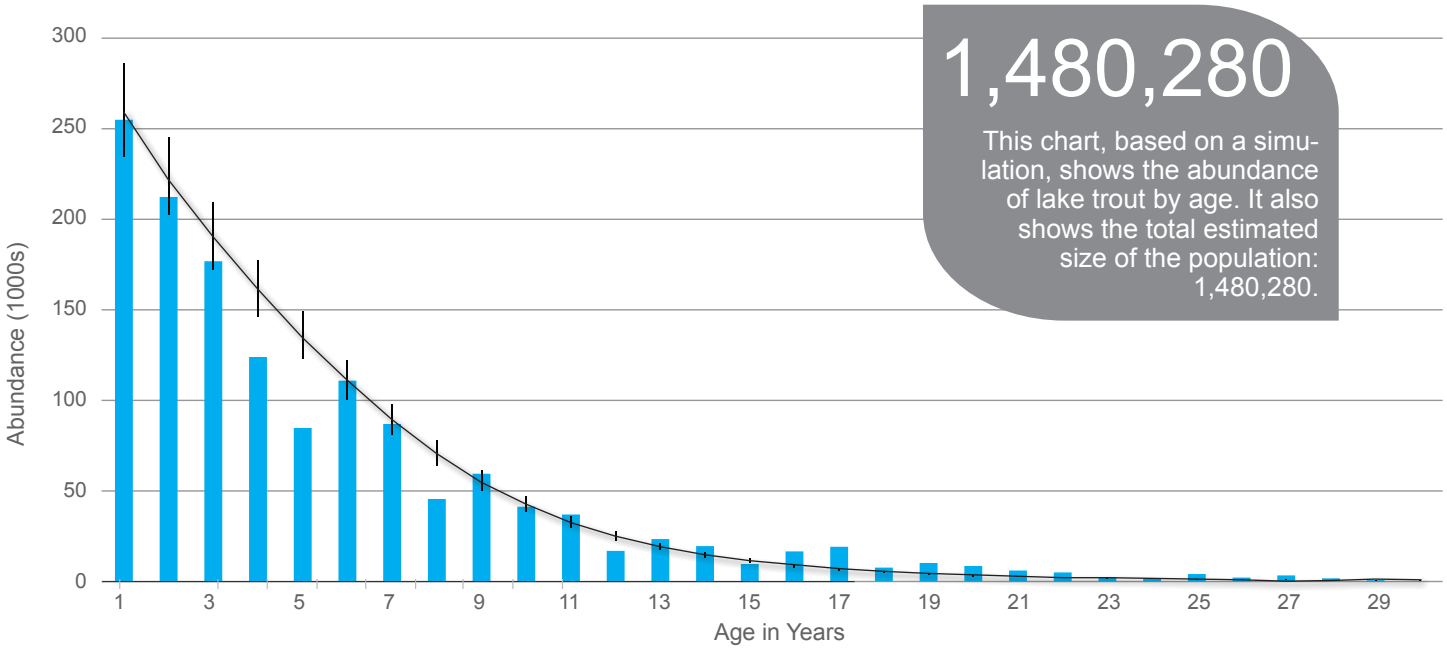


Figure 3.5. Simulated current lake trout population, derived from gillnetting and angling samples from 2008 - 2011 and corrected for length-selectivity of capture methods (Appendix 6).

Two different surveys with gillnets have been used to monitor trends in lake trout abundance. One is conducted in spring, with nets made of five different mesh sizes totalling 250 feet long, and set in 15 fixed locations (Deleray 1999). The other, conducted in autumn, consists of 300 foot-long nets made of 12 different mesh sizes, and is currently set in 72 stratified, random locations. The spring survey spans the pre- (1981-1983) and post- (1992 – present) *Mysis* periods and indicates stable catch rates in the post-*Mysis* period (Figure 3.6). The autumn survey began in the post-*Mysis* period and also indicates stable catch rates (Figure 3.7). The autumn survey also indicates stable catch rates of lake trout less than 30 inches long and increasing

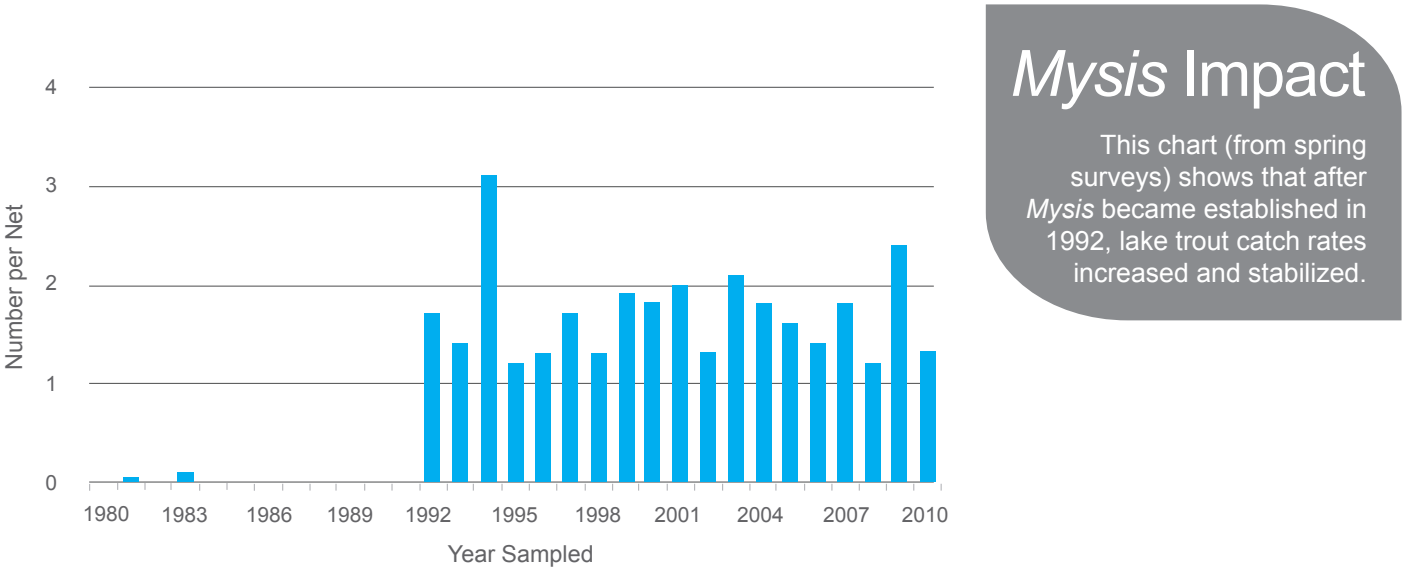
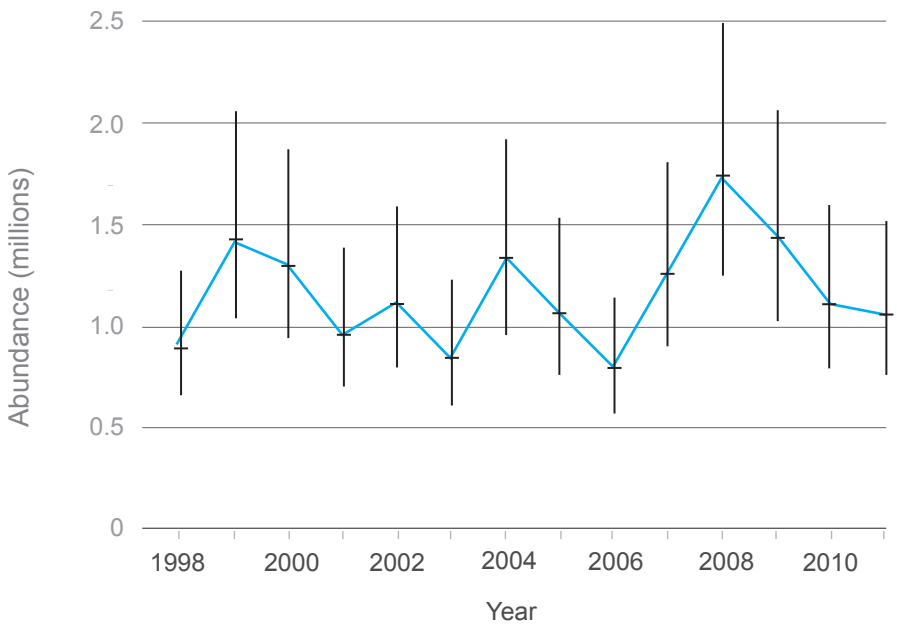


Figure 3.6. Average captures of lake trout in sinking gillnets (five mesh sizes) set in fixed locations during spring in Flathead Lake, 1981 to 2010 (MFWP). Nets were not set between 1984 and 1991.

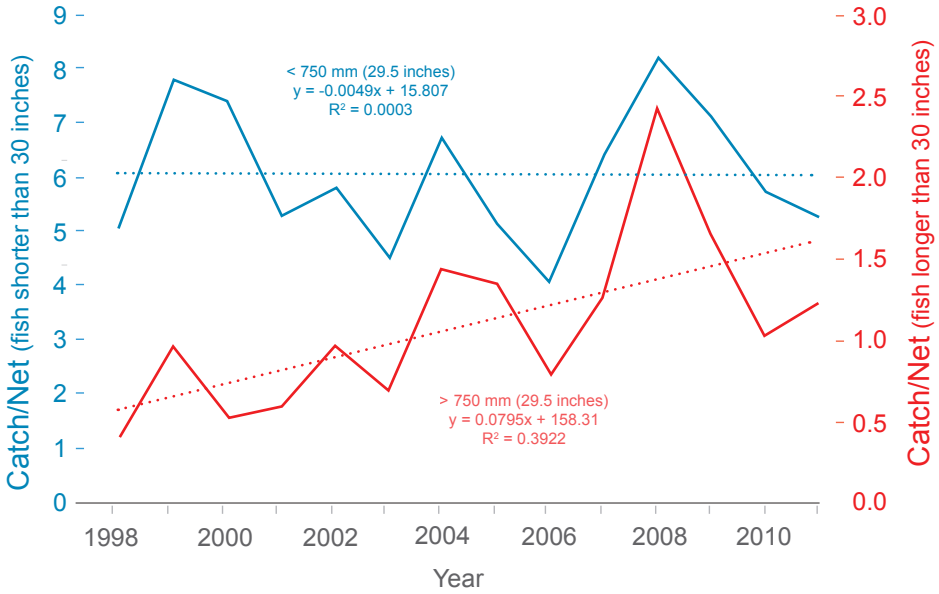


Stable Abundance

This chart estimates lake trout abundance from autumn surveys. It also shows stable catch rates for lake trout after *Mysis* became established.

Figure 3.7. Abundance of lake trout in Flathead Lake, Montana during 1998–2011, estimated from catch/net of all lake trout captured during standardized autumn gillnet surveys, scaled upward to the number of lake trout estimated by mark-recapture to be present in spring 2010 (+ 95% confidence limits on the mark-recapture estimate).

catch rates of lake trout greater than 30 inches long (Figure 3.8). The consistency of these results indicates that harvest levels over the last 12 years have been sustainable, total abundance has not changed, and angling opportunity has been constant.



Trends with Slot-Length

This chart shows that since 1998, catch rates stabilized for lake trout under 30 inches and increased for those over 30 inches.

Figure 3.8. Catch/net of lake trout shorter than a protected slot-length limit (<30 inches = blue line) and longer than a protected slot-length limit (>30 inches = red line) captured during standardized gillnet surveys in autumn in Flathead Lake, Montana during 1998–2011.

The density of lake trout in Flathead Lake is high relative to other lake trout lakes of North America. Lake trout population density in Flathead Lake is 2.4 times higher than in western Lake Superior for both age 4 and older (3.0/acre) and age 8 and older (1.4/acre) lake trout. This suggests that Flathead Lake is 2.4 times more productive for lake trout than western Lake Superior (M. Hansen, Dec 2011 correspondence).

Growth and Condition

The average body growth rate of individual lake trout in Flathead Lake (Figure 3.9) has been decreasing since 1996 (Appendix 6). Lake trout in Flathead Lake are also shorter and older when they reach maturity in comparison to many other populations (Healey 1978; Appendix 6; CSKT and MFWP 2006). Because growth rate has declined over the last decade, the age when lake trout reach maturity has increased over the same period. Male lake trout in Flathead Lake generally reach maturity at age-9 while females reach maturity at age 11 (Appendix 6). These changes are likely the result of increasing density of lake trout over time in which there are fewer resources available to each individual.

Growth Rates

The average growth rate of lake trout has been decreasing since 1996, and lake trout are also shorter and older when they reach maturity.

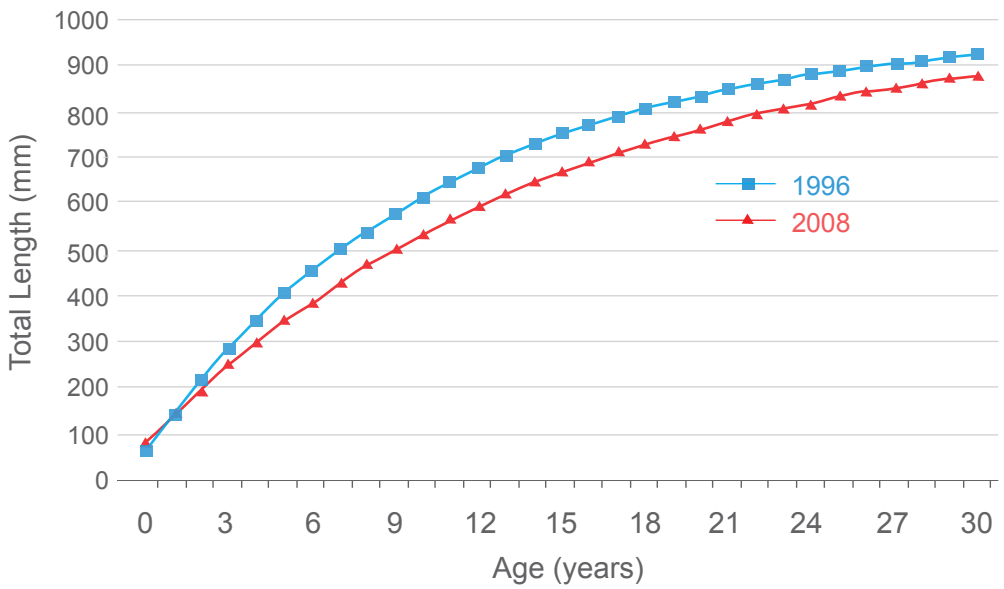


Figure 3.9. Growth rates of lake trout in Flathead Lake, 1996 and 2008.

Recent investigations have found that the lake trout of Flathead Lake exhibit two distinctive morphologies associated with different life history strategies, habitat preferences, and diets (Stafford et al. 2009). The original stock introduced into Flathead Lake is referred to as the “lean” form and it is capable of growing to large size and utilizes *Mysis* heavily during the juvenile and subadult years but switches to predominantly fish prey as adults. Evidence suggests that a new form, called dwarfs (because their growth is stunted) has developed in response to intensive competition with abundant leans (Stafford et al. 2009). Dwarfs prefer the deepest portions of the lake because they feed almost exclusively on *Mysis* throughout their lives. They grow slowly, mature at a small size, and generally do not exceed 24 inches

in length. The dwarf form has a life history analogous to "humper" lake trout from Lake Superior, to which it bears some physical resemblance (Stafford et al. 2009).

The youngest lake trout contributing to the Flathead Lake fishery are about 14 inches in length and five years old. Lake trout typically reach the slot length of 30 inches at about age 20. The oldest measured individuals are nearly age 40, but many individuals probably live longer. The largest known individual was caught in 2006 and weighed 42 pounds, 12.5 ounces.

The parameter "relative weight" is used to describe a population's condition relative to other populations across the range of lake trout. A score of 100 indicates that the population is in the 75th percentile of all populations across the species' range (Piccolo 1993). The Flathead Lake population has a low relative-weight score of 82, likely the result of strong competition for limited resources within this large population (Appendix 6).

Predation by Lake Trout

Lake trout prey on nearly all fish species present in Flathead Lake, and also prey heavily on invertebrates. Most juvenile lake trout rely predominantly on *Mysis*, while adults rely more on fish than on *Mysis*. Fish represent about one-third of the total energy budget of the lake trout population, while *Mysis* and other invertebrates make up the remaining two-thirds. Fish species in lake trout diets, by order of volume measured are: (1) lake whitefish; (2) yellow perch; (3) pygmy whitefish; (4) lake trout; (5) northern pikeminnow; (6) suckers; (7) westslope cutthroat trout; (8) sculpins; and (9) bull trout (Appendix 4). While native fish represent smaller portions of lake trout diets, the effect of predation on native fish is large because their populations are relatively small.

There are many examples of introduced lake trout populations negatively influencing native trout (Martinez et al. 2009). Within their endemic range where lake trout and bull trout distributions overlap, they typically segregate, with lake trout occupying lower-elevation lakes and bull trout occupying higher-elevation lakes where lake trout were likely not able to colonize (Donald and Alger 1993). Lake trout eliminated bull trout in Hector Lake, Bow Lake, and Spray Lakes in Canada not long after lake trout were introduced (Donald and Alger 1993).

There are several examples in Glacier Park (Logging, McDonald, Bowman, and Kintla Lakes) where lake trout have increased greatly, while bull trout have decreased greatly over the same period (Downs et al. 2011, Fredenberg 2007, and Meeuwig 2008). The declines of bull trout were greatest in Logging Lake where no bull trout were sampled in 2010 (Downs et al. 2011).

Bull trout also declined following an increase in lake trout in Priest Lake, Idaho (Venard and Scarnecchia 2005). The lake trout population there increased in the 1970s following the introduction of *Mysis*, and by the 1990s, the bull trout population was nearly extirpated.

Introduced lake trout populations have similar negative effects on cutthroat trout. Lake trout have caused a large decline of Yellowstone cutthroat trout in Yellowstone Lake (Koel et al. 2005). The fear that lake trout will extirpate cutthroat trout from Yellowstone Lake motivated the National Park Service to conduct an aggressive control strategy that began in 1994, and was expanded in 2010 based on monitoring that indicated past efforts needed to be increased to overcome the expanding lake trout population (Gresswell 2009). Managers have learned how and where to conduct netting to be maximize efficiency.

Improved efficiency coupled with increased effort are expected to reverse the lake trout expansion in Yellowstone Lake (Bigelow 2011).

While there is a very clear association between the increase in lake trout abundance and the decrease in native fish abundance, there remains some debate about the exact mechanism of the interaction. In the Flathead example, direct sampling and bioenergetics modeling have demonstrated that predation accounts for all or a substantial part of the decline in native trout abundance. Competition between the two species for similar food resources, especially among juveniles may also play a role, although there is no evidence that food resources are limiting or controlling the abundance of both species in Flathead Lake. Competition is difficult to demonstrate empirically, and does not cause immediate mortality as does predation. As a result, researchers are testing models to evaluate the importance of competitive interactions between lake trout and bull trout and preliminary results indicate that competition with lake trout also negatively affects bull trout abundance (Ferguson et al. 2012) (Appendix 13).

Trophy Lake Trout

Trophy lake trout are defined in this document as being 30 inches long and greater. Fish of this size have been protected by the slot limit (harvest of fish between 30 to 36 inches is prohibited) since 1994. Fish of slot-protected lengths are typically 20 years and older. They are relatively abundant because of protection by the slot limit and stock-piling of fish born in the late 1980s following the establishment of *Mysis*. We have not directly estimated the abundance of trophy lake trout because our mark and recapture methods do not include fish greater than 30 inches. However, in gillnet catches, trophy lake trout make up roughly one third of the fish that are greater than 20 inches in length (Figure 3.10).

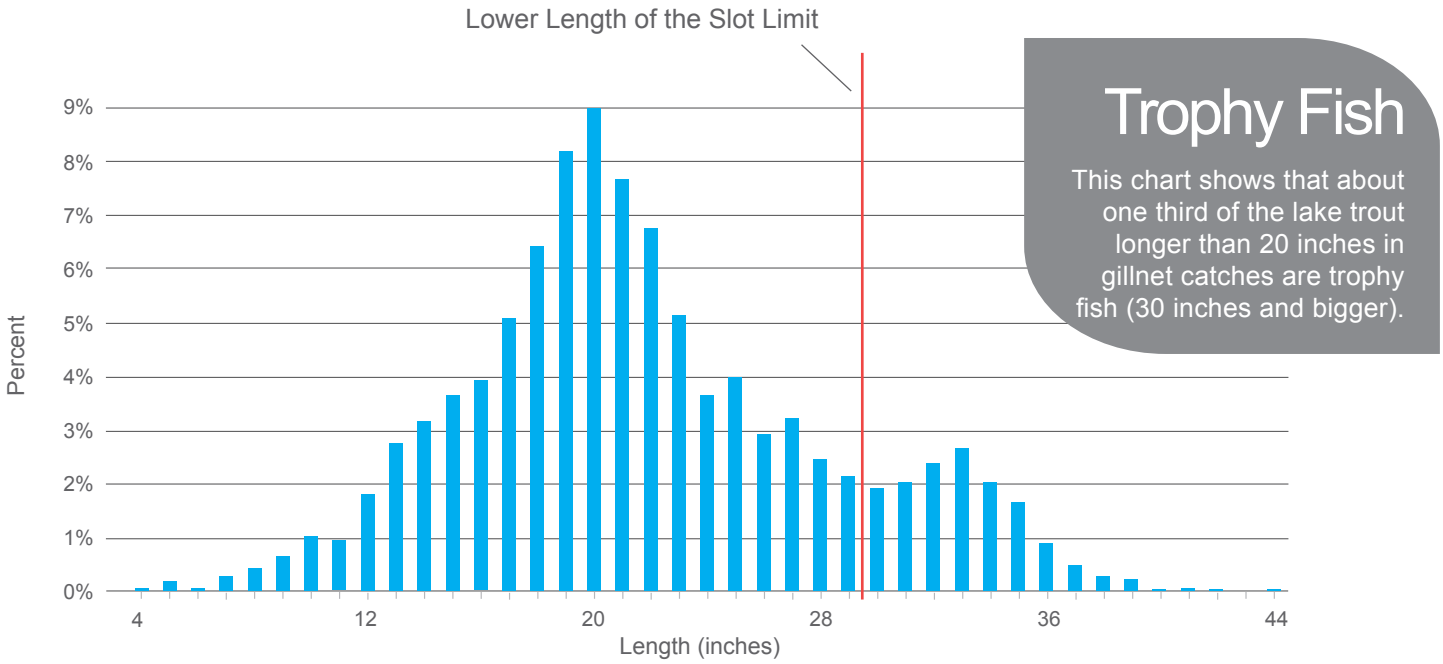
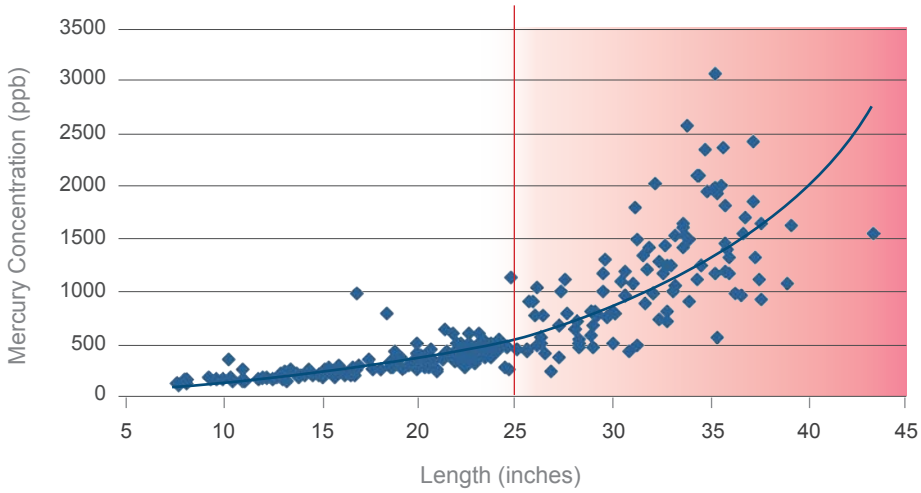


Figure 3.10. Average length distributions of lake trout captured in gillnets set in autumn in Flathead Lake, 2005 through 2010.

Trophy lake trout, being top-level predators, accumulate mercury in their tissues from their diet and consequently are subject to state and tribal consumption advisories. Lake trout in Flathead Lake average 300 ppb (parts per billion) mercury concentrations (EPA level screening value) at about 19 inches in length (Figure 3.11) (Stafford et al. 2004). The Tribes advise that children and women of child-bearing age avoid eating lake trout from Flathead Lake that are greater than 25 inches long.



Mercury Contamination

The Tribes advise that children and women of child-bearing age avoid eating lake trout from Flathead Lake that are greater than 25 inches long.

Figure 3.11. Methylmercury concentrations (ppb) in lake trout tissue relative to body length, Flathead Lake (CSKT files and Stafford et al. 2004). Vertical red line signifies Tribal consumption advisory threshold.

Environmental Consequences in the Project Area: Lake Trout

This section describes the environmental consequences or effects of the alternatives on lake trout in Flathead Lake and the Cumulative Effects Analysis Area (Figure 3.1).

Fish illustration by Joseph Tomelleri

ALTERNATIVE A: No Action (Maintain Status Quo)

Direct and Indirect Effects

In Alternative A, there would be harvest of lake trout both from angling during the general fishing season and from angling during Mack Days contests. Angling success can be variable and therefore it is not feasible to precisely predict future harvest under the status quo. Based on average harvest between 2007 and 2012, the status quo harvest would likely range from 55,000 to 78,000 lake trout. Total annual harvest from these sources is expected to equal 70,000 fish, which is roughly the average annual harvest in 2010 through 2012 (Table 3.1 and Appendix 5). This level of harvest is estimated to sustain the total lake trout population at 6% below maximum potential relative to the complete absence of harvest (Appendix 6).

Table 3.1. Potential annual lake trout harvest combinations and bycatch estimates for Alternative A.

		Bycatch Mortality[1]	
Harvest Method	**Number**	**Bull Trout**	**Cutthroat Trout**
General	25,000	55	11
Mack Days	45,000	108	0
Total	70,000	163	11

[1]See Appendix 5 for estimation of bycatch.

Model projections indicate that total lake trout abundance would likely decline in Alternative A by a small percentage over the short term (<5 years), although the range of possible outcomes is very large (Table 3.2). Short term projections are not highly reliable because of uncertainty in quantification of starting conditions that is compounded by high variability in recruitment dynamics. Therefore, although there is potential for lake trout to decline in the next five years, there is also potential for them to remain unchanged or to increase. The degree of uncertainty in outcomes decreases with: (1) increases in harvest (Alternatives B through D); (2) increases in age groups (ages 1-30 through ages 22-30); and (3) increases in time (short term through long term). In summary, short-term effects of Alternative A on the lake trout population include a wide range of possibilities. The most likely outcome is for there to be a negligible change in numbers of lake trout relative to the current condition.

Table 3.2. Projected lake trout abundance (+ 95% confidence limits) and percent change from current conditions (status quo) for four age groups from an age-structured stochastic simulation model for Alternative A (Appendix 6). A = 26%.

Age Group	Projected abundance	Lower 95% limit	Upper 95% limit	% Change from Status Quo (+ 95% limits)
Short-Term (5 years)				
Ages 1–30	1,335,969	593,369	3,072,931	0% (−56, +130%)
Ages 4–30	787,747	440,667	1,335,353	0% (−44, +70%)
Ages 8–30	325,220	199,280	459,656	0% (−39, +41%)
Ages 22–30	25,601	15,514	35,211	0% (−39, +38%)
Long-Term (50-200 years)				
Ages 1–30	1,480,274	1,343,150	1,633,349	0% (−9, +10%)
Ages 4–30	809,074	734,034	892,208	0% (−9, +10%)
Ages 8–30	312,890	283,660	345,892	0% (−9, +11%)
Ages 22–30	10,708	9,722	11,837	0% (−9, +11%)

The 70,000 harvest level would result in an annual mortality rate of 26%, which would maintain a stable population over time at about 6% below carrying capacity (Figure 3.12). The size structure of the lake trout population would change very little except for a decrease in those fish age 8 and older.

Age 22 and Greater Lake Trout

The population of lake trout in Flathead Lake currently consists of a relatively large number of old individuals (Figure 3.10). Alternative A retains the slot-limit protection (no harvest of lake trout between 30 and 36 inches). In all alternatives, including Alternative A, age-22+ lake trout would decline dramatically over time as recruitment into this size category declines, despite the slot-length protection.

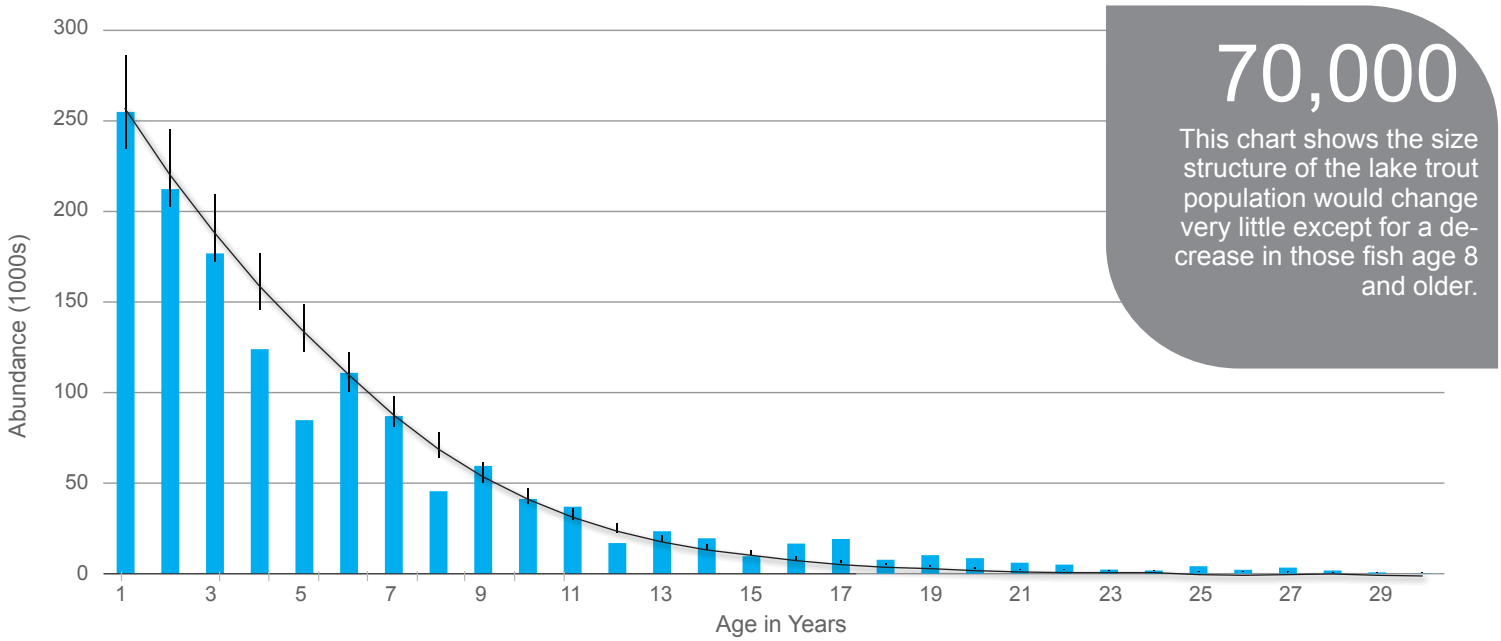


Figure 3.12. Current age structure (columns) and long-term simulated size structure (dashes with confidence intervals) of lake trout population, Flathead Lake under Alternative A (Appendix 6).

Lake trout age 22-30 (trophy size) currently make up about 3% of the total fishable lake trout population (age 4-30). These older fish were born in a unique transitional period in the late 1980s. At that time, juvenile lake trout survival was very high, creating a large cohort of fish currently longer than 30 inches. Survival was high at that time because *Mysis* provided abundant food for juveniles, there were fewer cannibalistic adult lake trout to prey on juveniles, and fishing mortality was low enough to allow them to escape harvest for at least 20 years.

In the short term (<5 years), numbers of large lake trout would likely decline because the current population-level mortality rate exceeds the current rate of recruitment into these size classes. In Alternative A, competition and self-regulation within the lake trout population restrict recruitment into the large fish category to a level that is not sufficient to sustain their numbers. Over the long term (>50 years), despite the protection of the slot limit, numbers of large fish would decline 50% relative to the current condition (Figure 3.12).

ALTERNATIVE B: Reduce Adult (Age 8+) Lake Trout Numbers by 25% Over the Long Term

Direct and Indirect Effects

Simulation modeling indicates that an annual harvest of 84,000 lake trout (the actual harvest could range between 79,000 and 100,000) would achieve a 25% reduction in adult lake trout numbers (>age 8) over the long term (Table 3.3). The slot limit, which prohibits anglers from keeping lake trout between 30 and 36 inches, would be removed. Bag limits for lake trout would remain at 100 fish per day. General harvest would continue as would efforts to increase it. Mack Days would continue as would efforts to increase it. Combined, the general harvest and Mack Days harvest have the potential to achieve the 84,000 target. If they do not, the difference would be achieved through the use of additional tools such as bounties, commercial fishing, or netting.

The target harvest of 84,000 lake trout would likely require a mix of harvest tools. If we assume that angling (general and Mack Days) will achieve a harvest of 70,000 lake trout, then an additional 14,000 lake trout could be harvested by netting (10,000 by gillnetting and 4,000 by trapnetting). This approach would require an estimated 65,000 feet of gillnet and 80 trap-days if 50 lake trout were caught per trap-day (Appendix 5).

Table 3.3. Potential annual lake trout harvest combinations and bycatch estimates under Alternative B (Appendix 6).

		Bycatch Mortality[1]		
Harvest Method	**Number**	**Bull Trout**	**Cutthroat Trout**	**Lake Whitefish**
General	25,000	55	11	0
Mack Days	45,000	108	0	0
Gillnetting and Trapnetting	14,000	58	0	35,000
Total	84,000	221	11	35,000

[1]*See Appendix 5 for estimation of bycatch.*

Estimates of bycatch for trapnetting are based on the rate determined from gillnetting, which is known to be higher than for trapnetting. In the short term (<5 years), total abundance of lake trout would decrease very little, with greater decreases for older age classes (Table 3.4). Over the long term (>50 years), lake trout abundance would be 13% lower for ages 4–30, 25% lower for age 8–30, and 56% lower for ages 22–30, relative to the status quo. Growth, body condition, and juvenile survival would all increase relative to Alternative A, whereas age at maturity and predation by lake trout on other species would decrease relative to Alternative A. Because growth rate would increase, the average concentration of mercury in lake trout tissue would likely decrease to a small degree (Stafford et al. 2004, Thomann 1989).

Table 3.4. Projected lake trout abundance and percent change from current conditions (+ 95% confidence limits) for four age groups from an age-structured stochastic simulation model under Alternative B (Appendix 6). Harvest = 83,459; A = 29%.

Age Group	Projected abundance	Lower 95% limit	Upper 95% limit	% Change from Alt A (Status Quo) (+ 95% limits)
Short-Term (5 years)				
Ages 1–30	1,293,545	567,929	3,221,596	−3% (−57, +141%)
Ages 4–30	717,219	386,308	1,312,613	−9% (−51, +67%)
Ages 8–30	271,702	158,969	385,250	−16% (−51, +18%)
Ages 22–30	23,195	13,438	32,420	−9% (−48, +27%)
Long-Term (50-200 years)				
Ages 1–30	1,350,493	1,208,832	1,503,268	−9% (−18, +2%)
Ages 4–30	700,007	626,265	778,961	−13% (−4, −23%)
Ages 8–30	232,176	208,183	258,733	−25% (−17, −33%)
Ages 22–30	4,670	4,174	5,213	−56% (−51, −61%)

Simulation modeling indicates that a harvest of 84,000 lake trout would produce an annual mortality rate of 29%, which is not sufficient to reduce total lake trout numbers (age 1-30) relative to the status quo (Figure 3.13). The size structure of the lake trout population would change very little except for those fish age 8 and older.

Age 22 and Greater Lake Trout

In the short term (<5 years), numbers of age-22+ lake trout would decline very little relative to the status quo (Alternative A). Over the long term (>50 years), numbers of age-22+ lake trout would decline 56% relative to the long-term status quo and 82% relative to the short-term status quo.

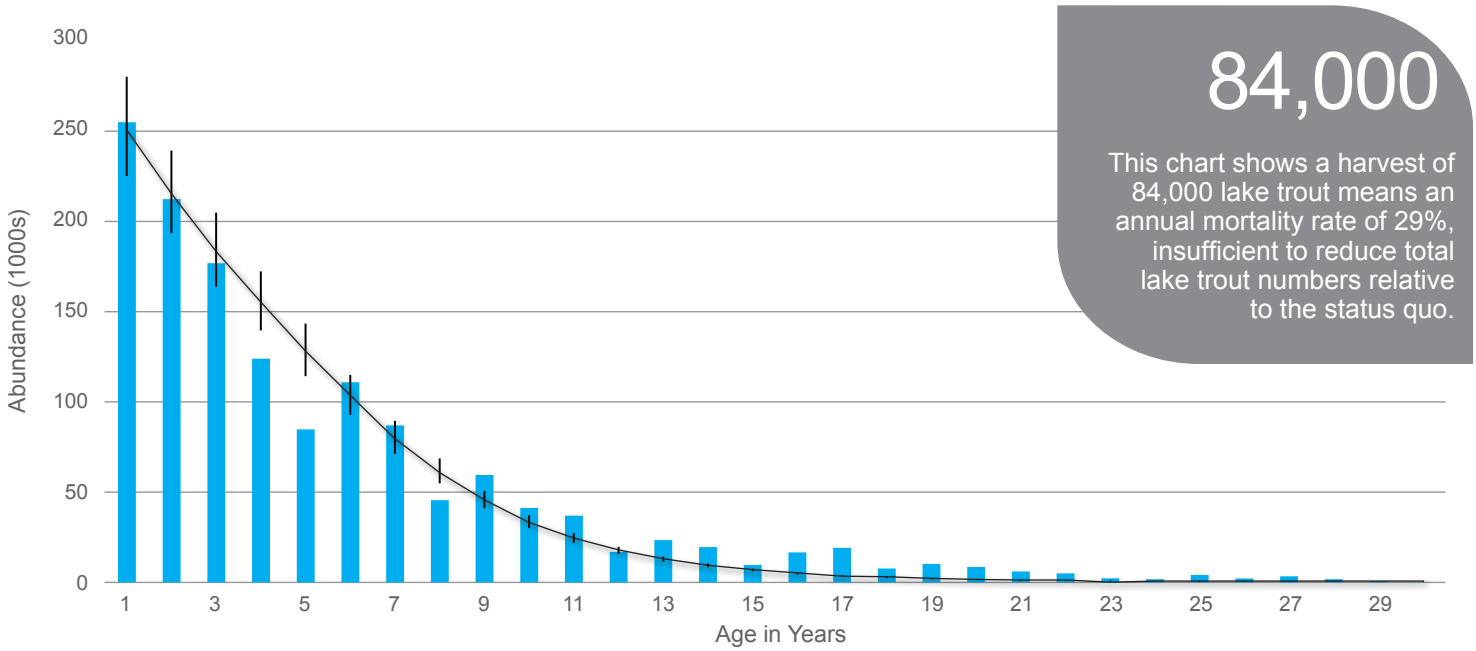


Figure 3.13. Current age structure (columns) and long-term simulated age structure (dashes with confidence intervals) of the lake trout population in Flathead Lake under Alternative B (Appendix 6).

Mitigation and Adaptive Management

Numerous mitigation measures would be employed to minimize catch of all non-target fish. Specific measures for the angling fishery (this includes the general public, Mack Days contestants, and potentially bounty and commercial anglers) would include education and the enforcement of angling regulations. Specific measures for a netting fishery would entail physical and operational modifications to mesh-size arrays, and to the depth, location, and timing of placement of nets (Appendix 5). Adaptations to identified problems would be facilitated by an inter-agency working group (Appendix 8).

ALTERNATIVE C: Reduce Adult (Age 8+) Lake Trout Numbers by 50% Over the Long Term

Direct and Indirect Effects

Simulation modeling indicates that an annual harvest of 112,000 lake trout (the actual harvest could range between 101,000 and 125,000) would achieve a 50% reduction in adult lake trout numbers (>age 8) over the long term (Table 3.5). The slot limit, which prohibits anglers from keeping lake trout between 30 and 36 inches, would be removed. Bag limits for lake trout would remain at 100 fish per day. General harvest would continue as would efforts to increase it. Mack Days would continue as would efforts to increase it. Combined, the general harvest and Mack Days harvest have the potential to achieve the 112,000 target. If they do not, the difference would be achieved through the use of additional tools such as bounties, commercial fishing, or netting.

The target harvest of 112,000 lake trout would likely require a mix of harvest tools. If we assume that angling (general and Mack Days) will achieve a harvest of 70,000 lake trout, then an additional 42,000 lake trout could be harvested by netting (32,000 by gillnetting and 10,000 by trapnetting). This approach would require an estimated 227,500 feet of gillnet and 200 trap-days if 50 lake trout were caught per trap-day (Appendix 5).

Table 3.5. Potential annual lake trout harvest combinations and bycatch estimates under Alternative C (Appendix 6).

		Bycatch Mortality[1]		
Harvest Method	**Number**	**Bull Trout**	**Cutthroat Trout**	**Lake Whitefish**
General	25,000	55	11	0
Mack Days	45,000	108	0	0
Gillnetting and Trapnetting	42,000	175	0	105,000
Total	112,000	338	11	105,000

[1]*See Appendix 5 for estimation of bycatch.*

In the short term (<5 years), the total abundance of lake trout would decrease very little, with greater decreases for older age classes (Table 3.6). The reduced abundance of lake trout would reduce intra-specific competition, thereby increasing growth and body condition and decreasing age at maturity.

Over the long term (>50 years), abundance would be 32% lower for ages 4–30, 50% lower for ages 8–30, and 85% lower for ages 22–30. Relative to Alternative A, growth, body condition, and juvenile survival would increase, while age at maturity and predation on other species would decrease. Because growth rate would increase, the average concentration of mercury in lake trout tissue would likely decrease to a small degree (Stafford et al. 2004, Thomann 1989).

Table 3.6. Projected lake trout abundance and percent change from current conditions (+ 95% confidence limits) for four age groups from an age-structured stochastic simulation model under Alternative C (Appendix 6). Harvest = 112,670; A = 33%.

Age Group	Projected abundance	Lower 95% limit	Upper 95% limit	% Change from Alt A (Status Quo) (+ 95% limits)
Short-Term (5 years)				
Ages 1–30	1,229,241	570,484	3,057,798	−8% (−57, +129%)
Ages 4–30	666,397	356,577	1,230,184	−15% (−55, +56%)
Ages 8–30	219,425	137,907	305,358	−33% (−58, −6%)
Ages 22–30	20,864	13,385	28,929	−19% (−48, +13%)
Long-Term (50-200 years)				
Ages 1–30	1,117,149	962,051	1,281,668	−25% (−13, −35%)
Ages 4–30	551,937	474,385	633,007	−32% (−22, −41%)
Ages 8–30	155,553	134,076	178,625	−50% (−43, −57%)
Ages 22–30	1,659	1,432	1,908	−85% (−82, −87%)

The 112,000 harvest level would produce an annual mortality rate of 33% (Figure 3.14). The size structure of the lake trout population would change very little except for those fish age 8 and older.

Age 22 and Greater Lake Trout

In the short term (<5 years), numbers of age-22+ lake trout would decline 9% relative to the status quo. Over the long term (>50 years), numbers of age-22+ lake trout would decline 84% relative to the long-term status quo and 93% relative to the short-term status quo.

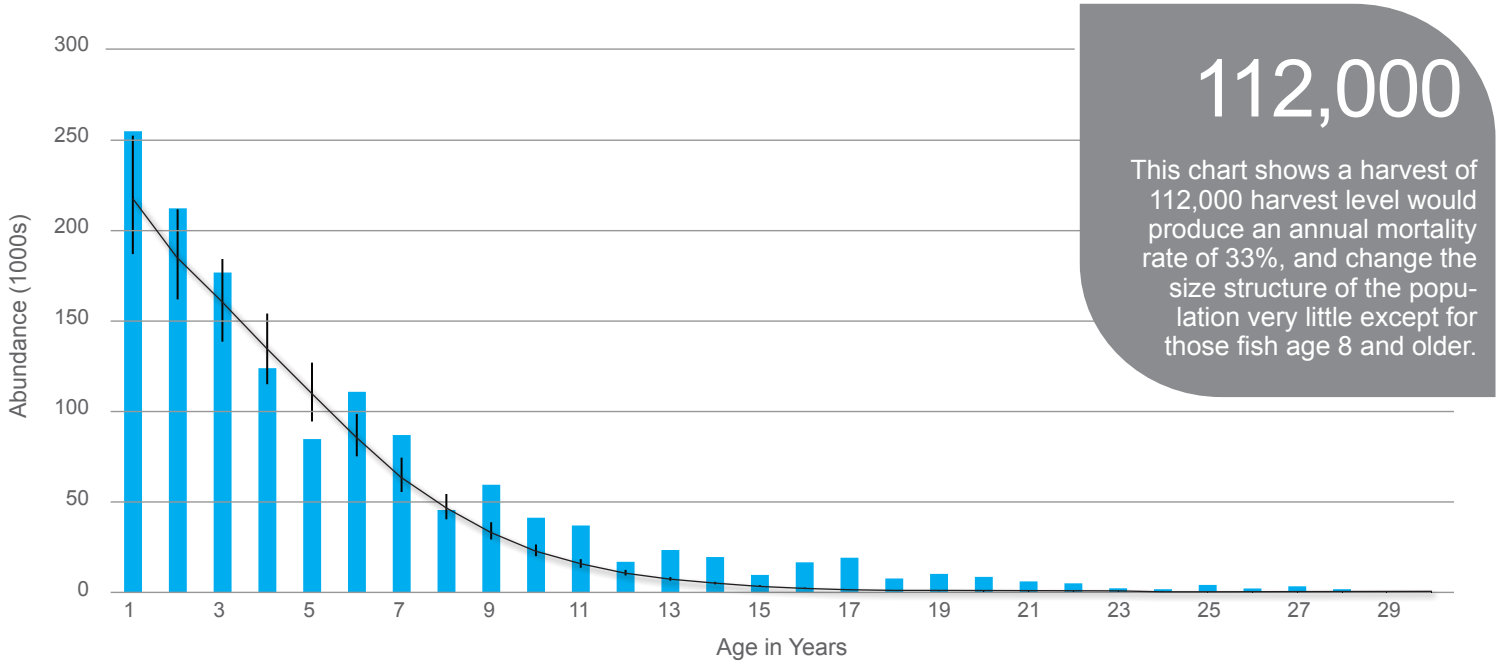


Figure 3.14. Current age structure (columns) and long-term simulated age structure (dashes with confidence intervals) of the lake trout population in Flathead Lake under Alternative C (Appendix 6).

Mitigation and Adaptive Management

Numerous mitigation measures would be employed to minimize catch of all non-target fish. Specific measures for the angling fishery (this includes the general public, Mack Days contestants, and potentially bounty and commercial anglers) would include education and the enforcement of angling regulations. Specific measures for a netting fishery would entail physical and operational modifications to mesh-size arrays, and to the depth, location, and timing of placement of nets (Appendix 5). Adaptations to identified problems would be facilitated by an inter-agency working group (Appendix 8).

ALTERNATIVE D: Reduce Adult (Age 8+) Lake Trout Numbers by 75% Over the Long Term

Direct and Indirect Effects

Simulation modeling indicates that an annual harvest of 143,000 lake trout (the actual harvest could range between 129,000 and 157,000) would achieve a 75% reduction in adult lake trout numbers (>age 8) over the long term (Table 3.7). The slot limit, which prohibits anglers from keeping lake trout between 30 and 36 inches, would be removed. Bag limits for lake trout would remain at 100 fish per day. General harvest would continue as would efforts to increase it. Mack Days would continue as would efforts to increase it. Combined, the general harvest and Mack Days harvest have the potential to achieve the 143,000 target. If they do not, the difference would be achieved through the use of additional tools such as bounties, commercial fishing or netting.

The target harvest of 143,000 lake trout would likely require a mix of harvest tools. If we assume that angling (general and Mack Days) will achieve a harvest of 70,000 lake trout, then an additional 73,000 lake trout could be harvested by netting (63,000 by gillnetting and 10,000 by trapnetting). This approach would require an estimated 420,000 feet of gillnet and 200 trap-days if 50 lake trout were caught per trap-day (Appendix 5).

Table 3.7. Potential annual lake trout harvest combinations and bycatch estimates under Alternative D (Appendix 6).

		Bycatch Mortality		
Harvest Method	**Number**	**Bull Trout**	**Cutthroat Trout**	**Lake Whitefish**
General	25,000	55	11	0
Mack Days	45,000	108	0	0
Gillnetting and Trapnetting	73,000	304	0	182,500
Total	143,000	467	11	182,500

[1]*See Appendix 5 for estimation of bycatch.*

In the short term (<5 years), total abundance of lake trout would likely decrease very little, with greater decreases for older age classes (Table 3.8). Reduced abundance would reduce intra-specific competition, thereby increasing growth and body condition and decreasing age at maturity.

Over the long term (>50 years), abundance would be 57% lower for ages 4–30, 75% lower for age 8–30, and 96% lower for ages 22–30. Relative to Alternative A, growth, body condition, and juvenile survival would all increase, while age at maturity and predation on other species would decrease. Because growth rate would increase, the average concentration of mercury in lake trout tissue would likely decrease to a small degree (Stafford et al. 2004, Thomann 1989).

Table 3.8. Projected lake trout abundance and percent change from current conditions (+ 95% confidence limits) for four age groups from an age-structured stochastic simulation model under Alternative D (Appendix 6). Harvest = 143,000; A = 38%

Age Group	Projected abundance	Lower 95% limit	Upper 95% limit	% Change from Alt A (Status Quo) (+ 95% limits)
Short-Term (5 years)				
Ages 1–30	1,151,049	526,543	2,508,318	−14% (−61, +88%)
Ages 4–30	590,048	324,515	970,565	−25% (−59, +23%)
Ages 8–30	177,642	110,213	246,673	−45% (−66, −24%)
Ages 22–30	19,319	12,415	26,516	−25% (−52, +4%)
Long-Term (50-200 years)				
Ages 1–30	742,192	581,550	910,852	−50% (−38, −61%)
Ages 4–30	349,727	274,645	429,312	−57% (−47, −66%)
Ages 8–30	83,249	65,275	102,227	−75% (−67, −79%)
Ages 22–30	421	329	520	−96% (−95, −97%)

Age 22 and Greater Lake Trout

In the short term, numbers of age-22+ lake trout would decline 25% relative to the status quo. Over the long term, numbers of age-22+ lake trout would decline 96% relative to the long-term status quo and 98% relative to the short-term status quo.

Mitigation and Adaptive Management

Numerous mitigation measures would be employed to minimize catch of all non-target fish. Specific measures for the angling fishery (this includes the general public, Mack Days contestants, and potentially bounty and commercial fishers) would include a combination of education and enforcement of angling regulations. Specific measures for a netting fishery would entail physical and operational modifications to mesh-size arrays, and depth, location, and timing of placement of nets (Appendix 5). Adaptations to identified problems would be facilitated by an inter-agency working group (Appendix 8).

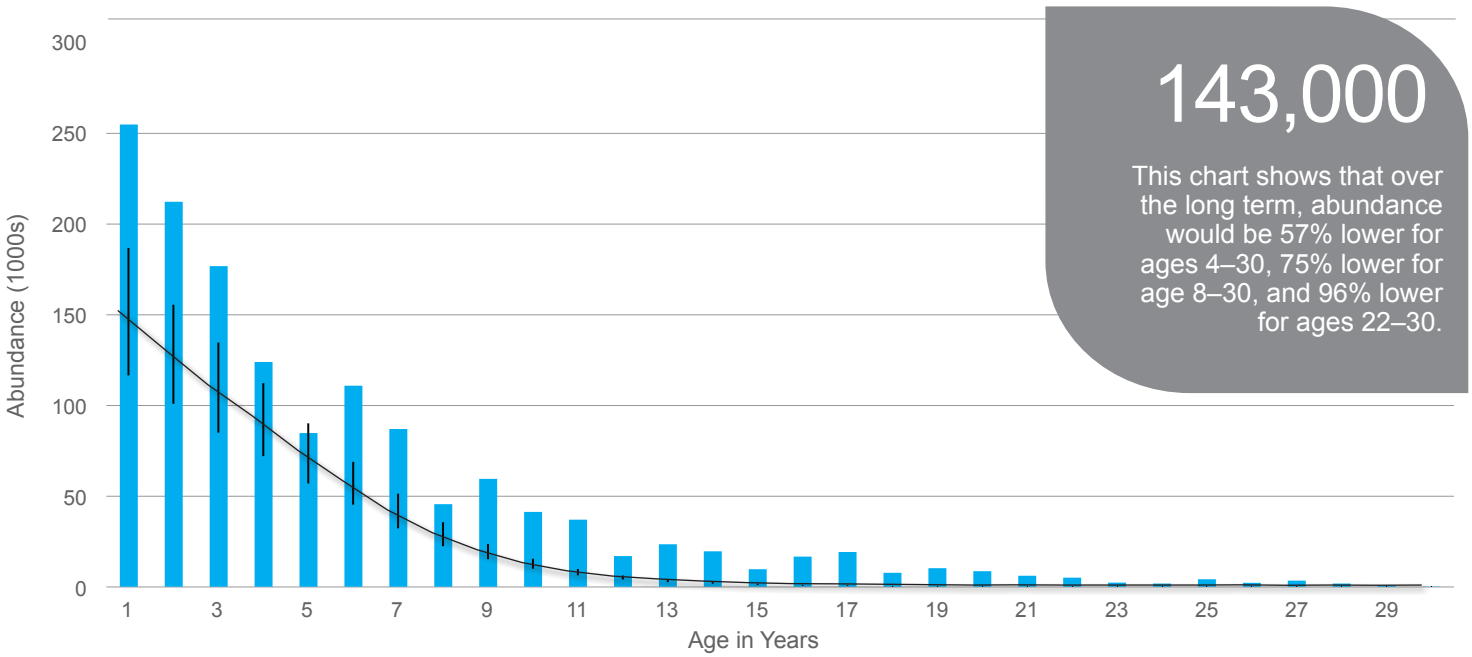


Figure 3.15. Current age structure (columns) and long-term simulated age structure (dashes with confidence intervals) of the lake trout population in Flathead Lake under Alternative D (Appendix 6).

Summary

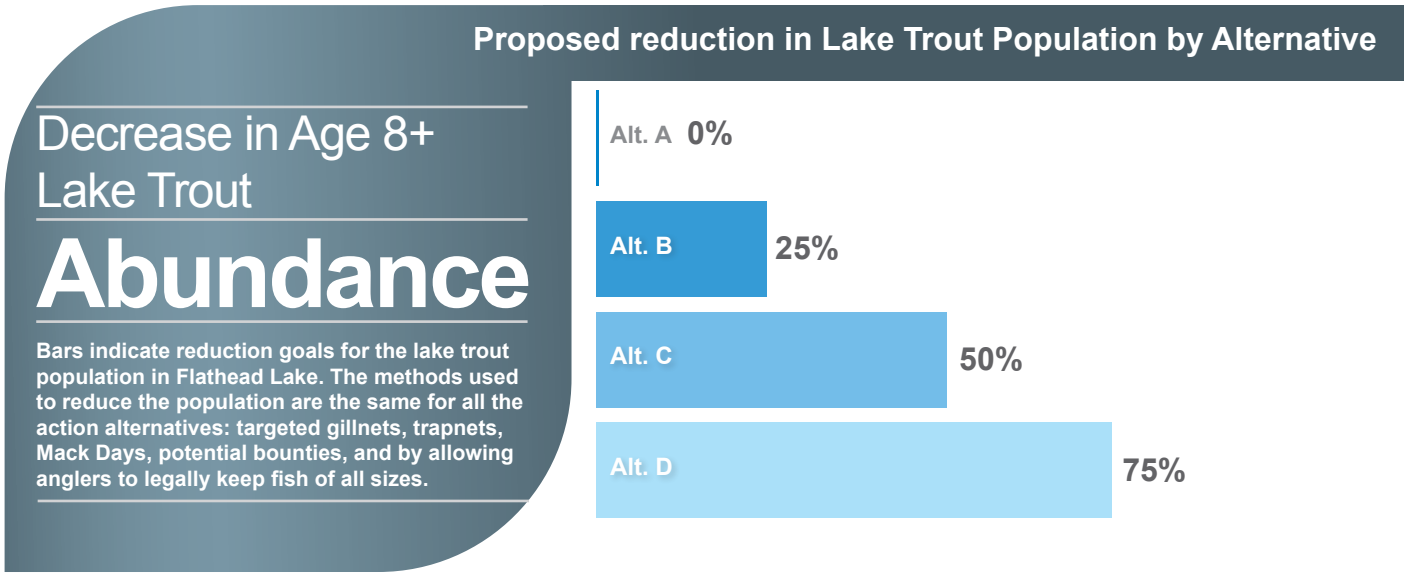


Figure 3.16. Population reduction goals for each alternative.

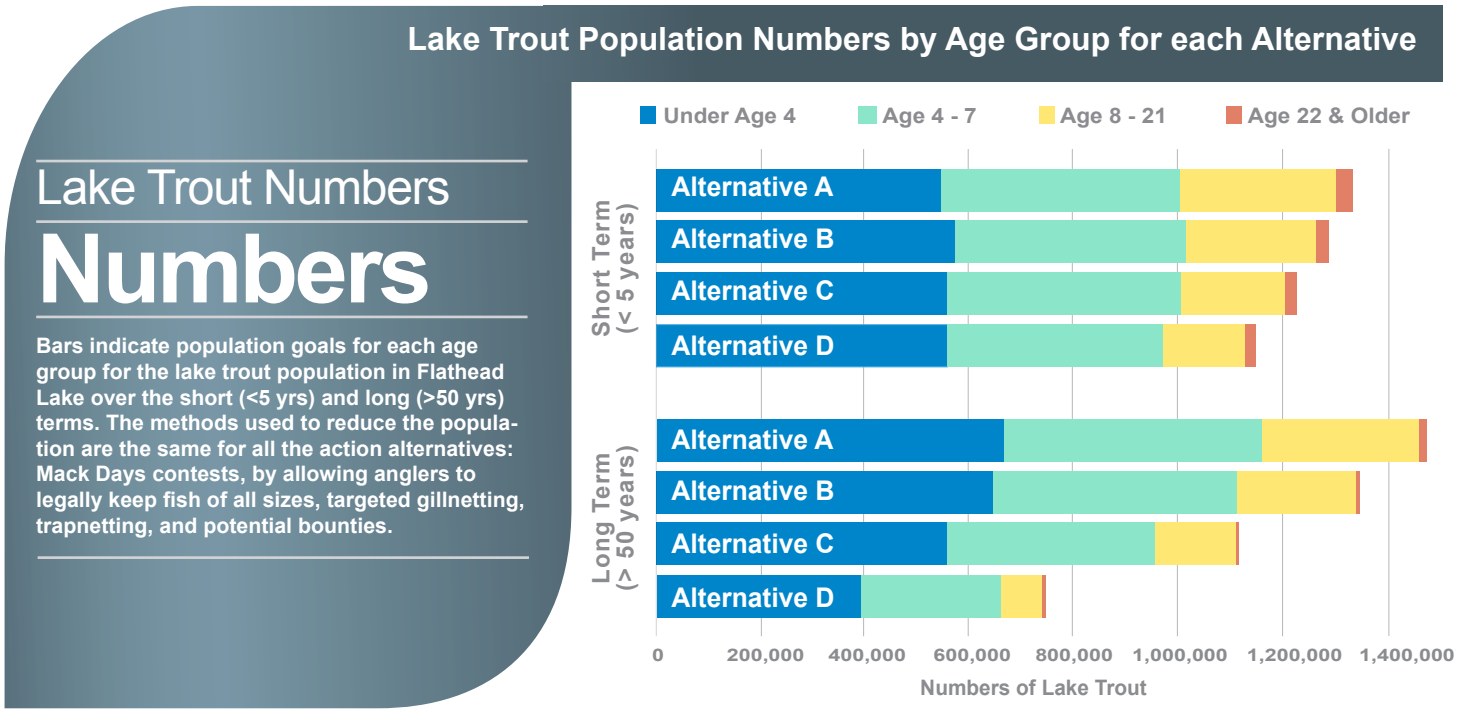


Figure 3.17. Predicted changes in four age groups of lake trout over the short and long term for each alternative.

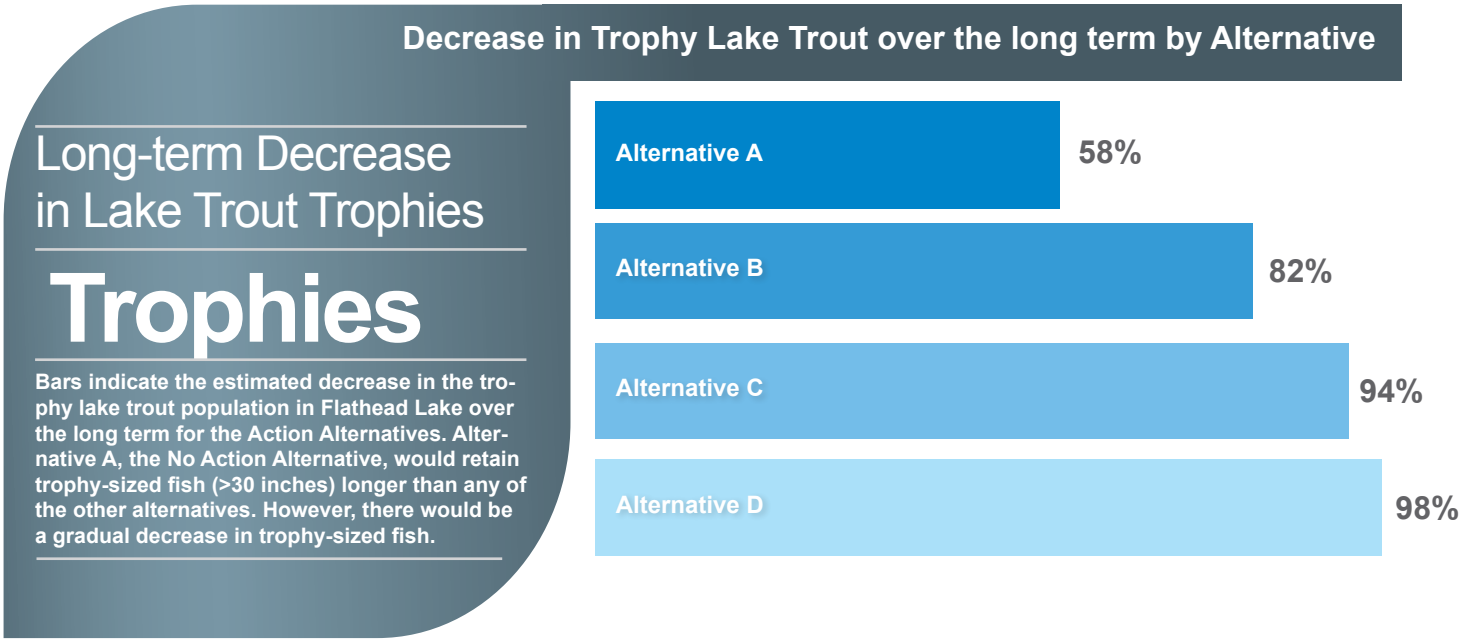


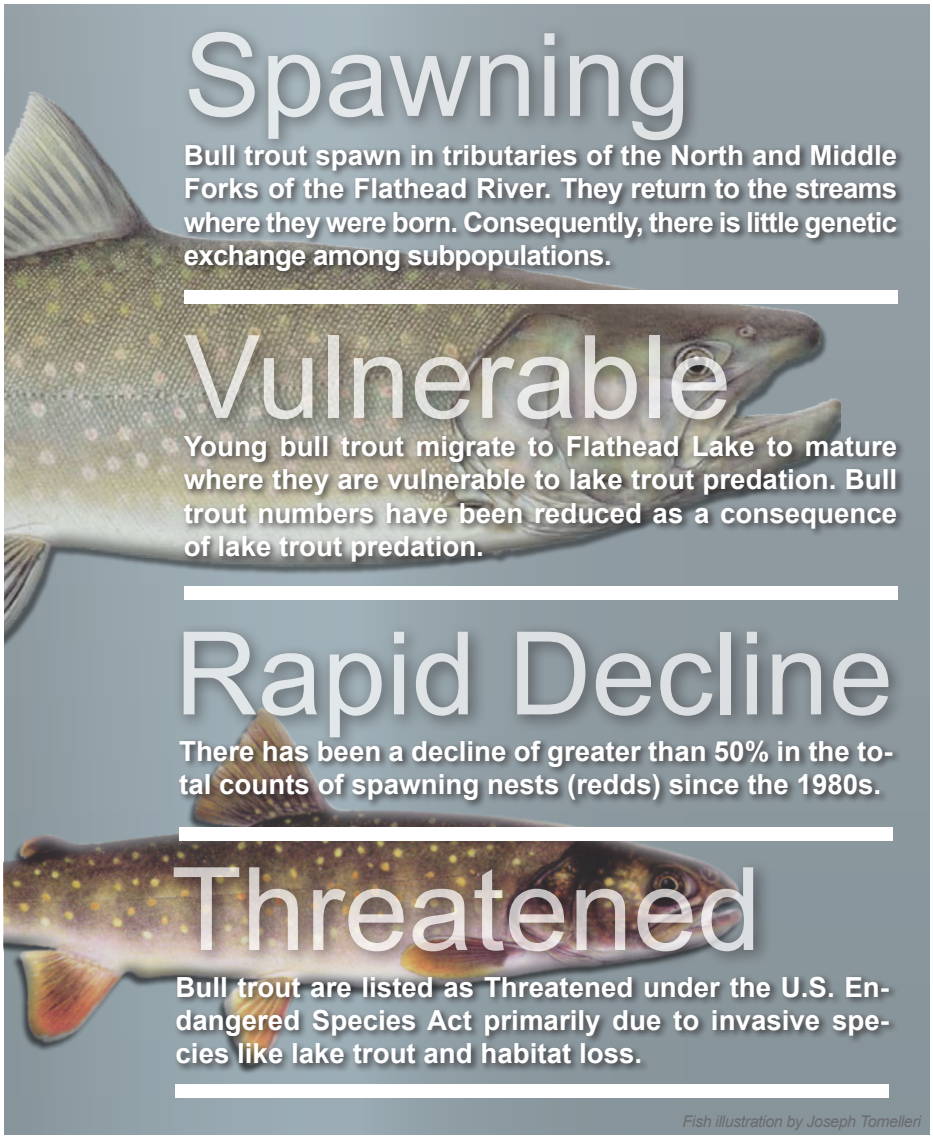
Figure 3.18. Predicted long-term reductions in trophy lake trout expected under each action alternative.

Affected Environment in the Project Area: Bull Trout

This section describes the affected environment or the current conditions for bull trout in Flathead Lake and the area delineated in red in Figure 3.1.

History

Bull trout are native to the Flathead Lake and River system and have likely persisted in the Flathead system since the last ice age or for more than 10,000 years, surviving and adapting to extreme catastrophic events, such as fire, drought, flooding, and glaciations. Migratory bull trout grow to maturity in the lake and then travel up to 130 miles upriver to spawn in their home streams that contain clean gravel, cold groundwater, and protective cover. Juveniles stay in those streams for 1 to 4 years and then move to Flathead Lake where they grow to maturity and complete their life cycle.



Bull trout are a highly valued cultural resource for the Tribes and played an important part in Tribal history. Historically, bull trout provided a rich food resource of high caloric value that did not require great effort to acquire. They were more consistently available than any other food resource utilized by the Salish and Kootenai people—while big game hunting was prone to cycles of feast and famine, fish resources were consistently available and reliable. Bull trout therefore provided a safety-net that enhanced the survival of tribal people and shaped the culture's perception of a secure future (Smith 2010). Tribal people often selected their winter camps based on locations where they could catch bull trout. Because of this practice there are more place-names in western Montana describing bull trout than any other plant or animal (Smith 2010). The importance of bull trout to the CSKT is evidenced today by the substantial efforts expended by the tribes to restore bull trout where they have been depleted, specifically in the Jocko River system (ARCO 2008).

Biology in the Flathead System

Bull trout in the Flathead System are migratory fish that spawn in tributaries of the North and Middle Forks of the Flathead River (Fraley and Shepard 1989). Juveniles rear in natal streams until migrating to Flathead

River and Flathead Lake where they reach full size and maturity (Muhlfeld et al. 2003; Muhlfeld and Marotz 2005). They reach maturity in Flathead Lake at five to seven years of age and return to spawn—with very few exceptions—to the same streams in which they were born. This fidelity to natal streams results in little genetic exchange between local populations and leads to genetically distinct populations in each stream (Ardren et al. 2011). Each of these local populations contributes to the larger Flathead Lake Core Area (Figure 3.19). Conservation of bull trout requires that as many local populations as possible be conserved within the larger Core Area. The likelihood of survival of a core population is improved when the risk of extirpation is spread among numerous local populations (Rieman and McIntyre 1995, Whitesel et al. 2004).

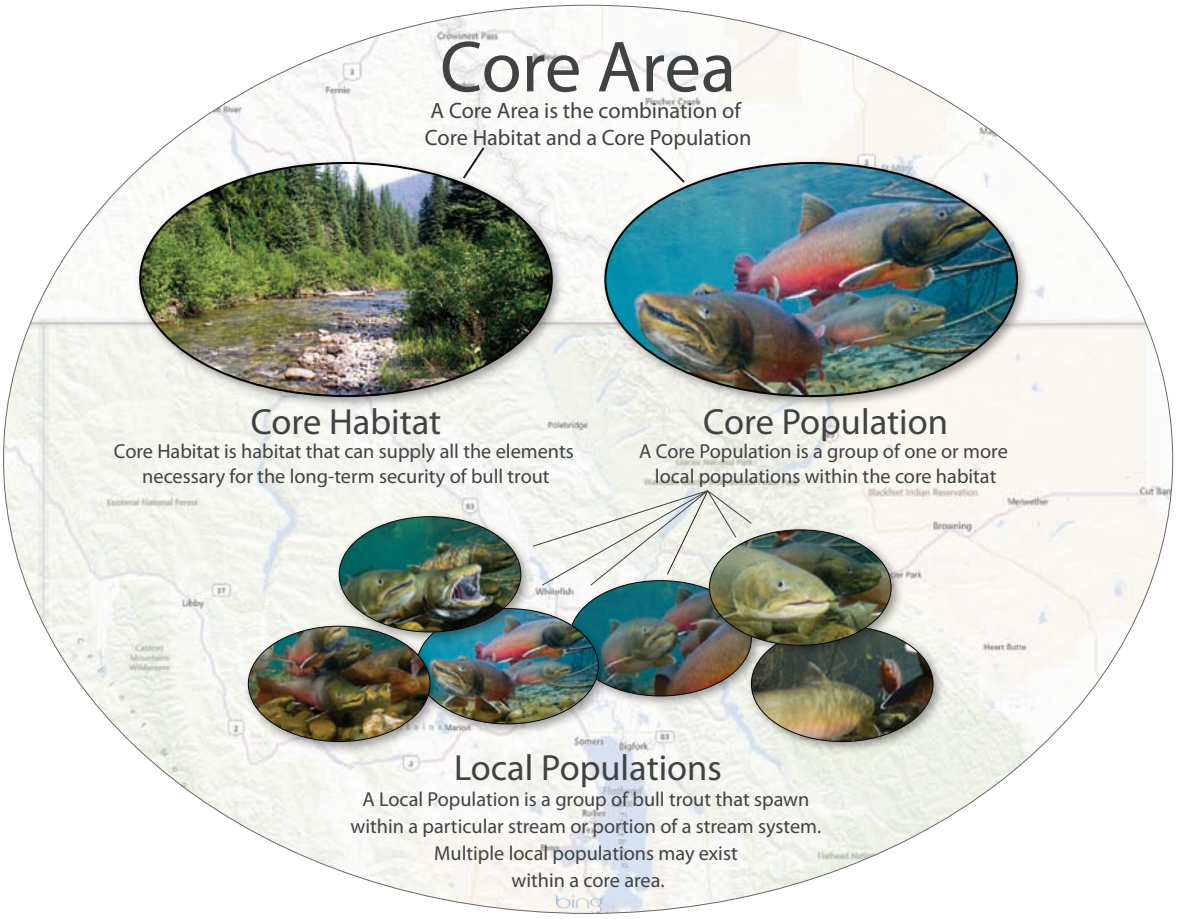


Figure 3.19. Core Areas are made up of Core Habitat and Core Populations. Core Populations are made up of Local Populations.

Distribution in Flathead Lake

Bull trout have a strong affinity for inshore waters of Flathead Lake. Since 1998 CSKT and MFWP have captured bull trout in 137 locations in Flathead Lake while randomly sampling with gillnets throughout the entire lake (Figure 3.20). Bull trout, regardless of their length, have most often been found in depths of less than 100 feet (Figure 3.21). This aspect of bull trout habitat use can be used to great advantage by managers seeking to minimize bycatch of bull trout while harvesting lake trout.

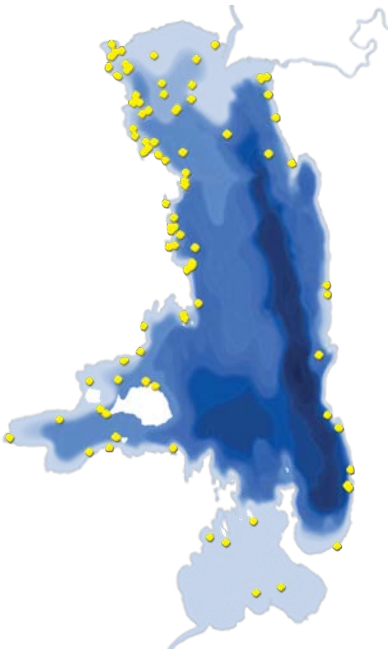


Figure 3.20. Locations of captured bull trout in gillnets set predominantly in the autumn in Flathead Lake, 1998 through 2010.

Fishing for bull trout in the Flathead system was closed in 1992 after redd counts had declined for five consecutive years. Redd counts did not increase following the fishing closure, suggesting that harvest was not the primary factor controlling bull trout abundance at that time. In 1998, the US Fish and Wildlife Service listed Columbia River bull trout, which includes the Flathead population, as Threatened under the Endangered Species Act.

Abundance and Extinction Risk

The total abundance of adult bull trout (fish older than age four) in the interconnected Flathead system (estimated from redd-count expansion) is about 3,000 (Weaver 2010). Estimates of adult bull trout abundance using the same method have ranged from a high of 8,100 fish in 1982 to a low of 1,300 in 1996 (Weaver 2010). In contrast, the nearby Swan Lake and river system supports a similar number of bull trout in a lake that is about two percent as large as Flathead Lake (Figure 3.22) (Rosenthal 2011). Lakes provide important rearing and adult habitat for adfluvial bull trout and play a role in determining the potential size of populations they support. Lakes typically provide richer forage opportunities that contribute to a larger potential population size.

Annual counts of spawning nests—termed redds—provide the data for enumeration of the number of adults spawning in a particular year. Bull trout spawn in September, when stream flows are low and redds are easily observed (Muhlfeld et al. 2006). Redd counts are expanded based on several assumptions including estimates of the number of adults that did not spawn to produce an estimate of the total adult population (Weaver 2010). The total numbers of redds counted have declined by over 50% since the highest counts in the early 1980s (Figure 3.23).

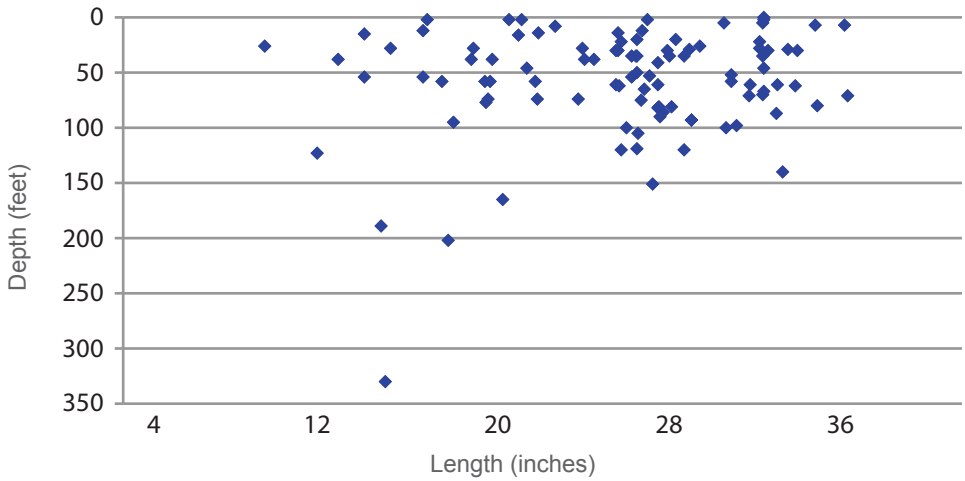
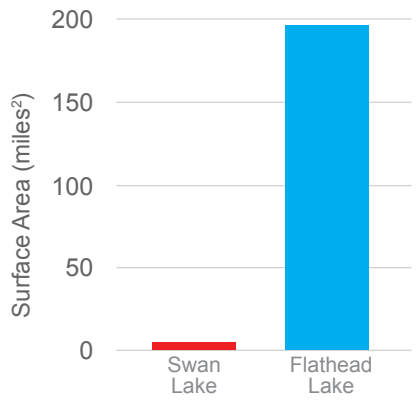


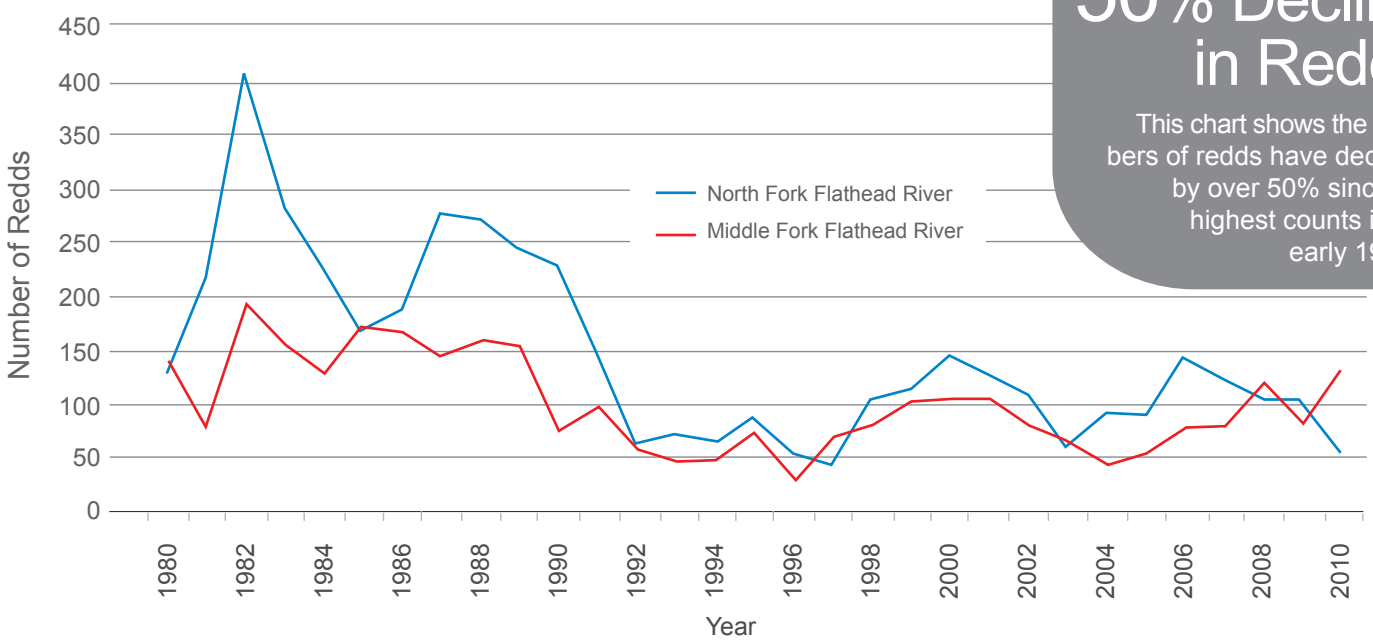
Figure 3.21. Bull trout length and depth-of-capture in gillnets set predominantly during autumn, Flathead Lake, 1998 to 2010.



Tale of 2 Lakes

This chart compares the sizes of Swan and Flathead Lakes. The lakes support a similar number of bull trout, but Flathead Lake is 38 times larger, which suggests it could support many more bull trout, as it did historically.

Figure 3.22. Surface area of Swan and Flathead Lakes. Swan Lake has a surface area of 5 square miles, Flathead Lake has a surface area of 197 square miles.



50% Decline in Redds

This chart shows the numbers of redds have declined by over 50% since the highest counts in the early 1980s.

Figure 3.23. Bull trout redds counted in eight index tributaries of the North and Middle Forks of the Flathead River, 1980 to 2010 (MFWP).

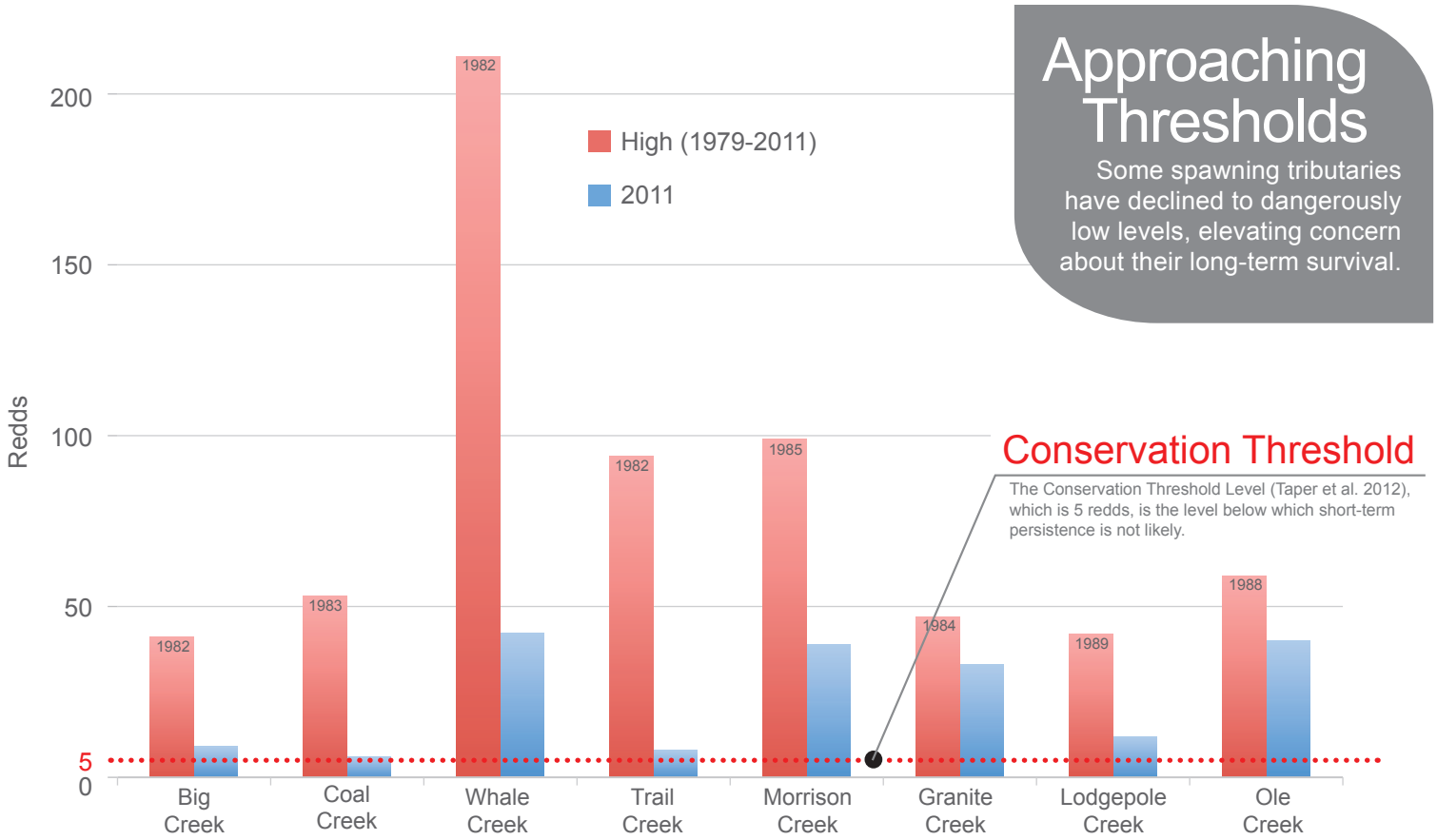
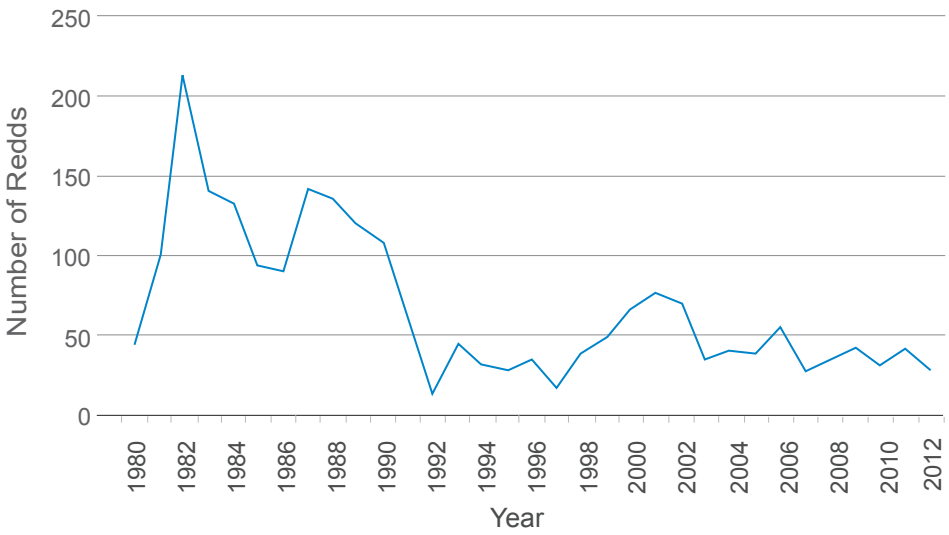


Figure 3.24. Redd counts on North and Middle Fork Flathead River tributaries (data from MFWP). Red columns are the highest counts between 1979 and 2011. Blue columns are the 2011 counts. The chart shows some North and Middle Fork subpopulations are nearly at the Conservation Threshold, elevating concern about their short-term survival.

Total redd counts can mask very low redd counts in local populations. The decline in the North Fork Flathead system has been greater than the decline in the Middle Fork system. Three of four index spawning reaches inventoried in 2011 had less than 10 redds each (Figure 3.24). These low counts are indicative of subpopulations at risk.

Whale Creek, tributary to North Fork Flathead River, exemplifies this point. Although there has been no discernible upward or downward trend in abundance of the total bull trout population (Figure 3.23), the Whale Creek subpopulation has been in nearly continuous decline since 1982 (Figure 3.25). Trends of this nature are difficult to reverse, especially without any intervention to address limiting factors.

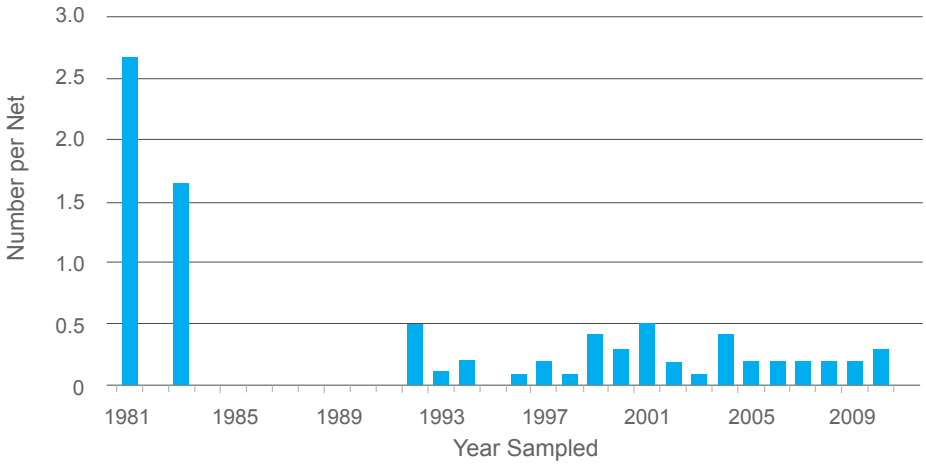
Researchers have evaluated extinction risk through various methods of population viability analysis. Rieman and Allendorf (2001) estimated that as few as half of a population contribute to breeding and that populations of fewer than 50 individuals may experience inbreeding depression, which is the reduced fitness in a given population as a result of breeding of related individuals. Taper and others (2012) identified five redds as the conservation threshold level below which short-term persistence is not likely. Their results indicate that many Flathead bull trout subpopulations are currently at such low levels that stochastic extinction is a foreseeable threat (Iwasa and Mochizuki 1988). Stochastic extinction refers to the probability that severe and inevitable random events, such as fire or flooding, could negatively affect small populations to the point that they decline to smaller sizes from which they cannot recover. The USFWS identifies



Redd Counts In Decline

This chart shows Whale Creek redd counts have been in a nearly continuous decline since 1982.

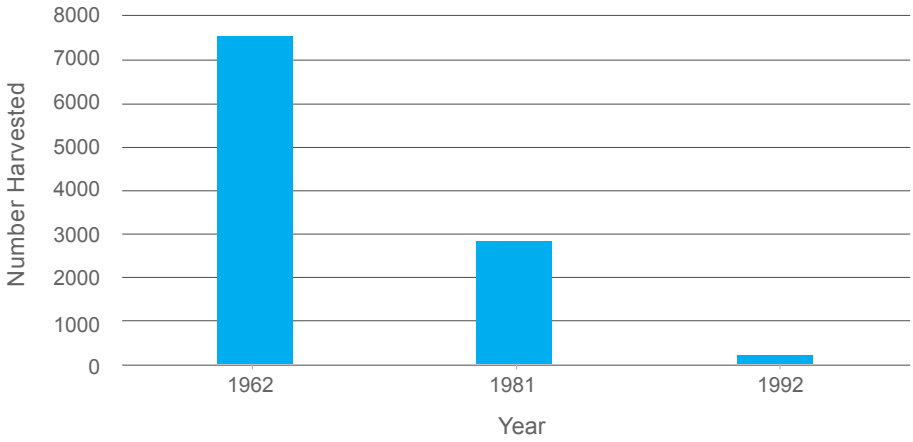
Figure 3.25. Bull trout redds counted in Whale Creek by MFWP, 1980 to 2012 (MFWP).



Gill-Net-Catch Declines

This chart shows dramatic declines in bull trout gill-net catches in Flathead Lake since the early 1980s.

Figure 3.26. Average catches of bull trout in sinking gillnets set during spring in Flathead Lake, 1981 to 2010 (MFWP). No nets were set between 1984 and 1991.



Harvest Declines

This chart shows how the harvest of bull trout has declined since the early 1960s.

Figure 3.27. Estimates of annual harvests of bull trout from Flathead Lake in 1962, 1981 and 1992 (Evarts 1998).

100 adults as a conservation threshold for local populations (Whitesel et al. 2004). Since 1980, many estimated sub-population levels have fallen below 100 adults during several years of monitoring.

In addition to redd counts, changes in bull trout abundance over time are monitored using standardized gillnetting during spring in five fixed locations (Deleray et al. 1999). Average catches have decreased 86% from 2.2 in the early 1980s to 0.3 bull trout per net over the last ten years (Weaver et al. 2006) (Figure 3.26). This has occurred despite conservation gains from improvements in tributary habitat and reduced exploitation by anglers. For example, Big Creek redd counts remain at a fraction of historic levels, although habitat conditions have improved to the degree that monitoring has produced evidence of these positive changes and resulted in the removal of Big Creek from Montana's and EPA's list of sediment-impaired waters (i.e., it has been removed from the Clean water Act 303(d) designation).

A third method to monitor changes in bull trout over time is the comparison of creel surveys conducted over the last 50 years. Like the gillnetting procedure, this method does not produce absolute estimates of abundance, but is useful for evaluating trends in abundance over time. In 1962 there were an estimated 7,487 bull trout harvested from Flathead Lake (Figure 3.27). In 1981, estimated harvest declined to 2,825 (roughly equal to the total population), and in 1992, prior to closure of the bull trout fishery, harvest of bull trout declined to 180 (Evarts 2010). Further, there has been a harvest restriction on bull trout since 1992.

The decline in bull trout abundance from the 1980s[1] raises questions about the future persistence of the population. Many experts are concerned that the population will continue to decline to possible extinction. Concern regarding further bull trout declines stems from numerous examples of bull trout lakes being invaded by lake trout. All of those systems have experienced sharp declines of bull trout due to predation and/or competition by lake trout (Martinez et al. 2009). Examples include the near or total extirpation of bull trout in Hector Lake in Alberta, Canada, Priest Lake in Idaho, and eight lakes connected to Flathead Lake via the Flathead River in Glacier National Park (Fredenberg 2002).

MFWP and CSKT first examined this question in 2002 when defining "secure" levels of bull trout for the Flathead Lake and River Fisheries Co-Management Plan. At that time, management agencies were tasked by a review board with determining whether bull trout were secure enough to justify a gradual and incremental approach to reducing lake trout numbers. The agencies concluded that if local populations remained widely distributed and a total of 300 redds were produced annually, then a slow approach was justifiable, and bull trout were not likely to decline "dangerously" (MFWP and CSKT 2000) while the lake trout suppression program was building (MFWP and CSKT 2002). This decision was challenged by many stakeholders, including Montana Chapter American Fisheries Society, and concern was expressed that "secure" levels as defined by agencies would be used as a goal, rather than as an interim justification for a gradual approach to reducing lake trout numbers. Management agencies responded that secure was an *interim objective* and would not be used as a threshold above which we would not reduce lake trout numbers.

In the mid-term review of the Co-Management Plan, agencies again evaluated the population trend of bull trout. They concluded at that time (2006) that total population abundance of bull trout since the beginning of the Co-Management Plan in 2000 indicated no clear upward or downward trend (CSKT and MFWP 2006). The population was considered to be stable—that is, with no discernible trend over the period examined. They further concluded—in effect reinforcing the decision made in 2002—that the bull trout popu-

1 The 1980s represent the oldest period of available records, so are often mistakenly used as a reference for full population potential. However, historic abundance of bull trout in the interconnected Flathead system prior to development likely exceeded 20,000 adults (Fredenberg, personal communication 2012).

lation size was unacceptably small. None of the experts we contacted indicated that the bull trout trend over the last ten years was upward or likely to increase in the near future.

The mid-term review was also used to solicit opinions from the expert reviewers regarding the potential for bull trout to survive if no management intervention was taken to reduce lake trout numbers. One reviewer, Dr. David Beauchamp of the University of Washington, wrote, “there is high likelihood that lake trout will completely eliminate bull trout in Flathead Lake over the long term.”

The losses of bull trout to predation by lake trout are estimated to be at least 19,000 bull trout annually (Beauchamp 2006), equating to over half the lowest annual production of bull trout outmigrants estimated by Weaver (2010). While bull trout are one of the least common fish in the diet of lake trout in Flathead Lake (most likely due to their low abundance), losses to predation are important because abundance of bull trout is very low (Beauchamp 2006). Thus, while bull trout may not be a common prey item of lake trout in Flathead Lake, losses to predation are large relative to the population size of bull trout and are responsible for the low abundance of bull trout in the Flathead system.

The possibility of further declines of bull trout has ramifications beyond the primary issue of biodiversity in the Flathead system. Further declines or even perpetuation of the status quo precludes attainment of recovery objectives for the crucially important Flathead Lake Core Area, which could block future delisting of bull trout throughout the Columbia River headwaters.

Environmental Consequences in the Project Area: Bull Trout

Fish illustration by Joseph Tomelleri

This section describes the environmental consequences or the effects of the alternatives on bull trout in Flathead Lake and the area delineated in red in Figure 3.1 .

ALTERNATIVE A: No Action (Maintain Status Quo)

Direct and Indirect Effects

The abundance of bull trout would probably remain unchanged (within the range of natural variation) over the short term (<5 years) because bull trout populations have not changed appreciably during the last 10 years of similar management. Predictions of future bull trout abundance are based on predictions of the future abundance of lake trout, which prey on and compete with bull trout. Simulation modeling indicates that the proposed harvest of 70,000 lake trout under Alternative A would maintain total lake trout abundance over the long term. There is a range of simulation outcomes that includes the possibility that total lake trout abundance would decline by 9% or would increase by 10% (Table 3.2). This uncertainty increases the short-term risk associated with Alternative A. Bull trout are vulnerable to irreversible decline over the short term because when their population is low, they have reduced resilience to disruptive stochastic events (Dunham et al. 1997; Morita and Yamamoto 2002), including the potential for a series of above average predation cycles. The greatest risk is that weak local populations will become extirpated and the greater core area will not be strong enough to refound them.

Population modeling indicates that large lake trout would decline, therefore Alternative A would reduce predation on bull trout over the long term (>50 years) by 38% (Appendices 4 and 6). Therefore, bull trout would likely benefit over the long term from implementation of Alternative A, provided that bull trout persist long enough to receive those benefits. This reduction in predation over the long term is predicted to occur because sustained annual harvest of 70,000 lake trout, while not sufficient to reduce total numbers, would gradually reduce the

abundance of large lake trout, and it is the large lake trout that have the greatest predatory effect on bull trout. While the exact relationship between population density and predatory effects on other species is not known, we assume in this analysis that the benefits are directly proportional to the reduction. The predicted reduction in predation is expected to facilitate a 38% recovery of the population lost since lake trout expanded in the 1980s, equating to 1,875 more adult bull trout in the population over the long term (Appendix 9).

Bycatch and Benefit-Risk Analysis
Angling during general harvest results in bycatch mortality of 55 bull trout, and Mack Days fishing contests account for bycatch mortality of 108 bull trout (Table 3.1 and Appendix 5). The total bycatch mortality is 163 individuals, the bulk of which would be sub-adults. This bycatch represents about 0.6% of the age 1+ bull trout population and about 5% of the current adult bull trout population.

Over the short term (<5 years) there would be an annual bycatch mortality of 147 individuals with no meaningful, off-setting reduction in predation by lake trout. Therefore, there would be about a 1% increase in the mortality rate of bull trout and no short–term benefits. Over the long term (>50 years), provided that the bull trout population persists over the next 50 years, adult bull trout are predicted to increase by 1,875 adults. If the assumptions underlying these predictions are correct, the potential population increase would be 11.5 times greater than the bycatch mortality.

ALTERNATIVE B: Reduce Adult (Age 8+) Lake Trout Numbers by 25% Over the Long Term

Direct and Indirect Effects

A 25% reduction of adult lake trout numbers under Alternative B would not be reached in the short term, and therefore the associated reduction in predation on bull trout would not be reached in the short term. However, a 16% reduction would be achieved and therefore a small decrease in predation and a small increase in juvenile bull trout abundance is likely during the short term.

Bioenergetics modeling indicates that Alternative B would reduce predation on bull trout by 65% over the long term (>50 years) (Appendices 4 and 6). This reduction in predation results from the large decrease in lake trout of the size classes that prey most heavily on bull trout. This reduction in predation is expected to facilitate a 65% recovery of the population lost since lake trout expanded in the 1980s, equating to 3,274 more adult bull trout (Appendix 9).

Bycatch and Benefit-Risk Analysis
Annual bycatch mortality of bull trout would be 55 in the general harvest, 108 in Mack Days, and 58 from gillnetting (Table 3.3 and Appendix 5). The total bycatch mortality is 221 individuals, the bulk of which would be sub-adults. This bycatch represents about 0.9% of the age 1+ bull trout population and 7% of the adult bull trout population.

Over the short term (<5 years) there would be an annual bycatch mortality of 221 individuals with a small reduction in predation by lake trout. Therefore, there would be about a 1% increase in the mortality rate of bull trout and a small decrease in predation, resulting in minimal short–term benefits. Over the long term (>50 years), provided that the bull trout population persists and withstands bycatch mortality, we expect the population to increase by 3,274 adults. Provided the assumptions underlying these predictions are correct, the potential population increase is 15 times greater than the bycatch mortality. Therefore Alternative B has a strong positive benefit-risk ratio for bull trout—one that is greater than that for Alternatives A, C, and D.

Mitigation and Adaptive Management

Numerous mitigation measures would be employed to minimize catch of all non-target fish. Specific measures for the angling fishery (this includes the general public, Mack Days contestants, and potentially bounty and commercial fishers) would include a combination of education and enforcement of angling regulations. Specific measures for a netting fishery would entail physical and operational modifications to mesh-size arrays, and depth, location, and timing of placement of nets (Appendix 5). Adaptations to identified problems would be facilitated by an inter-agency working group (Appendix 8).

ALTERNATIVE C: Reduce Adult (Age 8+) Lake Trout Numbers by 50% Over the Long Term

Direct and Indirect Effects

A 50% reduction in adult lake trout numbers under Alternative C would not be reached in the short term, and therefore the associated reduction in predation on bull trout would not be reached in the short term. However, some of the 50% reduction would be achieved, and therefore in the short term, a decrease in predation and an increase in juvenile bull trout abundance is likely.

Bioenergetics modeling indicates that Alternative C would reduce predation on bull trout by 84% over the long term (Appendices 4 and 6). This reduction in predation could result in an 84% recovery of the population lost since lake trout expanded in the 1980s, equating to 4,184 more adult bull trout in the population (Appendix 9).

Bycatch and Benefit-Risk Analysis

Annual bycatch mortality is estimated to be 55 in the general harvest, 108 in Mack Days, and 175 from gillnetting (Table 3.5 and Appendix 5). The total bycatch mortality is 338 individuals, the bulk of which would be sub-adults. This bycatch represents about 1.4% of the age 1+ bull trout population and 10% of the adult population.

Over the short term (<5 years) there would be an annual bycatch mortality of 338 individuals with a small off-setting reduction in predation by lake trout. Therefore, there would be slightly greater than a 1% increase in the mortality rate of bull trout and minimal short-term benefits. Over the long term (>50 years), provided that the bull trout population persists, adult bull trout are predicted to increase by 4,184 adults. Provided the assumptions underlying these predictions are correct, the potential increase in the bull trout population would exceed the bycatch mortality by 12 fold. Therefore Alternative C has a long-term positive benefit-risk ratio for bull trout, one that is equal to Alternative A, less than Alternative B, and greater than Alternative D.

Mitigation and Adaptive Management

Numerous mitigation measures would be employed to minimize catch of all non-target fish. Specific measures for the angling fishery (this includes the general public, Mack Days contestants, and potentially bounty and commercial fishers) would include a combination of education and enforcement of angling regulations. Specific measures for a netting fishery would entail physical and operational modifications to mesh-size arrays, and depth, location, and timing of placement of nets (Appendix 5). Adaptations to identified problems would be facilitated by an inter-agency working group (Appendix 8).

ALTERNATIVE D: Reduce Adult (Age 8+) Lake Trout Numbers by 75% Over the Long Term

Direct and Indirect Effects

A 75% reduction of adult lake trout numbers under Alternative D would not be reached in the short term, and therefore the associated reduction in predation on bull trout would not be reached in the short term.

However, some of the 75% reduction would be achieved, and therefore in the short term, a decrease in predation and increase in juvenile bull trout abundance is likely.

Bioenergetics modeling indicates that Alternative D would reduce predation on bull trout by 93% (Appendices 4 and 6). This reduction in predation is expected to facilitate a 93% recovery of the population lost since lake trout expanded in the 1980s, equating to 4,650 more adult bull trout in the population (Appendix 9).

Bycatch and Benefit-Risk Analysis
Annual bycatch mortality is estimated to be 55 in the general harvest, 108 in Mack Days, and 304 from gillnetting (Table 3.7 and Appendix 5). The total bycatch mortality is 467 individuals, the bulk of which would be subadults. This bycatch represents about 2% of the age 1+ bull trout population and 15% of the adult population.

Over the short term (<5 years) there would be an annual bycatch mortality of 467 individuals with a small reduction in predation by lake trout. Therefore, there would be about a 2% increase in the mortality rate of bull trout and minimal short-term benefits. Over the long term (>50 years), provided that the bull trout population persists, adult bull trout are predicted to increase by 4,650 adults. Provided the assumptions underlying these predictions are correct, the potential increase in the bull trout population would exceed the bycatch mortality by 10 fold. Therefore Alternative D has a positive benefit-risk ratio for bull trout, one that is less than Alternatives A, B, and C.

Mitigation and Adaptive Management
Numerous mitigation measures would be employed to minimize catch of all non-target fish. Specific measures for the angling fishery (this includes the general public, Mack Days contestants, and potentially bounty and commercial fishers) would include a combination of education and enforcement of angling regulations. Specific measures for a netting fishery would entail physical and operational modifications to mesh-size arrays, and depth, location, and timing of placement of nets (Appendix 5). Adaptations to identified problems would be facilitated by an inter-agency working group (Appendix 8).

Summary

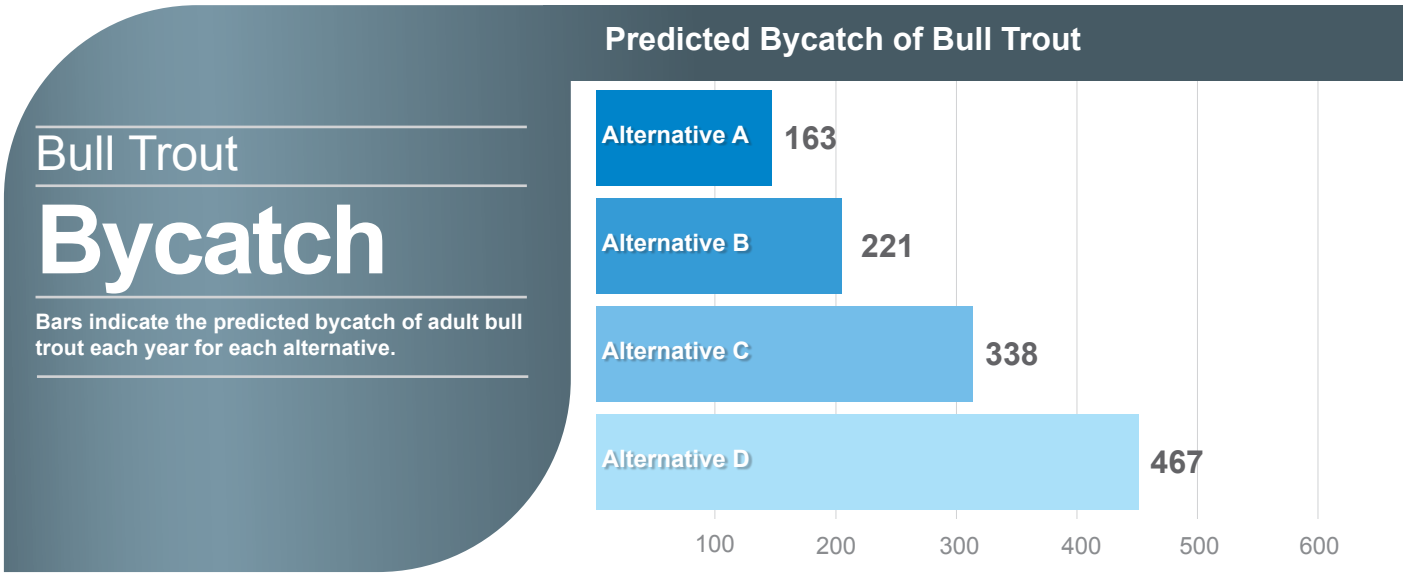


Figure 3.28. Predicted annual bycatch mortality for bull trout.

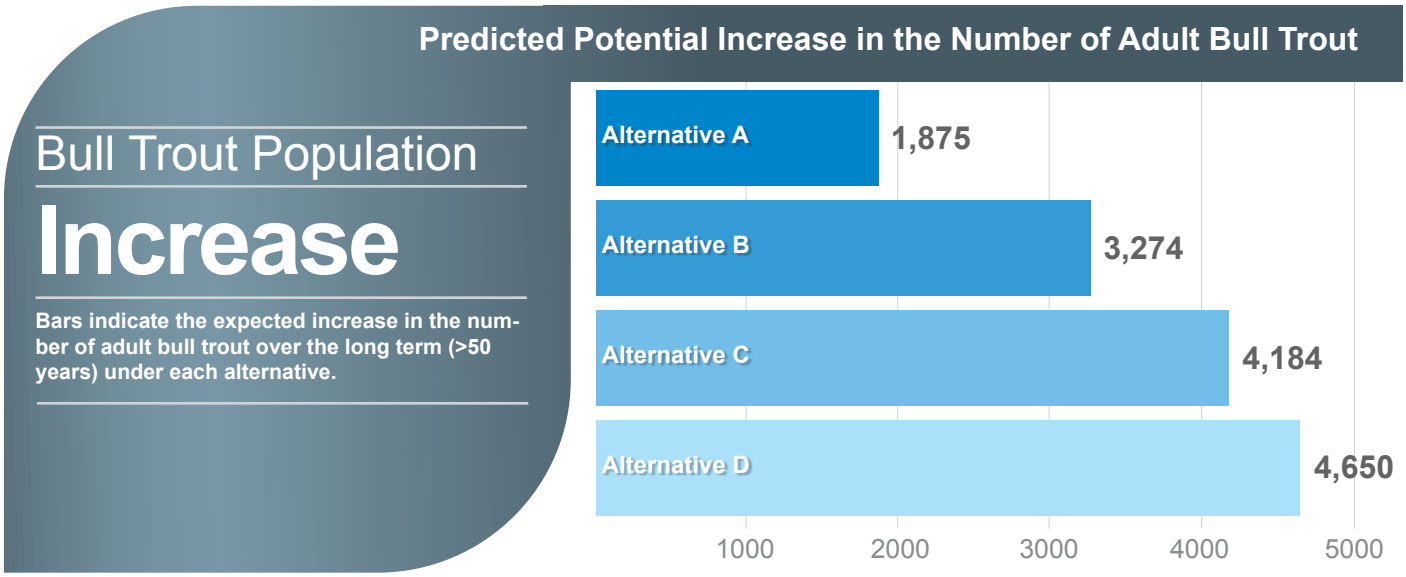


Figure 3.29. Predicted increase in adult bull trout numbers by alternative.

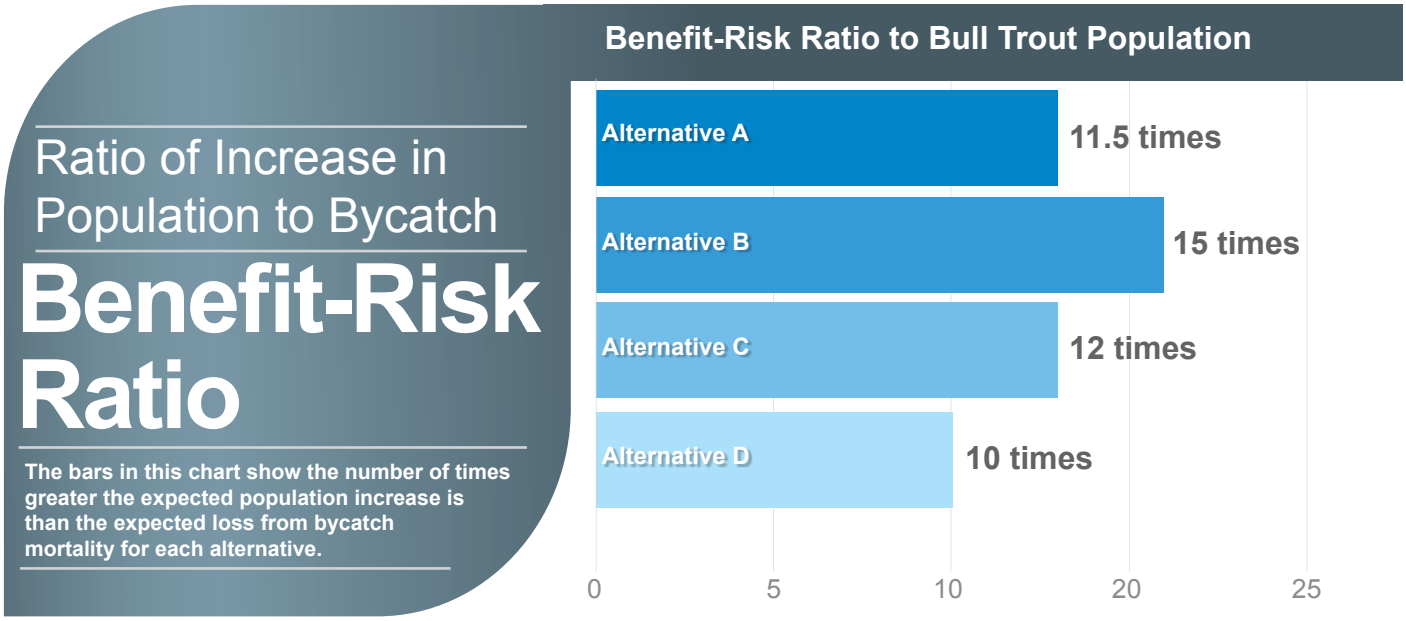


Figure 3.30. Benefit-risk ratio to bull trout population by alternative.

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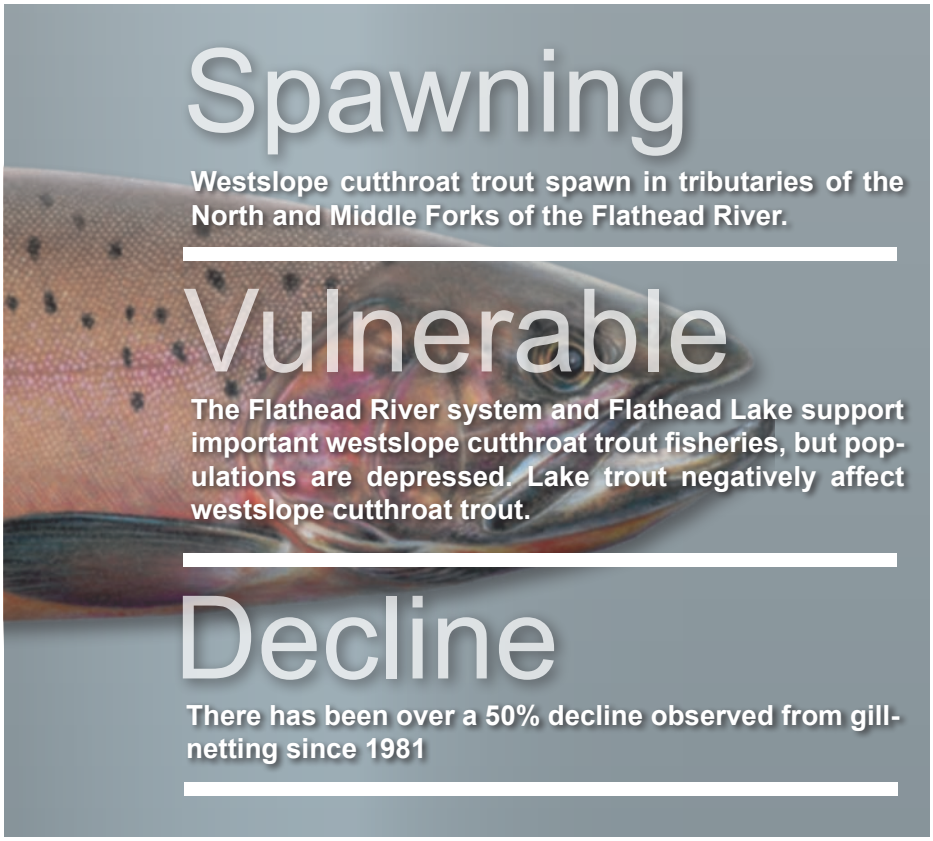
Affected Environment in the Project Area: Westslope Cutthroat Trout

This section describes the affected environment or the current conditions for westslope cutthroat trout in Flathead Lake and the area delineated in red in Figure 3.1.

Westslope cutthroat trout are native to the Flathead Lake and River system and have likely occupied this area since the last ice age or for over 10,000 years. Both migratory, and resident forms spawn in tributaries of the North and Middle Forks of the Flathead River. Juveniles rear in both forks until a portion migrate to the Flathead River or Flathead Lake to reach full size and maturity.



Westslope cutthroat trout spawn primarily in June. Consequently their redds are not visible to observers because of high spring flows. Because of this, and because of their wide distribution in the Flathead basin, we do not have good estimates of their abundance in Flathead Lake. Instead we rely on gillnetting to monitor trends in abundance over time. Catches in gillnets indicate a decline of roughly two thirds since monitoring began in 1981 (Figure 3.31).

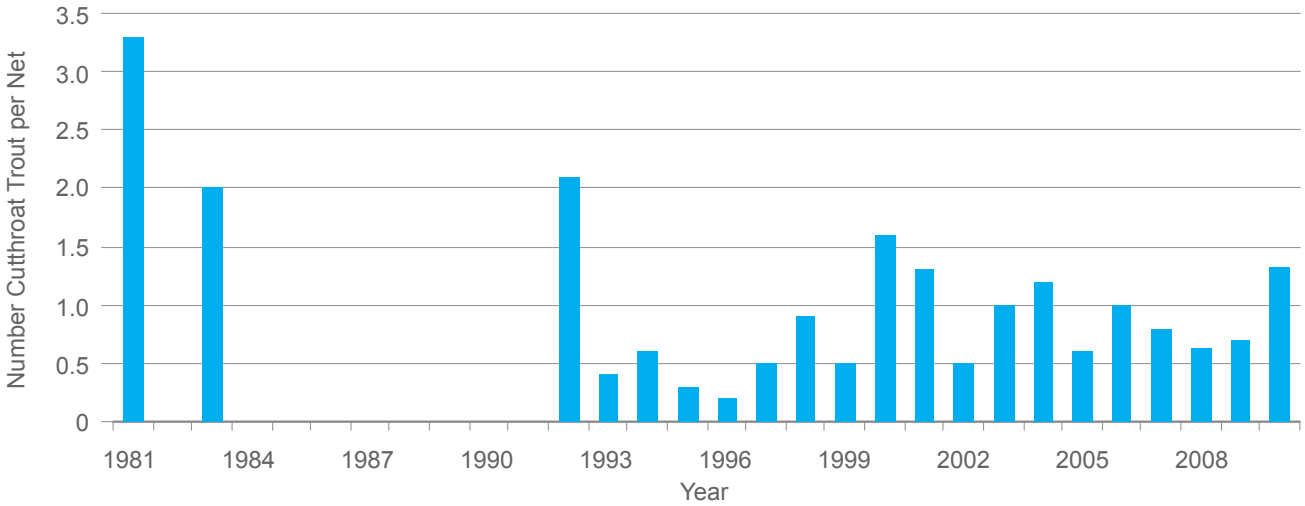


Figure 3.31. Average catches of westslope cutthroat trout in gillnets set during spring in Flathead Lake, 1981 to 2010. No nets were set from 1984 to 1991.

Westslope cutthroat trout are found in the nearshore area and surface waters of Flathead Lake and generally in shallow water. Their diet consists primarily of invertebrates. Because they typically do not use depths greater than 50 feet and are active during daylight hours, they do not typically feed on *Mysis*.

Westslope cutthroat trout are well represented in the diet of lake trout in Flathead Lake. Lake trout are estimated to consume 177,000 westslope cutthroat trout annually in Flathead Lake (Appendix 4).

Westslope cutthroat trout are the most abundant fish in the North and Middle Forks of the Flathead River (Weaver et al. 2006). Hybridization with rainbow trout (*Oncorhynchus mykiss*) is a continuing threat (Hitt et al. 2003; Boyer et al. 2008), as is predation by northern pike (Mulfield et al. 2009). Predation by lake trout in Flathead Lake penalizes the adfluvial life history and favors resident forms in the river system.

Environmental Consequences in the Project Area: Westslope Cutthroat Trout

This section describes the environmental consequences or the effects of implementing the alternatives on westslope cutthroat trout in Flathead Lake and the area delineated in red in Figure 3.1.

ALTERNATIVE A: No Action (Maintain Status Quo)

Direct and Indirect Effects

Abundance of westslope cutthroat trout would remain relatively unchanged within the short term (<5 years). Westslope cutthroat trout populations have not changed measurably during the last 10 years of current management, suggesting they would continue unchanged during the short term.

Fish illustration by Joseph Tomelleri

Over the long term (>50 years) there would be a substantial reduction in predation by lake trout on westslope cutthroat trout. The change in predation rate is predicted based on the 58% reduction in large lake trout anticipated under Alternative A over the long term.

Bycatch and Benefit-Risk

Angling during general harvest results in a small bycatch estimated to be 11 westslope cutthroat trout per year (Table 3.1 and Appendix 5). No westslope cutthroat trout have been recorded being caught during Mack Days fishing contests. The low level of bycatch and substantial reduction in predation would allow westslope cutthroat trout population numbers to increase. Alternative A would likely have a positive net benefit for westslope cutthroat trout.

ALTERNATIVE B: Reduce Adult (Age 8+) Lake Trout Numbers by 25% Over the Long Term

Direct and Indirect Effects

A 25% reduction in adult lake trout numbers under Alternative B would not be reached in the short term (<5 years), and therefore the associated reduction in predation on westslope cutthroat trout would not be reached in the short term. However, a 16% reduction would be achieved in the short term, and therefore a small decrease in predation and an increase in juvenile westslope cutthroat trout abundance is likely.

Bioenergetics modeling predicts that a 25% reduction in adult lake trout numbers over the long term (>50 years) would result in a 58% reduction in predation by lake trout on westslope cutthroat trout relative to Alternative A (Appendices 4 and 6). Assuming that lake trout predation accounts for a high percent of ad-

fluvial cutthroat trout mortality (Appendix 4), the long-term decrease in predation would likely result in at least a 58% restoration of the westslope cutthroat trout abundance lost since the 1980s.

Bycatch and Benefit-Risk
Bycatch mortality in the general harvest is estimated to be 11 per year, and bycatch for the fishing contests and gillnetting would likely be near zero (Table 3.3 and Appendix 5). Because the potential increase in westslope cutthroat trout is in the thousands and the bycatch is 11, the benefit-risk of Alternative is B is strongly positive for westslope cutthroat trout.

Mitigation and Adaptive Management
Numerous mitigation measures would be employed to minimize catch of all non-target fish. Specific measures for the angling fishery (this includes the general public, Mack Days contestants, and potentially bounty and commercial fishers) would include a combination of education and enforcement of angling regulations. Specific measures for a netting fishery would entail physical and operational modifications to mesh-size arrays, and depth, location, and timing of placement of nets (Appendix 5). Adaptations to identified problems would be facilitated by an inter-agency working group (Appendix 8).

ALTERNATIVE C: Reduce Adult (Age 8+) Lake Trout Numbers by 50% Over the Long Term

Direct and Indirect Effects
A 50% reduction in adult lake trout numbers under Alternative C would not be reached in the short term, and therefore the associated reduction in predation on westslope cutthroat would not be reached in the short term. However, some of the 50% reduction would be achieved, and therefore a decrease in predation and an increase in juvenile westslope cutthroat abundance is likely.

Over the long term (>50 years), bioenergetics modeling indicates that a 50% reduction in adult lake trout numbers would result in a 77% reduction in predation on westslope cutthroat trout relative to Alternative A (Appendices 4 and 6). Assuming lake trout predation accounts for a high percent of adfluvial cutthroat trout mortality, this long-term decrease in predation would likely result in a very large increase in westslope cutthroat trout abundance.

Bycatch and Benefit-Risk
Bycatch mortality in the general harvest is estimated to be 11 per year, and zero bycatch is estimated for the fishing contests and gillnetting (Table 3.5 and Appendix 5). Because the potential increase in westslope cutthroat trout is in the thousands, and the bycatch is 11, the benefit-risk of Alternative is C is strongly positive for westslope cutthroat trout.

Mitigation and Adaptive Management
Numerous mitigation measures would be employed to minimize catch of all non-target fish. Specific measures for the angling fishery (this includes the general public, Mack Days contestants, and potentially bounty and commercial fishers) would include a combination of education and enforcement of angling regulations. Specific measures for a netting fishery would entail physical and operational modifications to mesh-size arrays, and depth, location, and timing of placement of nets (Appendix 5). Adaptations to identified problems would be facilitated by an inter-agency working group (Appendix 8).

ALTERNATIVE D: Reduce Adult (Age 8+) Lake Trout Numbers by 75% Over the Long Term

Direct and Indirect Effects

A 75% reduction in lake trout numbers under Alternative D would not be reached in the short term, and therefore the associated reduction in predation on westslope cutthroat would not be reached in the short term. However, some of the 75% reduction would be achieved, and therefore a decrease in predation and an increase in juvenile westslope cutthroat abundance is likely.

Over the long term (>50 years), bioenergetics modeling predicts that a 75% reduction in lake trout numbers would result in a 91% reduction in predation on westslope cutthroat trout relative to Alternative A (Appendices 4 and 6). Assuming that lake trout predation accounts for a high percent of adfluvial cutthroat trout mortality, this long-term decrease in predation would likely result in a very large increase in westslope cutthroat trout abundance.

Bycatch and Benefit-Risk

Bycatch mortality in the general harvest is estimated to be 11 per year, and zero bycatch is estimated for the fishing contests and gillnetting (Table 3.7 and Appendix 5). Because the potential increase in westslope cutthroat trout is in the thousands, and the bycatch is 11, the benefit-risk of Alternative is D is strongly positive for westslope cutthroat trout.

Mitigation and Adaptive Management

Numerous mitigation measures would be employed to minimize catch of all non-target fish. Specific measures for the angling fishery (this includes the general public, Mack Days contestants, and potentially bounty and commercial fishers) would include a combination of education and enforcement of angling regulations. Specific measures for a netting fishery would entail physical and operational modifications to mesh-size arrays, and depth, location, and timing of placement of nets (Appendix 5). Adaptations to identified problems would be facilitated by an inter-agency working group (Appendix 8).

Summary

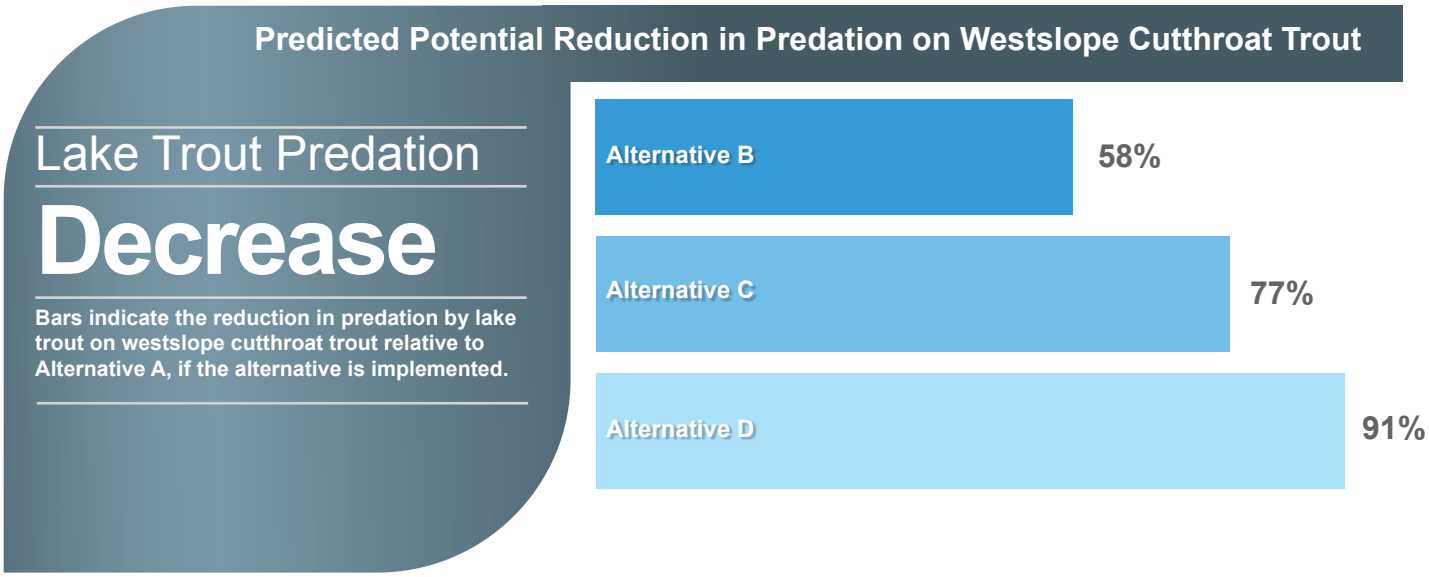


Figure 3.32. Predicted percent reduction in predation on westslope cutthroat trout by alternative relative to Alternative A.

Affected Environment in the Project Area: Lake Whitefish

This section describes the affected environment or the current conditions for lake whitefish in Flathead Lake and the area delineated in red in Figure 3.1.

History

Lake whitefish were introduced into Flathead Lake in the late 1800s. Like lake trout, they have benefited from the introduction of *Mysis* and greatly expanded in abundance since the 1980s. Early monitoring by Elrod (1929) indicated that it took at least 30 years after planting for this population to become well established. Early creel surveys showed little harvest of lake whitefish until 1992. Annual angler exploitation of lake whitefish is extremely low (3%). Such low exploitation has also allowed "stockpiling" of older, larger fish in the population (Figure 3.33).

We estimated lake whitefish abundance by comparing catches of lake whitefish to catches of lake trout in the same gillnets (Appendix 6). The purpose of this estimate was to provide a useful reference for the abundance of lake whitefish. The method assumed that lake whitefish and lake trout were similar in capture efficiency in standardized random gillnets used in Flathead Lake. Length-specific abundance of lake trout

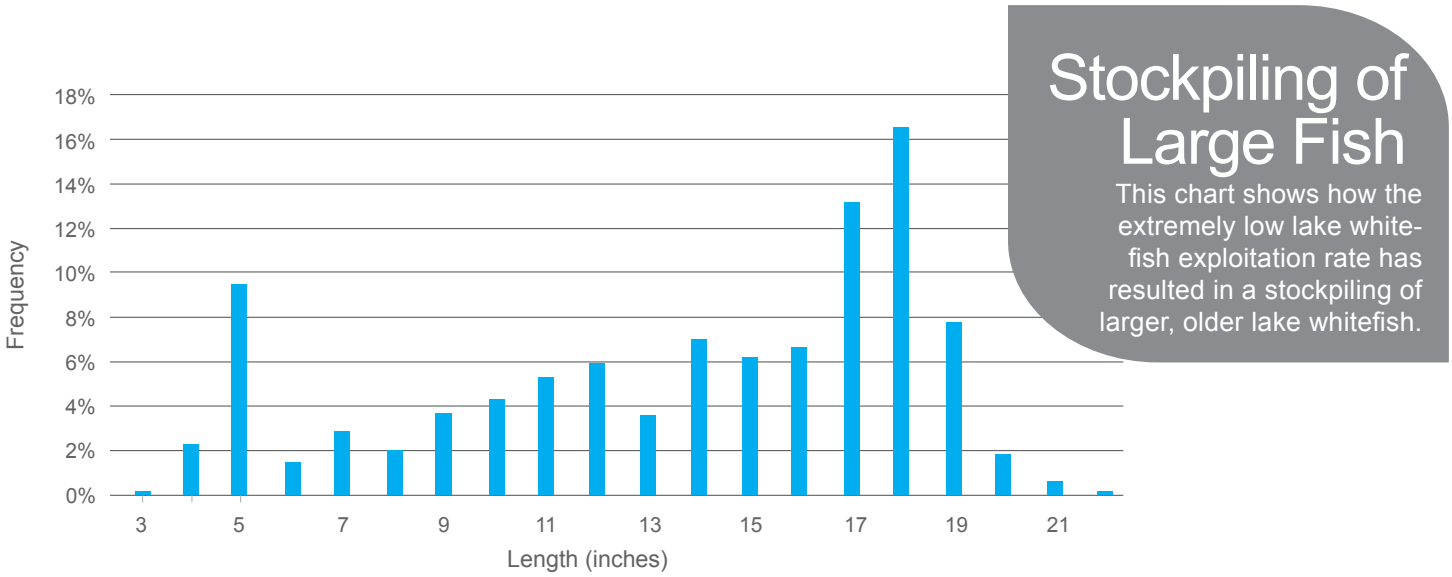


Figure 3.33. Length-frequency of lake whitefish caught in gillnets set in autumn in Flathead Lake, 2008 (CSKT files).

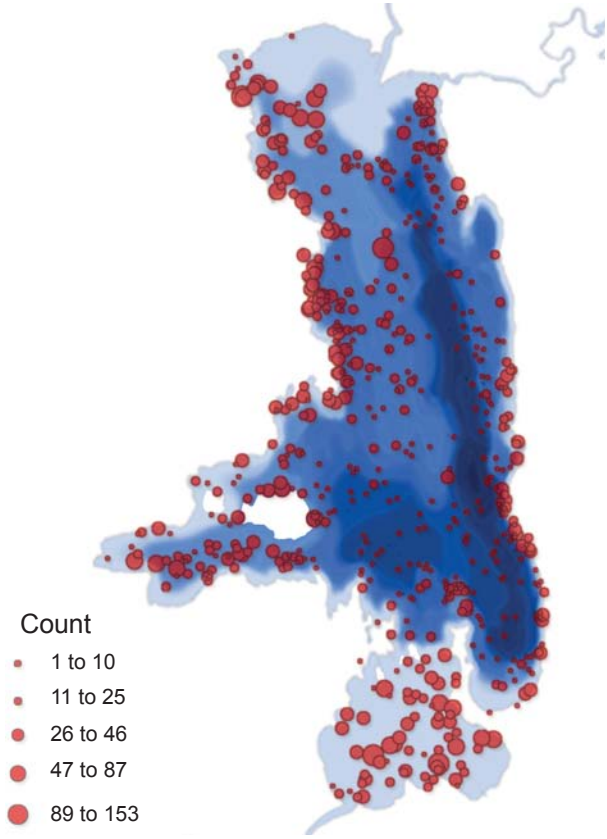


Figure 3.34. Locations in which lake whitefish were captured in gillnets set predominantly in autumn in Flathead Lake, 1998 to 2010 (CSKT).

was used to estimate length-specific abundance of lake whitefish by direct proportion in gillnets. Abundance of lake whitefish vulnerable to gillnetting (959,496 fish) was nearly two-times higher than abundance of lake trout vulnerable to gillnetting (Figures 3.34 and 3.35). Because the estimate was derived indirectly, we cannot verify its accuracy without completing a mark-recapture study. Further, we know the estimate was biased low because sampling for the estimate was in autumn when a substantial number of adult lake whitefish had moved out of the lake and into the Flathead River to spawn.

The diet of lake whitefish in Flathead Lake is dominated by chironomids (midges), *Mysis* and clams (Beauchamp 2006, Tohtz 1993). However, lake whitefish prey heavily on juvenile yellow perch in some years. This habit improves the catchability of lake whitefish. Angling for lake whitefish develops seasonally when the fish gather in large aggregations, such as during spawning in autumn, during *Hexagenia* (mayfly) hatches in July, and when large numbers of juvenile yellow perch congregate during July and August. In 2007, these conditions led to 110,000 lake whitefish being harvested in two months (CSKT files).

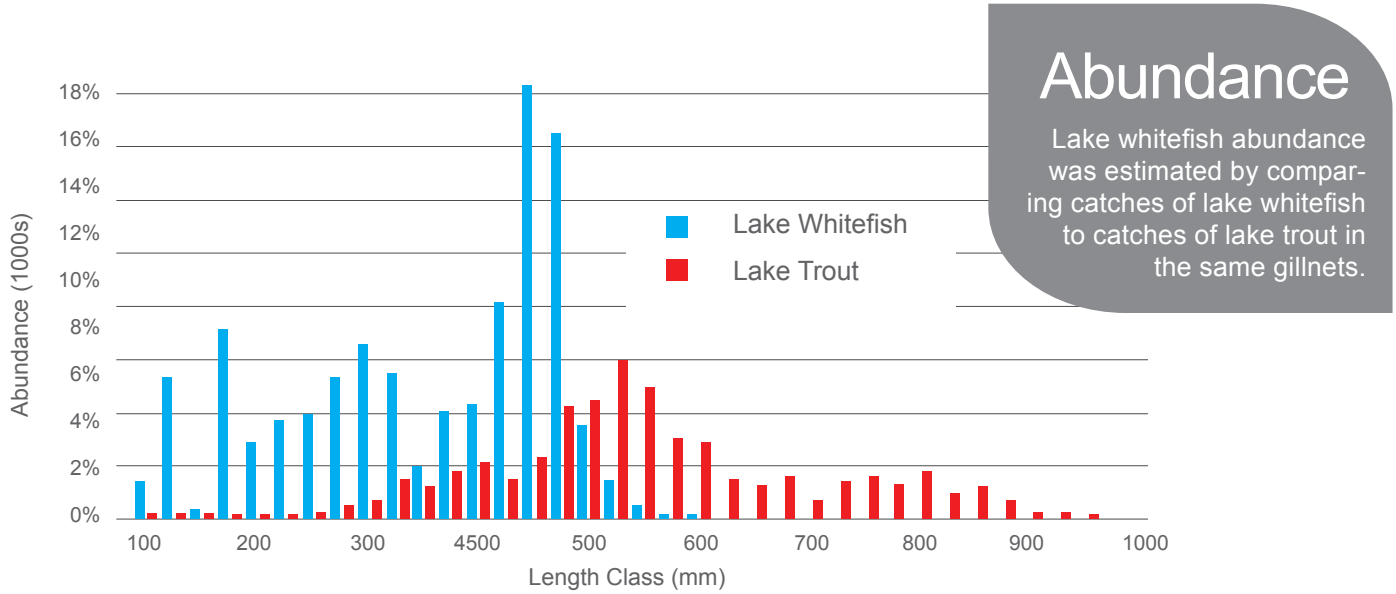


Figure 3.35. Length-specific abundance of lake whitefish and lake trout in Flathead Lake during autumn 2010 (Appendix 6).

Environmental Consequences in the Project Area: Lake Whitefish

This section describes the environmental consequences or the effects of implementing the alternatives on lake whitefish in Flathead Lake and the area delineated in red in Figure 3.1.

ALTERNATIVE A: No Action (Maintain Status Quo)

Direct and Indirect Effects

Under the No Action alternative, the abundance of lake whitefish is expected to remain relatively unchanged during both the short and long term because lake whitefish abundance has been stable for many years under the current action. Bycatch of lake whitefish by anglers is low and inconsequential relative to the size of the population.

Fish illustration by Joseph Tomelleri

ALTERNATIVE B: Reduce Adult (Age 8+) Lake Trout Numbers by 25% Over the Long Term

Direct and Indirect Effects

A 25% reduction in lake trout numbers under Alternative B would not be reached in the short term (<5 years), and therefore the associated reduction in predation on lake whitefish would not be reached in the short term. Therefore a small decrease in predation and increase in juvenile lake whitefish abundance is likely.

Bioenergetics modeling predicts that over the long term (>50 years) a 25% reduction in adult lake trout numbers would result in a 60% reduction in predation on lake whitefish (Appendices 4 and 6). The lake trout control effort would likely cause the bycatch of 35,000 lake whitefish (Table 3.3). The positive effect of reduced predation would likely be largely offset by the negative effect of bycatch of lake whitefish. Therefore the lake whitefish population, which is currently very large and near carrying capacity, is not likely to change appreciably.

ALTERNATIVE C: Reduce Adult (Age 8+) Lake Trout Numbers by 50% Over the Long Term

Direct and Indirect Effects

A 50% reduction in lake trout numbers under Alternative C would not be reached in the short term, and therefore the associated reduction in predation on lake whitefish would not be reached in the short term. However, some of the 50% reduction would be achieved, and therefore a decrease in predation and an increase in juvenile lake whitefish abundance is likely.

Bioenergetics modeling predicts that a 50% reduction in lake trout numbers over the long term (>50 years) would result in a 79% reduction in predation on lake whitefish (Appendices 4 and 6). The lake trout control effort would likely cause the bycatch of 105,000 lake whitefish (Table 3.5). The positive effect of reduced predation would likely be largely offset by the negative effect of bycatch of lake whitefish. Therefore the lake whitefish population, which is currently very large and near carrying capacity, is not likely to change appreciably. The predicted reduction in predation rate, although large, would likely cause only a moderate increase in the abundance of lake whitefish.

ALTERNATIVE D: Reduce Adult (Age 8+) Lake Trout Numbers by 75% Over the Long Term

Direct and Indirect Effects

A 75% reduction in lake trout numbers under Alternative D would not be reached in the short term, and therefore the associated reduction in predation on lake whitefish would not be reached in the short term.

However, some of the 75% reduction would be achieved, and therefore a decrease in predation and an increase in juvenile lake whitefish abundance is likely.

Bioenergetics modeling predicts that a 75% reduction in lake trout numbers over the long term (>50 years) would result in an 88% reduction in predation on lake whitefish (Appendices 4 and 6). The lake trout control effort would likely cause the bycatch of 182,500 lake whitefish (Table 3.7). The positive effect of reduced predation would likely be largely offset by the negative effect of bycatch of lake whitefish. Therefore the lake whitefish population, which is currently very large and near carrying capacity, is not likely to change appreciably. The predicted reduction in predation rate, although large, would likely cause only a moderate increase in the abundance of lake whitefish.

Summary

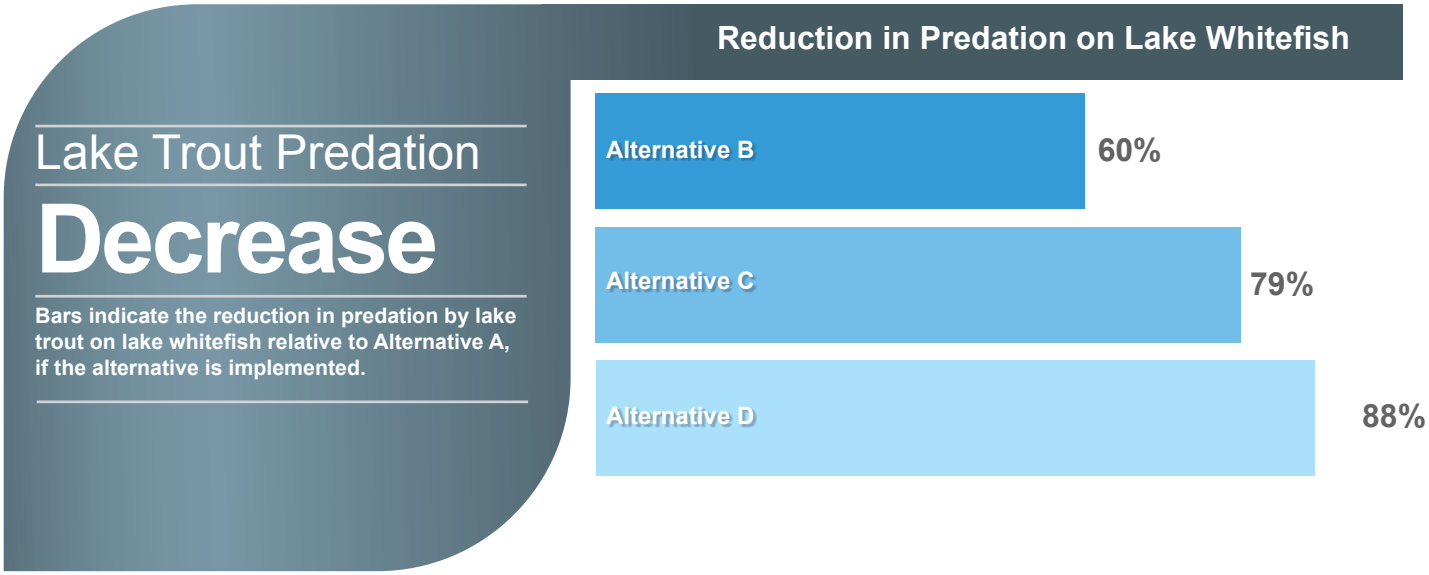


Figure 3.36. Anticipated percent reduction in predation on lake whitefish by alternative, relative to Alternative A.

Affected Environment in the Project Area: Yellow Perch

This section describes the affected environment or the current conditions for yellow perch in Flathead Lake and the area delineated in red in Figure 3.1.

Yellow perch, native to eastern North America, were introduced into Flathead Lake in 1910. They are generally restricted to shallow bays and the nearshore areas of Flathead Lake (Figure 3.37) where they feed predominantly on zooplankton and invertebrates, playing an important role in the Flathead Lake foodweb. They are the second most utilized fish prey of lake trout and the most important fish prey of lake whitefish.

Yellow perch spawn in spring on submerged vegetation in shallow bays. Their reproductive success is highly variable from year to year because they have very high fecundity and are vulnerable to weather events, especially wave action that can displace their egg masses. During the most successful reproductive years there is typically a response of predators, such as lake trout and lake whitefish, that target the young-of-year yellow perch.

Environmental Consequences in the Project Area: Yellow Perch

Abundance of yellow perch is typically controlled by environmental factors to a much greater extent than by predation. Yellow perch have high fecundity (up to 50,000 eggs per female). When suitable habitat is available and environmental conditions (like water temperature and turbidity) are suitable during spawning, the high fecundity translates into very large recruitment. During these years, food limitations may directly affect growth and indirectly affect survival. Predation by fish is most focused on young-of-year perch, which has a smaller population effect than the loss of older and mature individuals. Predation may dampen the effects of large recruitment on population growth, but is unlikely to exceed the effects of environmental factors. The two largest predators of perch are lake trout and lake whitefish, and the cumulative total numbers of those two predators will likely not decrease substantially under any of the proposed alternatives. Therefore the reduction in lake trout numbers identified in each of the alternatives will likely not change total predation on yellow perch to the extent that a measurable population change would occur.

Figure 3.37. Capture locations and numbers in randomly set gillnets throughout Flathead Lake, 1998-2012.

Affected Environment in the Project Area: Invertebrates (including *Mysis*), Zooplankton, and Phytoplankton

This section describes the affected environment or the current conditions of invertebrates, zooplankton, and phytoplankton in Flathead Lake and the area delineated in red in Figure 3.1.

Flathead Lake Limnology

Flathead Lake is characterized by relatively low nutrient levels and high water clarity (typically 30 feet of visibility, but occasionally over 60 feet). Nitrogen and phosphorous—the most important nutrients for phytoplankton growth—are supplied to Flathead Lake primarily during spring runoff, but atmospheric deposition and recirculation of nutrients from deepwater during autumn turnover are also substantial sources (Ellis et al. 2011). Increasing nutrient concentrations coupled with increasing day-length and water temperatures during spring stimulate phytoplankton growth. Large diatoms and golden algae dominate the spring bloom.

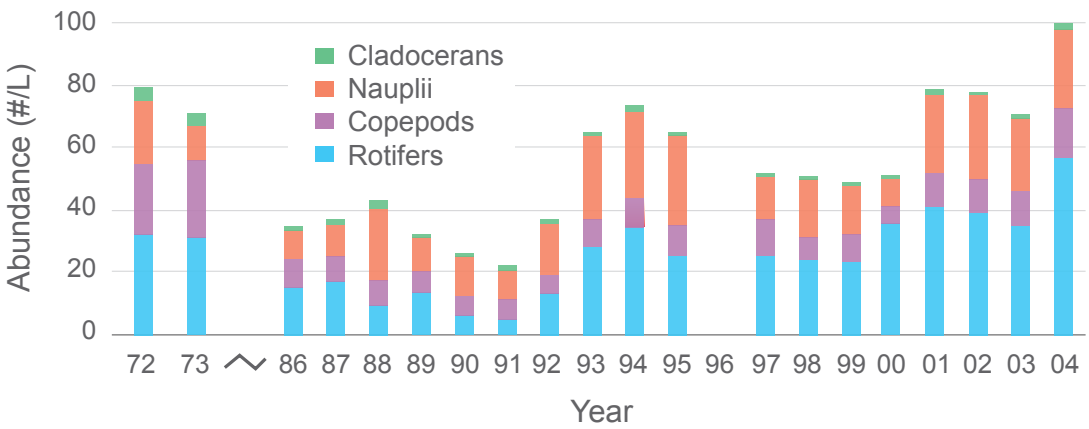
Nutrient Levels and Phytoplankton

Nutrient levels decline during summer for several reasons. Thermal stratification of the water column in midsummer inhibits the recycling of nutrients from deep water reserves, and the delivery of nutrients from river flows is greatly diminished. High phytoplankton production in late summer depletes the remaining nitrogen and phosphorus from surface waters. In addition, inorganic phosphorus remains below detection limits most of the year due to the rapid cycling by the microbial community. Small organisms adapted to low nutrient availability make up the phytoplankton community present during summer. Algal populations turn over rapidly (short time to grow, die, and decay) in response to low nutrient concentrations and high temperatures.

Primary productivity (the growth of algae) peaks in midsummer, coincident with peak sunlight and temperature. Total biomass of phytoplankton is higher during spring, but production is lower because the community is made up of larger and slower-growing diatoms. Smaller plankton present during summer are about one-third of the total algal biomass but account for about two-thirds of total primary production in Flathead Lake (Ellis and Stanford 1982).

Zooplankton

In Flathead Lake, the three main groups of zooplankton are rotifers (Phylum Rotifera) copepods, and cladocerans (the last two are included in Subphylum Crustacea). For our purposes, the copepods are further divided into a larval stage (nauplii), which is often quite abundant. Therefore, Figure 3.38 displays four groups of changing zooplankton abundance over time. Although cladocerans are numerically only two percent of the zooplankton community, they play a substantial role because of their high productivity, large size and biomass, and importance to both vertebrate and invertebrate consumers.



Zooplankton

This chart of the abundance of zooplankton over time shows the shifts that have occurred since the early 1970s.

Figure 3.38. Zooplankton abundance in Flathead Lake (Ellis et al. 2011).

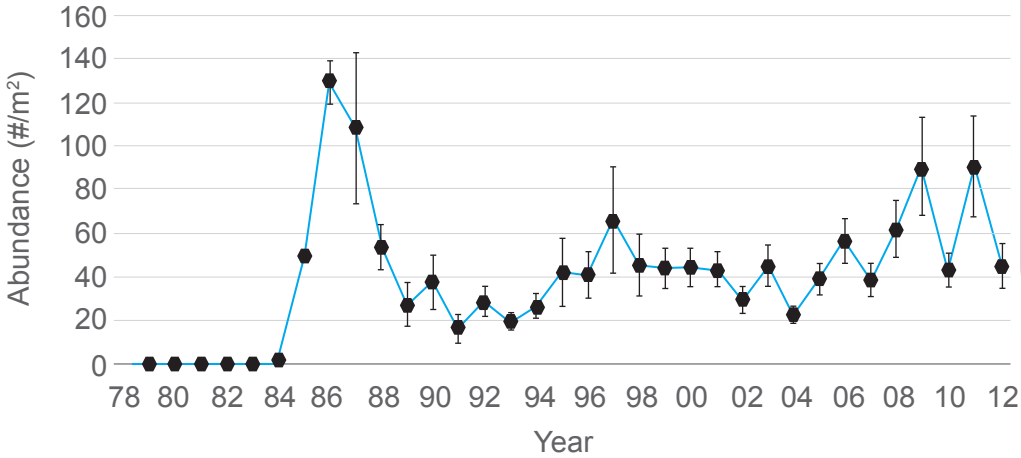
Mysis

The primary consumers of pelagic (open water) zooplankton in Flathead Lake are opossum shrimp known as *Mysis* (from the species name *Mysis diluviana)*. *Mysis* (about .5 inches long) (Figure 3.39) were first detected in Flathead Lake in 1981 and reached maximum abundance by 1986 (Figure 3.39). They were not introduced directly into Flathead Lake but drifted down to the lake from three upstream source lakes (Ashley, Swan, and Whitefish Lakes) where they had been planted during the late 1960s and early 1970s in a misguided effort to benefit kokanee populations. Instead, *Mysis* facilitated the collapse of kokanee in Flathead Lake. Additionally, the increase in *Mysis* caused cascading effects up and down the food chain (Spencer et al. 1991), caused the decline of several zooplankton species, and caused the increase in lake trout and lake whitefish (Ellis et al. 2011).

Figure 3.39. Mysis diluviana.

Mysids hide on the lake bottom during the day to avoid predators and migrate vertically at night to the upper water column where they feed on large zooplankton. In Flathead Lake, mysids prey primarily on the algae-eating zooplankter, *Daphnia thorata* (Wicklum 2000). In turn, *Mysis* are preyed on predominantly by lake trout and lake whitefish (Beauchamp 2006).

The *Mysis* population in Flathead Lake has a one-year life cycle in which juveniles are released each spring (Chess and Stanford 1998). The juveniles mature over summer and are able to produce young the following spring. After releasing their young, adults typically persist for several months before dying in midsummer. When resources are limiting, they are typically forced to shift to a two-year life history, but have not done so in Flathead Lake.



Mysis Abundance

This chart shows the peak in *Mysis* abundance that occurred in 1986 and the subsequent decline, the decline probably due to predation by lake trout and lake whitefish.

Figure 3.40. Mysis abundance in Flathead Lake, 1981 to 2011 (Flathead Lake Biological Station).

Because their abundance in Flathead Lake peaked and dropped over a short span of years (Figure 3.40) and the decline was coincident with decreases in zooplankton (Figure 3.38), it might appear that *Mysis* in Flathead Lake were regulated by the availability of their prey. But *Mysis* probably declined because of increasingly intense predation by lake trout and lake whitefish in the late 1980s (Figure 3.41). Modeling indicates that if there were no fish predators in Flathead Lake there would be sufficient forage for *Mysis* to increase four-fold (Wicklum 2000). Beauchamp and others (2006) drew similar conclusions and estimated that lake trout consumed about 30% of the annual Mysid production.

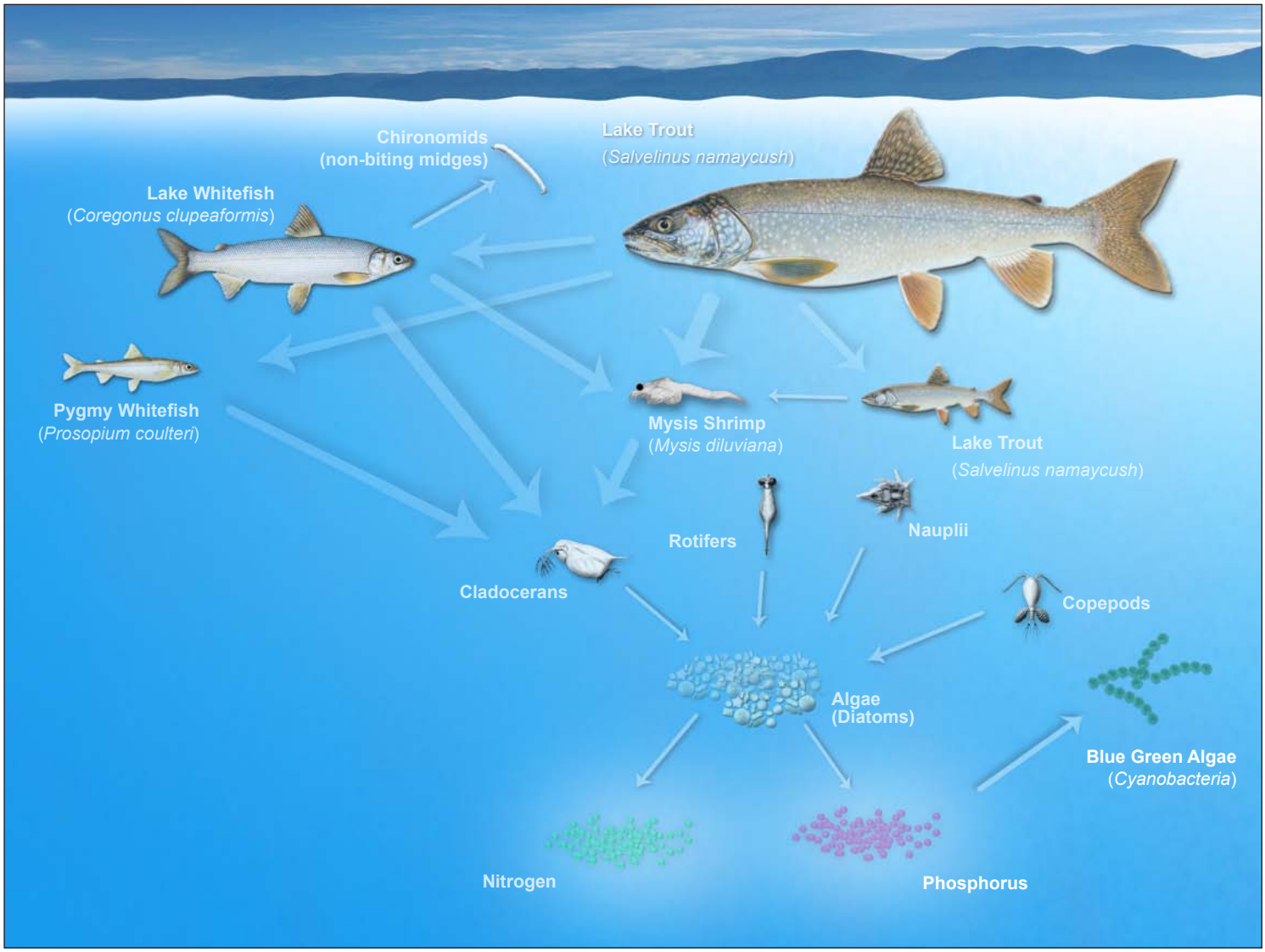


Figure 3.41. Simplified schematic (focusing on the role of Mysis*) of the overall foodweb for Flathead Lake. Arrowheads point to "prey" . (Not to scale.)*

Environmental Consequences in the Project Area: Invertebrates (including *Mysis*), Zooplankton, and Phytoplankton

This section describes the environmental consequences or the effects of implementing the alternatives on invertebrates, zooplankton, and phytoplankton in Flathead Lake and the area delineated in red in Figure 3.1.

ALTERNATIVE A: No Action (Maintain Status Quo)

Direct and Indirect Effects

Simulation modeling indicates that Alternative A would increase long-term total lake trout abundance (Age 1+) by 155,912 relative to the current condition (Table 3.2). Bioenergetics modeling indicates that the resulting net increase in predation by lake trout would cause *Mysis* to decrease from the long-term average density of 45/m^2 to 34/m^2 (Appendix 4). *Mysis* densities have been recorded in Flathead Lake within 20% of 34/m^2 in 15 of the 27 years of monitoring since 1985 (Figure 3.38). Therefore we do not anticipate that implementation of Alternative A would cause zooplankton or phytoplankton densities to change beyond the range that has existed in Flathead Lake over the last 27 years.

Tracking Potential Food Web Effects

Proposed decreases in lake trout abundance would likely affect the invertebrates they consume. Cascading secondary effects (Carpenter et al. 1985) would likely influence zooplankton and phytoplankton abundance (Figure 3.37). It is likely that decreased lake trout abundance would affect phytoplankton abundance, but the magnitude of the effect is not known due to the complexity of indirect interactions among species (Ellis et al. 2011).

Quantification of effects is complicated because the phytoplankton abundance in Flathead Lake is influenced both by nutrient levels and by abundance of consumers of phytoplankton. While we know from previous studies that phytoplankton production in Flathead Lake is stimulated by nutrients (Spencer and Ellis 1998; Spencer and Ellis 1990), *Mysis* appear responsible for the 21%-step increase in phytoplankton production that was documented in the period 1986-1987 (Ellis et al. 2011). That period approximately coincides with the time that Mysid numbers peaked (Figure 3.39). Because the rate of primary production has not increased substantially since the late 1980s (after *Mysis* became established), it is likely that future changes in phytoplankton densities would not occur unless there are very large increases (greater than historically measured) in *Mysis* densities and/or increases in nutrient loading.

ALTERNATIVE B: Reduce Adult (Age 8+) Lake Trout Numbers by 25% Over the Long Term

Direct and Indirect Effects

Simulation modeling indicates that Alternative B would decrease lake trout abundance (Age 1+) by 42,858 relative to the current condition (Table 3.4). Bioenergetics modeling indicates that the resulting net reduction in predation would cause *Mysis* to increase from the long-term average density of 45/m^2 to 51/m^2 (Appendix 4). *Mysis* densities have been recorded in Flathead Lake within 20% of 51/m^2 in 11 of the 27 years of monitoring since 1985. Therefore, we do not anticipate that implementation of Alternative B would cause zooplankton or phytoplankton densities to change beyond the range that has existed in Flathead Lake over the last 27 years.

ALTERNATIVE C: Reduce Adult (Age 8+) Lake Trout Numbers by 50% Over the Long Term

Direct and Indirect Effects

Simulation modeling indicates that Alternative C would decrease total lake trout abundance (Age 1+) by about 276,000 relative to the current condition (Table 3.6). Bioenergetics modeling indicates that the resulting net decrease in predation would cause *Mysis* to increase from the long-term average density of 45/m^2 to 81/m^2 (Appendix 4). *Mysis* densities have been recorded in Flathead Lake within 20% of 81/m^2 in two of the 27 years (2009 and 2011) of monitoring since 1985. There were also two years of monitoring in which higher densities were recorded. Changes in the size structure and species composition of the zooplankton population since *Mysis* became established complicates the process of predicting the response of the zooplankton or phytoplankton community to higher *Mysis* densities. While uncertainty exists, we do not anticipate that implementation of Alternative C would cause zooplankton or phytoplankton densities to change beyond the range that has existed in Flathead Lake over the last 27 years. Much higher densities of *Mysis* exist in other systems that do not have excessively high densities of phytoplankton. For example, in Lake Pend O'reille, *Mysis* densities have commonly reached 900/m^2, or 18 times greater than what occurs in Flathead Lake.

ALTERNATIVE D: Reduce Adult (Age 8+) Lake Trout Numbers by 75% Over the Long Term

Direct and Indirect Effects

Simulation modeling indicates that Alternative D would decrease total lake trout abundance (Age 1+) by 651,159 relative to the current condition (Table 3.8). Bioenergetics modeling indicates that the resulting net decrease in predation would cause *Mysis* to increase from the long-term average density of 45/m^2 to 130/m^2 (Appendix 4). *Mysis* densities have been recorded in Flathead Lake within 20% of 130/m^2 in 1 of the 27 years of monitoring since 1985. However, the only year when *Mysis* densities approached 130/m^2 was during the exponential phase of establishment in the lake in 1986. Changes in the size structure and species composition of the zooplankton population since *Mysis* became established complicates the process of predicting the response of the zooplankton or phytoplankton community to higher *Mysis* densities. While uncertainty about the extent of change is greatest in this alternative, we do not anticipate that implementation of Alternative D would cause zooplankton or phytoplankton densities to increase substantially beyond the range that has existed in Flathead Lake over the last 27 years. Far higher densities of *Mysis* exist in other systems that do not have excessively high densities of phytoplankton. For example, in Lake Pend O'reille, *Mysis* densities have commonly reached 900/m^2, or 18 times greater than what occurs in Flathead Lake.

Summary

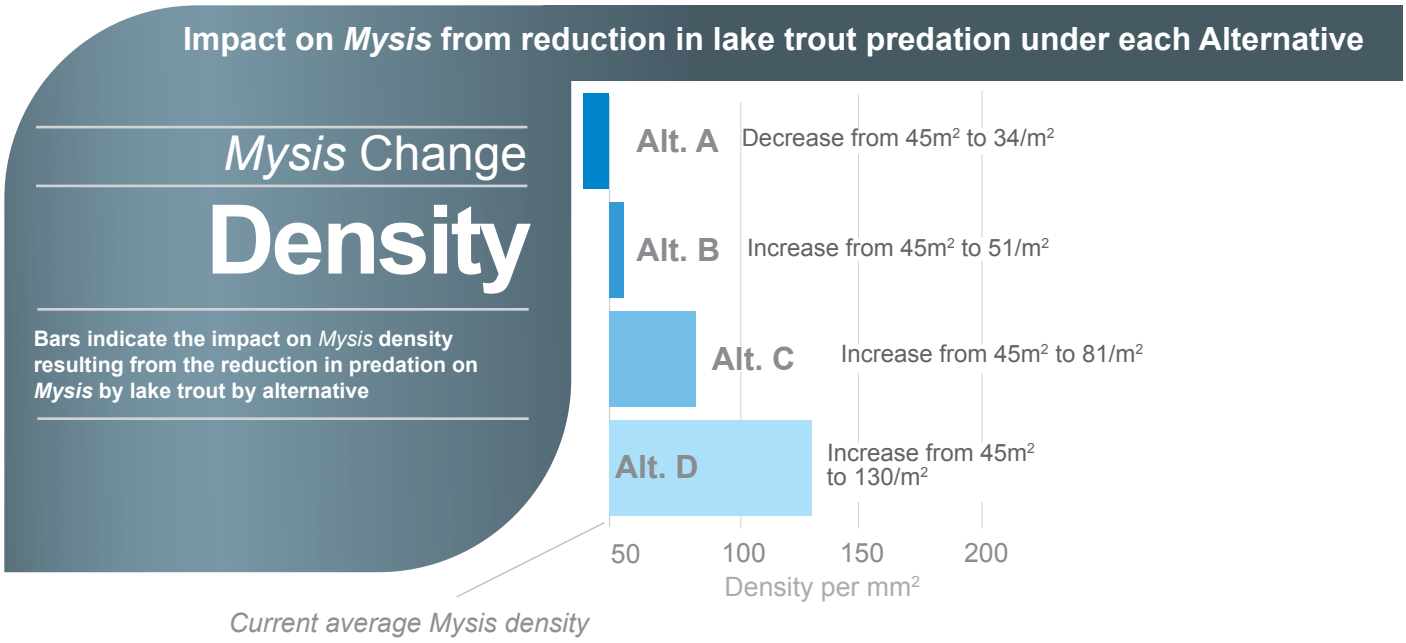


Figure 3.42. Anticipated change in Mysis *density resulting from reduction in predation on* Mysis *by lake trout by alternative. The long-term average density is 45/m² (2006-2012).*

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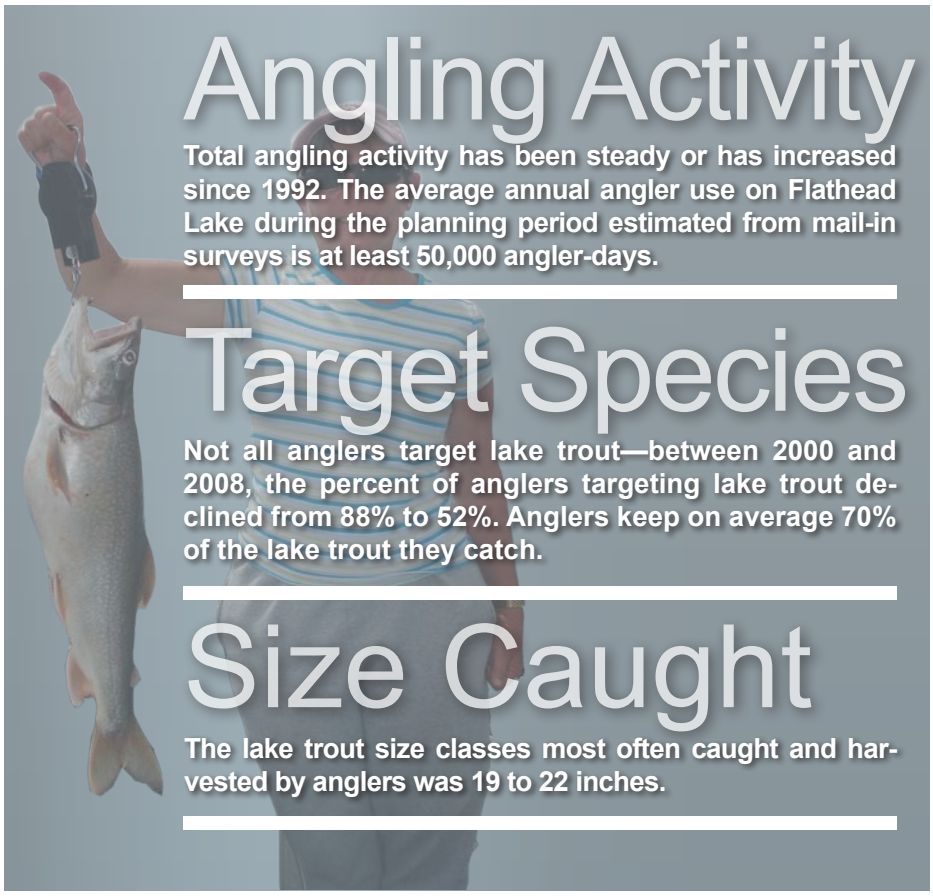
Issue 2: Fishing Opportunity

Affected Environment in the Project Area



A state-wide angler survey ranked Flathead Lake fifth in the state for use by anglers, behind the Madison River, Bighorn River, Canyon Ferry Reservoir, and the Missouri River (MFWP 2012). During the period of kokanee fishing (pre 1985), Flathead Lake usually ranked first, and in some years exceeded 100,000 angler days a year.

Total angler activity on Flathead Lake is measured two ways, aerial surveys and mail surveys. The mail-in survey method has been used every other year since the 1960s. The aerial survey method has been conducted annually since the late 1990s. Estimates of angling effort from the mail-in survey averaged 46% higher than those of the aerial survey. However, both surveys have trended in the same direction through time. The aerial survey averaged 35,847 angler-days while the mail-in survey averaged 52,528 angler-days per year since 1992 (Figure 3.43) (Evarts 2010).

Current (2000-2010)

Montana residents typically comprise about 85% of all anglers on Flathead Lake. The most frequent non-resident users come from Washington and Idaho. Anglers fishing from boats represent about 87% of the total angling effort, followed by anglers fishing on ice (9%) and anglers fishing from shore (4%) (Evarts et al. 1994). Between 2000 and 2011, the average annual angler use was above 50,000 angler-days, the target prescribed in the Co-Management Plan. In three of six years surveyed angling effort fell below the target (Figure 3.43). The intensity of use on Flathead Lake is low, averaging about 0.4 angler-hours per acre, in part because it is large and intimidating to many anglers. Canyon Ferry Reservoir, the top ranked reservoir in the state, typically supports 2.4 angler-hours per acre. Lake Mary Ronan, which offers ice fishing and less hazardous boating than Flathead Lake, supports about 12 angler hours per acre.

Past

Angling opportunities on Flathead Lake have changed dramatically in the last 50 years. The first documented creel survey on Flathead Lake was in 1962, with others conducted in the 1980s. Differences in survey methods among years make comparisons among surveys difficult (Evarts 1998). However, harvest estimates clearly show a shift in the species that dominate the angling harvest. Kokanee dominated har-

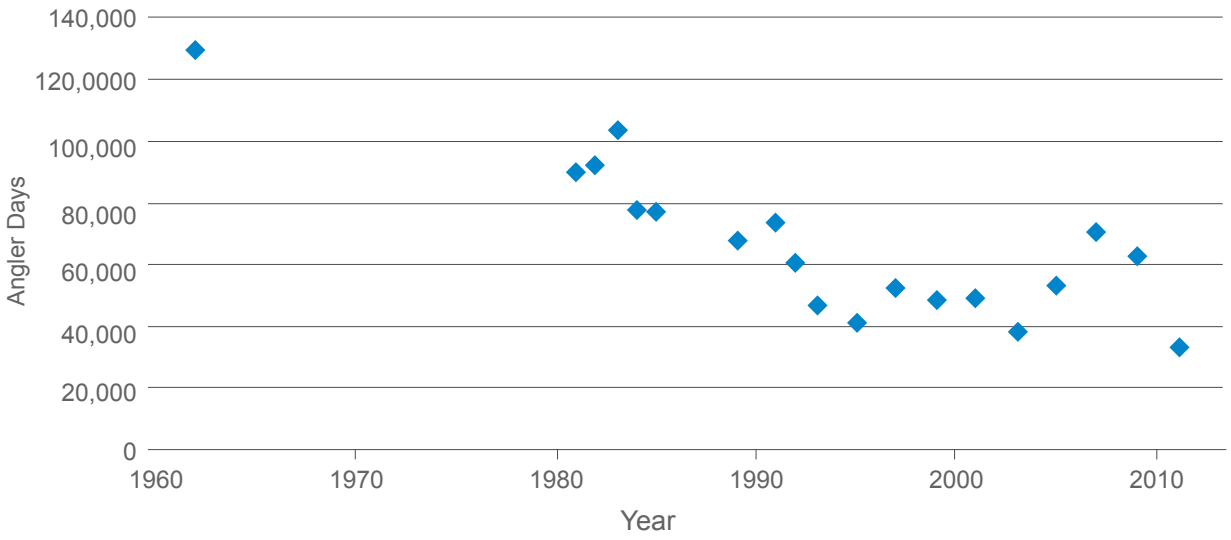


Figure 3.43. Total angler activity estimated from mail-in surveys, Flathead Lake, 1961 to 2011 (MFWP).

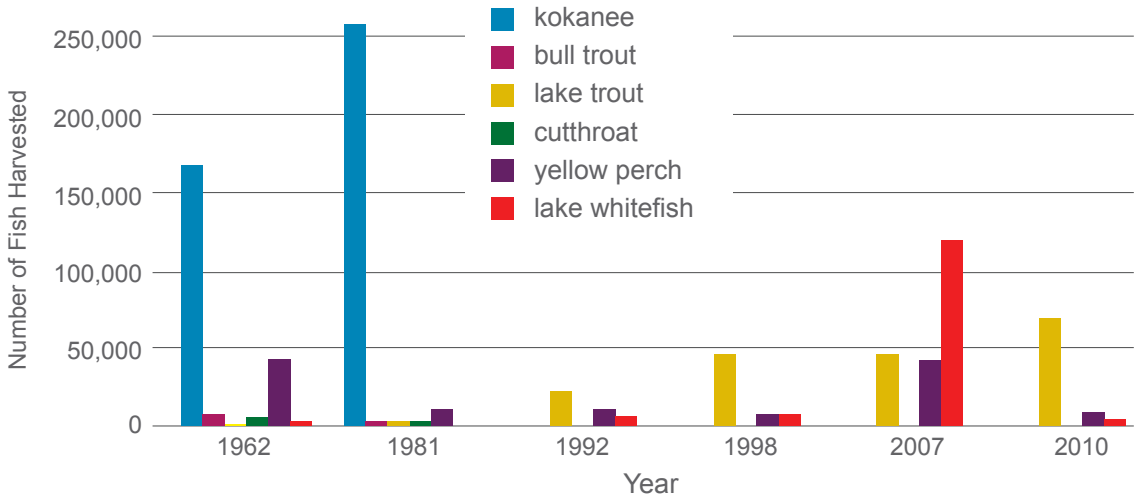


Figure 3.44. Number of fish of all species harvested in Flathead Lake, 1962 to 2010 (Evarts 1998 and CSKT files).

vests during the 1960s and 1970s (blue bars, Figure 3.44), however, a kokanee fishery no longer exists in Flathead Lake. After *Mysis* became established in the early 1980s, harvest has been dominated by lake trout (yellow bars). In some years, lake whitefish and yellow perch support a large amount of angling (red and purple bars respectively).

General angler use on Flathead Lake has declined substantially since the 1980s when kokanee were present (anglers harvested 150,000 to 250,000 kokanee during the years of the pre-*Mysis* era for which we have data). Current angling activity has been fairly stable at about one-half or less the level that occurred when kokanee were present (Figure 3.43).

Lake trout have been the species most commonly targeted by anglers in Flathead Lake since the collapse of kokanee in 1987. However, between 2000 and 2008, the percent of anglers targeting lake trout declined from 88% to 52% (Evarts 2010). The fishery for lake trout varies among seasons and angling methods, including trolling, jigging, ice-fishing, and casting from shore. Summer months are typically the most active on Flathead Lake, despite the fact that catch rates for lake trout during summer are much lower than in spring or autumn. Nearly half of all lake trout harvested by anglers (the combined average of all seasons and all methods between 2005 and 2009) are between 19 and 22 inches long (Figure 3.45).

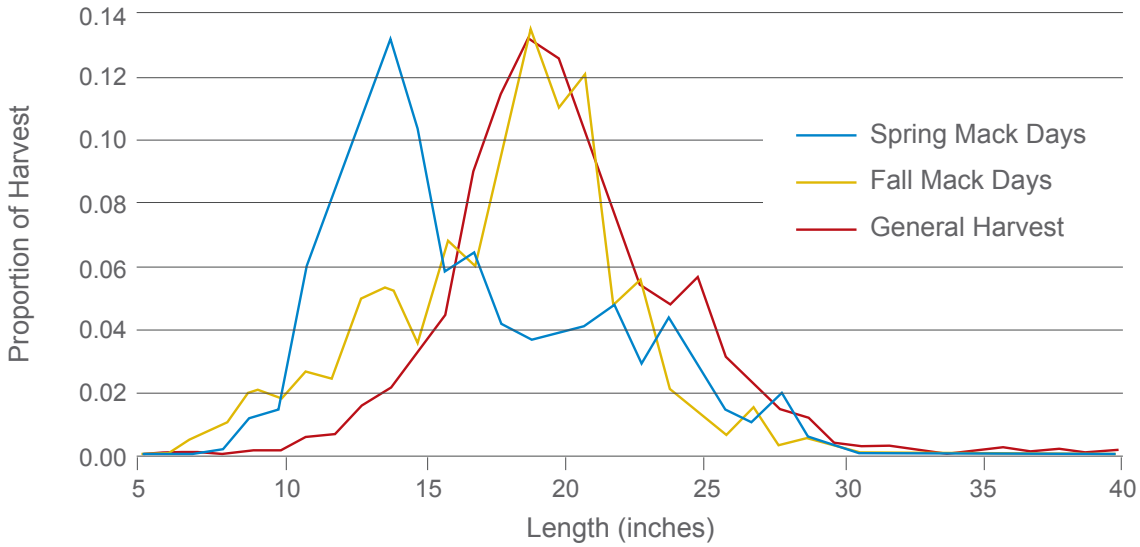


Figure 3.45. Lake trout harvested by anglers, by size-class and activity, Flathead Lake, 2005–2009 (CSKT files).

Angler catch rates for lake trout in Flathead Lake are much higher than for most other lakes, averaging about 0.6 lake trout per angler-hour between 2000 and 2008 (Evarts 2010). Catch rates for fish longer than 36” average 0.001 to 0.015 fish per angler-hour per year (Evarts 2010). Anglers on average keep about 70% of the lake trout they catch. Typically, the proportion of fish anglers keep from their catch decreases as the number caught increases.

The annual lake trout harvest has varied from 28,000 to 46,000 during 2000–2009 (Evarts 2010). Harvest peaked at 69,000 lake trout during 2010. This harvest was only 3.8% of the number of age 1–30 lake trout, 9.0% of the number of age 4–30 lake trout, and 13.1% of the number of age 8–30 lake trout (adults) estimated to be present at the time (Appendix 6).

The annual harvest of yellow perch is highly variable and subject to weather conditions that seem to facilitate large congregations in East Bay. Average harvests over the last five years peaked at 10 inches (CSKT files) (Figure 3.46). In many years, the yellow perch fishery is primarily an ice-fishery in shallow bays, or when conditions are right, during spring spawning (primarily in East Bay during April and May). In years when the congregation of yellow perch is large, a relatively brief but popular fishery develops that can exceed the fishery for lake whitefish (Figure 3.44).

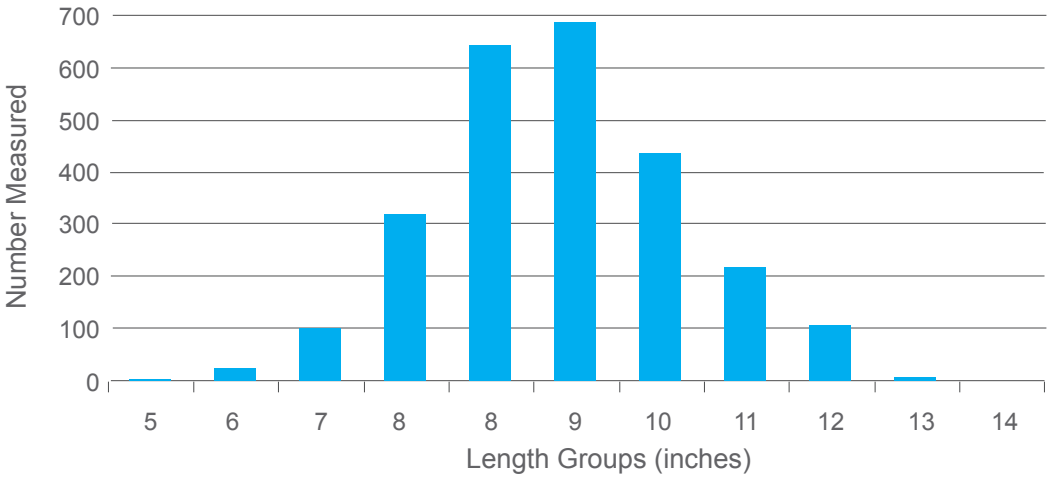


Figure 3.46. Yellow perch harvested by anglers, by length class, Flathead Lake, 2005 to 2010 (CSKT files).

Environmental Consequences in the Project Area: Fishing Opportunity

This section describes the environmental consequences, or the effects on fishing opportunity of implementing each action alternative in Flathead Lake and the area delineated in red in Figure 3.1. Parameters chosen for analysis are changes in catch rates for lake trout, westslope cutthroat trout, lake whitefish, and yellow perch.

The process of predicting future catch rates relative to reduced lake trout abundance drew from a small empirical data set for Flathead Lake and from a large body of research conducted on numerous other lake trout populations. Classical theory in fisheries science postulates that catch rates are proportional to density of target species provided that fishing is random (Ricker 1975). There are many fisheries for which fishing is effectively random; generally in water bodies that are not very large and have uniform habitat.

Walleye fisheries exemplify the classical theory in which there is a direct relationship between catch rates and abundance. Walleye lakes are typically small and can be efficiently searched within a short period of time, which leads to a directly proportional relationship between angling catch rate and fish population density (Isbell and Rawson 1989; Beard et al. 1997; Hansen et al. 2000; Newby et al. 2000).

Angling methods are greatly influenced by the nature of the distribution of the target fish. Fish distribution is typically patchy because habitat quality is patchy, and fish will seek the best quality habitat until it becomes saturated with other fish. When capacity is exceeded, fish not able to obtain optimal habitat must survive in lower quality or marginal habitat. As density declines in the best habitat, fish move in from marginal habitat to replace lost individuals and thereby sustain maximum numbers in high quality habitat, even as total population density declines. Because lake trout distribution is patchy, angling for lake trout is typically non-random as anglers search out specific locations where fish population density is high, rather than fishing randomly throughout an area (Hilborn and Walters 1992).

Paloheimo and Dickie (1964) provided some of the first examples of fisheries that did not conform to the classical theory that catchability and abundance are directly proportional. Since then many fisheries have

been studied that have been shown to lack direct proportionality between catch rates and fish density (Arreguin-Sanchez 1996). For example, sport-caught Chinook salmon fisheries in the Pacific Northwest have been shown to have higher catchability at lower population sizes (Peterman and Steer 1981). Hyper-aggregation in Atlantic cod, a process in which they form dense congregations, exemplifies the process by which densities increase locally while total biomass decreases (Rose and Kulka 1999).

Lake trout fisheries are prime examples of the inverse relationship between catchability and density. Shuter and others (1998) used data from 12 Ontario lakes supporting lake trout to demonstrate a strong negative relationship between catchability and population abundance. They also suggested this was a common feature of lake trout populations throughout Ontario.

The results of suppression of lake trout in Lake Pend O'reille are also instructional with respect to the effect of changing abundance on catchability. In Lake Pend O'reille total abundance of lake trout has declined by 80% from 2005, while total angler catch has declined by 40% (Andy Dux, Idaho Fish and Game, personal communication). Our observations of lake trout catchability in Flathead Lake also indicate that catchability is not directly related to density of fish and would probably not decline until lake trout density declines substantially. Data from Mack Days fishing contests suggest that the average lake-wide density of lake trout does not drive catchability, rather densities in specific locations are more important (Appendix 9, Figure 1). In the contests we observe very high catch rates in very small and fixed areas, indicating that the distribution of lake trout in Flathead Lake is very uneven or patchy.

We used the model developed by Shuter and others (1998) to predict future catch rates for lake trout in Flathead Lake under three levels of population abundance. The resulting catchability model predicts that catchability of lake trout would decline 8% under Alternative B, 21% under Alternative C and 45% under Alternative D (Appendix 13). These assumptions are based on the known behavior of anglers with basic skills in fishing for lake trout. Novice anglers represent an exception and would not conform well to model projections because they tend to fish randomly, and therefore their catch rates would likely decline in rough proportion to the decline in overall abundance of lake trout.

ALTERNATIVE A: No Action (Maintain Status Quo)

Direct and Indirect Effects

Lake Trout

The total abundance of age 4 and older lake trout would not be expected to change measurably in either the short term or long term under Alternative A. Therefore catch rates for age 4 and older lake trout are estimated to remain consistent with the level measured between 2000 and 2008, when the overall average catch rate was 0.59 lake trout per hour (Evarts 2010).

The abundance of age 8 (19-inches total length) and older lake trout would not be expected to change measurably in either the short term or long term. Therefore catch rates would likely remain unchanged for this size group.

The abundance of trophy lake trout (age 22 and older and greater than 30-inches total length) would decline slowly under Alternative A relative to starting conditions quantified in 2010. The effect of the projected annual harvest of 70,000 lake trout would be to gradually reduce the supply of individual fish reaching the age of 22 where they gain the protection of the slot-length restriction. The decline in abundance of fish age 22 and older would be too small to measure in the short term (<5 years), and so the catch rate for large fish would likely not change. Therefore in the short term, catch rates for large lake trout are

estimated to remain similar to the level measured between 2006 and 2008, which was 0.042 fish per hour (Evarts 2010). The gradual decline of large lake trout is expected to equal a 58% decrease after at least 50 years relative to levels present in 2010. Therefore catch rates for large lake trout would likely decline, but by much less than the percent decrease in abundance.

All Other Fish Species
Abundance of all other fish species will likely remain unchanged in the short term and increase slightly in the long term. Therefore catch rates for all other fish species would likely remain unchanged in the short term and increase slightly in the long term.

ALTERNATIVE B: Reduce Adult (Age 8+) Lake Trout Numbers by 25% Over the Long Term

Direct and Indirect Effects

Lake Trout
Implementation of Alternative B with the harvest of 84,000 lake trout would reduce the abundance of each age category within the lake trout population to varying degrees (Table 3.11). Catch rates for lake trout are influenced by many factors, most importantly abundance, but also weather, season, angler expertise, tackle, depth, and many others. While efforts to improve angler expertise would continue under Alternative B, the primary factor influencing future catch rates would be changes in the abundance of lake trout. The effect of abundance on fishing quality is moderated by changes in the vulnerability of lake trout to capture by anglers. Vulnerability to capture typically increases as abundance decreases, diminishing the role of abundance. The result is that capture rates decline more slowly than abundance (Shuter et al. 1998).

Table 3.11. Percent reductions in abundance of age-based categories of lake trout over the short term and long term under Alternative B relative to Alternative A.

Lake Trout Age Group	Short-term change relative to Alternative A	Long-term change relative to Alternative A
Age 4-7	4%	6%
Age 8-21	17%	25%
Age 22+	9%	56%

Short-term changes in abundance under Alternative B are small and not likely to affect catch rates of lake trout to the degree that they could be measured or that anglers would notice them. Long-term changes in abundance, however, are large enough to be measurable. The portion of the lake trout population reasonably vulnerable to capture by anglers consists of those fish longer than 13 inches and older than three years. We applied the Shuter model (Shuter et al. 1998) to the relationship between density and vulnerability to predict future catch rates in order to compare alternatives. The 25% reduction in Age 8+ abundance prescribed in Alternative B over the long term would reduce the density of the fishable lake trout population to the extent that overall catch rates would decline by 8% or by about one third as much as abundance would be reduced (Appendix 13). Therefore overall catch rates for age 4 and older are estimated to decline from the current overall average of 0.59 lake trout per hour under Alternative A to 0.54 lake trout per hour under Alternative B. Such a small change in catch rate would likely not be measurable and would be unlikely to be noticed by anglers.

Trophy lake trout (age 22 and older and greater than 30-inches total length) would decline over the long term by at least 56% relative to Alternative A largely from reduced recruitment into this age category but also from harvest. We do not anticipate substantial harvest of trophy fish in the 30-to-36-inch category

because they are generally unpopular for consumption and are unsafe because of high mercury content. Harvest of trophy lake trout greater than 36 inches for taxidermy purposes would likely continue at the current pace. Fishing opportunity for large lake trout would decline substantially under Alternative B, but viable opportunities would persist.

All Other Fish Species
The abundance of all other fish species will likely increase slightly in the short term and moderately in the long term. Therefore catch rates for all other fish species will likely remain unchanged or increase slightly in the short term and long term.

Mitigation and Adaptive Management
The predicted change in overall angling opportunity for lake trout is small and hence mitigation would not be required. A substantial reduction in the opportunity to catch large lake trout is likely and no mitigation or replacement for that size group is available within Flathead Lake. Potential increases in native and sport fishes may mitigate, although not in-kind, the reduction in large lake trout numbers.

ALTERNATIVE C: Reduce Adult (Age 8+) Lake Trout Numbers by 50% Over the Long Term

Direct and Indirect Effects

Lake Trout
Implementation of Alternative C with the harvest of 113,000 lake trout would reduce the abundance of each age category within the lake trout population to varying degrees (Table 3.12). Catch rates for lake trout are influenced by many factors, most importantly abundance, but also weather, season, angler expertise, tackle, depth and many others. While efforts to improve angler expertise would continue under Alternative C, the primary factor influencing future catch rates would be changes in the abundance of lake trout. The effect of abundance on fishing quality is moderated by changes in the vulnerability of lake trout to capture by anglers. Vulnerability to capture typically increases as abundance decreases, diminishing the role of abundance. the result is that capture rates decline more slowly than abundance (Shuter et al. 1998).

Table 3.12. Percent reductions in abundance of age-based categories of lake trout over the short term and long term under Alternative C relative to Alternative A.

Lake Trout Age Group	Short-term change relative to Alternative A	Long-term change relative to Alternative A
Age 4-7	3%	20%
Age 8-21	34%	49%
Age 22+	19%	85%

Short-term changes in abundance under Alternative C are small and not likely to affect catch rates of lake to the degree that they could be measured or that anglers would notice them. Long-term changes in abundance are large enough to be measurable. The portion of the lake trout population reasonably vulnerable to capture by anglers consists of fish longer than 13 inches and older than three years. We applied the Shuter model (Shuter et al. 1998) to the relationship between density and vulnerability to predict future catch rates in order to compare alternatives. The 50% reduction in Age 8+ abundance prescribed under Alternative C over the long term would reduce the density of the fishable lake trout population to the extent that overall catch rates would decline by 21% or by nearly one half as much as abundance would be reduced (Appendix 13). Therefore overall catch rates for age 4 and older lake trout are estimated to decline from the current average of 0.59 lake trout per hour under Alternative A to 0.47 lake trout per hour under Alternative C. This decline in

catch rate is likely sufficient to be noticed by those anglers who frequently target lake trout in Flathead Lake and would negatively affect their experience. While the fishing opportunity for lake trout would be reduced under Alternative C relative to Alternative A and B, it would persist at a level comparable to most other lake trout fisheries in western Montana.

Trophy lake trout (age 22 and older and greater than 30-inches total length) would decline over the long term by at least 85% relative to Alternative A largely from reduced recruitment into this age category but also from harvest. We do not anticipate substantial harvest of trophy fish in the 30-to-36-inch category because they are generally unpopular for consumption and are unsafe because of high mercury content. Harvest of trophy lake trout greater than 36 inches for taxidermy purposes would likely continue at the current pace. Fishing opportunity for large lake trout would decline greatly under Alternative C, and while large individuals would still be present in the fishery, catching them would be a rare opportunity.

All Other Fish Species
Abundance for all other fish species will likely remain unchanged in the short term and increase moderately in the long term. Therefore catch rates for all other fish species will likely remain the same in the short term and increase slightly in the long term.

Mitigation and Adaptive Management
The predicted change in overall angling opportunity for lake trout is moderate and hence mitigation may not be required. A large reduction in the opportunity to catch large lake trout is likely and no mitigation or replacement for that size group is available within Flathead Lake. Potential increases in native and sport fishes may mitigate, although not in-kind, the reduction in large lake trout numbers.

ALTERNATIVE D: Reduce Adult (Age 8+) Lake Trout Numbers by 75% Over the Long Term

Direct and Indirect Effects

Lake Trout
Implementation of Alternative D with the harvest of 143,000 lake trout would reduce the abundance of each age category within the lake trout population to varying degrees (Table 3.13). Catch rates for lake trout are influenced by many factors, most importantly abundance, but also weather, season, angler expertise, tackle, depth and many others. While efforts to improve angler expertise would continue under Alternative D, the primary factor influencing future catch rates would be changes in the abundance of lake trout. The effect of abundance on fishing quality is moderated by changes in the vulnerability of lake trout to capture by anglers. Vulnerability to capture typically increases as abundance decreases, diminishing the role of abundance. The result is that capture rates decline more slowly than abundance (Shuter et al. 1998).

Table 3.13. Percent reductions in abundance of age-based categories of lake trout over the short term and long term under Alternative D relative to Alternative A.

Lake Trout Age Group	Short-term change relative to Alternative A	Long-term change relative to Alternative A
Age 4-7	11%	46%
Age 8-21	47%	75%
Age 22+	25%	96%

Short-term changes in abundance under Alternative D are moderate and likely to affect catch rates to a moderate degree, enough that anglers would notice. Long-term changes in abundance are large. The portion of the lake trout population reasonably vulnerable to capture by anglers consists of those fish longer

than 13 inches and older than three years. We applied the Shuter model (Shuter et al. 1998) to the relationship between density and vulnerability to predict future catch rates in order to compare alternatives. The 75% reduction in Age 8+ abundance prescribed under Alternative D over the long term would reduce the density of the fishable lake trout population to the extent that overall catch rates would decline by 42%, or by more than half as much as abundance would be reduced (Appendix 13). Therefore overall catch rates for age 4 and older lake trout are estimated to decline from the current overall average of 0.59 lake trout per hour under Alternative A to 0.34 lake trout per hour under Alternative D. Although the fishing opportunity for lake trout would be reduced under Alternative D relative to Alternatives A, B, and C, a viable opportunity would persist for lake trout, most of which would be under 16 inches in length.

Trophy lake trout (age 22 and older and greater than 30-inches total length) would decline over the long term by at least 96% relative to Alternative A largely from reduced recruitment into this age category, but also from harvest. We do not anticipate substantial harvest of trophy fish in the 30 to 36 inches category because they are generally unpopular for consumption and are unsafe because of high mercury content. Harvest of trophy lake trout greater than 36 inches for taxidermy purposes would likely continue at the current pace. Fishing opportunity for large lake trout would decline greatly under Alternative D, and while large individuals would still be present in the fishery, catching them would be a very rare opportunity.

All Other Fish Species

Abundance for all other fish species will likely remain unchanged in the short term and increase moderately in the long term. Therefore catch rates for all other fish species will likely remain the same in the short term and increase moderately in the long term.

Mitigation and Adaptive Management

The predicted change in overall angling opportunity for lake trout, especially large lake trout is substantial. The reduction in the opportunity to catch large lake trout is nearly certain and no mitigation or replacement is available for that size group within Flathead Lake. Increases in native and sport fishes are likely and may mitigate the loss of angling opportunity for lake trout, and although not in-kind, also the reduction in large lake trout numbers.

Summary

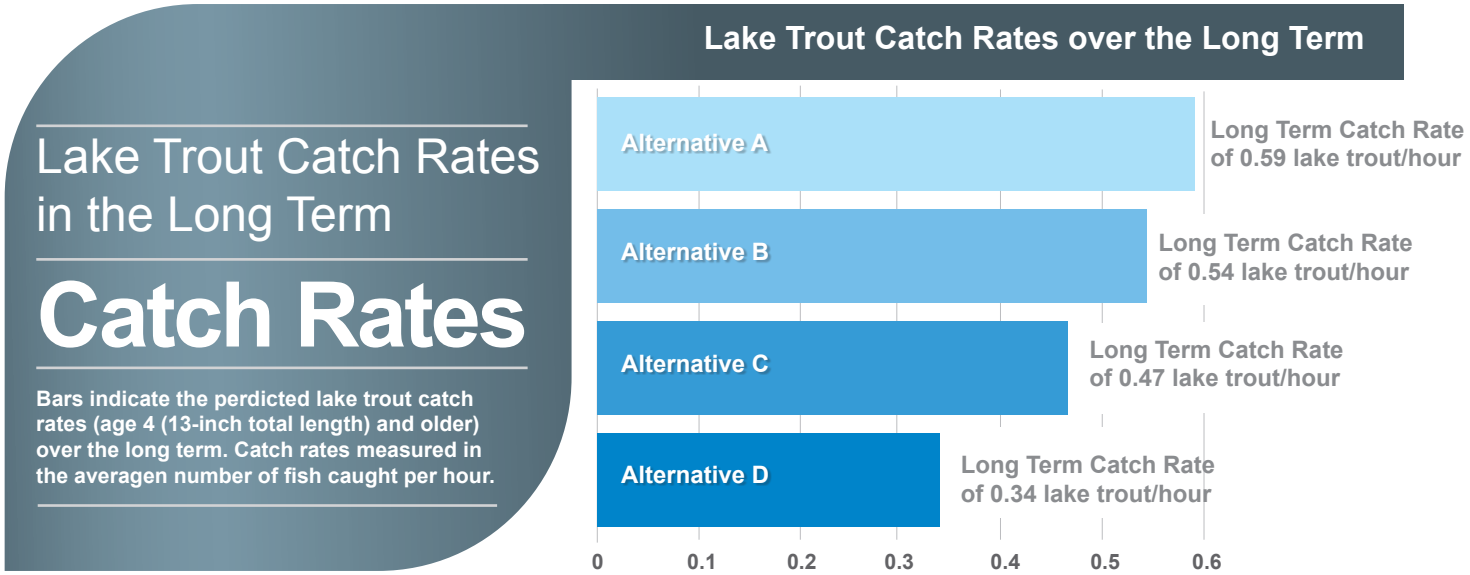


Figure 3.47. Anticipated long-term lake trout catch rates by alternative.

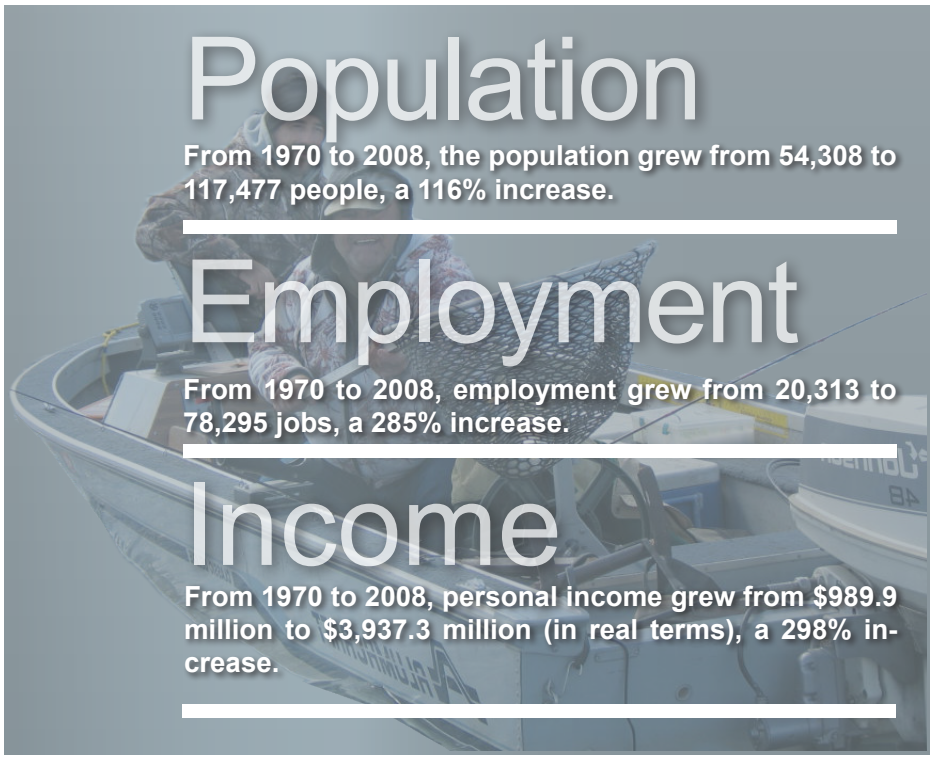
Issue 3: Fishing Economy

Affected Environment in the Project Area (Flathead and Lake Counties)

Population and Employment

The Lake and Flathead County area saw substantial growth in population, employment, and personal income between 1970 and 2008 (Table 3.14). These statistics do not capture the recent (2009-present) economic downturn. However, they show a consistent and long-term trend in growth in both population and economic activity.

Between 2001 and 2008, the primary analysis area of Lake and Flathead Counties saw a 23% increase in total employment (Table 3.15) due primarily to employment increases in the services and construction sectors, along with some increase in the government sector. Over this period, farm, forestry, and manufacturing employment decreased slightly.



The monthly unemployment rate for the Lake and Flathead County analysis area has risen consistently from 2006 through 2010 (Table 3.16 and Figure 3.48). Unemployment statistics show an economy with moderately fluctuating seasonal employment in which unemployment tends to reach its highest levels in winter and improve somewhat in late spring through early autumn.

Table 3.14. Total population, employment, and real personal income trends, 1970–2008.

Statistic	1970	1980	1990	2000	2008	Change 2000-2008
Population	54,308	71,177	80,593	101,332	117,477	16,145
Employment (full and part-time jobs)	20,313	31,444	42,333	62,706	78,295	15,589
Personal Income (in thousands of 2010 dollars)	989,879	1,615,890	2,015,459	2,972,837	3,937,293	964,456

Source: U.S. Department of Commerce. 2010. Bureau of Economic Analysis, Regional Economic Information System, Washington, D.C. Table CA30.

Table 3.15. Total population, employment, and real personal income trends, 1970–2008.

Sector	2001	2008	Change 2001-2008
Total Employment (number of jobs)	63,613	78,295	14,682
Non-services related	14,962	17,702	2,740
Farm	2,473	2,367	-106
Forestry, fishing, & related activities	1,009	982	-27
Mining (including fossil fuels)	350	742	392
Construction	5,836	8,626	2,790
Manufacturing	5,294	4,985	-309
Services related	41,026	52,339	11,313
Utilities	174	220	46
Wholesale trade	1,097	1,518	421
Retail trade	8,102	9,607	1,505
Transportation and warehousing	1,394	1,410	16
Information	876	1,087	211
Finance and insurance	2,112	2,971	859
Real estate and rental and leasing	2,710	5,295	2,585
Professional and technical services	3,730	3,783	53
Management of companies and enterprises	224	221	-3
Administrative and waste services	3,240	4,441	1,201
Educational services	509	893	384
Health care and social assistance	5,630	7,389	1,759
Arts, entertainment, and recreation	1,806	2,566	760
Accommodation and food services	5,521	6,475	954
Other services, except public administration	3,901	4,463	562
Government	7,344	7,946	602

Source: U.S. Department of Commerce. 2010. Bureau of Economic Analysis, Regional Economic Information System, Washington, D.C. Table CA25N.

Table 3.16. Seasonal unemployment rates: Lake and Flathead Counties, 2006-2010.

	Unemployment Rate (%)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2006	5.4%	5.4%	4.9%	4.2%	3.3%	3.5%	3.1%	2.9%	2.7%	2.9%	3.8%	4.2%
2007	5.5%	5.2%	5.0%	4.2%	3.3%	3.6%	3.2%	3.2%	3.2%	3.6%	4.6%	5.5%
2008	6.8%	6.7%	6.8%	5.5%	5.0%	5.2%	4.7%	5.1%	5.3%	6.6%	8.0%	9.2%
2009	11.4%	11.9%	12.2%	10.0%	9.2%	9.3%	8.8%	8.9%	8.9%	10.0%	10.7%	11.4%
2010	12.8%	12.9%	13.3%	11.7%	11.0%	11.1%	10.4%	10.0%	9.9%	10.6%	11.5%	11.9%

Source: U.S. Department of Labor. 2010. Bureau of Labor Statistics, Local Area Unemployment Statistics, Washington, D.C.

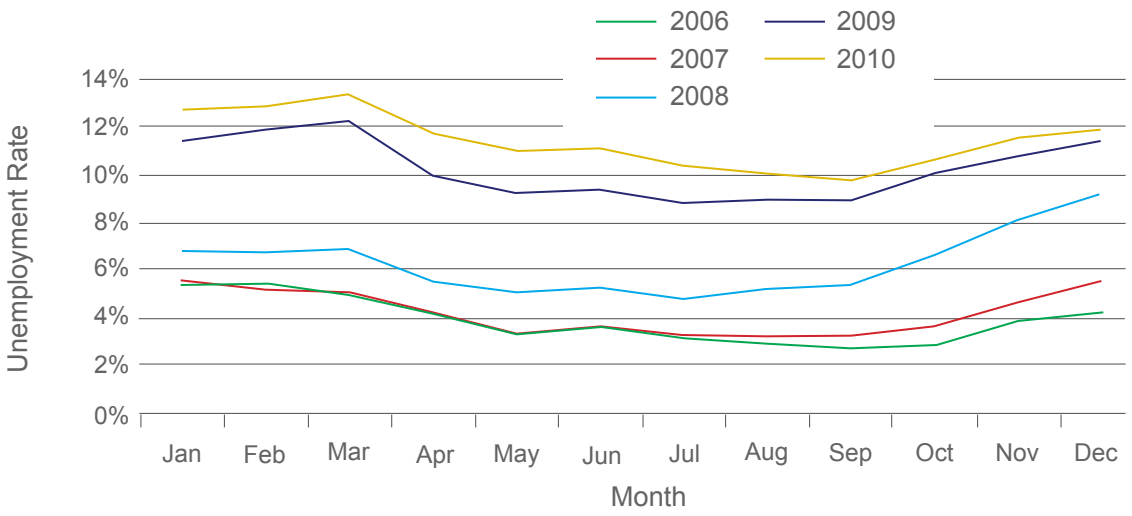


Figure 3.48. Lake and Flathead County unemployment rate by month, 2006-2010.

Income

Total personal income in the analysis area grew substantially during 1970–2008 (Table 3.17 and Figure 3.49). In addition, the overall composition of total personal income in Lake and Flathead Counties changed over that period (Table 3.18). In 1970, labor earnings accounted for 71.4% of total personal income. By 2008, labor income as a share of total income had shrunk to 57%. Over this period, non-labor income such as dividends, interest, and transfer payments increased.

Table 3.17. Lake and Flathead Counties, components of personal income changes: 1970-2008 (thousands of 2010 dollars).

	1970	1980	1990	2000	2008	Change 2000-2008
Total Personal Income	989,879	1,615,890	2,015,459	2,972,837	3,937,293	964,456
Labor Earnings	706,468	1,038,944	1,150,481	1,754,927	2,247,466	492,539
Non-Labor Income	283,411	576,946	864,978	1,217,910	1,689,827	471,917
Dividends, Interest & Rent	169,758	357,974	517,654	737,183	994,794	257,610
Transfer Payments	113,653	218,972	347,325	480,727	695,033	214,306
Percent of Total	**1970**	**1980**	**1990**	**2000**	**2008**	**% Change 2000-2008**
Total Personal Income						32.4%
Labor Earnings	71.4%	64.3%	57.1%	59.0%	57.1%	28.1%
Non-Labor Income	28.6%	35.7%	42.9%	41.0%	42.9%	38.7%
Dividends, Interest & Rent	17.1%	22.2%	25.7%	24.8%	25.3%	34.9%
Transfer Payments	11.5%	13.6%	17.2%	16.2%	17.7%	44.6%

Source: U.S. Department of Commerce. 2010. Bureau of Economic Analysis, Regional Economic Information System, Washington, D.C. Tables CA05 & CA05N. All income data are reported by place of residence. Labor earnings and non-labor income may not add to total personal income due to adjustments made by the Bureau of Economic Analysis.

Industries are organized according to three major categories: non-services, services, and government. Jobs within the services sector pay less than the average for the area, and those in the non-services private market and government sector pay more than average (Table 3.18).

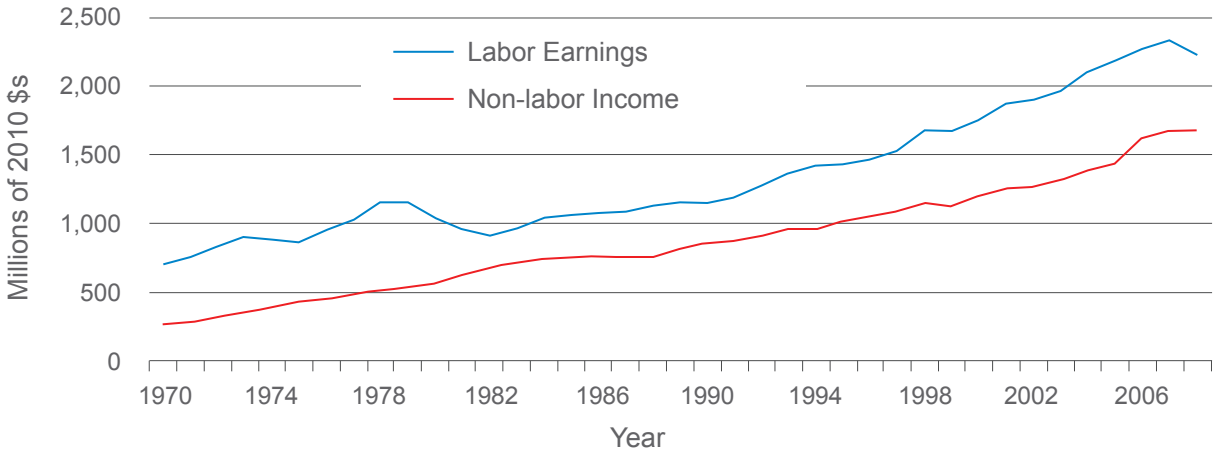


Figure 3.49. Lake and Flathead County components of personal income: 1970-2008.

Table 3.18. Lake and Flathead County employment and annual wages by industry: 2009 data in constant 2010 dollars.

	Employment	% of Total Employment	Avg. Annual Wages	% Above or Below Avg.
Total	45,542		$32,295	
Private	37,953	83.3%	$31,038	-3.9%
Non-Services Related	6,883	15.1%	$38,649	19.7%
Natural Resources and Mining	606	1.3%	$36,727	13.7%
Agriculture, forestry, fishing & hunting	386	0.8%	$32,651	1.1%
Mining (incl. fossil fuels)	221	0.5%	$43,679	35.2%
Construction	3,086	6.8%	$35,751	10.7%
Manufacturing (Incl. forest products)	3,190	7.0%	$41,829	29.5%
Services Related	31,071	68.2%	$29,351	-9.1%
Trade, Transportation, and Utilities	8,654	19.0%	$28,366	-12.2%
Information	736	1.6%	$42,410	31.3%
Financial Activities	2,630	5.8%	$41,379	28.1%
Professional and Business Services	3,965	8.7%	$34,032	5.4%
Education and Health Services	6,495	14.3%	$38,742	20.0%
Leisure and Hospitality	6,901	15.2%	$15,066	-53.3%
Other Services	1,692	3.7%	$21,129	-34.6%
Unclassified	3	0.0%	$48,244	49.4%
Government	7,589	16.7%	$38,585	19.5%
Federal Government	949	2.1%	$51,715	60.1%
State Government	724	1.6%	$43,581	34.9%
Local Government	5,916	13.0%	$35,866	11.1%

Source: U.S. Department of Commerce. 2010. Bureau of Economic Analysis, Regional Economic Information System, Washington, D.C. Table CA25N. This table shows wage data from the Bureau of Labor Statistics, which does not report data for proprietors or the value of benefits and uses slightly different industry categories than those shown in Table 3.12.

Recreation and Tourism

The issue of lake trout management within Flathead Lake necessarily affects fishing opportunities and economic activity associated with those opportunities. In 2008, 19% of employment in the two-county analysis area was directly tied to travel and tourism-related economic sectors (Table 3.19). Economic sectors tied to travel and tourism do not necessarily service only those activities. This percentage estimate provides an upper-bound estimate of the percent of total employment directly attributed to travel and tourism.

Table 3.19. Lake and Flathead Counties, employment in travel & tourism sectors: 2008

Industry Sectors	Flathead County	Lake County	Two-county Area
Total Private Employment	36,524	5,781	42,305
Travel & Tourism Related	7,178	998	8,176
Retail Trade	1,051	163	1,214
Gasoline Stations	412	98	510
Clothing & Accessory Stores	286	16	302
Misc. Store Retailers	353	49	402
Passenger Transportation	77	2	79
Air Transportation	69	2	71
Scenic & Sightseeing Transport	8	0	8
Arts, Entertainment, & Recreation	1,196	38	1,234
Performing Arts & Spectator Sports	63	4	67
Museums, Parks, & Historic Sites	11	4	15
Amusement, Gambling, & Rec.	1,122	30	1,152
Accommodation & Food	4,854	795	5,649
Accommodation	1,080	198	1,278
Food Services & Drinking Places	3,774	597	4,371
Non-Travel & Tourism	29,346	4,783	34,129
Percent of Total			
Travel & Tourism Related	19.7%	17.3%	19.3%
Retail Trade	2.9%	2.8%	2.9%
Gasoline Stations	1.1%	1.7%	1.2%
Clothing & Accessory Stores	0.8%	0.3%	0.7%
Misc. Store Retailers	1.0%	0.8%	1.0%
Passenger Transportation	0.2%	0.0%	0.2%
Air Transportation	0.2%	0.0%	0.2%
Scenic & Sightseeing Transport	0.0%	0.0%	0.0%
Arts, Entertainment, & Recreation	3.3%	0.7%	2.9%
Performing Arts & Spectator Sports	0.2%	0.1%	0.2%
Museums, Parks, & Historic Sites	0.0%	0.1%	0.0%
Amusement, Gambling, & Rec.	3.1%	0.5%	2.7%
Accommodation & Food	13.3%	13.8%	13.4%
Accommodation	3.0%	3.4%	3.0%
Food Services & Drinking Places	10.3%	10.3%	10.3%
Non-Travel & Tourism	80.3%	82.7%	80.7%

Source: U.S. Department of Commerce. 2010. Census Bureau, County Business Patterns, Washington, D.C. The data does not include employment in government, agriculture, railroads, or the self-employed because these are not reported by County Business Patterns.

The most obvious link between fish populations in the Flathead system and economic values is through angler use of the river and lake. Two distinct components of economic values associated with angler use are money fishermen spend on their trips to the river and lake and the additional value they derive from their fishing trips over and above the amount they actually spend. This second component of value is often referred to as net economic value, or net willingness to pay. While direct angler expenditures are examined in any analysis of changes in regional economic activity due to alternative lake trout management actions, potential changes in net economic value of anglers is included in an analysis of impacts within the separate benefit-cost analysis framework. Estimated total annual angler expenditures associated with fishing the North Fork, Middle Fork, and main-stem Flathead down to and including Flathead Lake is about 20,000,000 dollars (Table 3.20). Overall, based on 2007 angler use, Montana resident anglers spent 6.4 million dollars and non-residents spent 13.78 million dollars while fishing these waters.

Table 3.20. Estimated total annual expenditures by Flathead-system anglers.

Water/Parameter	Montana Residents	Non-Residents	Total
NF Flathead River angler days/year[1]	6,825	3,338	10,173
Section 2 Flathead River and NF Flathead angler days/year[2]	22,181	7,633	29,814
Flathead Lake angler days/year	60,618	9,891	70,509
Middle Fk. Flathead River angler days/year	4,754	2,260	7,014
Total Angler days/year	94,378	23,122	117,510
Angler expenditures/day[3]	$68.06	$591.86	--
Total annual angler spending	$6,423,000	$13,685,000	$20,108,000

1 2007 angler use estimates from http://fwp.mt.gov/doingBusiness/reference/surveys/anglerPressure.html
2 Main-stem Flathead River from Flathead Lake to the Confluence of the MF and NF Flathead
3 (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Census Bureau 2006 in 2010 dollars)

Estimated net economic value per trip for fishing in Montana is derived from the USFWS and Bureau of the Census study of Montana net economic value associated with trout fishing in the state (Table 3.21). Based on the Montana Fish, Wildlife & Parks estimates of 2007 angler trips and the estimated net economic value per trip, Flathead waters at risk provided an estimated 8.8 million dollars in net economic value to anglers in 2007. This value represents the amount anglers would be willing to spend over and above what they actually spent on their fishing trips.

Table 3.21. Estimated net economic value per year of Flathead River and Flathead Lake fishing.

Water/parameter	Montana Residents	Non-Residents	Total
Total Angler trips/year	94,378	23,122	117,510
Angler NEV/trip[2]	$38	$226	--
Total annual angler Net Economic Value	$3,586,000	$5,226,000	$8,812,000

1 2007 angler use estimates from http://fwp.mt.gov/doingBusiness/reference/surveys/anglerPressure.html.
2 (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Census Bureau 2006) (in 2010 dollars)

Mack Days Economics

The CSKT has sponsored twice-annual “Mack Days” competitions for anglers in an ongoing effort to control the population of lake trout. These competitions attract large numbers of anglers to the lake and

surrounding communities. These anglers, in turn, spend money on fishing within the local economy. Most participants in autumn 2010 Mack Days lived in the primary economic analysis area of Lake and Flathead Counties (68.8%). Nearly all other participants, 28.4% (except for a small percentage of out-of-state anglers, 2.8%) lived in other Montana communities (Figure 3.50).

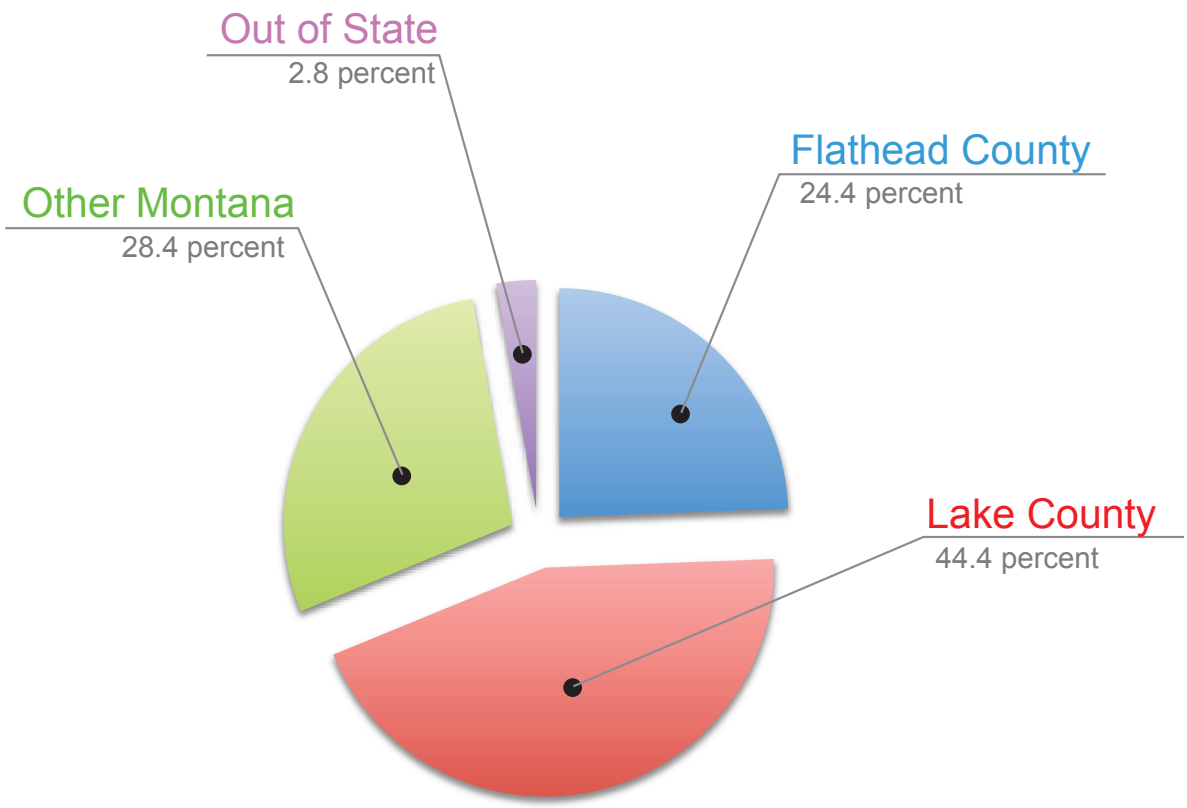


Figure 3.50. Reported location of home zip code of participants in autumn 2010 Mack Days.

During the Spring and Fall Mack Days fishing competitions in 2010, 1,807 people signed up to fish (Table 3.22). They reported catching 49,000 lake trout. The Tribes operate a fish-processing center to which anglers can donate their fish if they do not want to keep them. The Tribes employ Tribal members to fillet, package, and freeze them. These packaged fish are then donated to local food banks. During 2010 Mack Days competitions, 42,000 lake trout were donated to the Tribes for processing. Tribal members employed to process fish were paid $62,000.

Table 3.22. Flathead Lake "Mack Days" participation, harvest, and fish processing in 2010.

Statistic	Spring Mack Days 2010	Fall Mack Days 2010	Total 2010
Participating anglers	1,160	647	1,807
Fish reported caught	34,637	14,351	48,988
Estimated Fish donated to Tribes for processing	30,000	12,000	42,000
Estimated pounds of fish processed	30,000	12,000	42,000
Jobs provided by processing	12	12	12
Gross wages of fish processors	$38,000	$24,000	$62,000

Environmental Consequences in the Project Area: Fishing Economy

This section describes the environmental consequences or the effects of implementing the alternatives on fishing economy in Flathead and Lake Counties.

ALTERNATIVE A: No Action (Maintain Status Quo)

Direct and Indirect Effects

The primary expense of this alternative is the cost to conduct the Mack Days fishing contests (Appendix 5). The total estimated annual cost of implementing Alternative A is $350,000 (Table 3.23).

Table 3.23. Total annual costs to implement Alternative A.

Harvest Method	Number	Cost
General	25,000	0
Mack Days	45,000	$350,000
Total	70,000	$350,000

Total angling activity would likely remain unchanged from the current level, which between 1991 and 2011 averaged 37,417 angler-days in the Flathead River system and 52,448 angler-days in Flathead Lake (MFWP 2012). Mack Days contests are projected to generate 36,000 pounds of lake trout fillets per year that would be received by area food banks.

Population modeling (Appendix 6) predicts that Alternative A would lead to no change in medium-sized lake trout and a 58% decrease in large lake trout over the long term (>50 years). This reduction is estimated to result in a decrease of about 0.8% of annual Flathead Lake and River fishing trips compared to the 2007 estimated level of angler fishing pressure before any offsetting increases in fishing pressure for other species and to other areas are considered (Table 3.24).

Table 3.24. Estimated direct changes in lake trout angler trips and expenditures resulting from implementation of Alternative A over the long term (>50 years). Plus symbols (+) represent monetary changes we could not quantify, but may largely offset the quantifiable values.

Angler Activity	Montana Residents	Nonresidents	Total
Baseline Angler Trips to Flathead Lake and River sections	94,378	23,122	117,500
Estimated percentage reduction in angling trips to Flathead Lake and River sections due to reduced lake trout angling	-0.7%	-0.9%	-0.8%
Increased Flathead Lake fishing for non-lake trout species	+	+	+
Increased Flathead River angler trips due to improved river fish populations	+	+	+
Increased fishing at other Montana waters to substitute for lake trout fishing trips in Flathead Lake	+	+	+

ALTERNATIVE B: REDUCE ADULT LAKE TROUT NUMBERS BY 25% OVER THE LONG TERM

Direct and Indirect Effects

The primary expenses associated with Alternative B are the cost to conduct the Mack Days fishing contests and the cost to remove 14,000 lake trout by netting (Appendix 5). The total estimated annual cost of implementing Alternative B is 462,000 (Table 3.25).

Table 3.25. Total annual costs to implement Alternative B.

Harvest Method	Number	Cost
General	25,000	0
Mack Days	45,000	$350,000
Gillnetting	10,000	$80,000
Trapnetting	4,000	$32,000
Total	84,000	$462,000

Total angling activity would likely remain unchanged from the current level, which between 1991 and 2009 averaged 37,417 angler-days in the Flathead River system and 52,448 angler-days in Flathead Lake (MFWP 2012). Mack Days contests and netting are projected to generate 47,000 pounds of lake trout fillets per year that would be received by area food banks.

Population modeling (Appendix 6) predicts that Alternative B would lead to a 13% decrease in medium-sized lake trout, and an 82% decrease in large lake trout over the long term (>50 years). This reduction is estimated to result in an overall decrease of about 4.4% of angler trips to Flathead Lake and the upstream river sections[1] compared to the 2007 estimated level of angler pressure (Table 3.26) and to the estimated long-term angler pressure under the No-Action alternative, before any offsetting increases in fishing pressure for other species and to other areas are considered.

Table 3.26. Estimated direct changes in lake trout angler trips and expenditures resulting from implementation of Alternative B over the long term (>50 years). Plus symbols (+) represent monetary changes we could not quantify, but may largely offset the quantifiable values.

Angler Activity	Montana Residents	Nonresidents	Total
Baseline Angler Trips to Flathead Lake and River sections	94,378	23,122	117,500
Estimated percentage reduction in angling trips to Flathead Lake and River sections due to reduced lake trout angling (compared to No-Action alternative)	-3.4%	-4.2%	-4.0%
Increased Flathead Lake fishing for non-lake trout species	+	+	+
Increased Flathead River angler trips due to improved river fish populations	+	+	+
Increased fishing at other Montana waters to substitute for lake trout fishing trips in Flathead Lake	+	+	+
Passive Use Value	+	+	+
Potential off-setting increases in angling (other species and waters)	Up to 100% offset of estimated reductions		
Range of estimated reductions in angler trips and spending	No change to -4.2%	No change to -5.2%	No change to -4.4%

The estimated direct angler-expenditure reductions associated with reductions in lake trout abundance would probably be substantially offset within the region by increases in angler trips and spending associ-

1 While there would be a total net reduction in angler trips, the lake would experience a decrease while the river would see an increase, the increase in river trips partially offsetting decrease in lake trips.

ated with fishing for other species and/or on other regional waters. Additionally, the reductions will occur over a period of decades.

The total economic output (sales of goods and services) of the combined Lake and Flathead County area in 2007 was $4.1 billion (Minnesota IMPLAN Group 2010). This total economic activity in the two-county area generated $2.1 billion in employee compensation, and 73,528 full and part-time jobs. The estimated decreases in direct lake trout angler spending are very small, or less than one-tenth of 1% of the combined Lake and Flathead county economies. However, any change in the economic status quo impacts certain people and groups more than others.

Individuals and businesses most likely to be adversely affected by Alternative B are anglers and guide businesses focusing specifically or exclusively on lake trout or trophy lake trout fishing in Flathead Lake. Those potentially benefiting from this alternative would be anglers or guides fishing the Flathead River system upstream of the lake, or anglers targeting non-lake trout species within Flathead Lake.

It is estimated that the lake trout control actions in Alternative B would have a negligible adverse impact on income or employment in Lake and Flathead counties. However, the actions may (over the period of several decades) have a minor adverse impact on all Flathead Lake and River anglers, and a moderate adverse impact on anglers and guide businesses targeting only lake trout.

ALTERNATIVE C: REDUCE ADULT LAKE TROUT NUMBERS BY 50% OVER THE LONG TERM

Direct and Indirect Effects

The cost of this alternative is the sum of costs to conduct the Mack Days fishing contests, deploy an estimated 260,000 feet of gillnets, and deploy trapnets for 100 trap-days (Appendix 5). The total estimated annual cost of implementing Alternative C is $686,000 (Table 3.27).

Table 3.27. Total costs to implement Alternative C.

Harvest Method	Number	Cost
General	25,000	0
Mack Days	45,000	$350,000
Gillnetting	37,000	$296,000
Trapnetting	5,000	$40,000
Total	112,000	$686,000

Total angling activity would likely remain unchanged from the current level, which between 1991 and 2009 averaged 37,417 angler-days in the Flathead River system and 52,448 angler-days in Flathead Lake (MFWP 2012). Mack Days contests and netting are projected to generate 70,000 pounds of lake trout fillets per year that would be received by area food banks.

Population models predict that Alternative C will lead to a 32% decrease in medium-sized lake trout and an 85% (Table 3.6) decrease in large lake trout over the modeling period. This reduction is estimated to result in a decrease of about 9.4% of angler trips to Flathead Lake and the upstream river sections[2] compared

2 While there would be a total net reduction in angler trips, the lake would experience a decrease while the river would see an increase, the increase in river trips partially offsetting decrease in lake trips.

to the 2007 estimated level of angler pressure (Table 3.28) and to the estimated long term angler pressure under the No-Action alternative, before any offsetting increases in fishing pressure for other species and to other areas is considered.

Table 3.28. Estimated direct changes in lake trout angler trips and expenditures resulting from implementation of Alternative C over the long term (>50 years). Plus symbols (+) represent monetary changes we could not quantify, but may largely offset the quantifiable values.

Angler Activity	Montana Residents	Nonresidents	Total
Baseline Angler Trips to Flathead Lake and River sections	94,378	23,122	117,500
Estimated percentage reduction in angling trips to Flathead Lake and River sections due to reduced lake trout angling (compared to No-Action alternative)	-8.2%	-9.9%	-9.4%
Increased Flathead Lake fishing for non-lake trout species	+	+	+
Increased Flathead River angler trips due to improved river fish populations	+	+	+
Increased fishing at other Montana waters to substitute for lake trout fishing trips in Flathead Lake	+	+	+
Passive Use Value	+	+	+
Potential off-setting increases in angling (other species and waters)	Up to 100% offset of estimated reductions		
Range of estimated reductions in angler trips and spending	No change to -8.2%	No change to -9.9%	No change to -9.4%

The estimated direct angler-expenditure reductions associated with reductions in lake trout abundance would likely be substantially offset within the region by increases in angler trips and spending associated with fishing for other species and/or on other regional waters. Additionally, the reductions will occur over a period of decades.

The total economic output (sales of goods and services) of the combined Lake and Flathead County area in 2007 was $4.1 billion (Minnesota IMPLAN Group 2010). This total economic activity in the two-county area generated $2.1 billion in employee compensation, and 73,528 full and part time jobs. In the context of the entire two-county economy, the estimated decreases in direct lake trout angler spending are very small (less than one-tenth of 1%). However, any change in the economic status quo impacts certain people and groups more than others.

Individuals and businesses most likely to be adversely affected by Alternative C are anglers and guide businesses focusing specifically or exclusively on lake trout or trophy lake trout fishing in Flathead Lake. Those potentially benefiting from this alternative would be anglers or guides fishing the Flathead River system upstream of the lake, or anglers targeting non-lake trout species within Flathead Lake.

It is estimated that the Alternative C lake trout control actions would have a negligible adverse impact on income or employment in Lake and Flathead counties. However, the actions may (over the period of several decades) have a minor adverse impact on all Flathead Lake and River anglers, and a moderate to major adverse impact on anglers and guide businesses targeting only lake trout.

ALTERNATIVE D: REDUCE ADULT LAKE TROUT NUMBERS BY 75% OVER THE LONG TERM

Direct and Indirect Effects

The cost of this alternative is the sum of costs to conduct the Mack Days fishing contests, deploy an estimated 420,000 feet of gillnets and deploy trapnets for 100 trap-days (Appendix 5). The total estimated annual cost of implementing Alternative D is $934,000 (Table 3.29).

Table 3.29. Total annual costs to implement Alternative D.

Harvest Method	Number	Cost
General	25,000	0
Mack Days	45,000	$350,000
Gillnetting	63,000	$504,000
Trapnetting	10,000	$80,000
Total	143,000	$934,000

Total angling activity in Flathead Lake may decline slightly in the short term in response to the decrease in catch rates for lake trout. Total angling activity in the Flathead River system would likely not change in the short term because we do not anticipate any changes in the fishery in the short term. Mack Days contests and netting are projected to generate 94,000 pounds of lake trout fillets per year that would be received by area food banks.

Population models predict that Alternative D will lead to a 57% decrease in medium-sized lake trout, and a 98% decrease in large lake trout over the long term (>50 years). This reduction is estimated to result in a decrease of about 16.4% of angler trips to Flathead Lake and the upstream river sections[3] compared to the 2007 estimated level of angler pressure (Table 3.30) and to the estimated long term angler pressure under the No-Action alternative, before any offsetting increases in fishing pressure for other species and to other areas are considered.

Table 3.30. Estimated direct changes in lake trout angler trips and expenditures resulting from implementation of Alternative B over the long term (>50 years). Plus symbols represent monetary changes we could not quantify, but may largely offset the quantifiable values.

Angler Activity	Montana Residents	Nonresidents	Total
Baseline Angler Trips to Flathead Lake and River sections	94,378	23,122	117,500
Estimated percentage reduction in angling trips to Flathead Lake and River sections due to reduced lake trout angling (compared to No-Action alternative)	-14.3%	-17.3%	-16.4%
Increased Flathead Lake fishing for non-lake trout species	+	+	+
Increased Flathead River angler trips due to improved river fish populations	+	+	+
Increased fishing at other Montana waters to substitute for lake trout fishing trips in Flathead Lake	+	+	+
Passive Use Value	+	+	+
Potential off-setting increases in angling (other species and waters)	Up to 100% offset of estimated reductions		
Range of estimated reductions in angler trips and spending	No change to -14.3%	No change to -17.3%	No change to -16.4%

[3] *While there would be a total net reduction in angler trips, the lake would experience a decrease while the river would see an increase, the increase in river trips partially offsetting decrease in lake trips.*

The estimated direct angler-expenditure reductions associated with reductions in lake trout abundance would likely be substantially offset within the region by increases in angler trips and spending associated with fishing for other species and/or on other regional waters. Additionally, the reductions will occur over a period of decades.

The total economic output (sales of goods and services) of the combined Lake and Flathead County area in 2007 was $4.1 billion (Minnesota IMPLAN Group 2010). This total economic activity generated $2.1 billion in employee compensation, and 73,528 full and part time jobs. In the context of the entire two-county economy, the estimated decreases in direct lake trout angler spending are very small (about one-tenth of 1%). However, any change in the economic status quo impacts certain people and groups more than others.

Individuals and businesses most likely to be adversely affected by Alternative D are anglers and guide businesses focusing specifically or exclusively on lake trout or trophy lake trout fishing in Flathead Lake. Those potentially benefiting from this alternative would be anglers or guides fishing the Flathead River system upstream of the lake, or anglers targeting non-lake trout species within Flathead Lake.

It is estimated that Alternative D lake trout control actions would have a negligible adverse impact on income or employment in Lake and Flathead counties. However, the actions may (over the period of several decades) have a minor adverse impact on all Flathead Lake and River anglers, and a moderate to major adverse impact on anglers and guide businesses targeting only lake trout.

Summary

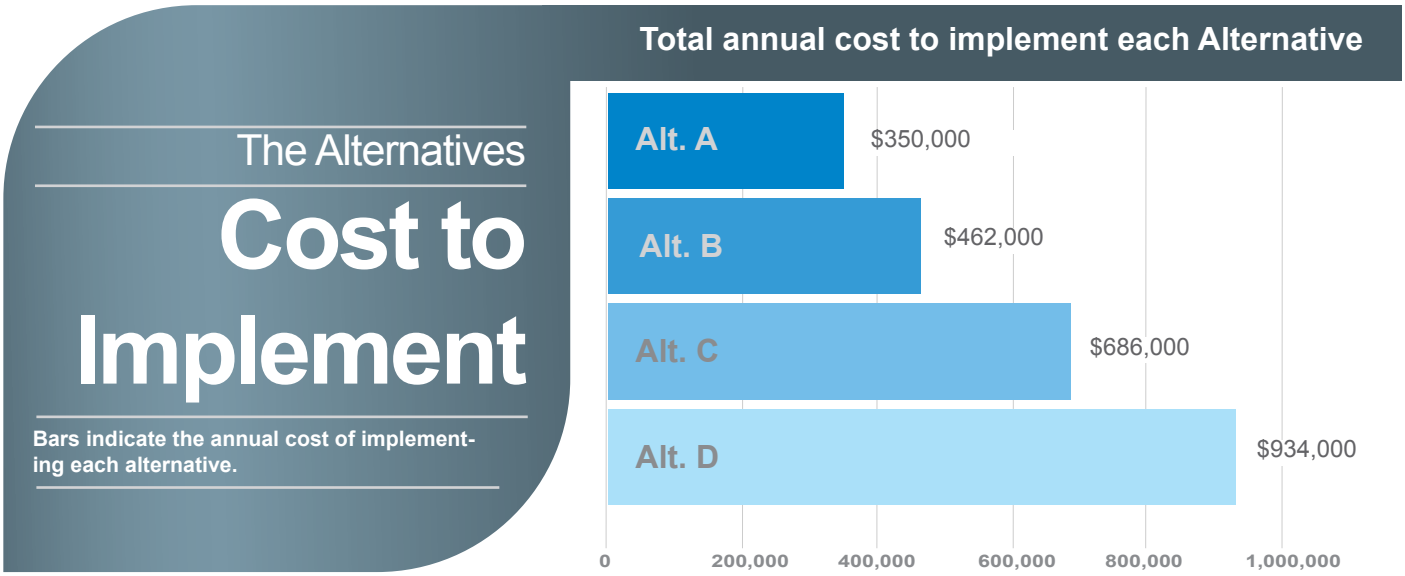


Figure 3.51. Anticipated cost of each alternative.

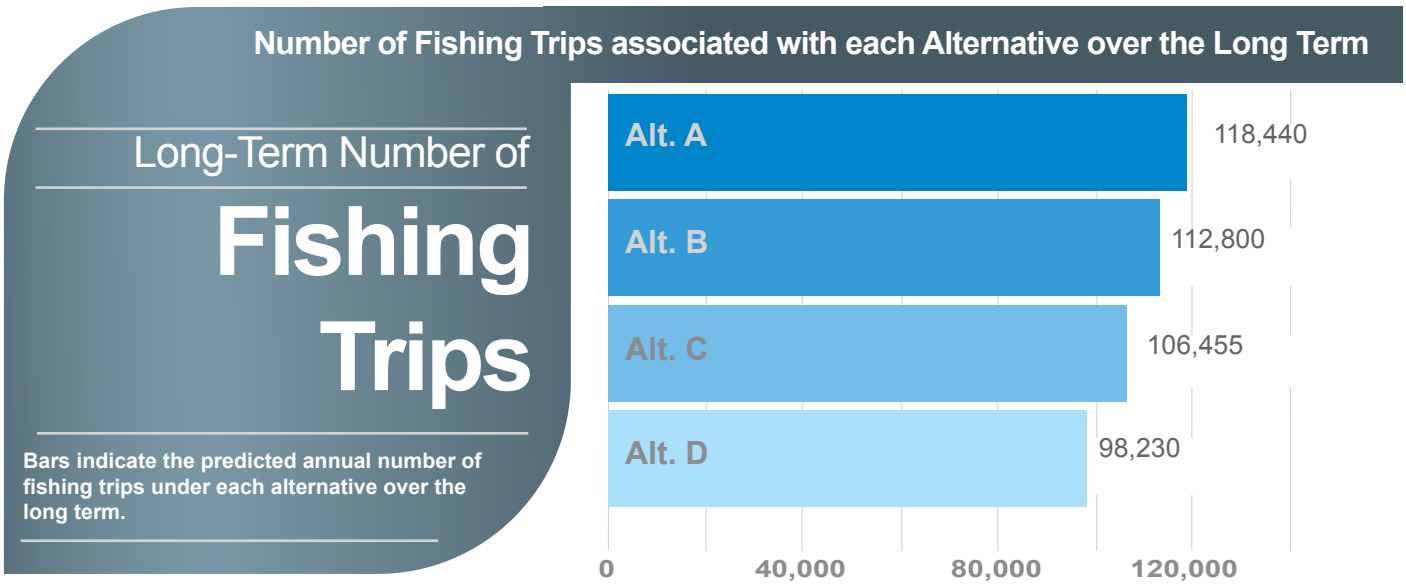


Figure 3.52. Predicted long-term number of fishing trips under each alternative.

Cumulative Effects Analysis Area

Introduction

A cumulative impact is defined as "the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). We determined cumulative impacts by combining the impacts of the alternatives with other past, present, and reasonably foreseeable future actions. The geographic scope for this analysis includes actions within the Cumulative Effects Analysis Area (CEAA) (Figure 3.53).

Affected Environment

Flathead River

The upper Flathead River consists of 30 miles of the main stem, 88 miles of the Middle Fork and 90 miles of the North Fork. A migratory fish starting its journey from the South Bay of Flathead Lake to the farthest headwaters might travel 130 miles. Bull trout and westslope cutthroat trout are present throughout the CEAA (Figures 3.56 and 3.57) and generally use the entire watershed to complete their life histories. The lower main-stem river is characterized by very low gradient, high sinuosity and a large mix of native and non-native fishes, while the upper forks have much higher gradient and support predominantly native fishes.

In the most recent creel survey of the main-stem river downstream of the North and Middle Forks, 87% of angler catches were non-native species (Deleray 2004). For example, a portion of the lake whitefish population residing in Flathead Lake moves upstream to spawn in the Flathead River in autumn. These large congregations of spawning lake whitefish are targeted by anglers from October through December and represent the largest component of the harvest. In 2003 an estimated 21,824 lake whitefish were harvested, supporting an average catch rate of 0.79 fish per hour (Deleray 2004). The same survey estimated westslope cutthroat trout were caught at an average rate of 0.16 fish per hour, which is second highest of all fish targeted in the main stem. Lake trout are probably migratory rather than resident in the main-stem river and with mountain whitefish support the third highest catch rates. In the 2002-to-2003 period anglers harvested an estimated 1,246 lake trout at an average catch rate of 0.07 fish per hour (Deleray 2004).

Electrofishing surveys within the main-stem Flathead River have produced variable estimates of the abundance of trout. Between 2000 and 2010, combined estimates of rainbow and westslope cutthroat trout abundance have generally trended downward, but the differences are not statistically significant (Steed et al. 2011).

The North Fork Flathead River is designated as a National Wild and Scenic River and supports a popular fishery for westslope cutthroat trout that are predominantly less than 10 inches in length. Angler catch rates for westslope cutthroat trout between 1990 and 2005 have averaged between three and six fish per hour (Weaver et al. 2006).

The Middle Fork Flathead River is relatively pristine and there are various Wilderness and Wild and Scenic River designations along its entire distance. Angler-caught westslope cutthroat trout tend to be larger than those caught in the North Fork Flathead River, and catch rates, while highly variable, range up to 6.5 fish per hour (Weaver et al. 2006).

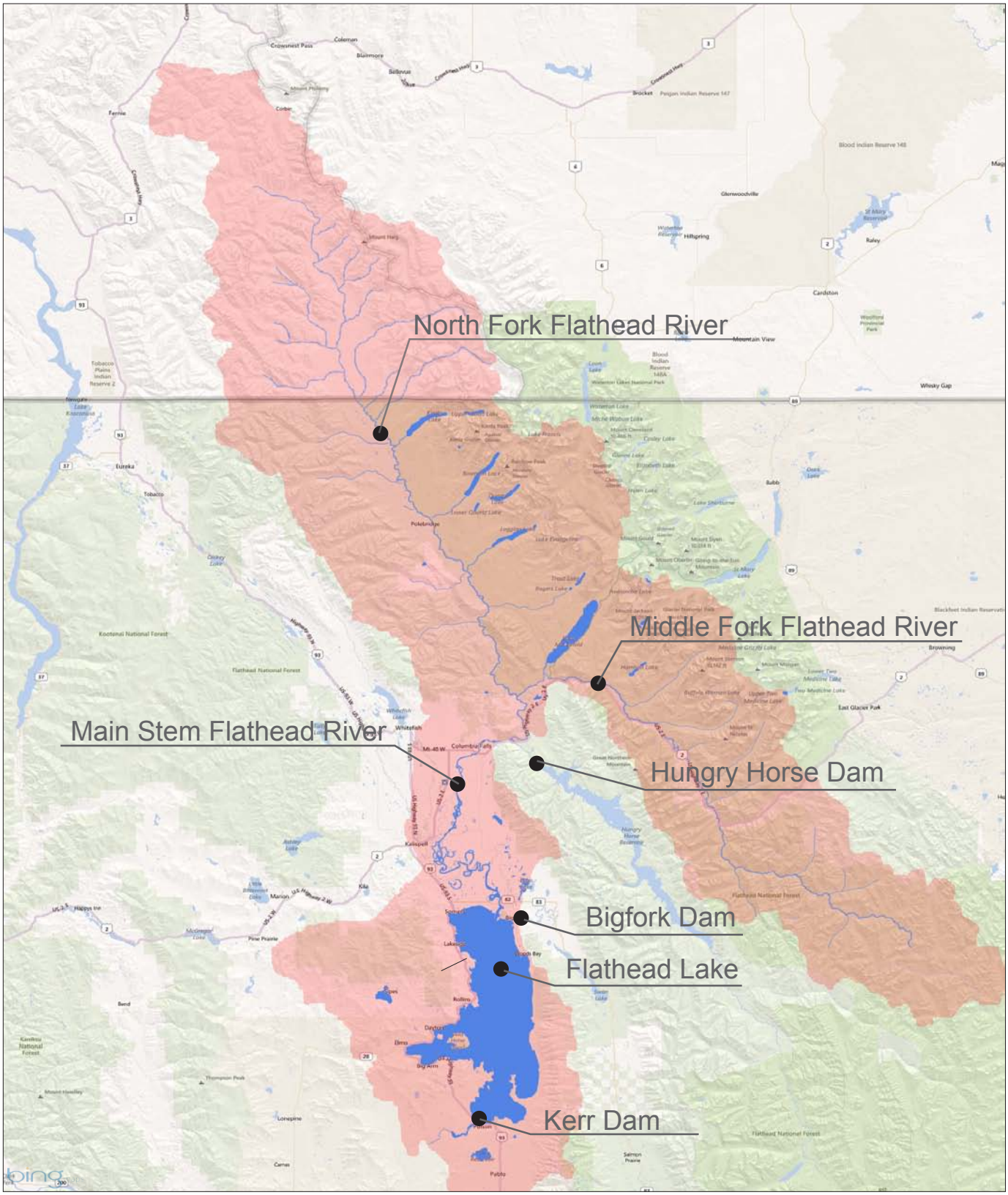


Figure 3.53. Cumulative effects analysis area (red shading).

Habitat Conditions

The interconnected Flathead River system provides all of the life history requirements for migratory westslope cutthroat trout and bull trout (Fraley and Shepard 1989; Muhlfeld and Marotz 2005; Muhlfeld et al. 2009). Habitat conditions within the basin are generally very good, with localized areas of disturbance and degradation. The Flathead River, downstream of the confluence of the Middle and North Forks, is an important travel corridor and rearing area for native trout (Muhlfeld et al. 2011). Lands within this area are predominantly private. Multiple governmental and non-governmental agencies have focused on protecting this important area in a process called the River-to-Lake Initiative (http://www.flatheadrivertolake.org/). Since 1998 over 10,000 acres of wetlands, riparian lands, and near-river lands have received protections through purchase or easements.

Figure 3.54. North Fork Flathead River (photo courtesy USFWS).

Adfluvial native fish spawn within tributaries of the North and Middle Forks of the Flathead River. Much of the lands within these drainages are in pristine condition because they are protected within Glacier National Park or in designated wilderness areas. In addition, there are timber production lands under state and federal jurisdiction that have received elevated protection and restoration since bull trout were listed as Threatened in 1998.

Nineteen local populations of bull trout reside within the interconnected Flathead system (USFWS 2005). Declines of bull trout have varied greatly among subpopulations—some spawning tributaries have declined to nearly zero, while others are currently supporting nearly the same abundance of spawners they did in the 1980s (Figure 3.58).

Since 1995, riparian areas on U.S. Forest Service lands have been managed under the relatively restrictive standards established under the INFISH protocols (USDA 1995). The Flathead National Forest has made substantial investments to improve water quality and aquatic habitat during the past two decades. This work includes road decommissioning, culvert removals and upgrades, and road improvements to meet State BMP standards. Since 1999, the Flathead National Forest has removed over 100 fish-migration barriers that benefit bull trout and westslope cutthroat trout. These projects have incorporated stream

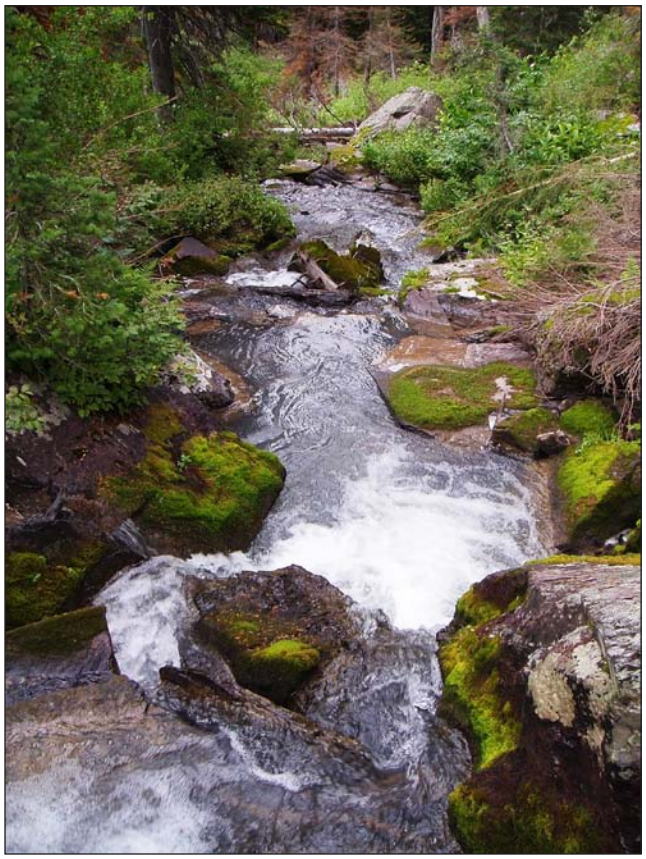


Figure 3.55. Upper Park Creek (photo courtesy USFWS).

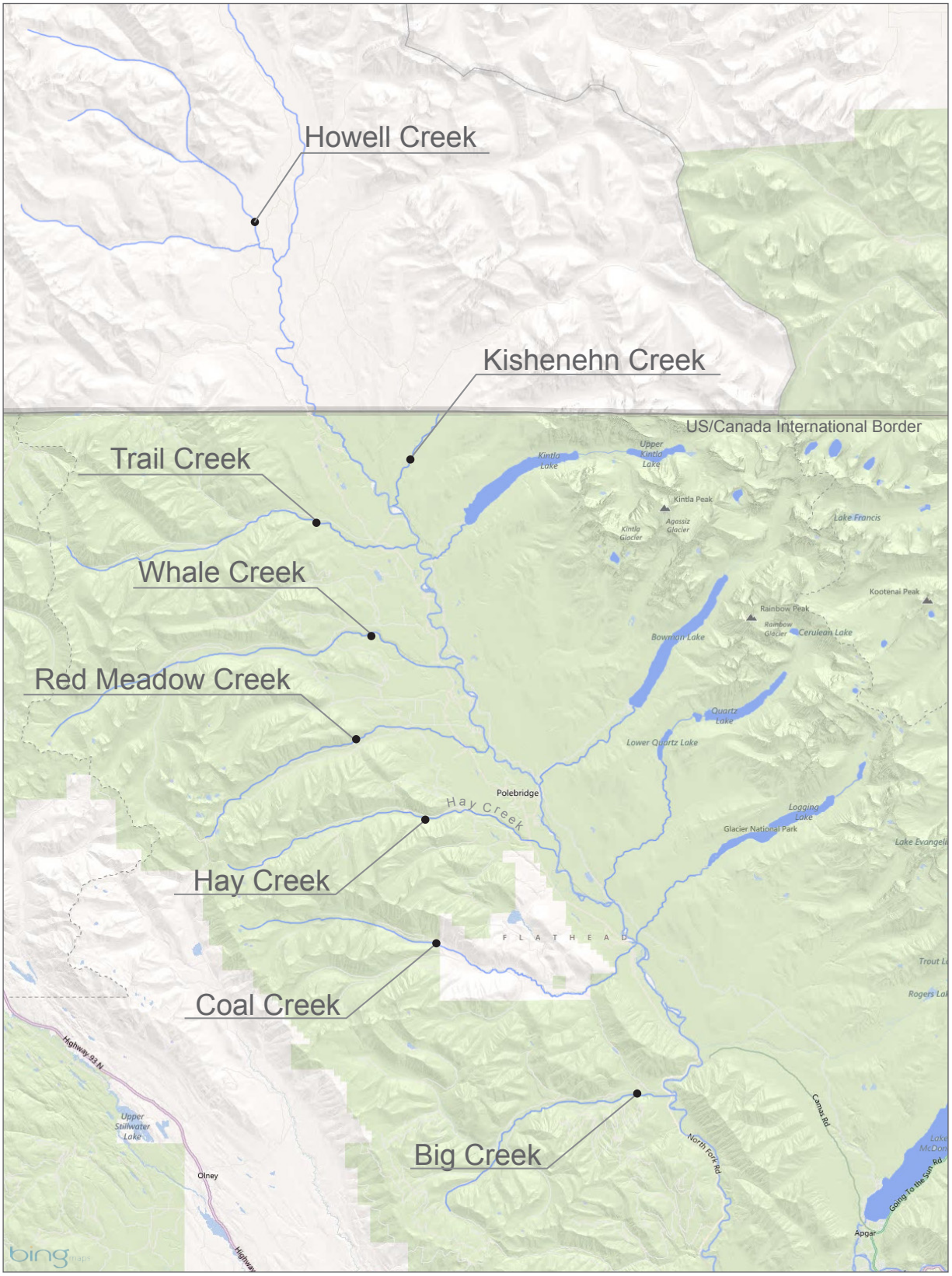


Figure 3.56. North Fork Flathead River tributaries.

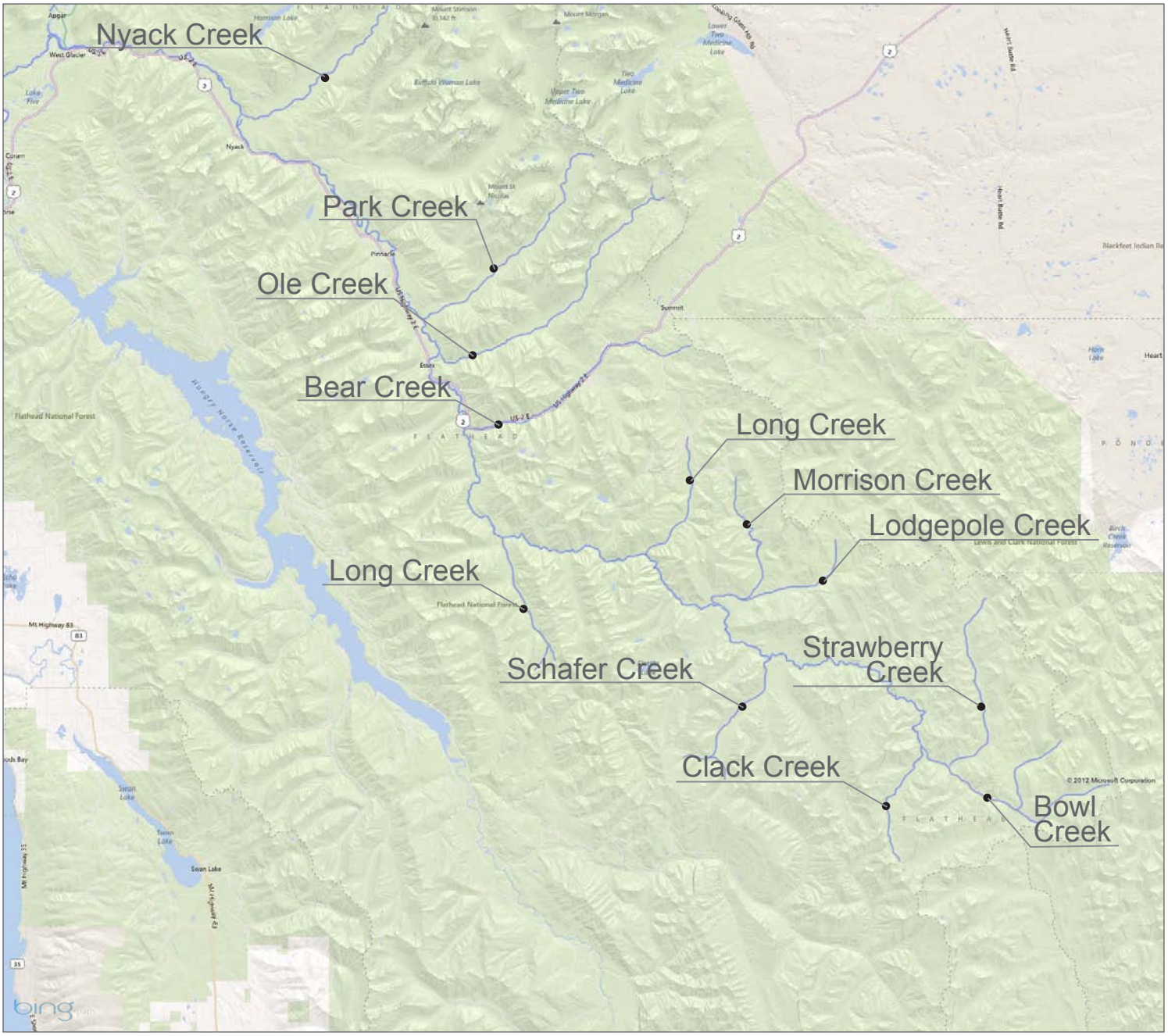


Figure 3.57. Middle Fork Flathead River tributaries.

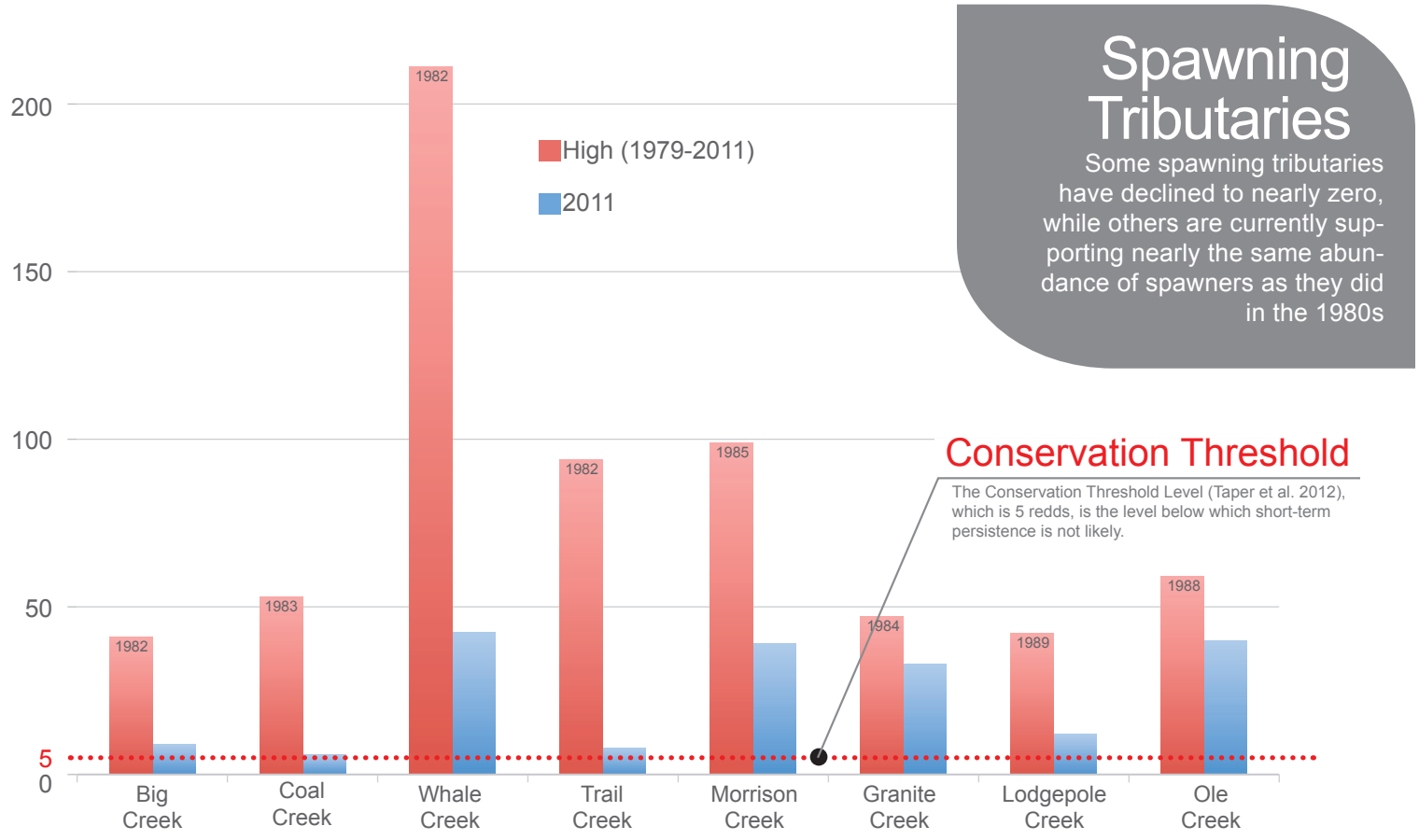


Figure 3.58. Redd Counts on North and Middle Fork Flathead River tributaries (data from MFWP). Red columns are the highest counts between 1979 and 2011. Blue columns are the 2011 counts.

simulation principles (USDA 2008) to ensure stream continuity and fish passage. Amendment 19 to the Flathead National Forest Plan, signed in 1995, established lower road-density standards in the Flathead River Basin. For example, in Big Creek, a tributary to the North Fork Flathead River where there has been extensive road decommissioning, restoration work has reduced sediment delivery to a level comparable to undisturbed systems. Monitoring has produced evidence of these positive changes and resulted in the removal of Big Creek from Montana's and EPA's list of sediment-impaired waters (i.e., it has been removed from the Clean water Act 303(d) designation).

Montana Department of Natural Resources and Conservation manages 18,370 acres of forested state trust lands within the Flathead River Basin under the guidance of a Habitat Conservation Plan written in cooperation with US Fish and Wildlife Service. Numerous conservation commitments in the plan ensure the continued protection of habitats for bull trout and westslope cutthroat trout (http://dnrc.mt.gov/HCP/Default.asp).

A key indicator of spawning habitat condition is the presence of fine sediments because high levels of fine sediment directly reduce spawning success (Weaver and Fraley 1993). MFWP monitors sediment levels in key bull trout spawning areas in the Flathead Basin (Weaver et al. 2006). Monitoring results indicate that the quantity of substrate consisting of materials less than 6.35 mm diameter fluctuates between 20% and 40%. Levels of fine sediment in spawning areas in both the North and Middle Fork drainages are gener-

ally lower today than they were in the early 1990s when the highest levels were measured, indicative of improving habitat conditions (Weaver et al. 2006).

Hungry Horse Dam, located on the South Fork Flathead River, has modified the natural-flow regime in the upper Flathead River for power generation, flood-risk management, and flow augmentation for anadromous fish recovery. Analyses comparing the natural flow of the main-stem Flathead River (pre-dam, 1929-1952) with five post-dam flow management strategies (1953–2008) show that the natural-flow conditions optimize the critical bull trout habitats and that the current strategy best resembles the natural-flow conditions of all post-dam periods (Muhlfeld et al. 2011).Therefore, current dam operations are likely to improve the chances of protecting key ecosystem processes in the main stem and are designed to help Threatened bull trout.

Climate Change

The CEAA (Cumulative Effects Analysis Area) is likely to undergo changes in the future related to global climate change that will be detrimental to native fish (Rieman et al. 2007). For example, winter floods may become more common, and they could mobilize channel substrates, which in turn could impact bull trout embryos incubating in the substrate (Seegrist and Gard 1972; Isaak et al. In-press). Increased fire frequency and intensity will likely remove riparian vegetation at a greater rate than is currently occurring (Westerling et al. 2006). Increases in ambient air temperatures in concert with reduced shade would contribute substantially to stream warming (Isaak et al. In-press; Jones et al. In-review). More frequent droughts and increased evapotranspiration will likely reduce baseflow conditions, degrading in-stream habitat quality and reducing the ability of autumn-spawning bull trout to access some stream segments (Rieman et al. 2007).

Historically, juvenile native trout adopted an adfluvial life history because there was a survival advantage to those fish that migrated to Flathead Lake where they grew larger than those that remained in the tributary system. Climate change will likely increase the importance of Flathead Lake to the adfluvial life history of native trout. With a warming climate, the cool-water refuge provided by Flathead Lake with optimal temperatures below the thermocline, will be increasingly important as the shallower waters of the spawning streams and mainstem river system continue to warm. The advantage of this temperature refuge in Flathead Lake will be minimized or negated if the lake includes the increased risk of predation by lake trout.

Ongoing Conservation Measures

About 25 miles of the North Fork Flathead River headwaters are in British Columbia. The British Columbia segment of the river and its tributaries currently support about 30% of the bull trout spawning in the North Fork system. The watershed is largely undeveloped and recognized by the United Nations Educational Scientific and Cultural Organization as a Biosphere Reserve. The lands hold large coal and natural gas deposits, yet the United States and Canada have jointly moved to protect the North Fork watershed and have chosen to elevate the area's biological importance above the values derived from mineral extraction (Hauer and Muhlfeld 2010). In February 2010, British Columbia Premier Gordon Campbell and Governor Brian Schweitzer signed a landmark agreement banning mining and oil and gas extraction in the North Fork Flathead Watershed.

Non-native aquatic predators

Northern pike (*Esox lucius*), like lake trout, are non-native predators and are common in lower Flathead River portion of the CEAA. Northern pike favor off-channel sloughs, which are common in the portion of Flathead River upstream of Flathead Lake (Muhlfeld et al. 2000). They are estimated to consume about 3,500 bull trout and 13,000 westslope cutthroat trout annually (Muhlfeld et al. 2008).

There have been several confirmed reports of walleye (*Sander vitreum*) in Flathead Lake, including captures during standardized sampling by the management agencies. Therefore we assume that the population is either very small and not well established, or past captures were individuals from illegal introductions that have not yet founded a reproducing population. The potential exists for this population to expand and become another mortality factor for native fish.

Smallmouth bass (*Micropterus dolomieu*) were not legally planted in Flathead Lake. Instead, they were probably transported there by anglers from nearby waters that support smallmouth bass. They have been documented frequently in creel surveys of Flathead Lake, but they are not vulnerable to gillnetting and have never been captured in standardized gillnet sampling by the management agencies. Many records exist of individuals caught by anglers in South Bay, but their presence in the rest of lake has not been confirmed. Smallmouth bass are likely to expand their range in Flathead Lake, especially in bays and throughout the nearshore area, which is also occupied by native trout. Smallmouth bass appear to be increasing in number and will likely become an increasing source of mortality for native fish.

Largemouth bass (*Micropterus salmoides*) were first planted in Flathead Lake in 1898. They have never become well established throughout the lake, but persist in small numbers, primarily in South Bay. Because largemouth bass have been present for such a long period of time without developing a large population, we assume the habitat is limiting, and the species will not be a threat to native fish.

Non-native aquatic competitors

The most important non-native competitor in the Flathead system is rainbow trout (*Onchorhynchus mykiss*). Substantial hybridization with westslope cutthroat trout has been documented and is advancing upstream from an initial source in a tributary to the main-stem Flathead River (Hitt et al. 2003; Boyer et al. 2008; Muhlfeld et al. 2009b). Efforts to remove rainbow trout and prevent passage into spawning tributaries are underway, but continuing hybridization remains a threat to westslope cutthroat trout genetic integrity, and possibly to salmonid population abundance and angling opportunity (Muhlfeld et al. 2009c; Steed et al. 2011). Declines in the abundance of westslope cutthroat trout accelerate the negative effects of hybridization.

Future potential aquatic predators and competitors

Many invasive species threaten to modify the Flathead Lake foodweb. Most notable are zebra mussels, quagga mussels, and New Zealand mud snails. These molluscs have caused enormous ecological upheaval in each of the lakes they have invaded. As prodigious filter-feeders they would probably initiate a new large-scale alteration of the food web of Flathead Lake. It is difficult to predict their potential impact, but it would probably be substantial, both biologically and economically.

Fishing Opportunity in the Flathead River System

Within Flathead Lake and the main-stem system upstream from the lake, total angler use ranged between 80,000 and 110,000 angler trips per year during 1985-2007. Total angler use is the sum of all trips for each angler—not just those targeting lake trout. Angling effort ranged from as few as 66,000 trips in 1995 to 117,500 trips in 2007 (Figure 3.59).

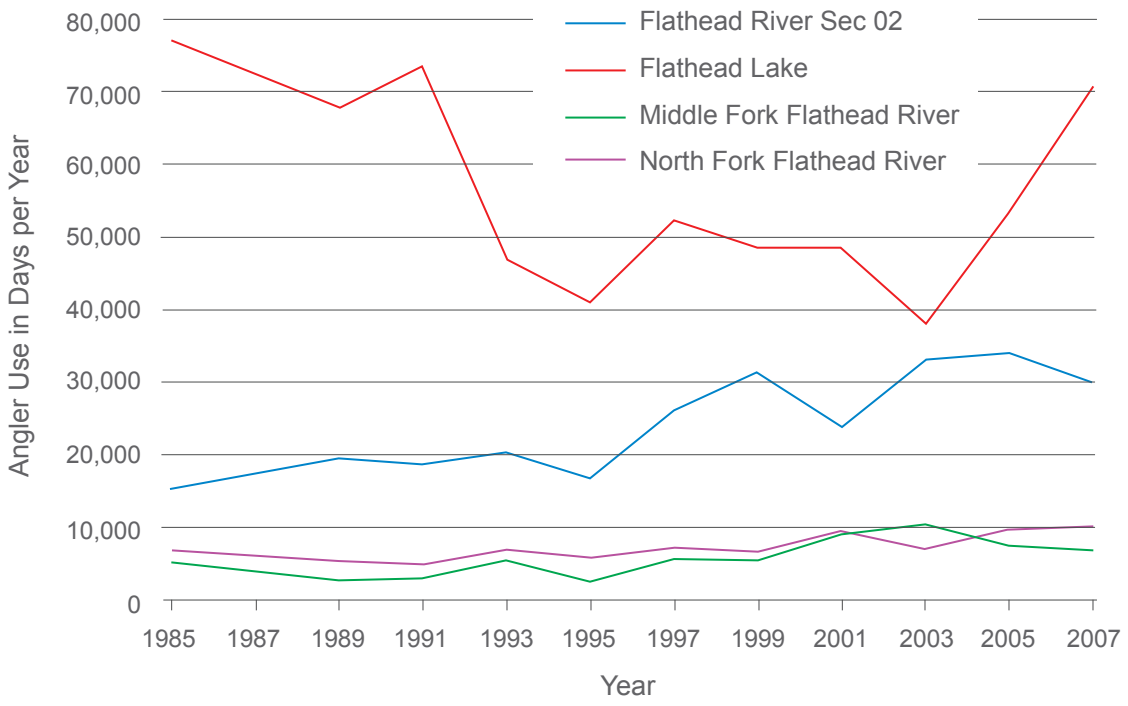


Figure 3.59. Annual angler use in the Flathead system, 1985-2009, from McFarland 2009)

Environmental Consequences

Flathead River

Populations of native trout would likely increase in the Flathead River system as a result of reductions in lake trout abundance in Flathead Lake. Because these native trout are migratory, utilizing the entire watershed, the same subpopulations that exist in the lake also occupy the river system for part of the year. The benefits of reduced predation by lake trout in Flathead Lake would therefore directly benefit adfluvial native fish occupying the river system.

Habitat Conditions

We anticipate, based on existing trends, that habitat conditions will remain stable or improve in the future. Therefore habitat in the Flathead tributary system would continue to be suitable and capable of supporting the additional numbers of native fishes resulting from reduced predation by lake trout.

Climate Change

Climate change will probably continue and worsen in the future, having a detrimental impact on native fishes. Benefits to native fishes resulting from reduced predation by lake trout will probably be partially offset by the detrimental effects of climate change. Conversely, the effects of climate change when combined with the chronic effects of predation by lake trout could drive the abundance of native fishes lower than currently exists.

The cumulative effects of climate change, when combined with predation by lake trout, represent a substantial long-term threat to westslope cutthroat trout and bull trout populations in the Flathead system.

Reducing the mortality rate of native trout that results from predation by lake trout would reduce the total future cumulative effects of climate change.

Alternative A is the status quo and will not increase carbon emissions over current levels unless there is substantially increased participation in fishing contests. Action alternatives are anticipated to include the use of netting to meet harvest targets for lake trout. Netting would require the use of power boats and would result in substantial increases in fuel consumption relative to Alternative A. Alternative B is projected to require the netting of 14,000 lake trout, resulting in the release of 8 metric tons (MT) of carbon dioxide (www.boatcarbonfootprint.com). Alternative C is projected to require the netting of 42,000 lake trout resulting in the release of 24 MT of carbon, and Alternative D is projected to require the netting of 73,000 lake trout resulting in the release of 42 MT of carbon.

Ongoing Conservation Measures

Protections given to the North Fork Flathead River watershed contribute greatly to supporting a long-term stable environment for migratory native fishes. These protections would help to ensure that the full benefits of reduced predation on native fishes are realized by maintaining suitable conditions within the spawning and rearing streams of the North Fork.

Non-native aquatic predators (other than lake trout)

Predation by introduced aquatic predators will probably increase in the future. If they were to become highly abundant and prey heavily on native fishes, they could completely negate the benefits of a reduced lake trout population. If that were the case, reducing lake trout abundance would not be effective unless we also took measures to reduce the abundance of these other non-native predators. The relative benefits of reducing the abundance of multiple species would have to be evaluated when and if those circumstances developed.

It is also possible that the abundance of other introduced aquatic predators would remain low, in which case they would be a small but additive source of mortality for native fishes. Increased mortality, when added to the chronic effects of predation by lake trout, could drive the abundance of native fishes lower than currently exists.

Non-native aquatic competitors

Non-native aquatic competitors drive down the abundance of native fishes through hybridization and reduced survival rates. It is likely that non-native aquatic competitors, especially rainbow trout, will increase in the future despite aggressive measures by MFWP to suppress them. If they become highly abundant, they could completely negate any benefits to westslope cutthroat trout derived from reducing lake trout predation. If that were the case, reducing lake trout abundance would not be effective unless we also took measures to reduce the abundance of non-native competitors. The relative benefits from reducing the abundance of multiple species would have to be evaluated when and if those circumstances developed.

It is also possible that the abundance of other introduced aquatic competitors would remain low, in which case they would be a small but additive source of mortality for native fishes. Increased mortality, when added to the chronic effects of predation by lake trout, could drive the abundance of native fishes lower than currently exists.

Future potential aquatic predators and competitors

The risk of additional introductions of aquatic predators and competitors is high. If prevented and even if controlled after an introduction, the impact on native fishes would be low, although the impacts would be additive to the existing impact of predation by lake trout. The merits of continued lake trout suppression during multiple additional invasions would have to be evaluated when and if those circumstances developed.

Environmental Justice (Executive Order 12898)

Executive Order 12898 (Executive Order) directs Federal agencies to address the environmental justice impacts of their actions on minority and low-income populations (as defined by poverty thresholds of the U.S. Bureau of the Census). Each Federal agency must analyze environmental effects, including human health, economic, and social effects, of Federal actions, including effects on minority communities and low-income communities. Where environments of Indian tribes may be affected, the Executive Order requires agencies to identify the tribal groups and consider pertinent treaty rights. Further, the Executive Order calls for agencies to analyze information on tribal patterns of subsistence consumption of fish, vegetation, or wildlife and the effects of the agency's action on those subsistence patterns of consumption and distinct cultural practices.

Minority and Low-Income Populations

The Region of Influence (ROI) for the project area encompasses the Flathead Indian Reservation (which includes portions of Lake and Sanders counties) and Flathead County.

According to the 2010 Census, 23,359 persons live on the Flathead Indian Reservation. Twenty nine percent of those are considered minorities as defined by the Executive Order (24.8% American Indian and 4% Asian, Black, or Hispanic). The population of Flathead County is 90,928. Two percent of those persons are considered minorities.

Based on the 2010 US Census, Lake County has a poverty rate of 23.2%. While approximately 14% of Lake County families are below poverty level, 65% of Confederated Salish and Kootenai Tribal members are reported to live below the poverty level. In Flathead County, 13% are reported as such.

The Tribes and the Treaty

The Flathead Indian Reservation is home to three tribes of American Indians: the Bitterroot Salish or Flathead, the Pend d'Oreille, and the Kootenai. The 1855 Hellgate Treaty, which established the Flathead Indian Reservation, provided for cession of tribal lands to the U.S. government in exchange for continued rights to fish, hunt, gather, and pasture on unoccupied (by non-Indians) lands and usual and accustomed places, exclusive use of a reservation (without trespass by non-Indians), and various annuities, goods, and services, all to be provided by the federal government. It was the understanding of both Governor Stevens and the tribal leaders who signed the 1855 Treaty of Hellgate that the rights of the Flathead, Pend d'Oreille, and Kootenai to gather, hunt, and fish were reserved and protected by this Treaty, including exclusive rights to do so on the Reservation. The Tribes continue to conduct hunting, fishing, and gathering activities, and these activities remain at the heart of Tribal spiritual and cultural practices.

Tribal Patterns of Subsistence Consumption

Bull trout and other native fish have always been and continue to be a highly valued cultural resource for the Tribes. While many native fish species were important in the traditional diet—westslope cutthroat trout, mountain whitefish, suckers, northern pikeminnow—none was more crucial to the Tribes' survival and well-being than bull trout (Smith 2010). This is because they were abundant, easy to harvest at certain times of the year, and a rich food of high caloric value and because the fluvial and adfluvial forms were the largest of the native fish species. In short, they were an ideal food for sustaining the Tribes through Montana's long, harsh winters. And because bull trout were more consistently available than any other food resource utilized by the Salish and Kootenai people (big game hunting was prone to cycles of feast and famine) they provided a safety-net that enhanced the survival of tribal people and shaped the culture's perception of a secure future (Smith 2010). The fish's importance is reflected in the fact that many traditional place-names within the Salish-Pend d'Oreille's aboriginal territory refer specifically to bull trout. In fact, there are more Salish place-names in western Montana describing bull trout than any other plant or animal (Smith 2010).

Flathead Lake was especially important with respect to bull trout and westslope cutthroat trout. The Pend d'Oreille band that lived in the Flathead Lake area was known in the Salish language as "The People of the Broad Water", after the name of the lake, which translates as "Broad Water". Anthropologist Carling Malouf wrote that "the density of occupation sites around Flathead Lake and along the Flathead River....indicates that this was, perhaps, the most important center of ancient life in Montana west of the Continental Divide." Lieutenant John Mullan, a member of Isaac Stevens' exploratory party journals indicate that one of the reasons why the lake and river was such vibrant center for the Pend d'Oreille was "the abundance of [bull trout,] these most excellent fish" -- "one of the chief articles of food for the Pend d'Oreilles at this [spring] season."

The importance of bull trout to the CSKT is evidenced today by the substantial efforts expended by the tribes to restore bull trout where they have been depleted, specifically in the Jocko River system (ARCO 2008). The restoration of the Jocko River is one of the widest-reaching, most ambitious efforts to restore bull trout in the northern Rockies. And today, hunting and fishing remain one of the most important opportunities for tribal members to learn about their culture, traditions, and history because they include practices such the planning, spiritual preparation, techniques of regulation, patience, the tradition of reciprocity, and a deep understanding of the fish's life history and behavior that is necessary for angling success. Overall, the exercise of the rights reserved in the Hellgate Treaty concern more than just protection of tribal subsistence resources. They are concerned with protecting a way of life or culture that is closely identified and intertwined with the exercise of these rights and activities throughout the CSKT homeland.

Impacts of the No-Action Alternative

Fishing for bull trout in the Flathead system was closed in 1992 after redd counts had declined for five consecutive years. Redd counts did not increase following the fishing closure, suggesting that harvest was not the primary factor controlling bull trout abundance at that time. In 1998, the US Fish and Wildlife Service listed Columbia River bull trout, which includes the Flathead population, as Threatened under the Endangered Species Act. The current depressed status of the many sub-populations prevents Tribal members from practicing their treaty rights and traditional patterns of subsistence consumption. Similarly, due to the concerns over the population status of westslope cutthroat trout, angling for that species is restricted to catch and release in Flathead Lake and the North and Middle Forks of the Flathead River (except in Wilderness portions of the Middle Fork where up to three fish under 12 inches may be kept).

Under the No-Action Alternative, The abundance of bull trout would probably remain unchanged over the short term (<5 years) because bull trout populations have not changed appreciably during the last 10 years of similar management. Alternative A would maintain total lake trout abundance over the long term. But bull trout are vulnerable to irreversible decline over the short term because when their population is low, they have reduced resilience to disruptive stochastic events (Dunham et al. 1997; Morita and Yamamoto 2002), including the potential for a series of above average predation cycles. The greatest risk is that weak local populations will become extirpated, and the greater core area will not be strong enough to refound them. Bull trout would likely benefit over the long term from implementation of Alternative A, provided that they persist long enough to receive those benefits. This reduction in predation over the long term is predicted to occur because sustained annual harvest of 70,000 lake trout, while not sufficient to reduce total numbers, would gradually reduce the abundance of large lake trout, and it is the large lake trout that have the greatest predatory effect on bull trout. However, any potential increase in bull trout resulting from decreased predation would be too small to measure. In addition, mortality from bycatch would partially offset the gains. Thus, removal of 70,000 lake trout annually is likely insufficient to drive an increase in bull trout numbers in a way that would improve opportunities for Tribal member subsistence consumption or practice of cultural fishing activities.

Abundance of westslope cutthroat trout would remain relatively unchanged within the short term. Westslope cutthroat trout populations have not changed measurably during the last 10 years of current management, suggesting they would continue unchanged during this period. Over the long term (>50 years) there would be a substantial reduction in predation by lake trout on westslope cutthroat trout. The change in predation rate is predicted based on the 58% reduction in large lake trout over the long term, which could potentially increase opportunities for subsistence consumption of this species. However, those opportunities would be at a level considerably below any of the action alternatives.

Impacts of Action Alternatives

None of the action alternatives will have disproportionate adverse human health or environmental effects on the Tribes or on low-income or minority populations living within the ROI. Indeed, reducing the population of non-native lake trout in Flathead Lake to benefit native fishes would help to protect the Tribes' treaty rights and, over the long term, has the potential to increase opportunities for subsistence consumption of bull trout and westslope cutthroat trout and the cultural practices distinct to the Tribes that are tied to harvest and consumption of these native fishes.

Short-term Uses and Long-term Productivity

NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity". As declared by the Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans. Short-term uses are those that generally occur for a finite time period. Long-term productivity refers to the ability of the land and water to produce a continuous supply of a resource.

Extensive research and monitoring has determined that lake trout threaten the persistence of native trout in the Flathead Lake and River system. This proposed action addresses the threat through a full range of alternative approaches that would reduce lake trout numbers. Therefore, all action alternatives are specifically intended to maintain the long-term productivity of the Flathead watershed by ensuring that the critical component species—native bull trout and westslope cutthroat trout—are increased to a point that their likelihood of persistence is greatly improved.

Alternatives B, C, and D would reduce lake trout numbers by fixed percentages that would ensure the long-term productivity of the lake trout population at new but lower levels. A description of impacts by resource can be found in the "Environmental Consequences" sections of this chapter.

Unavoidable Adverse Effects

Each alternative has unavoidable adverse effects in the form of bycatch of native trout. Alternatives have been designed to minimize bycatch and have been evaluated based on the level of bycatch. The effects are stated in terms of impacts to population stability and persistence, both in the short term and long term. Adaptive measures would be employed to reduce bycatch based on knowledge gained while implementing a particular harvest method.

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those that are lost for a period of time such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line rights-of-way or road.

Each alternative would cause the irretrievable loss of the monetary costs required to implement the alternative. The costs vary by alternative, with even the No Action Alternative incurring substantial costs.

Most projects requiring NEPA compliance have the risk of causing an irreversible impact that might result from implementation of the proposed action. In contrast, there may be the irreversible extinction of bull trout within the Flathead Lake and River system if one of the action alternatives is not implemented. Therefore the proposed actions are intended to prevent the irretrievable loss of a species. Each alternative is intended to reduce the threat from lake trout and in turn reduce the risk of irreversible extinction of bull trout.

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Consultation and Coordination

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The Department of the Interior, Bureau of Indian Affairs is the lead agency in this EIS. The cooperating agency is the Confederated Salish and Kootenai Tribes. The Bureau of Indian Affairs relied on and consulted with the following individuals; Federal, State, and local agencies; and tribes during the development of this Environmental Impact Statement:

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In addition, a Citizen Ad Hoc Group also participated. Members include:

Trout Unlimited
Flathead Lakers
Flathead Lake Outfitter
Flathead Wildlife, Inc.
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Distribution of the Draft Environmental Impact Statement

This draft environmental impact statement has been distributed to individuals who specifically requested a copy. In addition, electronic copies have been made available to the following Federal agencies, Tribes, Sate and local governments, and organizations representing a wide range of views regarding the purpose and need of the proposed action:

US Forest Service
US Fish and Wildlife Service
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Appendices

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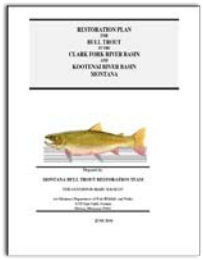
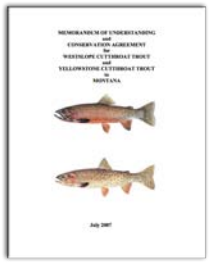
Appendix 1

Guidance Documents

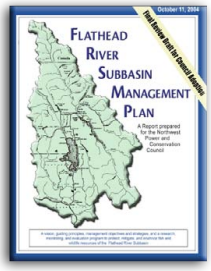
Lake River Fisheries Co-Management Plan



Montana Bull Trout Restoration Plan



Memorandum for Westslope Cutthroat Trout



Subbasin Plan, Part III

CSKT Comprehensive Plan

Introduction

The purpose of the proposed action—to reduce the population of nonnative lake trout in Flathead Lake to benefit native fish species—is based upon over two decades of continuous and cooperative regional research, management, and planning between Tribal, State, and Federal agencies. The research, joint planning efforts, and decision-making processes are recorded in our guidance documents, which include: the Flathead Lake and River Fisheries Co-Management Plan (2000), the Bull Trout Restoration Plan (2000), the Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout and Yellowstone Cutthroat Trout In Montana (2007), the Flathead Subbasin Plan, Part III (2004), the CSKT Comprehensive Resources Plan (1996), and the CSKT Fisheries Management Plan (1996). The project would play a critical part in achieving several of the goals and objectives of these plans and policies. This appendix includes the portions of these guidance documents relevant to the this project.

FLATHEAD LAKE AND RIVER FISHERIES
CO-MANAGEMENT PLAN
2001-2010

Montana Fish, Wildlife & Parks
490 North Meridian Road
Kalispell, MT 59901
406-752-5501

Confederated Salish and Kootenai Tribes
P.O. Box 278
Pablo, MT 59855
406-675-2700

November, 2000

Flathead Lake and River Fisheries Co-Management Plan (2000)

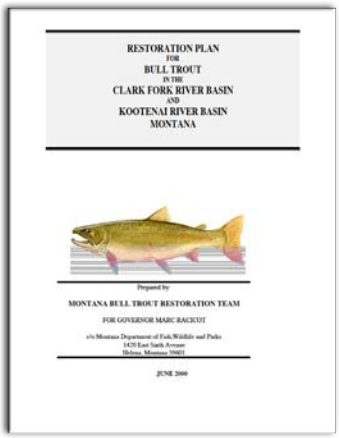
Flathead Lake and River Fisheries Co-Management Plan (Co-Management Plan) was signed by the MFWP Director and CSKT Tribal Chairman in November of 2000. It provides a framework for adaptive management to gradually reach the plan's stated goals over a 10 year period (2000 through 2010), with a mid-term review after 5 years. It was produced with extensive public input and scientific peer review. The plan seeks to increase bull trout and westslope cutthroat trout by suppressing the numbers of nonnative fish that compete with them. Copies are available at: http://fwp.mt.gov/fwpDoc.html?id=47167.

The following goals, objectives, and strategies from the Co-Management Plan are relevant to this project:

Goals
- Increase and protect native trout populations (bull trout and westslope cutthroat trout).
- Balance tradeoffs between native-species conservation and nonnative-species reduction to maintain a viable recreational/subsistence fishery.

Objectives
- Increase and protect native trout populations to at least secure levels.
- Maintain, or if needed, increase harvest of nonnative fish to benefit native fish species.
- Provide a recreational fishery based on nonnative and native fish with harvest opportunities based primarily on nonnative fish.

Strategies
5A: Suppress nonnative fish through recreational angling.
5C. Implement agency management actions if necessary to reduce nonnative fish.


RESTORATION PLAN
FOR
BULL TROUT
IN THE
CLARK FORK RIVER BASIN
AND
KOOTENAI RIVER BASIN
MONTANA

Prepared by
MONTANA BULL TROUT RESTORATION TEAM
FOR GOVERNOR MARC RACICOT
c/o Montana Department of Fish,Wildlife and Parks
1420 East Sixth Avenue
Helena, Montana 59601

JUNE 2000

Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin, Montana (2000)

This Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin, Montana (Montana Bull Trout Restoration Plan), prepared by Montana Bull Trout Restoration Team (including MFWP and CSKT, among others) at the request of the Governor, has as its purpose to provide the framework for a strategy to reverse or halt the decline of bull trout populations in western Montana and restore populations in areas where they have declined. The plan provides general guidance for conservation and protection of those populations that are stable or increasing as well as recommendations to restore populations that have declined. It is intended to guide state restoration efforts and complement federal conservation and recovery processes. It is intended to be used by management agencies, watershed groups, and private landowners as a reference to conserve and recover bull trout throughout western Montana. The plan

complements existing mandates and management objectives such as forest plans and is recommended to be adopted and incorporated into them. Copies are available at: http://www.flatheadtu.org/indexFiles/WebDocs/BT5.pdf.

The following recommendations from this plan are relevant to this project:

3.0. Suppress or remove introduced fishes that compete with, prey on, or hybridize with bull trout where appropriate

3.2. Determine site-specific impacts of introduced fishes where such species are suspected to be causing negative impacts to bull trout and review methods to reduce or eliminate impacts of those fishes.

3.2.1. Flathead Lake: a key portion of the Flathead River Drainage RCA, has become dominated by lake trout, to the point where they have become the top predator in that system and may be contributing to the decline of bull trout. Impacts to bull trout by lake trout in Flathead Lake and possible methods to reduce impacts should be reviewed and incorporated into a management plan for the lake.

3.2.1.a. Evaluate biological, economical, and sociological impacts of suppressing lake trout to enhance bull trout.

3.2.1.b. Implement management recommendations to reduce impacts of lake trout on bull trout in Flathead Lake.

In Appendix G (*Executive Summary - Assessment of Methods for Removal or Suppression of Introduced Fish to Aid in Bull Trout Recovery*) of the Montana Bull Trout Restoration Plan, five situations where removal and suppression of introduced fish should be considered are identified. Those include (our responses are in italics):

1. **Where recent invasions of introduced species have occurred or when the target species is restricted to a small area or is not well established but has a high potential for spreading.**
   Note: This situation does not apply to the current proposal because lake trout are already well-established in Flathead Lake. Therefore, our objective is not to eliminate the lake trout population, but reduce it. We hope that by reducing the number of lake trout in Flathead Lake, the chances of lake trout dispersal would be decreased. Currently, lake trout are spreading from Flathead Lake into the upper reaches of Glacier National Park, for example. The lake trout population in Flathead Lake has been established for over 100 years, is present throughout the lake, and there is abundant evidence that they have migrated both up and downstream from the lake.

2. **Where it is necessary to protect core areas and nodal habitats.**
   Flathead Lake and its tributaries are identified core areas necessary for protection of bull trout (USFWS 2002), Bull Trout Critical Habitat Designation (USFWS 2010).

3. **Where a bull trout population is in immediate danger of extinction.**
   Bull trout are in a long-term decline in Flathead Lake, and substantial evidence indicates that the cause is predation by lake trout (Beauchamp et al. 2006, Staples 2006).

4. **Where preservation of native species is a priority.**
   Preservation of native species is a priority for the Tribes, as stated in the Flathead Lake and

River Fisheries Co-Management Plan (2000) and the Flathead Subbasin Plan (2004). The interconnected Flathead Basin is a unique area, and one of the few remaining large systems that supports the full expression of the adfluvial life history of native fish. For example, most bull trout grow to adulthood in Flathead Lake, migrate upstream through the main stem and one of the forks, enter a tributary to spawn, then return to the lake. Offspring rear in tributary habitats for several years then migrate downstream to the lake. There, they grow to adulthood before returning upstream to complete the cycle. Thus, all parts of the aquatic system are crucial to life stages of these native fish.

5. **Where innovative experimental projects will further the knowledge of how this tool might be most effective. While all removal projects are experimental in nature, this refers to innovative projects that attempt to learn more about techniques and population effects of projects. New and innovative ideas and methods will have to be developed before introduced species control will be successful, particularly in large, complex lakes and streams.**
   The innovative nature of this proposal is the attempt to reduce rather than eliminate an extremely large and well-established lake trout population and to sustain a reduced lake trout fishery in order to benefit native fish species in the long term. Nearly all efforts to address the lake trout expansion in other systems have been based on the desire to eliminate lake trout, which is not considered feasible in Flathead Lake. Detailed monitoring would be conducted to measure and test the effectiveness of our approach.

The Assessment of Methods document lists a checklist of criteria that should be used to evaluate lake trout removal or suppression proposals. Those include (our responses are in italics):

1. **Assess the need for removal or suppression of introduced species:**
   Is there another alternative that may also protect bull trout?
   There is copious evidence indicating that predation by lake trout is the factor controlling the abundance of native trout in Flathead Lake. Therefore, the only means to benefit native trout is to reduce the predation pressure exerted by lake trout. While we have received suggestions for bull trout hatchery supplementation and habitat improvement, neither of these reduce the direct loss of bull trout from lake trout predation. The Tribes have conducted expert reviews of Flathead Lake management and solicited expert opinions during those reviews. Results indicate a high likelihood that bull trout would continue to decline unless lake trout numbers are reduced.

2. **Clarify goals and measures for success:**
   A. What life history form of bull trout will benefit?
   The primary life history form to benefit would be the adfluvial one, which is what was historically so well-represented in the interconnected Flathead system. Classic resident and fluvial forms have not been clearly identified in Flathead Lake, probably because it is too lethal for them to persist there due to predation by lake trout. We hope that by decreasing predation by lake trout on bull trout in Flathead Lake, more bull trout would survive such that resident and fluvial forms could develop in the future.
   B. What is the expected response of bull trout? Is the habitat available to support the expected response?
   We would expect bull trout abundance to increase once predation on bull trout has decreased.

We used Flathead Lake data from a period when lake trout numbers were substantially lower than they are currently to predict that with less predation on bull trout than occurs currently, bull trout abundance would increase. Estimates of potential bull trout increases are contained in Appendix 6. The currently available habitat supported more than 50% more bull trout in the 1980's than it does today, indicating that habitat is available and not currently limiting.

C. What is the spatial scale being considered? Is this project site-specific or does it relate to a larger area?
Predation in Flathead Lake is the bottleneck to bull trout recovery in the North and Middle Forks of the Flathead and their tributaries.

D. Is this a suppression or removal effort? If it is suppression, what are the long-term commitments?
This project is a suppression effort, designed to reduce an extremely large and well-established lake trout population, but not eliminate it. Suppression is chosen because elimination is neither feasible nor desirable due to factors of cost, social acceptance, recreational opportunity, and practicality. The CSKT have a 12-year record of investment in the current suppression program and are committed to sustaining the program indefinitely and with multiple funding sources.

E. What will be the measure of success or failure?
We would measure success as defined in the Flathead Lake and River Fisheries Co-Management Plan, by whether native fish increase or establish an upward trend in abundance. We are not setting a specific numeric goal, but we believe our efforts would be consistent with numeric goals set in the draft recovery plan. The CSKT approach to success includes balancing the trade-offs (that is, maintaining lake trout fishing opportunity while increasing bull trout numbers), which is more of an interactive process rather than a set of numeric goals. Additional problems with numeric goals are that small increases in rare species are difficult to measure, and there would be a lag time between implementation and native species' response. Also, bull trout redd counts are variable from year-to-year, making it difficult to correlate increases with specific actions.

3. **Evaluate how the removal or suppression fits into the recovery program:**
   A. How does this project fit into the genetic plan for the drainage?
   There are no direct objectives related to genetics in this program, although the program has the potential to indirectly improve the genetic integrity of subpopulations within the metapopulation. The subpopulations that are currently at precariously low levels may have the largest potential to benefit from reductions in numbers of lake trout.

   B. Is a recovery plan in place? How does this project factor into that plan?
   A final recovery plan has not been adopted, but a draft recovery plan was crafted during 2002. Our proposal would implement measures identified as priorities in the draft recovery plan. IV.

4. **Planning the effort:**
   A. Have possible problems been anticipated? Have contingencies for accidents been explored?
   The proposals being considered are not likely to result in accidents. The proposals would be

labor-intensive and long-term, yet can be stopped at any time. A detailed monitoring plan and adaptive management plan have been prepared so that adjustments may be made if deemed necessary.

B. Are there resources available for long-term implementation and monitoring?
The Tribes are committed to the protection and preservation of native fish. This commitment is evident in the Flathead Lake and River Fisheries Co-Management Plan, the Flathead Subbasin Plan, and other guiding documents. The Tribes have been conducting a program to reduce lake trout numbers in Flathead Lake since 2000 and recognize that the program to suppress lake trout in Flathead Lake is necessary to protect native fish and would only succeed with continued and consistent effort. The Tribes have long-term funding commitments for Kerr Dam Mitigation through the Bonneville Power Administration and others to sustain this program indefinitely.

C. What is the potential for reinvasion or compensatory population response by the target species and how will this be addressed?
Reinvasion is not an issue in this project because the intent of the project does not include the total removal of lake trout. The intent is to reduce lake trout numbers sufficiently to cause an increase in native fish. We do recognize that when we reduce lake trout numbers from current levels, we would likely cause a compensatory response in lake trout because the current lake trout population is near carrying capacity. (Evidence for this is the measured reduced growth rate, reduced condition, and delayed age at maturity in the lake trout population in Flathead Lake, compared to other lake populations.) Reductions in the size of the lake trout population resulting from this project would increase the amount of resources available to each remaining lake trout, causing compensatory adjustments in growth, condition and age at maturity. Each alternative addresses this situation by scheduling future harvest targets to meet these changes.

D. What non-target fauna exist and what are the expected impacts to them?
The non-target fauna likely to be affected by this action are other fish species, aquatic invertebrates, and possibly water birds. Fish and aquatic invertebrates are likely to increase if lake trout numbers are decreased. The primary potential impacts are from bycatch, resulting from the various methods employed to harvest lake trout. Estimates of bycatch are provided for each alternative.

E. How will fish disposal be handled?
Fish harvested in each alternative would be handled by CSKT. In general, each alternative is designed to harvest fish in a manner that generates fresh fish available for human consumption (that is, of sizes consistent with acceptable levels of mercury contamination). All fish would likely would be filleted, frozen, and distributed, so the project causes minimal waste and fully utilizes the harvested fish. Carcasses remaining after filleting would be composted and used in area gardens.

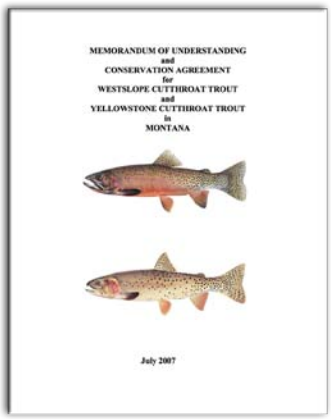
F. What might be the public response/support/opposition?
There were numerous strong and varied responses received during public scoping. There was very strong support for native fish protection. Although many respondents opposed the reduction of lake trout, their opposition was more focused on the method of reduction rather than the concept of reduction. For example, gillnetting received strong opposition, while bounties were endorsed.

G. What kind of NEPA (National Environmental Policy Act) or MEPA (Montana Environmental Protection Act) document is necessary?
This document is an Environmental Impact Statement prepared under the direction of the National Environmental Policy Act.

H. Is there potential for offsite mortality? How will it be taken care of?
There is no potential for off-site mortality. There is, however, potential for on-site mortality from bycatch, which is quantified by each alternative.

I. Is the body of water a source for domestic or livestock uses? Have all adjacent landowners been contacted?
Flathead Lake is a source for domestic and livestock use. Interested parties have been contacted and encouraged to participate in scoping and commenting on the project.

J. Have all necessary permits been obtained?
Permits would be obtained before any work could begin. We anticipate needing an Incidental Take permit issued by the US Fish and Wildlife Service as part of Endangered Species Act compliance, and a Cultural Clearance issued by the Tribal Preservation Office, as part of compliance with Historic Preservation laws.


MEMORANDUM OF UNDERSTANDING
and
CONSERVATION AGREEMENT
for
WESTSLOPE CUTTHROAT TROUT
and
YELLOWSTONE CUTTHROAT TROUT
in
MONTANA

July 2007

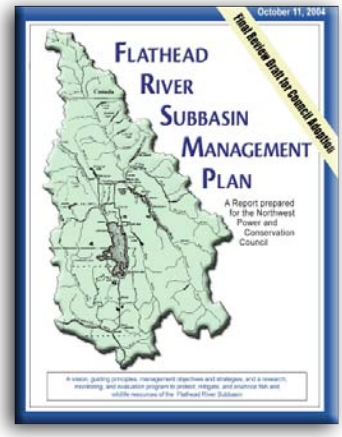
Cutthroat Memorandum of Understanding and Conservation Agreement (2007)

This Memorandum of Understanding and Conservation Agreement was developed to expedite implementation of conservation measures for westslope cutthroat trout and Yellowstone cutthroat trout throughout their respective historical ranges in Montana. It was a collaborative and cooperative effort among resource agencies, conservation and industry organizations, tribes, resource users, and private landowners and was signed by MFWP Director and CSKT Tribal Chairman, among others. Copies are available at: http://fwp.mt.gov/fwpDoc.html?id=28662.

The following objective from this agreement is relevant to this project (our response is in italics):

Objective 1. Maintain, secure, and/or enhance all cutthroat trout populations designated as conservation populations, especially the genetically pure components. Securing and enhancing populations will most frequently involve either limiting or removing nonnative species ...

Populations that move in and out of Flathead Lake are considered conservation populations.



Flathead Subbasin Plan: Part III, Flathead River Subbasin Management Plan (2004)

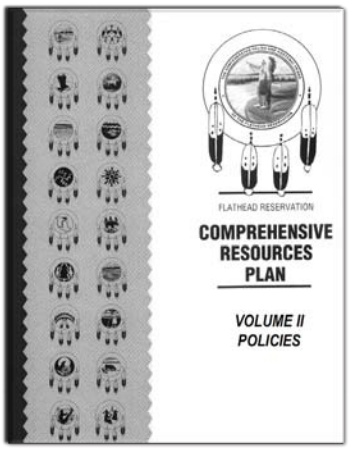
This management plan is Part III of the Flathead River Subbasin Plan. Considered the heart of the Subbasin Plan, it describes a vision for the subbasin and lists a series of objectives and strategies designed to address the limiting factors identified in the Assessment. The overall goal of Management Plan is to protect, mitigate, and enhance aquatic and terrestrial habitats, species assemblages, and ecological functions in the Flathead Subbasin over the next 10 to 15 years. It was prepared by Lead Agency CSKT and Co-Lead Agency MFWP. The document is available at: http://www.nwcouncil.org/fw/subbasin-planning/flathead/plan/

The following measurable actions from this plan are relevant to this project (our response is in italics):

- **Bull Trout: Prevent further expansion, suppress, and where possible, eradicate nonnative species in the regulated main-stem, reservoirs, and all streams and lakes ranked as high and/or moderate risk in the Qualitative Habitat Assessment spreadsheet model."**

- **Westslope Cutthroat Trout: Prevent further expansion, suppress, and where possible, eradicate species that hybridize, prey upon, or compete with native species.**

  The above criteria includes Flathead Lake as an appropriate area to implement these types of actions for both species.



CSKT Comprehensive Resources Plan Volumes I and II (1994 revised 1996)

The purpose of this plan is to guide natural resource management and development on the Flathead Indian Reservation. Volume I presents a profile and assessment of the condition of natural resources on the Reservation. Volume II identifies Tribal goals for each natural resource and explores a series of integrated alternatives for management. Finally it defines policies and processes that will guide future resource management on the Reservation. The plan focuses on lands and resources, but also incorporates social services and human concerns. The document is available at: http://www.cskt.org/tld/docs/compplanvolume2.pdf

The following elements of this plan are relevant to this project:

- **Foster and maintain wild, self-sustaining fish populations to meet cultural, subsistence and recreational needs.**

- **Preserve, protect, and enhance populations of native fish species. Species of special concern such as bull trout and westslope cutthroat trout shall receive top priority for protection activities.**

- **Establish and maintain wildlife protection areas, habitat enhancement programs, and programs that ensure the protection and recovery of threatened, endangered and sensitive species**

- **Develop and implement management actions to enhance existing bull trout populations both on and off the Reservation.**

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Appendix 2

Relationship to Laws and Other Documents

Introduction

The following laws and regulations and NEPA or MEPA documents Influence the actions proposed in this EIS:

- **Endangered Species Act (ESA) Compliance and Consultation with the U. S. Fish and Wildlife Service (USFWS)**
  During planning, USFWS staff on the Interdisciplinary team (IDT) will suggest design features and mitigation measures to minimize negative effects on listed species. The Tribes and IDT staff will draft effects on fish and wildlife species. The USFWS will review the project through the consultation or recovery permit process (W. Fredenberg, personal communication, 28 Feb 2012).The USFWS review would need to be completed, and the USFWS would need to issue a favorable decision, including appropriate management conditions, before any work could be implemented.

- **Clean Water Act**
  The Tribes will contact the Army Corps of Engineers to determine if a 404 permit would be needed. Because no dredging and filling will occur, it is likely that a 404 permit would not be needed. The Tribal Water Quality Regulatory Specialist would review the proposal and determine if a 401 certification for water quality would be needed. If no 404 permit is needed, the Regulatory Specialist may still propose design features and mitigation measures to minimize effects to water quality as part of the NEPA review process.

- **Tribal Regulations**
  The Tribal Fisheries Program will contact the Tribes' Shoreline Protection Office (SPO) to determine if a Shoreline application should be submitted in compliance with the Shoreline Protection Ordinance (SPO, 64A) and the Aquatic Lands Conservation Ordinance (ALCO, 87A). Because there is no disturbance to the bed and banks of the lake or streams, no permits will be needed.

  On the Flathead Reservation, the Tribal Preservation Office (TPO), as opposed to the State (SHPO), reviews ground-disturbing proposals for effects on cultural and historic properties as required by the Cultural Resource Protection Ordinance (95).

  The Tribal Wetlands staff will review the proposal for compliance with the Tribal Wetlands Conservation Plan (CSKT 2000).

- **Other NEPA or MEPA documents of connected, similar, or cumulative actions, that influence the scope of the current proposal include:**

  - USDI, National Park Service, Glacier National Park, Montana. 2009. Environmental Assessment on the Large-Scale Removal of Lake Trout in Quartz Lake, Finding of No Significant Impact (FONSI) signed 3 August 2009.

  - Montana Department of Fish, Wildlife, and Parks. Environmental Assessment and Decision Notice for an Experimental Removal of Lake Trout in Swan Lake, Montana. Signed August 3, 2009 Swan Lake.

  - Lake Pend Oreille Project. This research project investigates lake trout population control using various techniques, including gillnetting. See the Idaho Department of Fish and Game website at: https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/Forms/Show%20All%20Reports.aspx. NEPA compliance was through the Bonneville Power Administration's (BPA) Fish and Wildlife Implementation Plan (FWIP) and its Environmental Impact Statement and Record of Decision. To download their document, see their website at: http://efw.bpa.gov/environmental_services/Document_Library/Implementation_Plan/. References to the Lake Pend Oreille projects are in Volume 3, page 35/167.

  - Yellowstone National Park. Similar lake trout removal projects are on-going, and an EA for their Native Fish Conservation Plan was recently finalized. See http://parkplanning.nps.gov/yell

  - South Fork Flathead Watershed, Westslope Cutthroat Trout Conservation Program, Environmental Impact Statement and Record of Decision, prepared by BPA, MFWP, and USFS. This is a piscicide project to remove nonnative trout species to improve conditions for native westslope cutthroat trout. See the MFWP web site at: http://fwp.mt.gov/regions/r1/wctproject/

  - CSKT piscicide proposal. This project to remove invasive brook trout to protect native and genetically pure westslope cutthroat trout is proposed for Skidoo Creek. Native fishes

would be live trapped and removed, and then the stream treated with a piscicide to kill the nonnative fish. A barrier occurs in the stream, which would serve to keep nonnative species from re-occupying treated areas. The project is not yet scoped.

- CSKT Salish Point Park, Phase I, Environmental Assessment Checklist, signed 17 Feb 2004. Included boat ramp and dock facilities to increase Flathead Lake fishing access for lake trout.

- CSKT Salish Point Project Phase II Environmental Assessment, Finding signed 9 Aug 2004.

- CSKT Proposed Blue Bay Beach Restoration—Phase I and II, Flathead Indian Reservation, Checklist Environmental Assessment signed 15 April 2009.

- CSKT Dayton Creek perched culvert removal, covered in the BPA—FWIP, Sept 2008. Project is off-reservation.

- Skidoo Creek improvement project, covered in the BPA—FWIP. Dec 2007

- USFWS, 24 October 2000, Biological Opinion for the Biological Assessment for the Federal Energy Regulatory Commission (FERC) orders regulating the Kerr Dam (FERC No. 5-021) hydroelectric project. CSKT provides data to FWS with annual reports of incidental catch of bull trout for projects including Mack Days.

- Final Environmental Impact Statement for Proposed Modifications for the Kerr Hydroelectric Project, Montana, Federal Energy Regulatory Commission—FERC Project No. 5-021, July 1996.

- CSKT — Kerr Dam Settlement, Article 67 of the FERC's 25 June 1997 Order as amended, approving the mitigation and management plan for the Kerr Hydro Power Project (No. 5).

- CSKT — Atlantic Richfield Company (ARCO) Consent Decree signed 19 November 1998, which requires the Tribes to restore wetlands, riparian areas, and bull trout.

- CSKT — Fish and Wildlife Habitat Implementation Strategy (FWIS), 25 Sept 2000.

- CSKT — Habitat Acquisition and Restoration Plan (HARP), 25 Sept 2000.

- Bonneville Power Administration (BPA), Hungry Horse Dam mitigation, Fish and Wildlife Implementation Plan (FWIP), Record of Decision signed October 2003. See the web site at: http://efw.bpa.gov/environmental_services/Document_Library/Implementation_Plan

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Appendix 3

Scoping Comments and Responses

Introduction

This appendix contains the public comments received before and during scoping for the Environmental Assessment and the EIS. They are organized by topic and include comments that fall within the scope of our Purpose and Need Statement and that are focused on the effects of the proposed action. We used these comments to develop the Relevant Issues in Chapter 1 of the DEIS.

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Process-Related Comments

EIS

Kalispell —13 April 2010 (written) K-9-12. Please address these issues in an EIS! Define your goals to what native fishermen want to fish for in Flathead Lake not to what level to reduce Lake trout. Start over plan. It is time for a new co-management plan with an EIS!!!

Kalispell —13 April 2010 (verbal) Km-1. Don't you have to do an EIS?

Response
The analysis of the proposed action began as an Environmental Assessment (EA), during which time we held a series of scoping meetings. Based on the level of public interest surrounding the proposed action, we decided in February 2012 to prepare an Environmental Impact Statement (EIS). (Under such circumstances, a federal agency may choose to prepare an EIS without having first completed an EA.) The increased level of analysis required to move from an Environmental Assessment to an Environmental Impact Statement does not nullify the scoping conducted as part of the EA process. Indeed, according the Council on Environmental Quality the "…scoping process [can] be used in connection with preparation of an environmental assessment, i.e., before both the decision to proceed with an EIS and publication of a notice of intent…" (http://ceq.hss.doe.gov/nepa/regs/40/40p3.htm).

Public Involvement

(We received the following comments prior to when we opened scoping.)
E-mail E-21-3. Will the public get any more opportunity to be involved in the increased level of netting under the current plan? Secondly, when will the public involvement process begin for the next ten year plan?

E-mail E-21-4. I observed that the overwhelming number of people the other night would like to know if their opinion is going to be considered now on this issue; or are they going to have to wait for a new EA/EIS process for the next ten-year plan? Thanks in advance for your comments, Jon A Dahlberg.

Response
The public will have ample opportunity for comment and provide input when a new Co-Management Plan is prepared. The current proposal seeks to implement provisions of the current Co-Management Plan that have not yet been fully implemented, and the NEPA process provides substantial opportunities for meaningful public participation; we intend to read and respond in a meaningful way to all relevant comments.

Transparency

(We received the following comments prior to when we opened scoping.)
Letter L-3-3. NEPA requires full disclosure and transparency.

Letter L-3-4. All Public comments should be available on-line or hard copy.

Letter L-3-5. ID Team minutes should be available on line or hard copy.

Response
All of the relevant public comments we received are contained in this document. They are organized by topic, and each topic has a corresponding response. We have used the comments that are within the scope of our Purpose and Need and that are focused on the effects of the proposed action to develop the Relevant Issues in the Draft Environmental Impact Statement (DEIS).

Interdisciplinary Team (IDT) meetings are considered in-house management meetings and not public meetings. Because they are "intergovernmental exchanges" their release to the public could have a chilling effect on intergovernmental coordination and jeopardize the success of the cooperating-agency concept. Therefore the minutes will not be made available to the public.

Co-Management

E-mail E-59-5. The project should also be cooperatively managed and agreed upon by MFWP.

Response
MFWP has been invited by the CSKT to be a co-operator in both the DEIS and the proposed action. Their choice to not participate does not preclude us from following our guidance documents (Appendix 1) and proposing and implementing appropriate management actions, consistent with federal and tribal laws and policies.

Meetings

E-mail E-20. Who are you trying to buffalo with this meeting??? I want your best guess on how many people from the Flathead Valley can attend this meeting in Missoula on a Wednesday at 10 am??? I would venture to guess you will have the charter owners only. I know my boss will not let me leave to go...if you are after a truthful and honest public opinion then make it so everybody is able to give one!!! Leave the fishery alone.....

Response
The meeting to which the commentor is referring was a regularly-scheduled meeting of the Flathead Lake Fish and Wildlife Advisory Board. Board meetings occur, in accordance with the bylaws, every quarter. The location rotates between Missoula, Polson, and Kalispell consistent with the bylaws.

Trust, Listening

E-mail E-1-2. During the meeting, if it isn't too much trouble, you might consider having someone writing down or typing into the record the questions and comments that individuals, and organizations, pass along. I happened to overhear Mr. Zimmer say to someone as he left the meeting something to the effect of "the powers that be don't listen."

E-mail E-1-3. There is I believe, an unfortunate tendency for some folks to seek to create mistrust where it shouldn't exist. If there was someone from the CSKT making note of input at the meetings I think it would go a long way toward slowing statements like Mr. Zimmer's, and would show those in attendance that you have been extremely patient and open to input from the public throughout this process.

Response
We recorded comments during the meetings, and they are included here. The notetaker was in the back of the room. We wanted to encourage attendees to meet in small groups after the presentation so that we could better capture public comments. With the large numbers of people attending our meetings, we felt it was more fair to the average person to break into small groups and record comments at that time, rather than risk having the meeting dominated by a few of the most vocal attendees.

Kalispell —13 April 2010 (verbal) Km-3. You are not taking into account our feelings, but just making a project just for yourself.

E-mail E-57-6. The majority opinion does not seem to matter. Only 3 or 4 people who attended the public forum favored the idea of eradicating lake trout, but the idea was being pushed even after it was stated that the population of bull trout was stable. Verdell Jackson, Senate District 5.

Response
First, we are not attempting to eradicate lake trout. Our goal is to restore a greater balance to the Flathead Lake fishery in order to improve the long-term viability of native adfluvial fish. That means a reduced role for lake trout, but they would still be an important part of the fishery. Second, our DEIS has been very much shaped by the public scoping comments we have received. Indeed, the NEPA process was designed, in part, as a tool for incorporating public comments into planning and decision-making. The NEPA process does not, however, operate by majority rule or voting.

Scope

E-mail E-66-3. The process should ensure that options considered will make a real quantifiable difference for native trout. Has this been tried before and has it worked? What are the potential undesirable effects such as bycatch? The pilot project should be designed to result (1) in measureable and effective positive impacts for bull trout recovery and (2) in correlated and measurable effective reduction of lake trout. The pilot project should be consistent with and focused on what is needed to achieve goals set in the co-management plan. The status quo of bull trout in the Flathead Basin is not good enough; we need to know what is needed to support bull trout recovery in the Flathead system. The pilot project should be based on the best available fisheries science. The pilot should occur over a period of time long enough to ensure that monitoring can show conclusively whether or not efforts are being effective. There are also a number of socio-economic factors that we believe need to be addressed in the development and analysis of alternatives:

- What will be the direct and indirect effects on recreational fishing, both positive and negative?
- What will be the expected economic effects of any adverse or positive impacts on recreational fishing?
- How will netted fish be effectively utilized?
- What are the anticipated costs? What funds will be available to cover the costs? For how long?

Response
All of the issues you have raised are addressed in Chapter 3 of the DEIS.

Goals and Objectives

Letter L-8-4. As I am not very familiar with the Flathead Lake fishery I don't have any suggestions on how you should meet your goals. Perhaps when you update the Management Plan you should re-evaluate and possibly set different goals if the current ones are unobtainable or unsustainable. Lee Griswold

Letter L-5-3. Develop new management objectives for Flathead Lake fishery and spend current funding on those new objectives.

Letter L-5-6. Again, I respect your efforts on this noble goal. You fought the good fight, but it is now time to recognize the realities of the situation and adopt new management objectives for fisheries in Flathead Lake. Sincerely, Bruce W. Jeske, Missoula, MT

E-mail E-32-7. In reality this entire process needs to start with a reexamination of the goals in the Co-Management Plan NOT an EA to reduce lake trout numbers with no evidence that any reduction will result in an increased bull trout population.

E-mail E-71-3. Commit to a sustained period of lake trout removal until there are measurable improvements in bull trout and westslope cutthroat numbers

Response
The Co-Management Plan is one of our (the Tribes') guidance documents for managing fisheries on Flathead Lake. We believe it is possible to improve conditions for native trout species while maintaining fishing opportunities for lake trout. We are bound by Federal laws and Tribal policies to fulfill these obligations. In addition, the provisions of the current Co-Management Plan have not been fully implemented. The Co-Management Plan identifies fish population management actions in Strategy 5 as follows: (A) Suppress Nonnative Fish Through Recreational Angling; (B) Increase Suppression of Nonnative Fish if Necessary Through Commercial Harvest Techniques; and (C) Implement Agency Management Action if Necessary to Reduce Nonnative Fish. Because moving beyond strategy 5A was controversial at the time, the plan makes a commitment to public scoping should it be necessary to achieve the plan's goals. The DEIS fulfills that specific need and commitment. In addition to this basic need, this document affords decision makers the information they need to proceed.

As a matter of clarification, there was no NEPA-document prepared for the Co-Management Plan in 2000. While public meetings were held, no analysis or decision document was prepared that complied with NEPA guidance (40 CFR § 1500-1508). When implementing the Co-Management Plan, the Tribes have prepared NEPA documents for tasks accomplished with Federal dollars. We do not have inclusive information on MEPA-compliance for the Montana Department of Fish, Wildlife, and Parks.

Parameters of the Proposed Action

E-mail E-27-1. Thank you for moving forward with the NEPA process to determine a preferred alternative for the Flathead Lake and River Fisheries Co-management Plan Pilot Project. Montana Trout Unlimited and its Flathead Valley Chapter support a preferred alternative that results in measurable recovery results for native bull trout and westslope cutthroat in the Flathead Basin, including Flathead Lake and the Middle and North Forks and their tributaries, as well as the main stem of the Flathead River. Selection of an alternative for the pilot project should meet these objectives:

- It should answer the question: What is the appropriate population level and population structure for lake trout in Flathead Lake in order to recover bull trout and westslope cutthroat trout to population levels and distributions mimicking those present during the 1980s?
- It should be based on the best science available.
- It should be clear about what actions and impacts are reversible and which are not reversible.
- It should be unequivocally embraced by both partners in the co-management plan.

Response
We agree that these points should be addressed in our proposal. The lake trout population levels and structures that would occur under each of the alternatives are discussed in Chapter 3 of the DEIS and in Appendix 6. Chapter 3 and Appendices 4, 5, 6, and 9 discuss the science used. Chapter 3 of the DEIS also discusses reversible and irreversible impacts. We have no control over what MFWP might embrace.

E-mail E-67-3. Some criteria that I suggest a pilot project incorporate are as follow:

- A pilot project should be designed to result in a quantifiable increase in bull trout redds in spawning tributaries of the North and Middle Forks of the Flathead River.
- A pilot project should be conducted over a long enough period of time to ensure that that bull trout redd counts and data for westslope cutthroat trout and lake trout numbers are conclusive and trends can be identified with a high degree of confidence.
- A pilot project should be designed so that reductions in lake trout numbers can be correlated with meaningful increases in bull trout and westslope cutthroat trout.
- A pilot project should be designed to provide fisheries managers with the data they need to make informed management decisions in the future.
- Regarding the EA, it should fully discuss both negative and positive recreational impacts.

E-mail E-69-3. Triggers. I think triggers should include an evaluation of impacts on bull trout and westslope populations, not merely lake trout population declines.

E-mail L-23-1. Give us hard, accurate reliable data on numbers of bull trout & lake trout. Keep us up-to-date on the data and the effect of decreasing lake trout numbers.

E-mail E-59-3. Response by native fish to lake trout reduction will likely take multiple generations to show; therefore the angler-oriented reduction effort should continue for more than a decade. It is possible that a response may all ready be occurring, but not yet detectable. It is also probable that a compensatory response to lake trout reduction will be an increase in Mysis, lake whitefish, and juvenile lake trout.

Kalispell —13 April 2010 (verbal)
Km-24. Will you analyze effects to cutthroat trout?

E-mail E-70-5. The project must continue for a long enough period of time to scientifically verify the amount of lake trout reduction as well as to verify a positive response by native fish populations. The project will require a term on at least 8-10 years in order to assure that we are seeing a positive long-term response by bull trout and cutthroat trout. This must be a long-term process and it will require long-term planning. It will not be easy for anglers or managers, but if we keep the goal of recovering native fish at the forefront, the end result can be accomplished. Thank you very much for your open efforts to find solutions that will aid in the recovery of our bull trout and cutthroat trout in the Flathead watershed. LaVerne Sultz

E-mail E-67-4. I recognize that using current technology, lake trout could not be eliminated from Flathead Lake even if that were the goal of the co-management plan, and clearly it isn't. Therefore, once lake trout numbers are suppressed to the point that there is a meaningful recovery of bull trout and westslope cutthroat trout (I define meaningful recovery as populations recovered to pre-mysis shrimp/lake trout explosion levels), that this "magic" suppression level will need to be maintained. I foresee recreational angling for lake trout to continue to be

an important tool to maintain an effective lake trout suppression level and that harvesting lake trout for these purposes will remain a catch-and-keep fishing opportunity for decades to come.

Kalispell —13 April 2010 (written) K-5-2. The pilot program needs to set a standard that will warn of pending problems to avoid a repeat of past failures.

Kalispell —13 April 2010 (written) K-5-3. Continue research into collateral issues such as drought and other environmental factors to clarity to what extent other influences are playing a role.

E-mail E-21-2. (We received this comment prior to the opeing of scoping.) During the meeting there were quite a few questions about the amount of netting to occur, and would the public have an opportunity to be involved in the EA/EIS process. You both indicated that they have been and would indeed be included in the upcoming process. I am trying to get more clarification on the timing of this issue. Which upcoming process? One process I see is the stepped-up netting under the current environmental assessment and the other is a new environmental review for the next ten-year plan.

Response
All of the issues raised in these comments are addressed in Chapter 3 of the DEIS. We agree that the proposal needs to be implemented long enough to see results. That is why potential alternatives would be implemented indefinitely into the future, with monitoring and adaptive management provisions consistent with the alternative selected.

Kalispell —13 April 2010 (verbal) Km-12. Are you following the Swan Lake Results?

Missoula —14 April 2010 (verbal) Mm-1. Are you looking at Pend Oreille's plan? Lake Pend Oreille is dead and lake trout are gone. There are no fish left.

Response
We are including information from all similar projects, including Swan Lake, Quartz Lake, and Lake Pend Oreille. Preliminary indications are that bull trout have responded favorably to removing lake trout in those places.

Flathead Lake and Fisheries Co-Management Plan

E-mail E-27-12. 12. We support an extension of the current Flathead Lake and River Fisheries Co-management Plan for the duration of the pilot project.

E-mail E-64-1. Thank you for the opportunity to comment on the proposed action for the Flathead Lake and River Co-management plan. Although this is just a continuation of the work that has been ongoing for the last 10 years with the management plan, it is good to clarify the direction the plan will be going in the immediate future. The plan has been moving at a controlled pace that has limited the results of the plan. The plan has not met any of the goals set forth in the original plan and there has not been an increase in the native fish or a decline in the lake trout populations. If not for the information gathered from the work done each year, the plan is a complete failure as there is not an improvement in the native fish populations.

E-mail E-66-2. We understand that the pilot project now being proposed will be a cooperative venture of the CSKT and MFWP aimed at qualifying and quantifying the effort that might be needed to achieve objectives in the Co-Management Plan or perhaps assess the practicality of achieving those objectives. It is also our understanding that the pilot project is to be somewhat exploratory and is not necessarily intended to create and put a seal of approval on the alternative to be used for future management of the Flathead fishery, but rather to achieve specific levels of lake trout reductions, in a specific period of time, so as to facilitate future management decisions with the best available science. We understand that efforts to achieve lake trout reduction objectives with recreational angling as the primary tool have not been adequate to meet the Plan objectives and that the pilot project, to be considered and developed, will involve use of new tools, possibly including netting and/or trapping of lake trout in Flathead Lake in numbers that can then be correlated with measureable improvements in the population of native trout species. That said, here are a number of issues and topics that we believe need to be thoroughly addressed in the ongoing analysis and alternatives to be developed:

- The process should ensure that options considered will make a real quantifiable difference for native trout. Has this been tried before and has it worked? What are the potential undesirable effects such as bycatch?
- The pilot project should be designed to result (1) in measureable and effective positive impacts for bull trout recovery and (2) in correlated and measurable effective reduction of lake trout.
- The pilot project should be consistent with and focused on what is needed to achieve goals set in the co-management plan.
- The status quo of bull trout in the Flathead Basin is not good enough; we need to know what is needed to support bull trout recovery in the Flathead system.
- The pilot project should be based on the best available fisheries science.
- The pilot should occur over a period of time long enough to ensure that monitoring can show conclusively whether or not efforts are being effective.
- There are also a number of socio-economic factors that we believe need to be addressed in the development and analysis of alternatives:
    - What will be the direct and indirect effects on recreational fishing, both positive and negative?
    - What will be the expected economic effects of any adverse or positive impacts on recreational fishing?
    - How will netted fish be effectively utilized?
    - What are the anticipated costs? What funds will be available to cover the costs? For how long?

E-mail E-71-7. I believe that these actions are consistent with the goals of the original Co-management plan which were to:

- Increase and protect native trout populations (bull trout and westslope cutthroat trout)
- Balance tradeoffs between native species conservation and non-native species reduction to maintain a viable recreational/subsistence fishery.
- Protect the high quality water and habitat characteristics of Flathead Lake and its watershed.

E-mail E-79-1. Our chapter, along with Montana TU, supports of your efforts and will look forward to helping to move the pilot project forward to recover native bull trout and westslope cutthroat in any way possible. Sincerely, Chris. Chris Schustrom, President, Flathead Valley Trout Unlimited.

E-mail E-33-4. The Draft Recovery Plan for the Flathead Recovery Unit set a goal to reduce the negative effects of nonnative fishes and other nonnative taxa on bull trout. Angling through contests has not been adequate and instead has created a constituency for lake trout due to the high monetary incentives. Over the past 15 years lake trout have further invaded lakes in Glacier Park and are now found in Swan, Lindbergh and possibly Holland Lakes. Action is needed to suppress lake trout in Flathead Lake through more than recreational angling.

E-mail E-33-8. We realize that total removal of lake trout from Flathead Lake is probably not feasible, therefore angling for lake trout will still exist but at lower levels. Suppressing lake trout populations by commercial netting and/or other methods should be attempted. The Bull Trout Scientific Group in 1996 authored the Assessment of Methods for Removal or Suppression of Introduced Fish to Aid in Bull Trout Recovery. This paper contained a checklist for removal or suppression that could be useful in evaluating the pilot project. The Executive Summary and Checklist are appended to these comments.

Kalispell —13 April 2010 (verbal) Km-2. You need to update the whole plan and not do this pilot now.

Polson —12 April 2010 (verbal) Pm-2. How do we change the objectives.

Kalispell —13 April 2010 (verbal) Km-4. Why isn't the question—is there enough lake trout?

Response

A goal of the Flathead Lake and Fisheries Co-Management Plan is to increase and protect native trout populations (bull trout and westslope cutthroat trout) while balancing trade-offs between native species conservation and nonnative species reduction to maintain a viable recreational/subsistence fishery. The Co-Management plan has yet been fully implemented. Current and projected trends reveal that lake trout populations have not decreased and bull trout populations have not increased during the 10-year plan period (Co-Management Plan Mid-term Review 2006). The Co-Management Plan needs to be fully implemented before we can asses if the methods and strategies it identifies can be successful and before we can determine how to proceed with management in the future.

We have included the Bull Trout Scientific Group Assessment Methods checklist as Attachment A and corresponding answers to the questions posed in that checklist in Appendix 11.

Results from implementation of the proposed action (implementation of measures identified in the Co-Management Plan) will shape our management in the future and at some point will help us draft a new plan. The objectives of the current Co-Management Plan will remain in place until the current plan has been fully implemented.

With one of the highest lake trout populations recorded for a lake of this size, there are more than enough lake trout to sustain recreational fishing.

Alternatives

Goals

E-mail E-32-1. I attended the Polson public meeting. While it was stated repeatedly that the meetings were the first step in the process, it is obvious that some type of action and some type of plan is already being considered. Several preset conditions already exist: no hatchery involvement, no new introductions, statements by several CSKT personnel made it clear that the goals in the Co-Management plan would not be altered. While it was often stated that the goal was to increase the number of bull trout in Flathead Lake; no goals were discussed. So is a 1% increase acceptable? Or are we talking about a 100% increase?

E-mail E-32-2. At the Kalispell meeting Tom McDonald said he would like to return to the conditions of the 1960's, where anglers were allowed to keep one lake trout and one bull trout. Given the ecological changes that have taken place in the lake since the 60s such a goal is neither realistic or attainable.

E-mail E-32-3. During the technical presentation I did not hear any scientific method to determine how many lake trout needed to be removed and for how long to result in an increase of bull trout. Nor did I hear any evidence that any decrease in lake trout would not be replaced by more lake trout, whitefish or perch. Specific, realistic goals need to be presented in the EA.

E-mail E-32-4. The CSKT pilot project projected lake trout reduction levels through 2012, but it is obvious that reductions would need to be carried on for much longer if there is to be any increase in bull trout. Specific reduction numbers and time frames need to be fully disclosed in the EA.

Response

The goals of each alternative are described in Chapter 2 of the DEIS. Chapter 2 also contains information on specific targets and time frames. Scientific methods used to determine lake trout reduction goals are described in Appendix 4: Trophic Interactions, Appendix 5: Harvest Methods, Appendix 6: lake trout Population Dynamics, and Appendix 9: Estimation of lake trout Abundance. The lake trout and bull trout sections of Chapter 3 of the DEIS also includes information on this topic.

No Action Alternative

Kalispell —13 April 2010 (written) K-9-7. Please display a no action alternative to manage for 440,000 lake trout! And keep the bull trout numbers where they are currently at!

E-mail E-32-6. Any EA requires an "No Action" alternative. In any EA regarding the reduction of lake trout in Flathead Lake this alternative needs to be fully developed with respect not only to bull trout populations but also impacts to the recreational fishery and local economies.

Response
The NEPA process requires that we include a "No Action Alternative", which means an alternative that maintains current management. Alternative A in the DEIS is the No Action Alternative. Our analysis of all the alternatives, including the No Action, includes effects on fish populations and invertebrates, fishing opportunities, and the economy. Appendix 7 includes a description of an alternative considered and dropped from the EIS that proposed a completely hands-off management approach.

Action Alternatives

Missoula—14 April 2010 (verbal) M-4-3. Consider multiple methods (for reducing lake trout numbers).

Missoula—14 April 2010 (verbal) M-4-4. Thanks for proposing to move beyond the status quo which certainly isn't working.

Letter L-23-5. Explore options to increase bull trout and cutthroat numbers through other means. At least tell us if any other options are available.

Response
The alternatives in Chapter 2 of the DEIS include multiple methods to reduce lake trout populations to meet our targets. They represent a reasonable range for consideration by the decisionmaker.

How Long would the Project Need to Run?

Missoula—14 April 2010 (verbal) Mm-6. How long will you run a pilot to measure an increase in redds?

Missoula—14 April 2010 (verbal) Mm-7. Is there another measure (besides redds)?

Missoula—14 April 2010 (written) M-4-2. New project methods/efforts must be long enough and intense enough to show positive response (statistically reliable change) to bull trout numbers.

E-mail E-25-10. Maintain the suppression program for at least 5 years and up to 10 years, and closely monitor bull trout populations for 10 years. It will take 5-6 years to see any real impact of lake trout suppression actions on native fish numbers due to the migratory interval between juvenile bull trout leaving the lake and returning to spawn. We strongly urge the CSKT and MFWP to use an adaptive and flexible approach to manage trout populations in the lake over the next decade. And, for the most effective adaptive management strategy, it's critical to accurately and consistently measure the impacts of each management action on the lake's and rivers' fisheries to the best of both agencies' abilities.

Letter L-13-7. What will be the future—netting forever or is a fix plan out there. James R. Hoover, Whitefish, MT

Letter L-15-1. I attended the public meeting in Kalispell, MT, on April 13, 2010. Some questions that were not asked at the meeting pertain to how long of a pilot period is going to be conducted? 3 months, 6 months, or several years in the event of the continued coalition between the Salish Tribal and MFWP.

E-mail E-27-4. We support a pilot project that would last at least 10 years, to include the potential of measuring spawning from several bull trout year classes born during the suppression period. This approach is consistent with objectives stated in the State of Montana Bull Trout Restoration Plan signed by MFWP. It calls for evaluating three age-classes (15 years). A 10-year project will by necessity include years where suppression is the primary focus, and then years where monitoring the response in native fish populations are the focus.

E-mail E-28-4. These aggressive efforts also need to take place over a long enough period of time to be measured in the redds of bull trout spawning tributaries. This means that the pilot should take place for at least 5 years but likely up to 10 years before we can adequately begin to assess its success.

Response
The Interdisciplinary Team hopes to run the alternatives long enough to achieve measurable effects on fish populations. Based on results of our lake trout stochastic simulation model, we have decided to implement the action alternatives for an indefinite length of time while monitoring the results.

Gillnetting

Gillnetting—Duration, Locations, Impacts on Bull Trout

Kalispell —13 April 2010 (written) K-6-1. If netting is used, how often? Forever?

Kalispell —13 April 2010 (written) K-6-8. If the netting isn't working, how far will you take it?

Kalispell —13 April 2010 (written) K-6-3. What impact on large trophy fish?

Kalispell —13 April 2010 (written) K-6-4. How long for bull trout to recover, if ever?

Kalispell —13 April 2010 (verbal) Km-10. Did the govt. say the netting project is good?

Kalispell —13 April 2010 (verbal) Km-11. If you net and catch bull trout, would the relative proportions stay the same?

Kalispell —13 April 2010 (verbal) Km-13. If you start netting, how long would you see a delay in bull trout?

Kalispell —13 April 2010 (verbal) Km-14. Looking at Yellowstone and Pend O'rille, what is the limit, where is the end?

Missoula —14 April 2010 (verbal) Mm-10. What is the mortality on bull trout.

Missoula —14 April 2010 (verbal) Mm-11. If gillnets go in, will parts of the lake be closed?

Letter L-13-6. If netting takes place, will the whole lake be netted, even the north half?

Letter L-15-2. Where and how many beginning (pilot) areas are being planned for.

Letter L-15-3. (What is) the time the fish are going to be removed from the netting?

Responses
Regardless of which alternative is implemented, there will be a time lag before there is any kind of a response in the bull trout population. Effects to bull trout are discussed in Chapter 3 of the DEIS for both the short (<5 years) and long term (>50 years). Results from the monitoring of gillnetting at Swan Lake show beneficial effects within a few years of implementation (Rosenthal et al. 2012).

All of the action alternatives would run indefinitely into the future. It took decades for lake trout to build to their currently high population numbers; reversing that trend will be a long-term process.

Effects to trophy-sized lake trout are analyzed in the lake trout section of Chapter 3 of the DEIS.

Because gillnets and trapnets would be placed in areas that have many lake trout and few if any bull trout, the lake trout numbers would be reduced while bull trout numbers would increase because of the reduction in predation. The effects of the alternatives on bull trout are discussed in the Environmental Consequences section of Chapter 3 of the DEIS.

Gillnet locations would be marked, but we do not anticipate closing parts of the lake. While we have extensive information useful for determining target locations, depths, and seasons for gillnetting, we have not identified specifically where netting will occur. If nets are deployed, they would fish for one day at time. Bycatch mortality would exceed that from short-set gillnetting but is not a driving concern. Bycatch would be minimized by choice of depth and location.

Gillnetting—In Favor

Missoula —14 April 2010 (verbal) M-3-2. I would like to see the NEPA process consider more aggressive measures to reduce the lake trout population, including netting.

E-mail E-2-1. On behalf of American Rivers, thank you for inviting public comment on the proposal to begin gillnetting for nonnative lake trout in Flathead Lake. In the interest of protecting and restoring native salmonids in Flathead Lake and the upper Flathead River system, we strongly support the implementation of a gillnetting program that is designed to reduce the adult lake trout population to a point where bull trout and westslope cutthroat trout have a chance to rebound to 1980s levels. Our position is based on the best available science; federal laws and treaties; conservation agreements; international agreements; and a keen awareness of the importance of the Flathead Lake fishery to tribal and non-tribal fishers from Montana and across the nation. After carefully considering the best available science; existing laws and treaties (including the Endangered Species Act, National Park Service Organic Act, Wild and Scenic Rivers Act, and Hellgate Treaty of 1855); conservation agreements; and the recent agreement signed between Montana and British Columbia; American Rivers strongly urges the state of Montana and the Confederated Salish and Kootenai Tribes to launch an aggressive lake trout gillnetting program in Flathead Lake. This program should be carried out for a minimum of five consecutive years and have a goal of reducing the adult lake trout population in Flathead Lake by 20 to 50 percent. Such a program would give the native bull trout and westslope cutthroat trout populations a fighting chance to rebound to 1980s levels, while at the same time allow for the continued existence of a thriving recreational lake trout fishery.

E-mail E-5-2. I'd also like to see research into lake trout removal that include gill-netting and trapping, not just piecemeal fishing. We need all the help we can get if bull trout and cuts are to stand a chance here. You can't win a war with a pocket knife (unless maybe the enemy has only can openers, but that definitely ain't the case).

Letter L-1-1. I'm writing to enthusiastically support the Tribes' gillnetting plan. We need to give it an honest chance to succeed. Mack Days was given every opportunity to reduce lake trout numbers, but they've increased; even with thousands of dollars added.

Letter L-2-1. I wholeheartedly support the gillnetting proposed by the tribe. We're in our ninth year of the ten year plan and even with thousands of dollars added to the Mack Days event lake trout numbers have increased. The plan mandates netting. The first step to reduce lake trout, the Mack Days, has been a failure.

Letter L-6-4. Mack Days will not do the job to reduce numbers. We need to gillnet or find some other efficient way of exterminating lake trout.

Polson—12 April 2010 (written) P-1-5. Why can't we net lake trout here (like they did in YNP).

E-mail E-22-1. I think that preserving our native species in the Flathead system is very important for a variety of reasons. Everything in the ecosystem is connected in some manner or another and man-induced changes can have ramifications that may not become apparent for many years. At this time, I think that gillnetting is the best option for additional control of the lake trout. Attaining the exact numbers and fine tuning those numbers, appears to be best accomplished by gillnetting. Also, I have to believe that it is the most economically feasible approach. It also seems like the lake trout fisheries would benefit from a reduction in the numbers. Fish growing faster to the larger size classes would likely be stronger, healthier and better fighting fish. I would think that they'd also be tastier culinary fare. Serious fisherman should embrace these added benefits. Please don't let short-sighted options cloud the big picture. Thanks for listening to my input and good luck in achieving your goals. Fred Wallner

E-mail E-27-3. We support supplementing current angling measures with gillnetting, and trapping, if a method using the latter is deemed to be effective by the ID Team. Though we are dubious about the value of bounty programs, we urge the ID team to explore those options.

E-mail E-29-2. We need to produce better results by adding stronger methods such as netting, trapping, and bounties.

E-mail E-43-2. Please consider this message as my declaration of support for programs to reduce the numbers of lake trout from those waterways by means of gillnetting and trapping.

E-mail E-44-1. I very much appreciate the Tribes' efforts to control lake trout through fishing contests and regulations. I also appreciate the quality and quantity of research that you have conducted to support your plan. It is obvious at this point that angling contests and more liberal regulations are not going to be enough to reduce the lake trout population to a level that meets the goals of the co-management plan. So I applaud your willingness to bring in other strategies identified and approved in the co-management plan. Netting has been a successful tool used in other lakes with similar problems and should be tried here.

E-mail E-44-3. You have a good plan (the Co-Management plan), solid research, and a possible solution (netting) to the problem the plan hopes to address. The pilot project should move forward with all deliberate speed. Thank you for the opportunity to comment. David Rockwell, Dixon, MT

E-mail E-48-1. Please consider the most effective means of controlling lake trout numbers in Flathead Lake, including gillnetting. Sincerely, Alex Russell, Bozeman, MT

E-mail E-50-2. I support the environmental study that will use alternative actions such as gillnetting as a ways and means to reduce the ever-increasing number of lake trout within the lake. Efforts have been made in the last decade to curtail those numbers of lake trout to little or no avail. They multiply too quickly in the system and grow at an alarming rate due to their diet of native fish!

E-mail E-51-1. Hello - I want to weigh in re: whether to use gillnets to help reduce lake trout populations in Flathead Lake. YES - USE THEM.

I haven't been able to catch cutthroat or bull trout in Flathead since I was a child in the 1980s. TU uses a great program on Swan Lake - I hope that program is emulated on Flathead and you bring the lake trout population down to minimal levels by removing the lake trout with gillnets. This can be done in September when the bulls are spawning in the river.

E-mail E-52-2. It also seems clear that the only effective approach at hand is that of gillnetting and trapping the invasive lake trout. This method will work and will avoid the destruction of a native fishery that is invaluable to Montana and Montanans. Your leadership on this issue is paramount and timely. Thank you in advance, Jim Abel.

E-mail E-53-1. Gentlemen..I am writing in full support of controlling the lake trout population in Flathead Lake. Over the years, they have exploded in population, and have been a main reason for the decline in both the bull trout, and the cutthroat trout.. both native species. I feel there is a place for the lake trout, however because of their nature, they become the dominate fish in most lakes where they occur. The use of the gillnet in fisheries management is a most effective method of control, and the most efficient short of a total kill. Garry King, Denton, MT

E-mail E-54-5. How can anyone in good conscious support both a nonnative, predatory species AND the exclusionary/expensive option it forces upon our citizens? This is one of those rare cases where all political stripes should align to support THE STRONGEST POSSIBLE removal options for lake trout in this ecosystem.

E-mail E-55-2. Please consider this message as my declaration of support for programs to reduce the numbers of lake trout from those waterways by means of gillnetting and trapping.

E-mail E-56-1. I am writing regarding the proposed fisheries management plan for Flathead Lake. I support the plan to reduce or hopefully even eliminate non-native lake trout in the Flathead watershed. I believe that the proposed tools for lake trout population reduction, including liberal sport fishing bag limits, gillnetting, and trapping, will be effective and should be implemented. Thank you for considering my input. Best Regards, Scott Ziegenfuss, Hamilton, Montana.

Kalispell —13 April 2010 (written) K-1. Let's net for 2 to 3 years and see what happens to the bull trout redd counts.

E-mail E-33-9. The netting effort on Swan Lake should also provide more recent and valuable information about commercial netting. This includes appropriate net sizes, time of day to net, methods to reduce bycatch, etc.

E-mail E-42-2. I am hopeful that cutthroat and bull trout populations can recover to historic levels that existed prior to lake trout introduction. I believe that the proposed tools for lake trout population reduction, including liberal sport fishing bag limits, gillnetting, and trapping, will be effective and should be implemented.

Missoula —14 April 2010 (verbal) M-3-4. I grew up in the Jocko and have enjoyed first hand and lengthy experience with tribal fisheries

management. Since the Jocko River's dark days in the 1970s, the health of the river and its fishery has improved tremendously. The Tribes have a proven track record of excellence in their fisheries management. I am confident that the Tribes will bring this high level of excellence to this effort to reduce lake trout predation on bull trout.

Response
The potential harvest from gillnets is proportional to the quantity of nets deployed and the skill of the netting crew. Additionally, gillnets can target specific sizes of lake trout, and gillnetting can be more effective than other tools because the harvest can be pre-planned based on the established rate of capture from previous netting. If future catch rates are comparable to those measured during experimental netting, then approximately 6,500 feet of net would need to be deployed for every 1,000 lake trout captured. So the use of gillnets, while an emotionally charged issue, does make it possible to catch a substantial number of target fish over a short period of time. The Co-Management Plan identifies gillnetting as a management too to be used if necessary to reduce nonnative fish, and so we have included it in all of our action alternatives in the DEIS. We would mitigate negative effects on non-target species by targeting areas and depths of the lake used by lake trout but not by other species like bull trout or westslope cutthroat trout. Appendix 5 describes gillnetting in more detail and Chapter 3 of the DEIS discusses bycatch.

Gillnets—Opposed

E-Mail E-201.No gillnetting. Still no one knows what impact this COULD have on the lake. There has been no definitive count for the lake trout, how can we judge without knowing? Mack Days has been great for the area, and has made great progress. Bycatch of whitefish would ruin even more than just the lake's fishery. Bull trout have made a huge comeback already. If we truly want to remove the lake trout why do we have a slot fish ? (read the biology, they ARE prolific breaders, size matters). The Mysis shrimp were brought in to make the salmon fishery better ..... OOPS.....it contributed hugely to their demise. Lets NOT make mistakes until we know what WILL happen, not what might or should happen.

E-Mail E-204. I believe gillnetting will ruin this lake and will kill lots of other species, not just macinaw. Please continue the Mack Days tournament.

E-Mail E-205. I do not support gillnetting in Flathead Lake. Gillnetting is a very poor method of managment and has not been proven to help surpress numbers of Lake trout in Yellowstone or Swan. It also has a high bycatch rate. Flathead lake should be left alone. What about nonnative fish below Kerr Dam? You have to catch and release rainbows and browns their!!! We have a great lake trout fisherier in Flathead Lake, what will be able to fish for if they are knocked down to a low number? Northern Pike Minnow!! I think this is a money issue for the Tribe, I do not support it. Mack Days are working well keep using that to keep numbers of lake trout down.

E-Mail E-206. I have followed the controversy of Flathead Lake, attended your meetings and I fish on Flathead Lake whenever possible. I feel I am well informed of all of the issues and I am very much opposed to any netting of lake trout at this time. To do so will devastate a world

class fishery for no good reason whatsoever. Anyone who fishes on Flathead on a regular basis knows that the bull trout and cutthroat trout are recovering nicely with the current methods of lake trout control. Catch rates of native fish are way up from 7 to 10 years ago and get better every year. It makes no sense to me to take a drastic approach with unknown consequences at a time when things are improving under current management. Netting will devastate the local economy that relies on a viable Flathead Lake fishery and put people out of business. Please leave the current management controls in place and let things gradually improve as they are now. NO NETTING!

Letter L-19-1. I feel by netting the Mac's you would ruin the fishery we have here in the Flathead.

E-mail E-35-1. I would like to see it left alone. No nets. Thanks. Jon O. Bailey, Hub International

Missoula —14 April 2010 (verbal) M-1-2. No gillnetting (increase Mack days).

Missoula —14 April 2010 (verbal) M-2-1. Gillnetting No!!!!!!!

E-mail E-63-1. Please enter my comments as: netting the flathead could be a long-term mistake.

E-mail E-65-3. Please count me AGAINST the proposal to gillnet lake trout on Flathead Lake! Thank you, Bob Cole, Kalispell, MT

Kalispell —13 April 2010 (written) K-9-1. Numerous examples ie Yellowstone, Pend O'rille, & Priest have not shown positive results reducing lake trout & increasing cutthroat or bull trout. Why would FH (Flathead) be any different?

E-mail E-59-6. My comments reflect the lack of success of lake trout reduction in other large systems similar to Flathead Lake. None of the projects in place today (Pend Oreille, Yellowstone) to my knowledge have demonstrated long-term benefits to native fish. In light of this, I firmly believe we should allow a good recreational lake trout fishery to persist in Flathead Lake until new, proven methods are available.

E-mail E-24-6. (We received this comment before the scoping period opened.) Mechanical means of dealing with fish have a history of failure, usually totally, and are costly. Fish are not like livestock, and cannot be managed in the same way. Please consider more sound methods than gillnetting. Thank you for your consideration, Jerry Dwyer

E-mail E-24-2. (TWe received this comment before the scoping period opened.) As far as getting the lake trout out of the lake, that is simply impossible. Lowering their numbers will only help the ones that are left to grow faster and other introduced fish like Lake Whitefish and Yellow perch will increase.

Letter L-11-1. There is obviously no "silver bullet" to solve what you perceive as a problem with high Lake trout population (estimate). Probably the most time and money wasting effort will be to gillnet in order to remove excess lake trout.

Letter L-11-3. As for population control “show me the data that this in an effective method”. I worked with the USFWS in the mid to late 70’s netting suckers at Duck Lake to control that population. This did not work and was mainly an effort to appease the Blackfeet tribe in my opinion. What politics are coming into play in this current netting effort in Flathead Lake?

Letter L-17-1. I have been an avid angler on Flathead Lake for over 40 years. A lot of changes have taken place in that time. The worst has happen(ed) when fish management interfered (i.e., introducing *Mysis* shrimp). But the harm is done. We need to leave the fishery alone.

E-mail E-36-1. I find it very disturbing that your request for comments is to only include items that reduce lake trout numbers. It is impossible to reduce lake trout numbers in a Lake trout fishery and maintain the current fishery. Less lake trout numbers equals less fishery PERIOD. Bull trout and cutthroat trout are not present in significant numbers in Flathead Lake for them to be considered a fishery.

E-mail E-8-3. I believe that when we medal with nature we can cause terrible results. Look at the wolf introduction. I would venture to say that if a politician ran on one issue: to eradicate the wolves, there would be a huge support from Montana voters. I have talked with State and Federal wildlife officials and they tell me gillnetting is not the answer. Yellowstone Lake has been a failure, but it does supply jobs for those that are gillnetting. There is no documented evidence that this has worked any where in the world as far as bringing back the bull trout and we are willing to take the risk on a scientific guess that our way will work. I loved catching the bull trout as well as any one, but to slaughter every fish that goes into those nets, including perch, whitefish and bull trout does not make sense. I am surprised that environmental groups are not opposed to the indiscriminate killing of these fish.

E-mail E-11-5. These solutions (E-11-1 through 4) will take care of the problem and increase native fish. There is no reason to gillnet Flathead Lake and I am very much opposed to it. Greg Foley

E-mail E-31-1. I have a number of comments, but I would like to address two at this time. I would like NO gillnetting allowed on Flathead Lake. There are too many unknown issues and the damage may be irreversible.

E-mail E-40-5. I’m not in favor of gillnetting as a solution without considering other solutions, particularly where the recently updated results indicate the population of fish species in the lake are “stable”, though they may not be in the mix of species that are desired. Gillnetting would be catastrophic to a recovering sport fishing industry so dependent on Flathead Lake.

E-mail E-41-1. (We received this comment before the scoping period opened.) Thank you for presenting in Kalispell last night. While adamantly opposed to gillnetting, I was interested in your point of view. I have fished Flathead Lake for 34 years now. I have assisted the Fish and Game in tagging projects and probably bought a hot dog from you at Skidoo Bay in 85. The last 15 years I have spent on mostly fishing the south end, taking many, many friends and relatives who bought licenses and products from business in the area. Contrary to the opinion of some of the speakers last night Flathead is fishing better then ever for large lake trout. The last 5 years have been the best large lake trout fishing we have ever had. It would be a tragedy to see these large fish just killed in nets and removed.

Letter L-20-2. Do not gillnet.

E-mail E-37-1. Hello, My name is Chancy Jeschke I would like to comment on Flathead lake Program. I do not support gillnetting on Flathead Lake.

Response
Gillnetting can be more effective in reducing lake trout numbers than other tools because the harvest can be pre-planned based on the established rate of capture from previous netting. (The harvest from gillnets is proportional to the quantity of nets deployed and the skill of the netting crew.) Additionally, gillnets can target specific size ranges of lake trout, based on the size of meshes used. If future catch rates are comparable to those measured during experimental netting, then approximately 6,500 feet of net would need to be deployed for every 1,000 lake trout captured. So the use of gillnets, while an emotionally charged issue, does make it possible to catch a substantial number of target fish over a short period of time. The Co-Management Plan identifies gillnetting as a management too to be used if necessary to reduce non-native fish. Alternative A, the No Action Alternative, would maintain current management, which would mean no gillnetting. However, all of the action alternatives include gillnetting. We would mitigate negative effects to non-target species to the greatest extent possible by targeting areas and depths of the lake where we are unlikely to catch species like bull trout and westslope cutthroat trout. Appendix 5 describes gillnetting in more detail.

Gillnets are being used in many other lakes in the region (such as in Lake Pend Oreille and Swan, Quartz and Yellowstone lakes) in non-commercial applications to reduce lake trout numbers (Hansen et al. 2010; Rosenthal 2011; NPS 2009). Monitoring has shown that gillnetting has measurably decreased lake trout populations in these lakes.

Lake trout captured in gillnets would not be wasted but would be used at area food banks.

Gillnetting—Mortality associated with Gillnetting and Bycatch

Kalispell—13 April 2010 (written) K-4. Daily Interlake Feb 24, 2010. Front and Center netting kill everything.

Polson—12 April 2010 (written) P-3-3. Gillnets are non-selective meaning they kill everything that goes into them. The fish struggle for hours and finally succumb to a death similar to us suffocation. The food value of any creature that dies in the traumatic of a situation is questionable. The longer they're in the nets and dead the more they decline in value. If they assure us that they are going to process them who is going to monitor that and again why should we believe them? You never hear about all the benefit people receive from lake trout killed in Yellowstone Lake, Swan Lake, or Lake Pend O'rille which leads me to believe what they did would not be good publicity. Because gillnets are not selective and they're planning on targeting the fish when they are on their spawning beds these big mature fish will be in the most jeopardy. This plan will also kill bull trout, whitefish, perch and anything else that will be swimming by.

Letter L-13-4. What measures will be used to protect whitefish—all 3 types—that are in the lake as well as bull and cutthroat trout—saying that there will be minimum by catch just does not answer that problem. Check with fall river whitefish fishermen to see how many bull trout they catch—last fall I caught several and others did too.

Letter L-15-4. If reduction of the lake trout (mackinaws) is prime outcome of netting, are you serious to think that the smaller fish i.e., bull trout, cutthroat trout, are not going to be lost also.

E-mail E-33-13. Reduce bull and westslope cutthroat trout bycatch.

E-mail E-39-2. Any bycatch of bull trout and whitefish is not acceptable.

E-mail E-24-1. (We received this comment before the scoping period opened.) As a biologist with over 50 years of fishing experience I was astounded to hear that the Tribal council is considering gillnetting. Apparently they have received some very bad advice. Simply put, gillnets kill fish, and many bull trout of breeding age will die no matter how quickly the nets are emptied.

Letter L-11-2. (We received this comment before the scoping period opened.) Any beginning biologist knows this is non-selective and generally lethal to any fish caught in the nets. This is not “catch and release” so many bull trout will also be removed.

Letter L-20-3. Too many bull trout & cutthroat are killed (in gillnets).

E-mail E-63-2. Barry Hansen mentioned at the Kalispell meeting that they could not track the effect of the netting until 5 or maybe 6 years after the first netting occurs. Then how many years are you going to net?? How much are you willing to spend??? what if a major effect was to occurred during that time frame that is not discovered until it is too late. (like *Mysis* shrimp). please....let’s not keep making ‘mistakes’ with this lake.

Response

We believe that we have assessed all of the potential negative and positive effects that would occur from the alternatives, including effects from netting. Bycatch refers to the capture of non-target fish while targeting lake trout. In Appendix 5 and in the Environmental Consequences sections of Chapter 3 of the DEIS we discuss bycatch in some detail. With respect to bull trout, we believe that we could minimize bycatch by carefully selecting locations, seasons, and mesh sizes. To date, bull trout catches in gillnets in Flathead Lake have most often been in nets set at depths less than 80 feet and near shore. In standard, randomized gillnetting conducted by the Tribes and MFWP in all depths and locations, the catch rate has been about 80 lake trout for each bull trout caught. Targeted netting has been conducted on a small scale and experimental basis, and no bull trout have been caught (CSKT files), indicating we could design gillnetting sets to reduce bull trout bycatch to the lowest amount practicable. Bycatch of westslope cutthroat trout could be almost entirely avoided because cutthroat trout are rarely found at the depths that lake trout would be targeted with nets.

Gillnets—Presentations at Meetings

E-mail E-7-10. A number of people were expecting the specific gillnetting proposal that had been discussed before and were surprised that it wasn't presented that way.

E-mail E-21-1. (We received this comment before the scoping period opened.) I attended the meeting in Kalispell on 2-11 re: the Co-management Plan on Flathead Lake. I want to thank you for your presentations. They were quite informative, but I am still not clear on one issue, netting to reduce the lake trout population. I know there was a significant amount of public participation in the development of the Plan ten years ago and I believe that some degree of netting was discussed at that time. The issue of netting seemed to be the primary issue at the current meeting and I wonder if the netting 'plan' today is the same as it was 10 years ago. Netting to sample for various things is, to me, a different issue than netting to attempt to significantly reduce the population of lake trout in 'hopes' that the netting will improve and increase the population of Bull Trout and Cutthroat Trout.

Response

The scoping meetings were designed to help us gather information to craft a range of alternatives. Several of these alternatives have retained aspects of the original proposal, which at the time was termed the pilot project. All of the alternatives are presented in Chapter 2 of the DEIS and analyzed in Chapter 3. The public will have an opportunity to comment on the DEIS.

Currently, both co-managers—MFWP and CSKT—use gillnetting to quantify fish population parameters. The current proposal, which includes several netting options, would be sufficiently different from our on-going actions such that we are using the NEPA process to evaluate them. All of the alternatives are consistent with our guidance documents (Appendix 1).

Trapnets and Seine Nets

Letter L-4-1. I have an idea for catching the mackinaw trout, only, out of Flathead Lake. A fish trap. The gillnetting will be effective, but will kill too many fish that you don't want killed. The fish trap was used so successfully, in Alaska, that it was outlawed in the 30s. It may not work, in Flathead Lake, because in Alaska it was used in natural channels between islands, where the fish migrated, and the water flowed with the tides. There is a floating fish trap, that I don't know too much about. It could be placed in different parts of the lake. The land based fish trap is stationary. In both traps, the fish you want could be bailed out, and the fish you don't want, can be put back into the lake. The fish do not die when they enter, or live in the trap.

Letter L-13-9 Have other netting options been examined: purse seines - net traps and one similar to the ones used in the Great Lakes.

E-mail E-40-3. Has "seine netting" been contemplated as an alternate to gillnetting. It is much more selective and bycatch can be immediately placed back in the lake without injuring them. Here is a link describing it use in other areas. http://www.fisheriesmanagement.co.uk/seine_netting.htm

E-mail E-29-3. We need to produce better results by adding stronger methods such as trapping.

E-mail E-41-2. (We received this comment before the scoping period opened.) The trapnet solution is a good idea. Remove the smaller fish (maybe under 30”) and keep the trophy fishery intact. The other possibility is a bounty on a all smaller trout (again maybe smaller then 30”). Both these solutions avoid the firestorm that gillnetting would cause. Anglers could live with these solutions if there was an exact target and because there would be verifiable numbers attached to the harvest.

E-mail E-64-3. Every method, including trapping and netting, should be considered as tools to make the plan successful moving forward.

E-mail E-71-5. Implement a netting or trapping plan to make up any shortfall in target lake trout reduction numbers by anglers.

Letter L-23-3. Reach your goal through trapnetting—releasing larger fish.

E-mail E-12-4. A netting operation will take a lot of resources and I find that the gillnets are unpopular among many groups. It may be possible to use seining nets when the lake trout are sponging. This would allow other fish to be released.

E-mail L-7-2. If you’re not confident about this (the gillnetting method), have you considered other methods, such as purse seining, which allows you to pick and choose which ones die.

Response

Trapnetting is effective at targeting selected species and enables managers to release non-target species unharmed. We have included this method in all of the action alternatives in the DEIS. Trapnetting is typically restricted to areas in which the lake bed is relatively flat. In Flathead Lake that means trapnetting would generally be limited to South Bay and Big Arm Bay.

Trapnetting has the potential to be a very effective suppression tool, although it lacks the versatility of gillnetting. It is limited in that it is generally only deployed in a single location per season, is not effective at catching small fish (<20 inches), and cannot be deployed in depths greater than 80 feet. Its greatest strength is that it causes little bycatch mortality. For these reasons, it would be deployed to the greatest extent possible, but would be a companion tool to gillnetting rather than a replacement for it. Tapnetting is discussed in detail in Appendix 5.

Purse seining was evaluated and we concluded that the scale of the equipment required exceeded the nature of the problem and is no more efficient than gillnetting. While seining might have lower bycatch mortality than gillnetting, we addressed that concern by evaluating trapnetting, which has low bycatch mortality.

Angling Measures to Reduce lake trout

Bounties

Polson—12 April 2010 (written) P-3-9. A bounty would produce no wealth (no product) but it would give some income and still allow fishermen to be selective with their catch. Continue the contests (as an alternative) -- for this I have nothing but praise for those who have organized them but here again there is no wealth created. I do not want to discourage anyone from participating in the contests. They are a great experience. I'm not fishing much because of my work and to be honest, my skin is not thick enough to be around people by whom I feel betrayed. Continue the low cost of licenses.

Letter L-19-3. If you're willing to try that why don't you stimulate our local economy by putting a bounty on lake trout $5 to $7.00 a fish & bump up our economy around here & feed the food bank's around the county also. People would be buying boats, tackle, fuel, etc.

E-mail E-30-1. In keeping with the proposal to increase native fish while reducing lake trout I suggest the following formula: Year-round bounty program.

E-mail E-49-4. I wrote a letter to the editor of the Inter Lake a while back in favor of a $50 bounty on lake trout, among other things. They didn't print it. I suggested that a bounty program could be funded by the BPA. Idaho has a lake trout problem in Lake Pend O'Reille. They have started gillnetting and have a $15 bounty in place. http://fishandgame.idaho.gov/fish/misc/pendoreille_cash.cfm

Letter L-19-2. If you (the tribe) is willing to spend X amount of Dollar's to net X amount of fish over the next couple year's (as stated in local paper), if you take X / X = around $7.00 per fish & you still have too many mac's. If you're willing to try that why don't you stimulate our local economy by putting a bounty on lake trout $5 to $7.00 a fish & bump up our economy around here & feed the food bank's around the county also.

Kalispell —13 April 2010 (written) K-3. A bounty of $5.00 or so with a key pad system at the launches to verify the angler was in fact at the lake that day. A number and # of fish taken is all would need be entered. The fish could be turned in somewhere else.

Kalispell —13 April 2010 (verbal) Km-19. Why not have a bounty year round.

E-mail E-8-5. I would prefer a bounty system, because it is not to damage the other species in the Lake, however I believe if we killed every fish in the Lake, unfortunately, the bull trout will not come back. As you can tell, I have a passion for our fisheries. Please save the fisheries we presently have providing fun and recreation for all. Rick Skates, Polson, Montana

E-mail E-11-3. Establish a bounty on lake trout. Pay $5 for each lake trout caught. Money is a very motivational factor and this will greatly increase the number of fishermen and the number of fish caught.

Letter L-1-2. I would like to see a bounty paid to anglers to catch more fish and keep "angler days" up.

Letter L-2-2 We need to try netting to reach our target. I would also like to see a per fish bounty paid to anglers to catch more fish and to keep angler days up.

E-mail E-58-2. Place a bounty per fish during the other times of the year. Require that the fisherman in order to get the bounty have the fish cleaned and properly bagged or fresh. This will allow CSKT to maintain a good relationship with the local food banks as they will still have a supply of fish. Require a specific time and place for the fish to be turned in for the bounty. This will allow CSKT to minimize cost while still being able to get a hard count on the number of fish taken. I suggest a bounty somewhere around $5.00 per fish.

E-mail E-60-2. I would like to also propose a bounty of somewhere between 2$ and 5$ (as determined by the interagency or tribe) per frozen head turned in to predetermined drop off spots such as those used during Mack Days say once a month outside of Mack Days contest days. The angler would be responsible for processing his/her fish and either using for personal consumption or donating to area food banks.

E-mail E-63-3. I believe a bounty is way more selective and can be stopped or accelerated at any given time. Nets are not 'species select' and bounty fishing is. The anglers can help you control the fish taken from the lake. I see this as the only feasible way to attempt this.....both ways must deal with the distribution of the dead fish....Tony Anderson, Kalispell, MT

E-mail E-71-4. Encourage angling pressure on the lake trout through derbies and bounties.

Letter L-23-4. Reach your goal through a year-round bounty on small fish.

E-mail E-37-2. I think a bounty on lake trout would be much more productive. If the fish had a hard dollar # on them it would encourage many people to fish all the time (when they can) not just on weekends for Mac Days. It would eliminate bycatch of native species in gillnets, anglers can release bulls and cutts. It would also allow you to have hard numbers of macks that are being taken out of the lake.

Letter L-12-3. Place a bounty on all lake trout. ? $0.25, $0.50, $1.00.

Letter L-13-10 (3). Develop a bonus program similar to the one in use on the Columbia River for squaw fish—for live mass only.

Letter L-16-4. (anglers can dec lake trout…) Consider a bounty. (I lived in Oregon for awhile. This helped with the problem fish in the Columbia River.)

E-mail E-26-3. Most of all I feel a bounty would reduce the targeted amount of lake trout the CSKT would like to reduce in the next 3 years in lieu of gillnetting the lake. Wally Wilkinson, Whitefish, MT

E-mail E-29-4. We need to produce better results by adding stronger methods such as bounties.

E-mail E-30-4. INCLUDE the Northern Pikeminnow in the bounty program as other western states are doing (there OBVIOUSLY is a connection between heavy predation by NPM or they wouldn't be paying up to EIGHT DOLLARS per fish in Or and WA).

E-mail E-30-5. Pay a set fee for each lake trout, or use a sliding scale to reward those who are more progressive. For instance, pay $1 a fish if only the head is left at a collection point, and $1.50 if the fish are filleted and frozen.

E-mail E-30-6 to 30-12. Have registration kiosks at every boat launch where fishermen register with their ALS# and number of fish caught that day. If they are just leaving the heads, they fill out a form and leave the fish heads. If donating to food bank, they indicate which one. If they wish to donate the fish to a food bank, they fillet and freeze the fish and bring them to a food bank of their choice where they will fill out a donation form. The food bank worker verifies the ALS number and number of fish. (A little more work on the food bank volunteer, but in trade for quality food). Monthly, MFWP and or CSKT employees match the donation cards to the registration forms from the kiosks, report the information and checks are mailed out to the anglers. You get hard data about fish kill, anglers receive an incentive, food banks get fish and there is little involvement on managers except for clerical work that can probably be done by employees currently on the payroll, (it ain't rocket science...). Get some sponsors to help offset the cost (signs at the kiosks, signs at the food banks, logo's on the envelopes the checks are mailed in, be creative). Offer awards to the anglers who catch the most, donate the most etc. Sportsmens groups can staff the stations at peak times/dates to help educate public? MFWP/CSKT biologists also? I think there is a LOT of merit in a year round bounty and with a little thought, a program that could be the envy of all the western states could easily be implemented here in NW Montana.

E-mail E-41-3. (We received this comment before the scoping period opened.) The other possibility is a bounty on a all smaller trout (again maybe smaller then 30"). Both these solutions avoid the firestorm that gillnetting would cause. Anglers could live with these solutions if there was an exact target and because there would be verifiable numbers attached to the harvest.

E-mail E-39-1. I think the best way to decrease lake trout is to do away with the Spring and Fall Mack Days and put a year round bounty on lake trout for the next 3 years. This will keep the fishermen more involved in the process. I am against netting lake trout because we do not know what the long term consequences for Flathead Lake would be. Thank You, Tom Cobianco

E-mail E-40-4. Has "bounties" or "rewards" for fish turned into the Tribe been contemplated? There are many unemployed boat owners that could use money and would happily purse this as an activity to supplement their income, I would personally be interested in this.

E-mail E-59-1. Recreational angling should be the only method employed to seek the present and proposed management goals. Utilize lake trout bounties and additional angling incentives such as commercial hook and line to increase harvest as outlined in the plan and not yet attempted. Angler opportunity and use must continue to be a priority. Netting reduction should not be used as a management tool.

E-mail E-60-4. The slide on page 24 of 60 of the same Scoping Meeting Presentation defined the goal of the 2001 thru 2010 Flathead Lake and River Fisheries Comanagement Plan Goal as to: "Balance tradeoffs between native species conservation and nonnative species reduction to maintain a viable recreational/subsistence fishery". Nonnative species have been hit hard recently, and the 60,000 lake trout goal will be met without doubt in 2010 (from Mack Days), which will also no doubt benefit the conservation of native species and will continue to

maintain a viable recreational /subsistence fishery if this course is maintained which is what I have proposed. Thank you for the opportunity to comment. K. Douglas Bolender

Response
Bounty fishing for lake trout on Flathead Lake is not available as a management too because it is not legal. During 2011, MFWP introduced a bill in the legislature to legalize bounty-fishing for lake trout on Flathead Lake. However, in the face of opposition, the bill was withdrawn before a committee vote was cast. A bounty is not an option until the a bill legalizing it is passed. No bill was introduced into the 2013 legislative session. We have no way of predicting whether such legislation will be introduced or will pass in future sessions and what it would look like if it did. We have discussed how a bounty could work if it were to become legal in Appendix 5.

Licenses

E-mail E-12-5. The use of sportsmen has not been optimized yet but is in fact working to some degree. We are asking sportsmen to donate their time and equipment to help us reduce the lake trout. Why are we charging them a license fee, setting limits of any kind other than on other species? Why don't we have a article in the sports magazines and all local papers on a weakly basics? We should explain where to fish and what equipment to use. Show more pictures of the successful catches. There is a lot of things we could do the encourage year around fishing do to the fact that many people will not fish in the cold weather when the contest are running. I live on the lake and have had many people ask me to take them fishing but some refused to pay the high fees for one or two days. Again, I'm just talking about getting more lake trout out of the lake and this type of reduction would not be for more that 2 or 3 years. The tagged fish could be turned in for a prize any time of the year. This would show up in the magazines and papers encouraging more fishing activity. The fishermen must have an idea of what gear, how deep to jig or troll and where to fish so they can be successful and spared the word. I know I can put 30 to 50 new fishermen a year on the lake and I'm only one person.

Response
In 2005, the Tribes decreased the cost of a license to fish the Flathead Reservation portion of Flathead Lake by establishing an inexpensive annual license specific to the lake. This new license increased sales, but we cannot attribute any increase in recreational harvest directly to the additional license sales. We do not expect potential future increases in the general harvest to be large because individual harvest is restricted by the typically low level of demand by anglers to consume lake trout. The average harvest per angling party that caught lake trout during the period of 2005 to 2010 was 1.4 fish per trip (CSKT files). The primary goal of increasing limits, rods, and license sales was not to influence the general harvest but to heighten awareness (i.e. public education) and to allow the expansion of harvest of lake trout within Mack Days contests. That is, increased bag limits and rod numbers allowed anglers, who are fishing competitively, to maximize their harvest for reasons independent of their own consumption patterns.

Limits

E-mail E-11-1. So far in the Mack Days contest, 45 limits of 50 fish have been acheived. The limit of 50 fish is counterproductive to reducing the lake trout population, the goal of Mack Days. How many more fish would have been caught if there were no limit? Increase the limit to 100 fish or take the limit off entirely.

Letter L-10-6. Eliminate any limit on lake trout.

E-mail E-18. Wayne Harman, Condon. Suggest lifting all angling limits (daily and possession) on lake trout in Flathead Lake. Prefer this step to gillnetting of Lake trout. This will favor bull trout and result in less capture of bull trout in nets.

Letter L-12-2. Double the daily catch limit from 50 to 100.

Letter L-16-1. More could be done by the anglers to decrease lake trout. Increase limit on lake trout.

E-mail E-30-2. Number one, remove the lake trout limit on Flathead.

Response

The Flathead Lake and River Fisheries Co-Management Plan identified recreational harvest as the first of a group of tools to be used to reduce lake trout numbers. Together with the state (the Tribes and MFWP are co-managers of the Flathead Lake fishery), we began to encourage greater recreational harvest in 2004 by increasing the bag limit from 15 to 20. Again with MFWP, we increased bag limits in 2006 from 20 to 50, and in 2010 from 50 to 100. The latter increase increased the total harvest in 2011 by 988 lake trout. In spring 2011, there were 25 angler-days in which greater than 50 lake trout were caught. During fall 2011, there were 57 angler-days in which 50 fish were exceeded. We do not consider it likely that the effect of the 100-fish bag limit will increase substantially in the future.

We also increased the number of rods allowed per angler from one to two in 2004. Evarts (1998) determined that increasing bag limits in excess of three lake trout would not increase the total general harvest because anglers rarely catch and keep more than three lake trout. We do not expect potential future increases in harvest to be large because individual harvest is restricted by the typically low level of demand by anglers to consume lake trout. The average harvest per angling party that caught lake trout during the period of 2005 to 2010 was 1.4 fish per trip (CSKT files). The primary goal of increasing limits, rods, and license sales was not to influence the general harvest but to heighten awareness (i.e. public education) and to allow the expansion of harvest of lake trout within Mack Days contests. That is, increased bag limits and rod numbers allowed anglers, who are fishing competitively to maximize their harvest for reasons independent of their own consumption patterns.

In addition, liberalizing bag limits and other similar measures are within the purview of our annual work plans and fishing regulations set by the CSKT and MFWP and do not require an EA or EIS.

Recreational Fishing

E-mail E-27-9. We support identification by the ID team of angling pressure objectives. Currently there are 40,000 to 70,000 angler-days on Flathead Lake. It can be argued that these numbers may not be appropriate to maintain as they are heavily influenced by the Mack Days contests, which are a tool being used to attempt to reduce the lake trout population. Goals for angling pressure should reflect appropriate levels following the attainment of recovered bull trout and westslope cutthroat population objectives.

E-mail E-32-5. Outside of the "Mac Days" events I have never seen a effort to promote recreational fishing on Flathead Lake. A serious effort to increase recreational fishing might substantially the total lake trout harvest.

E-mail E-59-1. Recreational angling should be the only method employed to seek the present and proposed management goals. Utilize lake trout bounties and additional angling incentives such as commercial hook and line to increase harvest as outlined in the plan and not yet attempted. Angler opportunity and use must continue to be a priority. Netting reduction should not be used as a management tool.

Response

We do not expect potential future increases in recreational angling to be large because individual harvest is restricted by the typically low level of demand by anglers to consume lake trout. The average harvest per angling party that caught lake trout during the period of 2005 to 2010 was 1.4 fish per trip (CSKT files). The primary goal of increasing limits, rods, and license sales was not to influence the general harvest but to heighten awareness (i.e. public education) and to allow the expansion of harvest of lake trout within Mack Days contests. That is, increased bag limits and rod numbers allowed anglers, who are fishing competitively to maximize their harvest for reasons independent of their own consumption patterns. Appendix 5 discusses the general harvest and Mack Days and angling pressure objectives.

Commercial Fishing

Letter L-17-3. If greater numbers need to be harvested maybe a commercial venture could be explored which would add much needed jobs.

Letter L-17-4. A commercial license could be issued with a tribal cannery and processing facility.

Missoula —14 April 2010 (verbal) Mm-9. Is commercial netting market driven? Or, would you contract the effort out? (later he said he thought you would need to be able to sustain the effort to see a response and thought commercial netting might be predictable enough to do that.

Missoula —14 April 2010 (verbal) Mm-18. Is there a commercial market for lake trout?

Polson—12 April 2010 (written) P-3-8. Develop a commercial fishery. With the nation in the condition it is in, creating wealth and jobs together is the only thing that is going to save us from eventual collapse. When these contests were first conceived anybody could come by the Blue Bay processing facility and pick up lake trout. As these contests continue year after year the lake trout became more and more popular

in groups to with they were donated because people enjoy eating them. Now all the lake trout caught are spoken for even with increased harvest. They don't even give to people who ask for them anymore unless you are in the contest and are bringing fish in. Because of this popularity they have as a source of food that doesn't take a quantum leap to ascertain that a market demand could be achieved fairly easily.

E-mail E-11-4. If, after three years, [a bounty does] not work to achieve the desired harvest then establish a limited commercial lake trout fishery. This would have to be closely monitored to achieve the desired harvest and not more.

Letter L-7-7. One other thing; now that commercial-type netting is being considered, what do you think about a commercial Great Lakes White fishery? These fish are a restaurant staple in the Great Lake states, and there are apparently sufficient here to support a commercial operation. Do you want this to happen, or could it happen as an unintended consequence of this first netting operation?

E-mail E-25-8. 3. Explore the potential for a commercial lake trout fishery, and offer incentives like bounties and contests for increased recreational angling of lake trout. Angling has been a successful community-supported method for lake trout removal, and is a good tool in concert with more aggressive approaches to suppression. These incentives will also help restore bull trout by providing invaluable opportunities to continue and expand public educational efforts on threats facing native trout. We also encourage the CSKT and MFWP to continue the free donations of protein-rich lake trout to local food banks with appropriate mercury warnings.

E-mail E-74-1. (This comment was received prior to scoping meetings.) I am interested in finding out more information about your plans to reduce, or eliminate, the non-native lake trout in the Flathead Lake system. I am interested because the use of commercial salmon fishing techniques would seem to fit the plan from what I have learned about it.

E-mail E-74-3. What I am proposing is a fee based quota system similar to Mac Days that would allow a few licensed fisherman to troll for the fish. The fish would be gutted and chilled in ice until delivery to the tribe for further processing or distribution. The season would have to be from about the first of May to about the first of October to make any dent in the lake trout population. I have looked at the Mac Days monetary offerings and think it would be in the range of a successful effort if it could be enlarged to allow a boat to earn as many quotas as it could catch. If a pilot program was allowed for one year, it could possibly allow for tribal members to form a small commercial fishing operation on the lake. If any of this sounds interesting to you, please contact me with your thoughts. Sincerely, Gene Holt

Response

Commercial fishing is not available in the near future (at least until the next legislative session) because it is not currently legal on the Montana portion of Flathead Lake. There is the possibility that the Tribes could develop a commercial fishery on the Reservation portion of the lake, although it would probably be less successful than one conducted lake-wide. There has been interest expressed in small-scale fish-smoking operations, which would add value to the product and potentially increase the profitability. We consider it unlikely that a commercial processor would develop independently. Rather it would probably require an agency-directed subsidy. A commercial operation requires that a buyer and processor develop locally. It is dependant on the local demand for processed lake trout and is limited in scope by the market

prices for lake trout, which are generated in the Midwest by large processors operating under a different economy of scale than is feasible locally. In addition, the potential would be influenced by the use of other management tools (i.e. bounties or fishing contests) during the same period. Anglers would likely favor the method that was the most profitable. There is substantial uncertainty in predicting the potential harvest to be generated by a commercial fishery. As a business venture there is no guarantee of success. We consider an optimistic projection of harvest to be 75,000 fish per year.

Outfitting

E-mail E-40-1. Regarding "Commercial" fishing solutions; have increasing sport fishing guide licensees been considered both Tribal and Non-Tribal? Allowing off reservation licensees to guide within Tribal waters? If not, I would sure suggest these prior to gillnetting.

E-mail E-23-1. From: Mike King. How can you say you want to reduce the numbers of lake trout in the lake without gillnetting but yet you will not let the fishing outfitters from the north end of the lake fish in the south end of the lake. Nor do you have anyone in your tribe with any ambition enough to do any outfitting fishing in the south end of the lake which would bring income to the businesses in Polson and other towns in the area.

E-mail E-34-5. I have also wondered why the 'commercial guides' do not fish the southern half of the lake. If that were open to them, it would also increase the 'take' of LT.

Response

Currently there are two Tribal Council-approved outfitters that operate in the southern half of the lake, and the Tribal Council will consider future applications on a case-by-case basis. However, we believe harvests generated by increasing outfitters on the south half of the lake would be very small relative to the total harvest.

Mack Days

E-mail E-60-1. I suggest that the 2010 Spring Mack Days as is, in conjunction with the proposed 2010 Fall Mack Days, will prove to exceed the removal of 60,000 lake trout through angler participation only, as was the goal for 2010 in the new 5 year plan. As you are aware, after week 9 of the 2010 Spring Mack Days, 28,467 lake trout were caught, killed, and turned in. This exceeds 1,000 fish per contest day. With 33 Spring, 2010 Mack Days plus 33 Fall, 2010 Mack Days for a total of 66 contest days, we should exceed the 60,000 lake trout removal goal for 2010 without counting the additional recreational harvest throughout the rest of 2010 prior to Spring Mack Days, between Spring and Fall Mack Days, and following Fall Mack Days, not to mention the additional Mack Attack contest harvest. I see no reason to even consider netting as an option considering the success of 2010, and hopefully future, Mack Days.

Kalispell—13 April 2012 K-5-1. I think the pilot program needs to expand angler participation through near year-round events. This is a

major benefit to our local economy. Increase catch limit, increase payouts or install a bounty. The current lake trout fishery is a world class resource and can be promoted.

E-mail E-57-3. What a waste of money. Every person who pays an electric bill is paying for this effort to kill lake trout which directly decreases their success to catch fish.

E-mail E-58-1. Here are my thoughts on how to maximize CSKT's efforts to meet the goals of decreasing the lake trout population in Flathead Lake. 1). Continue the Mack Days efforts. Cost are minimal compared to the results. The results are hard counts.

E-mail E-51-2. What is especially sad is the fact that the current "tournament" system of management - in addition to being completely ineffective - is just breeding a sportfishing following for these invasive fish. We need less pike and mac sportfishing so the bucket biology stops. Please stop the madness.

E-mail E-64-4. It is not fair that we pay people to catch these unwanted lake trout and it makes them more popular. The lake trout are being caught and removed from the system by people who catch them for money and not for the simple pleasure of fishing. The food banks do benefit from paying the fishermen for these fish but lake trout fishing is becoming a competition rather than a sport. The fish removed by other means and methods can still be used by the food banks. The native fish are the losers. We need to change our views back to the true importance of the native species. This is our watch, now is the time to create a plan that works and provides a positive increase in the number of native fish. If we do not provide a plan that works, natural events such as fire or floods, could eliminate a local population of our native fish and we move closer to extinction of the native fish. The health and numbers of native fish are greatly diminished in their historic range and we have a chance with this plan to make a difference in our area.

Polson—12 April 2010 (written) P-1-3. Some members of Audubon enjoy fishing from shore and find lake trout fishing elitist.

Polson—12 April 2010 (written) P-1-4. In a week of trying to catch lake trout from a canoe they were only able to catch cutthroat trout

E-mail E-64-6. Quit listening and pandering to just the vocal lake trout fisherman. There is another group that fishes the river that is important too! There are almost as many fisherman on the rivers that are fishing for fun and the true enjoyment of fishing. They are not getting paid to catch fish! If we did not pay people to catch lake trout and we increased the number of native fish, there would be more fish on the river than on the lake!

Response

We do not know if the contests reached their peak in 2010 or if there is substantial growth remaining to be realized. In 2010, the spring and fall contests generated a harvest of over 49,000 fish. In 2011 the total Mack Days harvest declined to 45,000 fish, in 2012 they went up to 50,699. Future growth potential remains for: (1) increases in the number of participants by increasing public awareness of the events and

increasing prize money, (2) increases in the skill of anglers, and (3) increases in the daily harvest attributable to the change in bag limit from 50 to 100 fish.

Currently, the level of participation in Mack Days is lower than that for many other contests conducted in the Flathead Valley, which suggests that there is potential to increase Mack Days participation in the future. To improve the overall success of the anglers, we have developed tools such as instructional videos and brochures and are working on web-based fishing forecasts. We believe these measures will increase the success of less experienced anglers, although the increases will probably not be large relative to the total harvest.

Minor changes to Mack Days are within the purview of annual work plans and management decisions of the CSKT. While Mack Days does help us reduce lake trout numbers, it does not by itself trigger a NEPA action.

Mack Days is paid for by the CSKT and has nothing to do with electric bills from Mission Valley Power.

We agree that a substantial number of the angling public enjoys participating in Mack Days, and that this may seem counter-intuitive if we are also trying to increase the populations of native trout. However, NEPA requires that we must address the current conditions we operate in, which includes a popular lake trout fishery. We believe that we can maintain a lake trout fishery while improving conditions for native trout species, which is why we embarked on this proposal and NEPA process.

Mack Days are described in more detail Appendix 5.

Slot Limit

Missoula —14 April 2010 (verbal) Mm-17. Hit it hard and get rid of the slot to maybe increase your chances for success.

Missoula —14 April 2010 (verbal) Mm-2. What is the rationale for having a slot limit on FH Lake?

Missoula —14 April 2010 (written) M-4-1. Strongly consider elimination of slot limit. Larger fish are more predaceous and are (at) spawning age = (therefore) more young lake trout (are produced).

E-mail E-30-3. KEEP the slot, as these larger fish are NOT doing the heaviest predation/reproducing, according to the science. (Maybe allow ONE fish in the slot each day for mortality).

E-mail E-11-2. The slot limit makes no sense if the goal is to reduce the lake trout population. I like to catch the big fish as much as anyone but we can't have it both ways. If we must reduce the lake trout population, we have to do away with the slot limit. The argument that the big fish help keep the population down by eating the smaller lake trout is wishful thinking but does not make sense. They are spawners and are contributing to the problem, not solving it and there are more fisheries biologists that agree with that than disagree.

E-mail E-12-6. I think the slot limit is just making a very few outfitters happy and counter productive to a short time goal we are faced with. This really upsets many fishermen when this goal in mind. Take it off for at least two or three years. There is no way that this will hurt their business for after this reduction is completed they will have many more large fish to catch when the number are reduced. A very aggressive action is necessary and a combination of these actions may be necessary but in specified areas of the lake to allow us to gather information on witch ones work the best with as little impact as possible to our other sport fish.

Letter L-6-5. MFWP needs to figure out what their priorities are. What sense does it make to 'throw all the big ones back'? You can't have it both ways (population control of lake trout and 'trophy' - that's laughable - lake trout).

Letter L-8-3. Would eliminating the slot limit on lake trout have any noticeable effect? (in meeting your goal).

E-mail E-24-4. Also to get rid of the slot limit, so large lake trout of spawning size are reduced in numbers without killing bull trout.

E-mail E-25-9. Eliminate the slot limit for lake trout. Larger adult lake trout eat bull trout, which means the current restriction on catching large lake trout is counterproductive to the goal of the Co-Management Plan to: "Increase and protect native trout populations (bull trout and westslope cutthroat trout)."

Letter L-10-5. Eliminate the 30-36 inch slot.

Letter L-12-1. Remove the 30-36 inch slot limit. Allow all lake trout caught to be kept.

Letter L-13-2. Since spawning fish are now at least ____(can't read, maybe resold spelled rysold) why are the smaller fishes that are not spawners being targeted and the larger spawners are in the slot? It seems to me you are treating the symptom and not the cause—If there are too many fish-target the spawners-all of them.

Letter L-15-5. It seems getting rid of the larger lake trout would make better sense if you want to see the population decrease by larger numbers, as they are the spawners, and decreases would be on a shorter time basis.

Letter L-16-2. (anglers can dec lake trout…) Get rid of the "slot". You catch it, you can keep it.

E-mail E-29-1. The current plan has been less than effective in the first nine years. We need to produce better results by adding stronger methods such as removing the slot limit, netting, trapping, bounties and any other proven scientific measures.

E-mail E-33-11. Remove the slot limit for lake trout.

E-mail E-27-10. We support re-analyzing the need to maintain the current slot limit in effect on Flathead Lake. Please disclose the benefits of attracting anglers with a slot versus the negative impacts of maintaining a size cohort that accounts for the most predation on native bull trout and westslope cutthroat.

Letter L-20-1. Allow fishermen to keep all lake trout regardless of size.

E-mail E-64-5. Consider the slot limit as a tool to decrease the number of lake trout! Why keep the most prolific spawners and fish that eat larger native fish and say we are recovering the native fish? This seems counterproductive to the goal of increasing the native fish.

E-mail E-71-6. Remove the slot limit on large lake trout

Letter L-23-2. Do not kill the big lake trout!! Keep the slot limit. Protect big lake trout as much as you try to increase bull trout. Rick Anfenson, Kalispell

Missoula —14 April 2010 (verbal) Mm-13. At what age do lake trout start to reproduce? That is, if you keep the slot, how will you ever reduce the overall lake trout population?

Response

Trophy lake trout are defined in this proposal as being 30 inches long and greater. Fish of this size have been protected by the slot limit (harvest of fish between 30 to 36 inches is prohibited) since 1994. Fish of slot-protected lengths are typically 20 years and older. They are relatively abundant because of protection by the slot limit and stock-piling of fish born in the late 1980s following the establishment of *Mysis*. We have not directly estimated the abundance of trophy lake trout because our mark and recapture methods do not include fish greater than 30 inches. However, in gillnet catches, trophy lake trout make up roughly one-third of the fish that are greater than 20 inches in length. All of the action alternatives in the DEIS would do away with the slot limit.

The IDT initially considered reduction alternatives that retained the slot limit. However, several IDT members felt the slot limit was counterproductive to the purpose and need to reduce lake trout to benefit native fish species. Other members suggested that retaining the slot provision as part of Alternative C would be misleading because our analysis showed that over time, trophy-sized fish would still become rare-to-absent, even with the slot limit. This is because with increased harvest levels, fewer intermediate-sized fish would survive to move into the trophy size-class. This phenomenon would occur at the 50% lake trout reduction level, although the trophy-sized fish would be able to persist longer under this scenario than in the other reduction alternatives. Still, the Interdisciplinary Team felt retaining the slot limit might make it appear that trophy-sized fish would be retained, even though our analysis shows that trophy-sized fish would essentially be lost over time. Therefore, the alternative that would retain the slot limit was eliminated.

Male lake trout in Flathead Lake generally reach maturity at age 11 while females reach maturity at age 15, which is older than lake trout in other systems.

Other Measures to Reduce lake trout

Killing Eggs

E-mail E-33-10. Some other issues that need to be addressed in the pilot project: Is it feasible on Flathead Lake to tag some adult lake trout to see where they are spawning, net the spawners and kill the eggs?

Letter L-22-1. Grey (lake) trout prefer spawning beds with a very coarse bottom covering I understand. Perhaps these spawning areas are limited in area/extent in Flathead Lake such that we can consider treating them in some way? Do any other fall spawners, such as lake whitefish, use these same beds? If not, may I suggest looking into smothering the gray trout eggs with some biodegradable substance. For example, spring wheat or winter wheat grains will sink in water. A one-inch covering might be enough. A railcar load (about 3,300 bushels) could cover about one acre. Derailments of grain railcars and grain spills are not uncommon. What becomes of the cleaned-up grain? Edwin Speelman, Kalispell, MT

Response

We have analyzed two tools to kill spawning lake trout or their embryos: electrofishing and the use of electrodes to destroy embryos. Lake trout adults are vulnerable to electrofishing when they move into shallow water to spawn during autumn, and this tool has been effectively employed as a way of capturing adult lake trout in Lake Pend Oreille and in Yellowstone and Swan lakes. Costs are moderate, and bycatch risk is low. The primary limitation is that it is only effective to a depth of about 10 feet. Consequently, we would only be able to electrofish for lake trout in the very narrow shoreline zone. This tool could have utility in Flathead Lake, but we do not propose to employ it during this planning period because we do not consider it to be any more cost-effective than the combination of gillnetting and angling.

A developing tool for killing lake trout embryos is the use of electric current deployed in an array of electrodes towed by a boat over known spawning areas. To date we have not used this tool in Flathead Lake. It could have utility in the lake, but is not ideal because of the large extent of potential spawning habitat. While we have not quantified spawning habitat in Flathead Lake, we consider the essential elements of spawning habitat to be present in excess of fifty miles of shoreline. In addition, the efficacy of this tool has not been determined for embryos placed well into the interstitial spaces of ideal cobble substrate. This tool will be reviewed as the technology develops. We do not propose to deploy it in Flathead Lake during this planning period.

Trout Calls

Letter L-4-2. Get a trout call. I'm not joking. The University of Washington, or U of M could produce a sound that attracts fish. Maybe a thrashing minnow, or spawning trout, or an egg smell, that attracts fish to the trap, since I don't know of any migrating trout patterns that could be used in the lake. Thank you, Ried Hurtig, Pablo, MT

Response
We are not aware of trout calls, but remain open to effective, economically feasible methods to target lake trout for removal.

Spear fishing

E-mail E-40-2. I know of one Tribal Member who approached the council to guide spear fishing in the lake and was denied. Is there an opportunity there for some of your members for earning money in tough economic times that could be exploited?

Response
Spearfishing is not considered to be sufficient to meet the scale of the problem but will continue to be evaluated adaptively in the future.

Control Northern Pike

E-mail E-9-2. Northern pike are also a major contributor to the decline in our native trout. Northern pike are very easy to target and eliminate from our system. They spawn in the spring and are easy to target by shocking methods. Also, opening spear fishing for pike in the Flathead River sloughs would be a very affective way to reduce populations.

Kalispell —13 April 2010 (verbal) K-9-11. How much effect are northern pike having on migratory bull trout as they come down the river to the lake?

Kalispell —13 April 2010 (verbal) Km-17. At the north end of the lake, pike are depredating bull trout, cutthroats and ducks and goslings.

E-mail E-27-11. We recommend the ID team revisit what is known or inferred about the mortality on bull trout and cutthroat trout caused by northern pike. A final alternative should consider whether reduction of northern pike numbers could result in a measurable improvement in native fish abundance.

E-mail E-70-7. I would also like to see some consideration given to the heavy predation by northern pike on our native fish in the lower river. Consideration should be given to ways to reduce or eliminate pike numbers.

E-mail E-76-1. If I understand you correctly, Pike can be a part of this management plan. If that is the case…I think it is a good thing. I think that Pike in the sloughs, as well as anglers being able to keep cutthroat in the sloughs (regs), are two very important points that need to be addressed in order to promote healthy native fish populations in the river. Thanks, Jim Voeller

E-mail E-33-5. The Co-Management Plan Five-Year Review disclosed that approximately 30,000 bull trout per year are being consumed by lake trout. Add that to the estimated 3,500 bull trout being eaten by pike in the Flathead River (Muhlfield et al., Using Bioenergetics Modeling to Estimate Consumption of Native Juvenile Salmonids by Nonnative Northern Pike in the Upper Flathead River System, Montana 2008) and

the result is a depletion of bull trout in the Flathead River/Lake system by non-native fish.

Response
While northern pike do prey on bull trout, pike are not the bottleneck for bull trout populations in Flathead Lake. Bioenergetic estimates of predation on native trout by northern pike is less than 10% of the amount attributed to lake trout. Nevertheless, incentives to harvest more northern pike can be implemented by the Tribes through fishing regulations and do not need to be addressed in a separate NEPA document. Northern pike are also discussed in the Cumulative Effects to Bull Trout section of Chapter 3 of the DEIS.

Explosives

E-mail E-12-7. If none of these ideas work well we can always use depth charges and pick up the floaters after words. Thank you for taking the time to give these ideas a thought. Ken Richardson

Response
Explosives would kill all fish the fish in the area where they are being used and therefore are not an option.

Poison lake trout

E-mail E-12-1. Poisining when lake trout are grouped up after sponging and some fry are searching for their first meal. This is a lesser option do the extreme cautions to upset a balance of other fish or a food chain.

Response
While some piscicides (fish poisons) can be used effectively in smaller lakes that do not contain endangered or threatened species, it would not be feasible, practical, or responsible to do so in Flathead Lake.

Electroshocking

E-mail E-12-2. Shocking techniques that allow fish to be selected and disposed of. Again if this tec was used at the right places and the right times of the year it may be a option to conceder. Don’t laugh at this one!

Response
Lake trout adults are vulnerable to electrofishing when they move into shallow water to spawn during autumn. This tool has been effectively

employed as a way of capturing adult lake trout in Lake Pend Oreille and in Yellowstone and Swan lakes. Costs are moderate, and bycatch risk is low. The primary limitation of electrofishing is that it is only effective to a depth of about 10 feet. Therefore, we would only be able to electrofish for lake trout in the very narrow shoreline zone. This tool could have utility in Flathead Lake, but we do not propose to employ it during this planning period because we do not consider it to be any more cost-effective than the combination of gillnetting and angling.

Stock other fish

E-mail E-7-2. Stocking fish in the lake could make up for the loss of lake trout fishing if it's reduced; how about walleye.

E-mail E-49-7. In other parts of the country, triploid rainbows have been stocked and are breaking records. Triploid rainbows commonly reach 20 pounds and have reached 40. They are being bred and stocked in Idaho, Washington, Utah and California.

If triploid rainbows were stocked in the Flathead, that would take some of the wind out of the lake trout sails. People would hire charters for rainbows if 20-pounders were coming out of the lake. MFWP might say that it would be expensive to breed and stock the triploids, but the question then is, how much do you value the bull trout and the flat trout? Are they worth spending money on?

Rainbows should not have the destructive effects on native fish that namaycush does. Rainbows are better eating than macks. Triploid rainbows tend to be grotesque looking in the same way that Mrs. Barber's record mack was grotesque looking, so if triploid rainbows were a possibility, one might want to look at triploid steelhead. Steelhead are sleeker fish than regular rainbows and their triploids might be better shaped. The Canadian triploid on the first link below tho has good body conformation: www.wired.com/wiredscience/2009/09/biotech-fishing; www.northwesttrout.com/NewsItems/triploid.htm; www.google.com/images?hl=en&q=triploid%20rainbow%20trout&rlz=1W1ADFA_en&um=1&ie=UTF-8&source=og&sa=N&tab=wi. A thought might be given to stocking triploid macks too. Someplace a triploid mack will be a new national record. Wherever that happens, that will be a boon for charter boat operators. It will increase the dollar value of the resource.

E-mail E-49-9. Burbot are known as being predators on small lake trout and they are good eating. They are absent from this part of the Clark Fork drainage. In terms of predation, they would give macks competition and would actually predate small macks. They have been described as "voracious predators." They occur in numbers at lake trout spawning grounds when the lake trout are spawning. They are supposed to eat the spawn but one study found that they ate more small macks as they emerged from the spawning areas than they did eggs. Cottids in that study ate more eggs but I am sure in Flathead that macks eat more cottids than cottids eat macks. http://fieldguide.mt.gov/detail_AFCMA01010.aspx

In the Great Lakes, the sea lamprey *Petromyzon marinus* found their way through the Erie Canal and caused severe damage to lake trout populations. To use them in Flathead Lake would be too risky. They would have to be sterile and there would have to be a failsafe mechanism in place in case two lampreys escaped sterilization. They should not reproduce well in the Flathead system because the larvae require muddy backwaters. They reproduce well enough in trout rivers back east tho. They have been a problem for lake trout in the Finger Lakes of New York but not as bad as they have been in the Great Lakes. Sea lampreys on a lake trout: http://en.wikipedia.org/wiki/Sea_lamprey

The Wikipedia article says that lampreys are native to the Finger Lakes but that is not so. They came in via the Cayuga-Seneca Canal from the Erie Canal. That should about cover it from my end.

Response
Stocking fish is not an appropriate action because it is not consistent with our Co-Management Plan. Moreover, stocking almost always results in unintended and severe negative consequences, two examples of which are the stocking of *Mysis* shrimp into the Flathead system and the stocking of lake trout into Flathead Lake.

Measures to Increase Bull Trout

Hatchery

Polson—12 April 2010 (written) P-3-12. Fish hatcheries-No one argues that they could in a very short time bring bull trout numbers to a point where they would have both recreational and economic value by raising them in fish hatcheries and release them into the lake. These could be relatively unsophisticated like Rick Jore's cutthroat trout operation which is low expense.

Polson—12 April 2010 (written) P-3-13. Everyone would be happy except the progressive environmentalists who seem to prefer failure over success because continued failed programs bring money in to coffer. The argument that fish hatcheries are not natural is baseless. Nature is their enemy not their ally in increasing bull trout numbers. Macman (Mr. Zimmer).

E-mail E-8-6. In my mind, we need to replenish those eggs in the river system and believe hatcherys' could be the answer. I would support this 100% and would contribute money to that cause.

E-mail E-23-3. (We received this comment before the scoping period opened.) Also how about a fish hatchery in the lake for bull trout &/or cutthroat trout. How about using the old salmon hatchery above Lakeside which in the lake using lake water, you can't get more natural then that. Please Advise, Mike

E-mail E-33-15. We appreciate that the CSKT will not consider alternatives that introduce more nonnative fish or involve hatchery production. Please keep us informed and involved in this project. Sincerely, Arlene Montgomery, Program Director For Michael Garrity, Executive Director, Alliance for the Wild Rockies

Response
The Bull Trout Restoration Plan (2000) states, on page 102: "…restoration stocking [is an approved recovery strategy] only if the actual cause of extirpation is identified and corrected first." Hatchery solutions to fish population issues tend to result in "put-and-take" scenarios that are not sustainable in the long term. A more sustainable solution seeks to remedy the underlying reason for low population numbers. Because we know the habitat is suitable and indeed in the 1980s produced at least twice the number of redds than are present today, we know that if the bottleneck to bull trout recruitment is removed, this area can produce higher numbers of native fish. For these reasons, hatcheries were not included in our Co-Management Plan and are beyond the scope of this analysis.

Dams

Polson—12 April 2010 Pm-3. How did the dam affect bull trout, lake ecology, or lake trout. Implication that the dam is responsible for declines in bull trout and not lake trout.

E-mail E-6. Sir, I hold a Masters degree in Zoology, have done field research, and been a fisherman for over 50 years. I live in Western Montana, and have fished Flathead lake for 35 years. Everyone with any acumen knows that the gorilla in the living room on this Lake trout fiasco is the fact that Bull trout need clean, unblocked running water to spawn. So no Bull trout recovery will succeed until the dams at Bigfork and Hungry Horse are removed, and the sewage systems for towns on the upper Flathead river are cleaned up. The so called "Mac Attack" is a joke, and you will find gillnetting to be as well, in the long run. Bull trout are in a very similar situation to the salmon on our west coast, only in a smaller ecosystem. When you block such populations from their breeding areas, they suffer huge population declines. If you are serious about actually saving the Bull trout instead of posturing for the public, get rid of the dams, as they are doing now all over the country to save native fish. This, coupled with cleaner water in the rest of the river is the only real hope. Time for you "movers and shakers" to take a real stand for the Bull trout. I can only hope that you will. Good luck in your endeavors, and thank you for your service, Jerry Dwyer.

E-mail E-24-3. (This comment was received before the scoping period opened.) A far better solution would be to get rid of the dam at Bigfork, so a very important spawning stream is available again to both bull trout and cutthroat trout.

Letter L-5-5. (This comment was received before the scoping period opened.) removing barriers to fish migration for spawning in rivers.

Missoula—14 April 2010 (verbal) Mm-2. Re bull trout spawning—are there redds in the south fork? What about a fish ladder at HH? The implication was to build fish ladders to enhance bull trout that way, vs removing lake trout.

E-mail E-7-5. Need to consider that the bull trout in Hungry Horse are part of the native trout picture in the system. The reservoir provides a lot of habitat for bull trout that used to be part of the Flathead population. Also think of Koocanusa as a stronghold of bull trout

Response
Our redd counts are from tributaries to the North and Middle Forks Flathead River. While fish barriers do cut off some Flathead Lake bull trout from spawning habita in the South Fork of the Flathead, fish still spawn in the Flathead River and the North and Middle Fork drainages. Overall, redd counts have decreased from 1980s levels in the North and Middle Forks, and that is the key problem that needs to be addressed.

Even if habitats were connected over Hungry Horse dam, lake trout would still be able to pioneer into lakes in Glacier National Park—decreasing those lakes' suitability for native species. Restoring connectivity over Hungry Horse would not address this factor of lake trout biology, but removing lake trout from Flathead Lake would help to do so. In fact, the argument could be made that native trout in the South Fork drainage are more secure because lake trout are cut off from that area.

Hungry Horse Reservoir is not currently connected to the Flathead Lake system because Hungry Horse Dam has effectively separated the two systems. While we agree that Lake Kookanusa may be considered a stronghold for bull trout, this does not remove our obligation to fully implement our guidance documents, which include measures to remove lake trout to improve conditions for native fish species.

The operation of Kerr Dam does not affect the presence of lake trout in Flathead Lake.

Monitoring

E-mail E-27-5. We support the measurement of some combination of the following metrics, if helpful, in order to judge success: redd counts on index reaches in the Middle and North Forks; juvenile bull trout counts; gillnet samples in the lake; lake trout stomach samples; cutthroat population estimates in the Middle and North Forks of the Flathead River: and possibly angler success rates or a similar metric for native fish in the river. We ask that the agencies judge success by finding a positive response in at least two of the selected metrics, or another number acceptable to the ID team. If the criterion is only bull trout redd counts in index reaches, we ask that the pilot be continued until there is a statistically valid determination that the project is working or not. That, in our estimation, would necessitate no less than an 8-10-year project.

E-mail E-27-8. 8.We support the monitoring of other biological signals, such as Mysis shrimp densities, prime productivity in the lake, and perhaps some sort of water quality measure like clarity (the latter will provide some insights on how removal of lake trout affects organisms farther down the tropic ladder, and how they in turn might create new impacts or fishery benefits).

E-mail E-59-2. Obtain an accurate estimate of lake trout abundance and total harvest annually to thoroughly evaluate effectiveness of (angling only, see E-59-1) reduction. Monitor bull trout and cutthroat trout response concurrently. Incremental success criteria should also be developed that must be attained to continue lake trout reduction (angling only). If these are not met the project should be discontinued and the lake allowed to stabilize on its own.

E-mail E-70-6. As the project continues, it is imperative that meticulous data be collected by reputable scientific organizations that can serve to answer future questions about the ecology of the entire lake and river system. Much can be gleaned by studying data produced by similar efforts in Lake Pend Oreille, Yellowstone Lake and elsewhere. The importance of data collected for this project will be invaluable for future managers. I support extending the current co-management plan for the life of the project and producing a new long-term plan at the end of that time based on data collected by the project.

Response
Monitoring and adaptive management are key components of our management approach. Monitoring will include the indicators listed for Significant Issues in Chapter 2 of the EIS. Monitoring and adaptive management strategies are described in Appendix 8.

Native Fish

Native Species and Habitat Conditions

E-mail E-60-3. In reviewing the bull trout redd counts slide on page 17 of 60 in the scoping meeting power point presentation, it appears quite evident that bull trout populations are very stable as evidenced by redd counts in the Middle Fork and the North Fork alike. The 2009 bull trout redd counts were higher than 1992, 1993, 1994, 1995, 1996, 1997, 2003, 2004, and 2005. The 2009 bull trout Redd counts were also approximately equal to 1979, 1998, 2002, and 2007. It appears very clear to my untrained eye that there is virtually no difference between the 1979 bull trout redd counts and the 2009 counts.... a span I might note of 30 years!

E-mail E-33-7. The Co-Management Plan Five-Year Review considered bull trout populations secure. “Secure level criteria include a stable or increasing population trend, wide geographic distribution, and at least 300 redds in the basin.” Redd counts have fluctuated in the North Fork and Middle Fork Flathead index streams over the last 10 years and are not even close to the redd counts in the 1980s that were as high as 600 in 1982. Year 2000 – 251 redds, 2001 – 230 redds, 2002 – 190 redds, 2003 – 130 redds, 2004 – 136 redds, 2005 – 144 redds, 2006 – 221 redds, 2007 – 203 redds, 2008 – 225 redds and 2009 – 187 redds. These numbers do not meet the secure level criteria. In addition, the ten years that the Co-Management Plan has been in place is not an adequate timeframe to determine a trend. We believe that there must be more aggressive actions to control lake trout in Flathead Lake and the agencies’ priorities should be to recover bull trout and westslope cutthroat trout.

Response
Annual counts of spawning nests, termed redds, provide the data for enumeration of the number of adults spawning in a particular year. The total numbers of redds counted have declined by over 50% since the highest counts in the early 1980s. Total redd counts can mask very low redd counts in local populations. The decline in the North Fork Flathead system has been greater than the decline in the Middle Fork

system. Three of four spawning streams inventoried in 2011 had less than 10 redds each. Such low counts are indicative of a population at risk. Taper and others (2012) identified five redds as the conservation threshold level below which short-term persistence is not likely. Their results indicate that many Flathead bull trout subpopulations are currently at such low levels that stochastic extinction is a foreseeable threat (Iwasa and Mochizuki 1988). Since 1980, many estimated sub-population levels have fallen below 50 and 100 adults during several years of monitoring. The USFWS identifies 100 adults as a recovery threshold (Whitesel et al. 2004).

The decline in bull trout abundance from the 1980s[1] raises questions about the future persistence of the population. Many experts are concerned that the population will continue to decline to possible extinction. Others suggest that the population will persist indefinitely at the current low levels of abundance. Concern regarding further bull trout declines stem from numerous examples of bull trout lakes being invaded by lake trout. Many of those systems have experienced sharp declines of bull trout due to predation by lake trout. Examples include the near or total extirpation of bull trout in Hector Lake in Alberta, Canada, Priest Lake in Idaho, and eight lakes connected to Flathead Lake in Glacier National Park (Fredenberg 2002).

Email E-51-4. It would also be wonderful to catch something in the Flathead River system again. The South Fork of the Flathead should be the ultimate goal for management of the main river flowing into Flathead - big bulls and lots of cuts. no pike, no Macs. It would be great if my kids could catch native fish on Flathead like I used to when I was a kid. Lake trout are just not the same quality of fish. Sincerely, Carey Schmidt

Email E-54-4. Lastly and perhaps most important for the political realties of MT and the Flathead, it cannot be forgotten that lake trout represent exclusionary policy on a massive scale. Consider that any young boy with a cheap fly rod and reel could catch healthy cutthroat on our rivers if they existed, but a very expensive boat, downriggers, rods, trailer, vehicle (you get the point) are required to fish for the invasive lake trout.

Email L-21-1. Restoration of cutthroat trout is my main concern because they taste so good. No rubs, marinades, batters, spices or additives of any sort are needed to make them well palatable. The same cannot be said, in my opinion, for that now predominant trout in Flathead Lake—the one Canadians call the grey trout. The current catch-and-release cutthroat fishing in Flathead Lake and Flathead River is of no interest to me. Only paltry fish can be angled. I want to see catch-and-keep (if you want) for cutthroat.

Response
We agree and hope that we can recover bull trout enough that they can be fished for (and kept) in the future.

1 The 1980s represent the oldest period of available records, so are often mistakenly used as a reference for full population potential. However, historic abundance of bull trout in the interconnected Flathead system prior to development likely exceeded 20,000 adults (Fredenberg, personal communication 2012).

Kalispell—13 April 2010 (written) K-10. Would like to see more cutthroat and bull trout in system.

Polson—12 April 2010 (written) P-1-6. With climate change bull trout will get hammered by effects.

Polson—12 April 2010 (written) P-2-1. The issues dealing with netting of non-native lake trout from Flathead Lake have farther reaching effects than just with some recreational anglers and charter boats having lower catch numbers and smaller fish. Flathead Lake historically was filled with native bull trout and westslope cutthroat trout-people tell stories of watching the "flats" rising in the evenings in Big Arm Bay and what a beautiful sight it was. Elders have told about ice fishing out by Wildhorse Island and having to make larger holes in the ice to get the bull trout out. Anglers in boats caught bull trout that were large and fought valiant fights at the ends of twisting lines. Time brought changes to the system--some good and some bad. Dams were built, non-native species were introduced, some flourished and then disappeared, but the fishery of Flathead Lake was soon no longer a native Montana trout fishery-the non-native lake trout had taken control and are now the dominant fish. Native fish numbers have dramatically declined and are just holding on by threads.

The native fish numbers are indicators now of species in trouble-they indicate the health of watershed systems-they give us a wake up call as they struggle to survive-it is time to pay attention to what is happening. It is not time to blame anyone for the changes that have occurred, or to blame anyone for the plans to help try restore numbers, or to believe that the only answer is to leave things alone. Leaving things as they are-would be like looking the other way while someone sets fire to a wilderness area. We are all responsible for what has happened and we all need to take some responsibility in helping to restore what was. Twenty years from will we look back and be proud of making a difference and helping to carry on a tradition of native Montana fish in Flathead Lake or will we look back and be proud of doing nothing with a lake full of non-native lake trout that some call trophy fish.

The following is from: Native vs Non-native USFWS-Union Blvd. Lakewood, Co. Vol 11, No. 1:

> In certain instances where man has altered the habitat in some way, non-natives actually take advantage of the new ecosystem by fulfilling an unoccupied niche, Stempel adds. "But we need to recognize that proliferation of non-native fish, along with habitat disturbances, is one of the most significant causes of the decline of native fish throughout the West."
>
> The evidence is compelling: Seventy percent of the 27 fish extinctions in North America were caused in part by non-native fish interactions. In many cases, the country's native fish populations continue to lose ground because of sportfishing's dependence on non-native fish stocking.
>
> Growth of non-native fish stocks are a result of satisfying the demands of recreational anglers. Many states, particularly in the West, rely almost exclusively on non-native fishes to provide the angling public with fishing opportunities. Anglers generate game cash for state fishery budgets through the purchasing of licenses, and states have tried to accommodate anglers' needs by maintaining a level of quality fishing. This has forced most states to develop stocking programs that use hatchery-reared non-native fish.

When Congress passed the federal Endangered Species Act, USFWS was mandated and given legal authority to save rare or declining species. Maintaining and recovering native fish stocks is a step toward the larger goal of maintaining overall health of the entire ecosystem, or biodiversity.

Under this type of management, a given area should have healthy populations of all fish, animals and birds that are considered native, or naturally existing prior to European settlement in America. An important guideline for management is to prevent conflicts with native species from introduced non-native species whenever possible.

Managing the nation's fisheries used to mean providing ample stocking offish for anglers. But with alteration of habitat from dams and development, loss of water quality, introduction offish diseases and other impacts on the aquatic environment, the job of managing today's fisheries includes conservation and recovery of native fishes. However, implementing the Endangered Species Act can conflict with the interests of various groups who see threatened and endangered species recovery as detrimental to their own pursuits.

"The real urgency is for all anglers to unite, regardless of the native vs. non-native issue, and focus on preservation of habitat, improved water quality and overall health of the entire ecosystem," Stempel says.

The decision to stock non-native fish in sensitive habitat will always carry risk, says Stempel. "If the scientific hunch is wrong and non-native fish do enter large watersheds and impact native fish, the problem is nearly irreversible. Biologists must err on the side of conservation of native fishes."

So it is time to choose—either we jump in and help try to bring a balance to the fishery of Flathead Lake and help to restore native species that are vital to the whole ecosystem. We would then be able to at least say at least we tried—or do we do nothing and have a non-native sport fishery that is a boon for commercial fishing and then we could look back and say we watched as this system lost native fish that had been in the lake for hundreds and hundreds of years. It is up to all of us to protect and preserve for the younger generations. It does not mean we have to destroy -we can try to balance-but we have to choose. Meetings will be held in areas and information given on the fishery of the lake. Data has been collected, scientists consulted-the numbers were not just randomly chosen. Listen to the information before making your decision about what is right and what is wrong.

Thank you for the opportunity to give my opinion on this issue. Let's work together to find common ground and goals to move forward in preserving part of a Montana fishing heritage. Cindy Bras-Benson Hot Springs, MT

Response

We agree that we can strive to maintain a balance for all users, and this is reflected by the range of alternatives in our proposal. A goal of

the Flathead Lake and Fisheries Co-Management Plan is to increase and protect native trout populations (bull trout and westslope cutthroat trout) while balancing trade-offs between native species conservation and nonnative species reduction to maintain a viable recreational/subsistence fishery. Implementation of the Co-Management Plan has not decreased lake trout populations and has not increased bull trout populations during the 10-year plan period (Co-Management Plan Mid-term Review 2006). Further, research indicates that bull trout and westslope cutthroat trout declines in the Flathead system are the result of lake trout increases, which have cascaded through the Flathead Lake foodweb (Bull Trout Study Group 1997; Beauchamp 2006; Flathead Lake Co-Management Plan Expert Panel 1998). In addition, bull trout are listed as a Federally threatened species under the Endangered Species Act, and the Tribes are committed to improving conditions for Threatened and Endangered Species (Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin, 2000; Flathead Lake and River Fisheries Co-Management Plan, 2000). Because increases in the lake trout population have put native trout at risk, there is a need to implement management actions or strategies directed in the Co-Management Plan, which is what the action alternatives in the DEIS propose to do.

Letter L-7-3. Have you considered assisting the bull trout population by habitat enhancement, such as providing cover for young trout returning to the lake from upstream? One possibility is the placement of structures in suitable locations. Perhaps the North Shore underwater logging operation could move some non-merchantable logs into appropriate locations for a reasonable fee. Have you considered gathering additional biological information on sub-surface conditions by working with the people who will soon be removing logs from the lake. Their project involves extensive use of side scan sonar, plus many hours of diving time. It will be very simple to arrange with divers to photograph and make a record of things of interest; records would include date, time, location, depth, temperature, etc. Also, the presence of local certified divers represents a resource that could be tapped for the mutual benefit of the divers and the Tribes. These divers (4 are available now) would love the chance to gather subsurface info on flowering rush, Eurasian milfoil, structures providing fish habitat, etc. The Fisheries Program could use the info, and the divers would be adding to their resumes. And I, as a Certified Diving Instructor, will be more than happy to provide training to new students. I have been trying for years to encourage connections between Tribal resources and all those people who want to help and who need help. I'm talking about young people, under or unemployed people, SKC students, and folks who need better food. Sincerely, Bud Papin

Response
Thank you for your suggestions. The habitat enhancement measure of adding logs to provide cover would need to be researched to determine the extent to which it would benefit bull trout and westslope cutthroat trout, but we do not believe that lack of cover is the limiting factor for bull trout. Documenting non-native aquatic plant species occurrence is beyond the scope of the proposed action.

Email E-27-14. Bull trout and westslope cutthroat are highly valued by a large constituency. They are culturally, environmentally and economically important throughout the Flathead Basin in Montana, extending into the Canadian headwaters of the North Fork Flathead River. The Confederated Salish and Kootenai Tribes have valued and continued to work to sustain native bull trout and westslope cutthroat

throughout the tribes' history. The recently signed MOU between the State of Montana and the Premier of British Columbia protecting the Transboundary Flathead used as one of its strongest arguments in favor of protection the value of headwater tributaries that are used by threatened and species of special concern bull trout and westslope cutthroat. From this perspective, it would be contradictory not to work to recover the native species that played such a key role in protecting the Transboundary Flathead.

Email E-28-1. Thank you for the opportunity to comment on the EA pilot to improve the native trout fishery in the Flathead drainage. Unless additional efforts are undertaken to reduce lake trout numbers, bull trout will not recover in the Flathead system and their small numbers may decrease further. Continued small numbers of bull trout or their elimination from the Flathead system is unacceptable. The damaging affects of lake trout stretch beyond the lake and far into the middle and north forks of the Flathead River which drain some of the most beloved lands in Montana. Native trout must continue to be our management priority for this important region.

Email E-33-1. Please accept the following comments on the Confederated Salish and Kootenai Tribes lake trout Reduction Pilot Project on behalf of Friends of the Wild Swan and Alliance for the Wild Rockies. As staunch defenders of native fish and aquatic ecosystems we appreciate CSKT's initiative to reduce lake trout in Flathead Lake and facilitate recovery of imperilled bull and westslope cutthroat trout.

Email E-33-2. Bull trout were given Endangered Species Act protection in 1998, critical habitat is currently proposed for Flathead Lake and the draft Recovery Plan was released in 2002.

Email E-33-3. In 1995 the Montana Bull Trout Restoration Team's Bull Trout Scientific Group completed a status report for the Flathead drainage. Fisheries management was listed as a very high risk to bull trout. The Scientific Group stated: "Over decades, the erosion of these native populations has resulted in increasingly restrictive regulations and the coinciding rise in introduced species (particularly lake trout and northern pike) has led to a regulatory environment that has attempted to provide quality angling opportunities for both native and introduced species. The Scientific Group feels that this "have your cake and eat it too" approach has harmed native species and will continue to be detrimental to bull trout recovery." This statement holds true today, 15 years later. Bull trout must be the priority due to its threatened status, not maintaining a trophy lake trout fishery.

Response
We agree that it is time to fully implement our Co-Management Plan. We hope to retain angler opportunities for lake trout fishing, which is consistent with our Co-Management Plan. Our models predict varying levels of recovery for bull trout under the three action alternatives and these are discussed in Chapter 3 of the DEIS.

Polson—12 April 2010 (written) P-1-2. All proposed measures for lake trout reduction are acceptable in an effort to save native fish including bull trout and cutthroat trout. The overwhelming majority of members support lake trout reduction.

Missoula—14 April 2010 (verbal) M-3-1. Thank you for embarking on this process to explore additional tools for addressing the low-level of

bull trout and associated predation by Lake trout. The current approach is not enough to bring bull trout up to more sustainable levels. Native fish species such as bull trout are an essential element of the Flathead system. Native fish should be the priority for management throughout the Flathead lake and river system.

E-mail E-1. Thank you for beginning the public process to move forward with a proposed pilot project to recover bull trout and cutthroat in Flathead Lake and River. We are supportive of a pilot project that takes major steps to recover native bull trout and westslope cutthroat.

E-mail E-2-7. It's not just about Flathead Lake. As an organization that is focused on protecting and restoring healthy rivers, American Rivers is particularly concerned about the adverse impacts that invasive lake trout have had, and continue to have, on bull trout and westslope cutthroat trout that migrate upstream from Flathead Lake into the North Fork and Middle Fork of the Flathead River to spawn in their tributaries. These spawning migrations, which have been documented at up to 150 miles, reach into the headwaters of the North Fork in British Columbia. Not only do migratory bull trout and westslope cutthroat trout provide unique angling opportunities for recreational fishers (especially in Canada where angling for bull trout is legal), but spawning fish are consumed by dozens of wildlife species such as grizzly bears, river otters and bald eagles.

E-mail E-2-8. Impacts to native fish & wildlife in Glacier National Park. Lake trout not only have decimated bull trout and westslope cutthroat trout populations in Flathead Lake proper, but they have also moved upstream into the North Fork drainage and colonized several lakes on the west side of Glacier National Park. There are 17 lakes on the west side of Glacier that historically supported bull trout. Today, eight of those lakes (Bowman, Harrison, Kintla, McDonald, Logging, Lower Quartz, Quartz, Rogers) have been invaded by lake trout originating from Flathead Lake, and in all but one of those lakes bull trout have been driven to the brink of extinction. The National Park Service Organic Act established the National Park System "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Clearly, Glacier National Park's bull trout and westslope cutthroat trout have been impaired by the invasion of nonnative lake trout from Flathead Lake.

Response
The Flathead Lake and Flathead River System are managed as one entity because of the migratory nature of fish in the system. Therefore the DEIS analyzes effects of the proposed actions on these connected areas north (or upstream) of the lake as well as on Flathead Lake itself.

E-mail E-2-9. Wild and Scenic Rivers Act protections
The Wild and Scenic Rivers Act is another federal law that grants certain protections to native fish in the upper Flathead River system. Both the North Fork and Middle Fork of the Flathead River were included in the National Wild and Scenic Rivers System with the passage of the Act in 1968. Under the Wild and Scenic Rivers Act, "outstandingly remarkable values" are identified for each designated river, and these ORVs cannot be degraded. Among the outstandingly remarkable values that were identified for the North Fork and Middle Fork are their unique fisheries consisting of bull trout and westslope cutthroat trout; and abundance and diversity of wildlife species, many of which prey on these native fish.

E-mail E-2-10. Montana Bull Trout Restoration Plan. In 2000, MFWP and the Confederated Salish and Kootenai Tribes developed and signed a bull trout restoration plan that set the following goals for the upper Flathead River system: 1) maintain or restore self-sustaining populations in core areas; 2) protect the integrity of the population genetic structure; 3) enhance the migratory component of the population; and 4) increase bull trout spawners to attain the average redd counts of the 1980s and maintain this level for 15 years in the North and Middle Fork monitoring areas. The average number of redds counted in index streams in the 1980s was 240 in the North Fork drainage (Whale, Trail, Coal, and Big creeks) and 151 in the Middle Fork drainage (Morrison, Granite, Lodgepole, and Ole creeks). Today, the total number of redds counted in both drainages combined is just over 200. Clearly, the goals of the bull trout restoration plan are not being met, largely due to predation by lake trout in Flathead Lake. The most promising way to reduce this predation is to launch an aggressive gillnetting program.

Response
We agree that redd count totals are disturbingly low compared to 1980s levels, and we have included this information in the Affected Environment section of Chapter 3.

E-mail E-2-11. Cutthroat Trout MOU and Conservation Agreement. In 2007, the state of Montana and Confederated Salish and Kootenai Tribes signed a Memorandum of Understanding and Conservation Agreement for westslope cutthroat trout and Yellowstone cutthroat trout in Montana. According to the agreement, the management goals for cutthroat trout in Montana are to: 1) ensure the long-term, self-sustaining persistence of each subspecies distributed across their historical ranges as identified in recent status reviews; 2) maintain the genetic integrity and diversity of non-introgressed populations, as well as the diversity of life histories, represented by remaining cutthroat trout populations' and 3) protect the ecological, recreational, and economic values associated with each subspecies. The primary objective in order to achieve this goal was to: "Maintain, secure and/or enhance all cutthroat trout populations designated as conservation populations, especially the genetically pure components." Barring a concerted effort to further reduce the lake trout population in Flathead Lake by gillnetting, it is difficult to imagine how this objective can be met for the conservation populations of westslope cutthroat trout in the upper Flathead system.

E-mail E-27-6. We recommend the ID team ensure that the pilot project helps achieve objectives identified in the State of Montana Memorandum of Understanding and Conservation Plan for Westslope Cutthroat Trout and Yellowstone Cutthroat Trout in Montana (2007). This plan was developed and signed by 23 public and state agencies, Indian tribes and private entities, including MFWP, the Confederated Salish-Kootenai Tribes, the Montana Chapter of the American Fisheries Society, and Montana Trout Unlimited. The primary objective identified in this plan is to "Maintain, secure, and/or enhance all cutthroat trout populations designated as conservation populations, especially the genetically pure components." The cutthroat trout populations of Flathead Lake and the Main, Middle and North Forks have been identified as conservation populations, and thereby are deemed deserving of being maintained, secured or enhanced.

Response
We agree that the provisions in the MOU are important. It is one of our guidance documents (Appendix 1), and we believe the action alternatives in the DEIS will help us meet the document's management goals.

E-mail E-2-12. Transboundary agreement between the U.S. and Canada. Since the 1970s, sportsmen and conservationists in the U.S. and Canada have fought proposals to mine and drill for oil and gas in the North Fork Flathead River watershed. They were rightfully concerned that industrial-scale mining and oil and gas drilling in the headwaters of the drainage could degrade water quality in Flathead Lake, thus diminishing one of the most popular recreational fisheries in the state. Earlier this year, Montana Governor Brian Schweitzer and British Columbia Prime Minister Gordon Campbell signed a formal agreement that permanently withdrew the Canadian portion of the Flathead watershed from all mining and oil and gas drilling, and committed the U.S. to pass federal legislation that would do the same in our portion of the watershed. Subsequently, U.S. Senators Max Baucus and Jon Tester introduced legislation (S.3075) to implement that commitment. This legislation is now pending in Congress. In order to honor this new agreement, the state and tribes should do everything in their power to protect and restore the native bull trout and westslope cutthroat trout in Flathead Lake, as these fish migrate upstream into British Columbia where they provide prey for wildlife and recreational opportunities for anglers.

E-mail E-3-1 I am writing this letter to cast my support for protecting the native bull and cutthroat trout in the Flathead River basin. I believe that global warming will have an effect on how populations survive. It is important to protect those populations that have evolved with this region and have a better chance of survival. Please make sure that our native fish gain a preferred importance on non native species. I support the gillnetting of lake trout and believe a long term effort must be taken in any lake that drains into the flathead. I realize that this will be a long process and would like to thank those who are taking on such an important task. I am an angler on both the rivers and lake. I believe that with the reduction of lake trout our native trout will rival those of more popular fishing destinations through out the west. It will be important to our economy and our quality of life; lest we forget why we live here. Thank you for a forum where the public may voice their interest. Derreck Thompson

Response
We agree it is important to look at the economics of retaining native fish species. This analysis is in Chapter 3 of the DEIS.

E-mail E-4-1. I'm writing to support the removal on non-native species of trout like the like trout from the Flathead Lake and River System. As an avid outdoorsman and Flathead County resident I cherish this outdoor gem, and would like to see it grow into another high quality river system for local and non local anglers. In order to do this we will need to support proposed methods for non native species removal. We have one of the few areas with any bull trout remaining.

E-mail E-5-1. The first fish that my four-year-old son caught was a small bull trout, which was itself just past being a toddler. I couldn't help but get choked up thinking how amazing it was seeing my young son, so new to it all, holding up this fish, it just as new but truly a piece of living, swimming natural history of this place I love so much. A direct descendent of the fish that four-year olds have been pulling from these waters since the beginning. It would have still been exciting if he'd caught a lake trout or other transplant, but not nearly so. I can go to any number of places across the country to catch them, but we here in Montana still have the ability to preserve our own history, the best kind that renews itself across the centuries. That's the kind of thing that sticks with people and makes Montana the attraction that it is: a place that is still whole, Last Best and all that. Glacier wouldn't hold nearly the mystique without its snarling griz, and for those that know their fish, our

lakes and streams would be just as generic without the unique species that give it flavor. Hopefully this shows why I'd like to see bull trout and cutthroats recovered as much as possible in Flathead Lake and its connected rivers. I helped my son put that bull trout back, but it would have been even cooler to have taken it home.

Response
We agree and hope that one day we can have fishable (to keep) populations of bull trout again.

E-mail E-43-1. I support the Trout Unlimited goals for restoration of native trout numbers in the Flathead Lake and River systems to the population numbers that existed in the 1980's. Thank you, Michael A. Raczkowski, a.k.a. "Raz"

E-mail E-48-2. Fishing for migratory cutthroat and bull trout is some of the most exciting fishing there is. The South Fork of The Flathead is my favorite fishing destination in Montana because of the cutthroat fishing and seeing bulls swimming in the gin-clear waters.

E-mail E-49-10. I hope that whatever you do results in the successful re-establishment of bull trout and flat trout. I'm sure it's not going to be easy but I believe it will be worth the effort. If you have a mailing list for information on this, I would appreciate being put on it. Thanks. All the Best, Ed Rittershause

E-mail E-50-1. My name is Brendan Friel (guide lic#12077) and I have been guiding the Flathead Valley for the past 4 years. I have lived and fished around the Whitefish area for 14 years. I guide up on the Middle and North Fork Rivers through Glacier Guides, and also have a cabin up the North Fork and fish there quite frequently. We are at a pivotal time with the native species recovery plan and the lake trout dilemma. I have personally been fly fishing the river system in many places and caught lake trout throughout. I have caught lake trout in the South Fork below Devil's Elbow, up the North Fork below the Big Creek area, the Middle Fork up by Moccassin Creek, and many, many different spots on the mainstem. I have even caught them on dry flies near Pressentine Bar. I also guided up in Alaska for 8 years where the lake trout are not as abundant, but still exist throughout many regions. They are aggressive, carnivorous fish and are crushing the native Westslope cut-throat and bull trout in the Flathead River system. Anyone who spends some time on this river system knows that the native species use the Flathead River(s) as corridor to travel to and from the lake for feeding and spawning purposes. The lakers will sit throughout the river, but also right at the mouth where they know the native fish have to "run the gauntlet" and feast.

E-mail E-64-2. Moving forward, actions should increase the number of native fish in Flathead Lake and in the river. Enough lake trout need to be removed from Flathead Lake so that there is an improvement in the number of native fish. Scientific data should be used to determine the number of lake trout removed each year to achieve a positive impact on native fish numbers. The Bull Trout and Cutthroat Recovery Plans , prepared and approved by the State of Montana, would be good guidelines for determining if the Flathead Lake and River Co-management plan is working moving forward. The number of lake trout being removed needs to be measured each year and the results on the native fish population documented until we meet the new goals of the plan. Make the plan work so that native fish can once again be fished and kept in

our rivers and lakes. The objective for the bull trout and cutthroat trout recovery program in the Flathead Lake and River system should be to get both native species' levels back up to where they were in the 1980s before there was this issue.

E-mail E-51-3. This should be one of Montana's premier fisheries (for native species), yet it is essentially a dead zone - unless you are into lake trout.

E-mail E-52-1. It seems clear that the recovery of bull trout and Cutthroat Trout in the Flathead area is no less important than the current effort in Yellowstone Lake.

E-mail E-54-2. I write today to beg that you do the right thing for our rare and valuable resource. There are few places on this earth where vibrant populations of native Cutthroat and Bulltrout are possible. If we do not correct the obvious errors of our ways, I predict our greed and short sightedness will be rightly grouped along with that which nearly wiped out our bison. We should and must do what is possible to aid in the population recovery of native species in the Lake. The benchmark for success should be at least "pre crash" populations

E-mail E-54-6. I strongly encourage you to side with our native species and our citizens, even if a small and vocal minority out screams the vast majority. Ryan Busse, Kalispell MT

E-mail E-55-1. I support the Trout Unlimited goals for restoration of native trout numbers in the Flathead Lake and River systems to the population numbers that existed in the 1980's. Thank you, Michael A. Raczkowski, a.k.a. "Raz"

E-mail E-56-2. I am hopeful that cutthroat and bull trout populations can recover to historic levels that existed prior to lake trout introduction (with plan implementation, 56-1).

E-mail E-27-16. Thank you for pursuing the recovery of native bull trout and westslope cutthroat in the Flathead Basin. We look forward to supporting implementation of the pilot project that will result from this inclusive NEPA process. Footnotes from E-27: MT Bull Trout Restoration Plan Appendix D. Summary of restoration goals for Bull Trout RCAs in Montana: FLATHEAD: - Increase bull trout spawners to attain the average redd count level of the 1980's, and maintain this level for 15 years (3 generations) in the North Fork and Middle Fork monitoring areas. Provide a long-term stable or increasing trend in overall population. [2] 1987 (Duffield et al. 1987)

E-mail E-28-5. I look forward to reading the EA and hope that this pilot brings about a real improvement for the outlook of bull trout in the Flathead system. Thank you, Pelah Hoyt, Missoula, MT

E-mail E-25-11. The Coalition applauds the CSKT and MFWP for working cooperatively to protect and restore native trout in Flathead Lake, one of the Clark Fork watershed's most treasured resources. Thank you for considering our recommendations. Please feel free to contact us with any questions regarding these comments. Respectfully, Brianna Randall, Water Policy Director

E-mail E-17. On behalf of Flathead Valley Trout Unlimited I would like to thank you all for conducting the Flathead Lake and River Fisheries Co-Management Plan public meetings this week. Your patience is admirable. Everyone who attended the meetings made note of the exceptional job that Germaine did in facilitating the meetings and keeping them on track. Your commitment to native bull trout and westslope cutthroat recovery in the Flathead basin is much appreciated, and we will continue to work to support your efforts. We are putting together our comments based on the points to address from Barry Hansen's presentation. We will also continue to encourage our members and other conservation organizations and their members to comment in support of recovering bull trout and westslope cutthroat. Sincerely, Chris Schustrom, President, Flathead Valley Trout Unlimited

E-mail E-64-2. Moving forward, actions should increase the number of native fish in Flathead Lake and in the river. Enough lake trout need to be removed from Flathead Lake so that there is an improvement in the number of native fish. Scientific data should be used to determine the number of lake trout removed each year to achieve a positive impact on native fish numbers. The Bull Trout and Cutthroat Recovery Plans , prepared and approved by the State of Montana, would be good guidelines for determining if the Flathead Lake and River Co-management plan is working moving forward. The number of lake trout being removed needs to be measured each year and the results on the native fish population documented until we meet the new goals of the plan. Make the plan work so that native fish can once again be fished and kept in our rivers and lakes.

Response
Our document discusses the numbers of lake trout that would need to be removed in order to see a measurable benefit for native fish species, and we have used data from Flathead Lake for our population model. We agree that the guidance documents signed by both co-managers are important and we have included them in Appendices 1 and 11.

E-mail E-66-1. We appreciated the opportunity to participate in the meeting on April 14th here in Missoula to learn more about the species dynamics in Flathead Lake and the proposal thru the Co-Management Plan to enhance bull trout and cutthroat trout populations in the Lake and its principal tributaries, the North and Middle Forks of the Flathead River. The long term viability of our native wild trout species is very important to us. We appreciate the opportunity to participate in the "Scoping" phase of a proposed pilot project and look forward to tracking the development of alternatives and the analysis to be done by the committee of scientists.

E-mail E-64-7. Now is the time to truly make a difference. Reduce the number of lake trout enough to see a positive increase in the number and health of the native fish population. Use the state Bull Trout and Cutthroat recovery plans as a minimum basis for success of the new plan. Let's recover the native fish populations so we can fish for them again and recover a piece of our heritage and place the native fish above the non-native fish. Now is the time to act. Make a difference! Thanks again for the opportunity to comment on the direction the Flathead Lake and River Co-management plan should move forward (not backward). Glen D. Anacker, 1649 Hwy 2 W, Kalispell, MT 59901

E-mail E-66-10. Flathead Lake has, in terms of native fisheries, been adversely impacted by humans "management" efforts over the last century. We look at this proposal for a pilot project as one that will be undertaken with a goal, realistically achievable in the eyes of the best available scientists, of making a positive difference for the fishery and all the people of Montana for whom it is to be managed now and long into the future. Tim Aldrich, President, Hellgate Hunters and Anglers

E-mail E-67-1. Thank you for the opportunity to provide scoping comments on this important issue I currently reside in Missoula and formerly lived in Hungry Horse and Kalispell. I have spent many memorable days fishing all three forks of the Flathead River and Flathead Lake. This system is one of Montana's most important fisheries and one that deserves to be restored – if we lose the viability of native bull trout and westslope trout in Flathead Lake and the North and Middle Forks, we have failed not only the fisheries we are entrusted with the care and management of, but we have failed ourselves and our children of right to experience and enjoy these irreplaceable native trout fisheries.

E-mail E-67-5. I do not view the management of Flathead system as either "all lake trout", or "all native trout"…quite simply, neither end of the fisheries spectrum is feasible in this case. I believe that the only effective way to manage the fishery is to suppress lake trout numbers, ideally to pre-*Mysis* shrimp/lake trout explosion levels, so that bull trout and cutthroat trout populations can recover to pre-decline levels. In doing so, there will be a balanced fishery, defined as a recreational lake trout fishery along with a native trout fishery sustained at pre-decline levels. I do not believe that the current state of the Flathead system is balanced or that the status quo is acceptable. I fully support whatever tools it takes to achieve the level of lake trout suppression it requires to recover bull trout and westslope cutthroat trout in the Flathead Lake system and achieve much-needed balance in the fishery. Sincerely, Corey Fisher

E-mail E-69-1. First of all, I am in favor of the plan. There are, however, a few issues that seem to me to be important and should not to be overlooked: Social issues. The Polson conference yielded a very clear verdict: The fishery could not be managed for trophy lake trout and at the same time produce an increasing bull trout population. As one participant put it, "Jim, just take the heat. It's part of the job." Well, no one took the heat, and the result was a management compromise that went full in the face of the Polson conference's verdict. The result has been a downward spiralling bull trout population. The commercial outfitters have had their chance; now it is time for the native fish to have their turn. Sincerely, John Winnie Sr.

E-mail E-70-2. I would very much like to voice support for the inclusive efforts of the fisheries managers to find ways to reduce the overgrown lake trout population in Flathead Lake in order to give our vanishing native fish species a chance to survive.

E-mail E-71-1. Thank you for the opportunity to comment on the Flathead Lake and River Fisheries Co-Management Plan Pilot Project NEPA process. I applaud your ability to continue to work together on this issue of such importance to our state. I firmly believe the course of action you ultimately choose will have a significant impact on the angling opportunities in Northwest Montana for decades to come. I have been fishing Flathead Lake and the Flathead River for over 30 years. I remember catching westslope cutthroat and bull trout from the dock of our family cabin on the west shore of Flathead lake in the 1970's and 80's. It has been a long time since I have landed or even fished for a cutthroat off the dock. I also spent many hours trolling for kokanee salmon on the lake with my father-in-law and my son and nephews. I remember when the fishery started changing-no more cutthroat or bulls from the dock, fewer kokanee and more lake trout. At the time, I did not understand why the fishery changed in the way it did. I am not a biologist nor do I have any kind of a science background. For many years

I simply accepted that the change I was seeing in the Flathead fishery was inevitable and part of some type of divine plan. My simple acceptance ended when I started becoming aware of what happens when non-native species and organisms are introduced into a watershed and how those introductions affect native species. This leads me to the point I would like to make to you and everyone else that is making decisions about the Co-management plan: Lake trout are not native to the watershed and they eat young cutthroat and bull trout. The only chance we have of saving our westslope cutthroat and bull trout fishery is to suppress lake trout numbers to a level that gives our native species the opportunity to grow and reproduce.

E-mail E-71-10. Our headwaters in Northwest Montana are a source of some of the cleanest and purist water on the planet. This clean, pure water is not a particularly nutrient rich environment for aquatic species to live in. Two of the native species that have uniquely adapted and habituated to this harsh, nutrient poor environment are the westslope cutthroat and the bull trout. The introduction and presence of lake trout not only makes a harsh environment harsher, it threatens the very viability of these native species. I urge you to choose a course of action that will remove enough lake trout to allow our native species to thrive and grow and reach population levels similar to what we had in the 1970's and 80's. Thank you again for the opportunity to comment. Dan. Dan Short

E-mail E-67-2. The NEPA notice page asks the questions: "If possible, tell us how you would suggest that we meet our goals of increasing native species and decreasing lake trout, within the confines of our current Flathead Lake Co-Management Plan?" In short, I would suggest that the goals of increasing native species and decreasing lake trout be achieved by whatever means are necessary. I'm not a fisheries biologist, so it would not be inappropriate that for me to suggest that I know more about the best way to suppress lake trout than the people who are trained and manage this system and recover native trout species. However, as one of the many people who use, enjoy, and care about this fishery, I throw my full support behind reducing lake trout and increasing bull trout and westslope cutthroat trout populations…how this goal is accomplished is not nearly as important to me as actually achieving this goal.

If gillnets are required to reduce lake trout numbers and increase bull trout and cutthroat trout, then so be it. The bottom line is that recreational angling has not resulted in reductions of lake trout in the amounts set in the co-management plan and something more needs to be done. In my opinion, a pilot project should test new and more effective lake trout suppression tools so that future management decisions can be made knowing if that chosen tools are effective to meet the twin-goals of reducing lake trout and increasing bull trout and westslope cutthroat trout.

E-mail E-70-3. I fully support the use of gillnetting, trapping or any other methods needed to supplement recreational fishing in order to remove sufficient numbers of lake trout. Any preferred solution must above all be based on sound science.

Letter L-24-1. Postcard from 28 people:

- Reduce lake trout population to result in the recovery of native fish.
- Use best available science.
- Any proposed project should complement the current angling strategy with more aggressive methods based on the best available science.

Letter L-24-5. Our native fish deserve our energy

Letter L-24-6. Years ago it was always a fisherman's pleasure to always catch your limit of westslope cutthroat. Today it is almost impossible.

Letter L-24-8. Save our native fish for our children's children.

Letter L-24-9. Go Bulltrout.

E-mail E-75-2. I know that this issue will be coming up for consideration this summer and I hope you will put the emphasis on saving our native stocks and the resource they represent. Thank you. Sincerely, Jim Borowski, Kalispell

E-mail E-44-2. I am curious: are Tribal, federal, and State agencies not obligated under the Endangered Species Act to do all they can in terms of management of the lake to ensure the survival of bull trout, a listed species? To not use strategies that have proved successful in other large lakes and instead allow bull trout to be extirpated from the lake and its tributaries seems irresponsible at best and in violation of at least the spirit of the law. I agree with Marc Racicot when he said, "The bull trout is a native Montana fish and Montanans have not only a legal but a moral obligation to maintain viable populations of native species. We owe it to future generations of Montanans to be good stewards of resources that are as much theirs as ours."

E-mail E-27-13. If the results of the pilot project indicate that lake trout can be suppressed to increase bull trout and westslope cutthroat numbers, we recommend that the ultimate objective for both species—to be identified in a new co-management plan with new objectives—should be population levels emulating those of the 1980s, when angling and limited harvest for recreational and cultural purposes was allowable. The Confederated Salish and Kootenai Tribes have supported this position throughout the current Co-management plan. We recommend both co-managers support this long-term objective. The Montana Bull Trout Restoration Plan, which MFWP helped prepare and signed the same year the existing co-management plan was approved, states this as an objective.

Response

The purpose of the action alternatives is to reduce the population of non-native lake trout in Flathead Lake to benefit native fish species. They are based upon over two decades of continuous and cooperative regional research, management, and planning between Tribal, State, and Federal agencies. The research, joint planning efforts, and decision-making processes are recorded in our guidance documents, which include: the Flathead Lake and Fisheries Co-Management Plan (2000), the Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin (2000), the Cutthroat Memorandum of Understanding and Conservation Agreement (2007), the Flathead Subbasin Plan, Part III (2004), the CSKT Comprehensive Resources Plan (1996), and the CSKT Fisheries Management Plan (1993). The action alternatives would play a critical part in achieving several of the goals and objectives of these plans and policies (Appendix 1)

Missoula—14 April 2010 Mm-8. Is there a target # of redds that indicate recovery?

Response
Items that we plan to monitor are listed in Chapter 1: Relevant Issues and the analysis of each action alternative estimates increases in adult bull trout, which would be determined through a formula based on the number of redds. While we do not have a target number of redds that indicate recovery, we do know the redd counts during the 1980s were substantially higher than redd counts from recent years.

Remove lake trout

E-mail E-2-5. American Rivers recommends the implementation of a lake trout gillnetting program aimed at reducing the adult (age 4+) lake trout population in Flathead Lake by 25-50 percent. This will ensure harvest levels are sufficient to offset any compensatory recruitment that results from decreased lake trout densities and younger spawning ages. In order to maximize this program's chances for success and measure its impact on multiple age-classes of bull trout and westslope cutthroat trout, the program should be carried out for at least five consecutive years.

Letter L-1-3. My worry is that the 25% target isn't enough to increase bull trout and cutthroat. The panel of experts (1997) pretty much agreed that a 70% to 90% reduction was needed.

Letter L-2-3. My worry is that the 25% target isn't enough to increase bull trout and cutthroats. The panel of experts in 1997 pretty much agreed that a reduction of 70% to 90% was needed to start increasing bull trout. I fish the river (North Fork, Middle Fork, and Main Stem) a lot, all year, and I've noticed a disturbing absence of juvenile bull trout the last three years. The cutthroat fishing isn't good either. If the lake was still healthy the river would have more fish. We need to increase the harvest and use the river as the litmus test of success. Please support the Tribes' plan to gill (and or trap) net Flathead Lake. Done carefully with thought it seems our best chance to restore bull trout (and cut throat) to the river and achieve the goals of the Ten Year Plan. Thank you. Sincerely, George Widemer.

Letter L-9-2. For successful bull trout re-establishment, the scale or formula for lake trout removal must be significantly shifted to the "removal" part of the equation. By removing only 25% (100,000) lake trout, your attempts will be unsuccessful. Please, if you're going to gillnet (which I feel you should), reconsider this consideration.

Letter L-9-3. The outfitters pressure is not insignificant I realize, but with the slots available, they will still be able to offer their clients a chance of a trophy. But as a scientist myself, I don't think a harvest of 25% lake trout is enough to make a difference, and a waste of money. Sincerely, Patrick Robins, M.D., Missoula

E-mail E-25-7. Suppress the adult lake trout population to 50% of current population levels by launching sustained gillnetting and live trapping programs. It's critical to suppress lake trout at a much faster rate than we've seen in the past decade under the current management

plan. One important factor is to ensure that the removal rate exceeds the lake trout recruitment rate (estimated at 25%). Flathead Lake would still have a robust population of lake trout—and easily sustain a thriving recreational lake trout fishery—even if the current population is reduced by 50%. Gillnetting and live trapping can be conducted to minimize bycatch of native trout, and are scientifically proven to be effective means of lowering the number of nonnative trout to restore native trout numbers.

E-mail E-27-2. Montana Trout Unlimited and its Flathead Valley Chapter support a preferred alternative that would include the following elements:

- A reduction rate of age 3+ or 4+ lake trout of no less than 50 percent and perhaps up to 75 percent of the current estimated populations. This is within the range of the modeling that has been shown to overcome a compensatory effect of increased lake trout recruitment. The remaining lake trout population in Flathead Lake will still produce a good lake trout fishery, and probably one that includes more fish in good condition with higher growth rates than is currently the case.
- A rate of annual removal that is adaptive in nature and which the ID team concludes is necessary to meet the target for measurable bull trout recovery at the end of the pilot project. We recommend, however, the ID team examine a couple of approaches: 1.) Achieving most of the reduction in the first couple of years, with another large reduction effort in years 5-6 to reduce fish from the expected recruitment bubble generated after the first years of the suppression effort; or, 2.) taking a more incremental approach, annually increasing the exploitation rate over time.

E-mail E-28-3. A lake trout reduction of 50% would be acceptable to me. This may have an impact on recreational fishing in the lake, but lake trout can be harvested from lakes all over this country, and the loss of bull trout from the system would be far more harmful to the people of this state than a reduction in lake trout fishing opportunities.

E-mail E-13-2. The recent proposal by the CSKT to remove 60,000, 80,000, and the 100,000 lake trout per year by 2012 is a good goal, as far as it goes – but it doesn't go nearly far enough. I strongly encourage you to continue ramping up the lake trout harvest until 200,000 fish are removed per year by 2015. Contrary to your stated goal at the Kalispell public meeting, the objective must absolutely be to "crash" the lake trout population, but to do so in a controlled process whereby native fish populations are assisted in recovering, as lake trout numbers are reduced.

E-mail E-53-2. By reducing their numbers by say 50%, you would expand both the bull and cutthroat population, and provide much more fishing days on the Flathead river system for the public.

E-mail E-70-4. Scientific evidence suggests that a removal of at least 50% of the lake trout population will be needed in order to assure a decline in the population.

E-mail E-71-2. That said, I personally want to see the Tribes and MFWP agree on a course of action that would—Reduce lake trout numbers by an absolute minimum of 50% from current levels.

E-mail E-71-8. Your own studies have shown that the reduction in the numbers of lake trout that prey on the native species is our best op-

portunity to restore the westslope cutthroat and bull trout populations. If you were able to reduce lake trout numbers by 50% or more, not only would you give our natives species a fighting chance to survive, you would still have a viable lake trout fishery. And it would be a more diverse fishery.

Letter L-24-3. Let's shoot for more than 50% reduction (in lake trout)

Letter L-24-4. Please get at least 70% of the lake trout.

Letter L-24-11. Please shoot for 50% of the lake trout.

E-mail E-75-1. As a concerned angler and resident of Flathead Valley I strongly support restoring the Flathead's native fish populations. To this end I favor gillnetting and trapping of lake trout in Flathead Lake to reduce their numbers by at least 50%. I fear that without such measures, conducted for at least a 10 year period to effectively gauge the impact on bull trout, we will lose both the bull trout and the westslope cutthroat as a viable fishery. That would be a loss far greater than any benefit derived by retaining high lake trout numbers.

Response
Population modeling has helped us set targets (Chapter 2). Based on results, our action alternatives B, C, and D include 25%, 50% and 75% reductions in lake trout numbers from 2010 levels. Effects on fish species and invertebrates are discussed in Chapter 3 of the DEIS.

E-mail E-13-5. The Tribes – and MFWP if it rediscovers its biological and professional spine – should accomplish these significant reductions in lake trout through a comprehensive program of gillnetting, commercial netting, angling, and the use of new technologies as they arise. Fish caught by the Tribes and MFWP should continue to be donated to food banks, while commercial operations should develop contracts with local restaurants to provide them with a consistent supply of lake trout for their menus – providing an economic boost throughout the Flathead and Mission Valleys.

E-mail E-14-1. I support the Tribes efforts to control lake trout in Flathead Lake. I believe there is enough evidence that angling alone will not do the job, and so I support gillnetting if the Tribes' biologists believe that is the appropriate control measure. David Rockwell

E-mail E-13-3. While we all understand that it is not possible to completely remove lake trout from the Flathead system, at least with current technology, the effort to systematically and dramatically reduce their numbers must begin now, and once achieved, continue at a maintenance level in perpetuity. Despite their misguided introduction by Montana Fish, Wildlife and Parks (MFWP) nearly a century ago, lake trout are alien invaders that have no place in an ecologically healthy Flathead basin system. They are the fish equivalent of Canadian Thistle, Russian Knapweed, and European Starlings, and should be treated as such.

E-mail E-7-4. We need to remove more lake trout from Flathead Lake, design way to do this that is acceptable to all.

E-mail E-13-4. . Bull trout and westslope cutthroats have co-evolved along with the Flathead River system for at least 10-12,000 years, and as such, their ecological health depends on one another. The same is not true for lake trout, and as their introduction graphically demonstrates, their presence not only disrupts the ecological balance, but leads to its destruction, and cannot be tolerated for political reasons – as we currently see MFWP doing.

E-mail E-13-6. Because they spawn in shallower water, bull trout and cutthroat trout potentially provide valuable protein sources to everything from loons, mergansers and osprey, to bald eagles and grizzly bear. As deep-water spawners, lake trout provide none of these benefits – once more short-circuiting a 10,000 year-old ecological system that both the Tribes and MFWP are supposed to be protecting.

E-mail E-13-7. The National Forest Management Act (NFMA) and the Endangered Species Act (ESA) require all federal agencies, as well as non- federal agencies that receive federal dollars, assistance, and authorizations, to manage for viable populations of all native species; to conserve listed species and their habitat; to take no action that Jeopardizes a listed species; and to prohibit the unauthorized "Take" of listed species. The continued presence and dominance of lake trout in the Flathead Lake and river system (aided and abetted by MFWP's inaction) violates all of these principles.

E-mail E-13-8. Proponents of keeping high numbers of lake trout in the system often state that significantly reducing lake trout numbers will destroy a large recreational fishery that bull and cutthroat trout, even if recovered, cannot replace. This of course is nonsense. They seem blissfully unaware of the multi-million dollar fishing-based economy in Montana's "Golden Triangle" without a lake trout in sight.

They also appear to be clueless as to the historic Flathead fishery, producing significant numbers of large bull trout and cutthroats, until they were decimated by over fishing, logging, roading, and sedimentation of key tributaries, and now lake trout. I would suggest that your slide shows incorporate historic photos from the Hungry Horse News and MFWP archives showing the huge stringers of 16-20" cutthroats and 24-36" bull trout that were common right up until the 60's.

E-mail E-13-9. If we get the majority of lake trout out of the system; continue restoring logging-damaged watersheds, and reduce excessive densities of forest roads, it's probable that we could once again have a tremendous fishery and recreational economy based on Natives – not Alien Invaders. Sincerely, Brian Peck, Columbia Falls, MT

Letter L-6-2. Lake trout are an invasive species and quite boring to catch (might as well tie a log on the end of your line and pull it in for fun). They are ugly, if someone wants to sully their walls with a lake trout mount, that's their problem. If people want to fish for them, go back to Minnesota!

Letter L-6-3. Lake trout gobble up everything in sight, hence, are very easy (and boring) to catch. They also eat up preferable game fish such as bull trout, cutthroat trout, and rainbow trout (an acceptable 'invasive' specie).

Letter L-6-6. In summary, if all the lake trout were ousted from Montana, I would be a very happy and content angler and conservationist . If people don't like fishing for Montana Fish in Montana, tell them to get out of our state and go fish the Midwest instead! I'm glad to see the Tribes and MFWP are working together to get it done! Thank you for working together on this matter. Nate Buffington, Polson, MT

Letter L-9-1. I am a regular recreational fisherman for the past 30 years on Flathead Lake, and applaud your plan to help replenish the populations of bull trout and cutthroat trout. In my opinion, spending countless hours on the lake, there is really not much of vibrant recreational fishing for lake trout on the lake. A few scattered boats on any day at best.

Polson—12 April 2010 (written) P-1-1. On behalf of Mission Mountain Audubon, as President, we have had lake trout presentations for 10 years. There are 130 members who support the Tribes' proposal to reduce lake trout.

Letter L-6-1. Thank goodness, finally a plan that addresses the invasive lake trout in Flathead Lake and associated drainages (getting up into Glacier National Park and above the Swan, I understand?)!

E-mail E-2-3 Why further reducing the lake trout population is necessary. Flathead Lake is hardly the only place in the west where nonnative lake trout have caused sharp declines in native icthyofauna. Lake trout have been implicated in the decline or disappearance of Yellowstone cutthroat trout in Jackson, Heart, and Yellowstone lakes in Wyoming; Bonneville cutthroat trout in Bear Lake, Idaho-Utah; Lahotan cutthroat trout in Lake Tahoe, California-Nevada; bull trout in Lake Pend Oreille, Idaho; and Utah chub in the upper Green River upstream of Flaming Gorge Reservoir in Wyoming.

E-mail E-2-4. While the current strategy of keeping Flathead Lake's lake trout population in check via recreational angling and fishing tournaments is well-intended and popular with anglers, it clearly is not doing enough to give bull trout and westslope cutthroat trout a chance to rebound to 1980s levels. The lake trout population in Flathead Lake is estimated at 400,000 individuals, while the bull trout population is estimated to be less than one percent of that, or approximately 2,500-3,500 individuals. This is despite a decade of targeted angling for lake trout, which has removed an average of 45,000 lake trout a year from the lake.

Letter L-1-4. I fish the river (North Fork, Middle Fork, and Mainstem) a lot, all year, and I've noticed a disturbing absence of juvenile bull trout the last three years. The cut fishing isn't as good either. I think if the lake was healthy we'd have more fish in the river. We need to increase the harvest and use the river as the litmus test of success. It's nice to be preaching to the choir. Thank you, Sincerely, George Widemer

E-mail E-25-1. The Clark Fork Coalition appreciates the opportunity to provide comments on the Flathead Lake Co-Management Plan. The Coalition supports the goals of increasing native trout populations and decreasing lake trout in Flathead Lake, one of the most treasured lakes in the Clark Fork watershed and one of the most pristine lakes in the world. We urge the Confederated Salish and Kootenai Tribes (CSKT) and Montana Fish Wildlife and Parks (MFWP) to expand their management plan to include more aggressive lake trout suppression tools in order to restore bull trout and westslope cutthroat trout in Flathead Lake.

E-mail E-25-5. The Coalition believes that the Co-Management Plan offers an opportunity for the CSKT and MFWP to proactively address the imbalance in Flathead Lake's fishery by significantly ramping up efforts to suppress lake trout and restore native trout populations. We recommend undertaking the following actions:

E-mail E-25-6. 1..Set a target for true bull trout recovery. The Coalition encourages the CSKT and MFWP to ensure this Plan restores bull trout to population levels found in the 1980s, before the collapse of kokanee salmon and the discovery of *Mysis* shrimp.

Letter L-12-7. * I enjoy fishing for lake trout, but I remember what this lake was like in the 70's and 80's. I would love to see the bull trout & Cutthroat Trout return to previous levels. It was a better fishery back then!! Marion Cooper, Polson, MT.

Letter L-16-6. I enjoyed the slideshow at the meeting and appreciate all your efforts to control the lake trout. I can remember catching both bull trout & Kokanee from the lake. We need to find a way to have that diversity again. Thanks, Darlene Cooper.

E-mail E-28-2. I encourage the Tribes to consider aggressive efforts to reduce lake trout in the environmental assessment. These aggressive efforts will likely need to include netting of lake trout that is targeted to reduce bycatch of bull trout. Lake trout numbers should be reduced enough to make a real difference in their numbers.

E-mail E-42-1. I am writing regarding the proposed fisheries management plan for Flathead Lake. I support the plan to reduce or hopefully even eliminate non-native lake trout in the Flathead watershed. Thank you for considering my input. Best Regards, Scott Ziegenfuss, Hamilton, Montana

E-mail E-49-3. Basically, my feelings on this are more radical than any I have heard expressed. If it were possible to totally eliminate lake trout from the Flathead system, I would be in favor of it.

Letter L-21-2. So any method for decreasing grey (Lake) trout ought to cause as little cutthroat kill as practicable, should it not? (wants to be able to fish for cutthroat trout to keep, L-21-1). Edwin Speelman, Kalispell, MT

E-mail E-50-4. Just wanted to give my "2 cents" on this issue. I send accolades to those involved with this concerted effort and hope the environmental plan is moving forward, receiving the much needed support it deserves. Take care. Please feel free to email and questions or comments you may have. Brendan.

Response
We used an age-structured stochastic simulation model to predict changes in the age structure and size of the lake trout population resulting from the various levels of harvest that would occur under the four alternatives. The results are presented in Chapter 3. The modeling is

described in more detail in Appendix 6. The predicted bycatch for bull trout, westslope cutthroat trout, and lake whitefish that would occur under each alternative is included in Chapter 3.

Leave the Lake Alone (Support No Action)

E-Mail E-200. Please no action - continue sport fishing and Mack Days!!!

E-Mail E202. I support alternative (1) no action (maintain the status quo of lake trout harvest from general harvest and fishing contests). I have vacationed in the Flathead Valley for several years primarily for the opportunity to fish for and to catch lake trout on Flathead Lake. I feel that gillnetting will drastically reduce the excellent lake trout fishing that I have been coming for, and I doubt I will come back if you end up gillnetting Flathead Lake. In addition, I doubt other tourists such as myself will continue coming if drastic measures such as gillnetting are taken. Should myself and other tourists stop fishing Flathead Lake as result of gillnetting, the Tribes will not receive the $12.00 fishing license fee for the South half of the lake. On June 30th, 2012, I caught and released the attached 26.4# lake trout so that someone else might have the same enjoyment that I did.

E-Mail E203. I support alternative (1) no action (maintain the status quo of lake trout harvest from general harvest and fishing contests. With Spring and Fall Mack Days which are well received by those of us in the angling public and a combined harvest of lake trout out of Flathead Lake in excess of 56,350 fish per year and rising, general public harvest of over 40,000 lake trout per year, Charter Boat combined harvest, and Mack Attack harvest, over 100,000 lake trout are currently being removed per year. As you know, MFWP will be doing a complete Flathead Basin wide bull trout redd count this fall which will give all of us a better idea of the bull trout populations. I feel that netting is unwarranted and a terrible waste of taxpayer dollars, not to mention the horrific bycatch of non-targeted fish that we all know will happen especially to bull trout (as has happened in Swan Lake), Lake Superior whitefish, and other species of fish that are native fish. MFWP has taken a beating over mysis shrimp. If the trophy lake trout fishery and water quality degrade due to gillnetting, does the Confederated S&K Tribes want to be known as the Native Peoples that ruined Flathead Lake? I think not, but if Flathead Lake is ruined due to actions taken By the S&K Tribes, you know that will NEVER be forgotten. Thank you for the opportunity to comment.
E-mail E-45. Flathead Lake native species include lake trout. Maintain recreational fishing and please leave the lake alone. Bill Bailey

Letter L-13-14 I fish between 150 and 200 days a year and I have noticed an increase in bull trout. James R Hoover, 101 Antelope Trail, Whitefish, MT 59937-8426, 862-1316

E-mail E-47-2. My suggestion is this... Stop increasing the amount of lake trout killed for a few years and stay at the present rate of elimination to observe what impact that we have made already. (We have made one...) It takes time for the results to catch up with our actions. I personally know of more bull trout being caught this year than I have seen in many years past. If, after some time, we see that the results don't match what is desired, then we move ahead SLOWLY! The decisions that we make now affect the ecosystem here for many years to come, so nothing drastic should be done all at once. It just seems that the more fish that we catch and kill, the higher that the numbers

get that you plan to eliminate each year. (Your numbers and statements keep changing...)

E-mail E-34-1. An old lady once told me; “What wuz, wuz”. I guess that summarizes my feelings about the fishery on Flathead Lake. There used to be a good fishery for a number of species on the lake and then the *Mysis* shrimp was introduced. The fishery changed dramatically and I don’t believe it will ever return to what it was, no matter what we do in an effort to ‘return to the good old days’.

E-mail E-34-3. There is a good, fishable, population of lake trout and they are fished by both the commercial guides and the general public. They have the ability to catch large fish and large numbers of fish. To me, this is what the public, in general, wants to see. I don’t think the public wants to ‘take out the lake trout’ and then have a minimal fishery for all species.

Response
We understand the importance of lake trout to many Flathead Lake anglers. This does not, however, undo our obligation to improve conditions for native species where appropriate. The Flathead Basin provides superb native fish habitat, and it is an appropriate place for our efforts to improve conditions for native fish species. In our assessment, we can do this while continuing to provide substantial lake trout fishing opportunities in Flathead Lake. The effects of each of the action alternatives on fishing opportunities are discussed in detail in Chapter 3 of the DEIS.

Letter L-5-1. Generally I am a proponent of native fisheries and have supported your noble objectives to restore bull and cutthroat trout in Flathead Lake. However, even the smartest, toughest, and most skilled boxers in the world lose a match. The objective to restore native bull and cutthroat trout in Flathead Lake cannot be achieved and should be abandoned. Please discontinue the expensive and unsuccessful Mac Days and abandon plans for more drastic measures like gillnetting or fish trapping. If fishery managers need to resort to these drastic measures, I am afraid that the lake trout have already won the battle in Flathead Lake. It is time to throw in the towel and live to fight another day for a different management objective. I would propose you focus on the following: Reallocate the funding for restoring native bull and cutthroat trout in Flathead Lake and spend it in other locations where prudent management may still make a difference, there is a higher probability of success, and there is a higher return on the investment.

Kalispell—13 April 2010 (written) K-6-5. Quit living in the past—can bull trout recover?

Kalispell—13 April 2010 (written) K-9-2. The Flathead River System has one of the strongest bull trout populations anywhere. Why do you think we need more? Kokanee was a main food source for past high populations of bull trout in the lake. Is it ever possible to have a higher population without the kokanee? The upland spawning habitat has been improved. Why don’t we give it another 20 years to see the results. Address the lake trout in Swan Lake and lakes in the Park first before doing anything in FH! You have gain (gained?) very little public support for reducing lake trout. Why aren’t you listening. Gary Dahlgren

Polson—12 April 2010 (written) P-3-1. There has been a steady increase in bull trout. Redds (the place in a stream where they lay their

eggs). This statistic comes from the state fish and game who I believe are creditable as opposed to the tribal fish and game who are attempting to create a picture of failure so they can go ahead with a massive gill-netting campaign which is a bridge to nowhere and will stuff somebody's pocket with green backs.

E-mail E-16-1. I am very strongly AGAINST this proposal. I believe that the natural resources of this state of for us all to enjoy and use and benefit from. Right now, the Flathead Lake fishery is wonderful. My kids and I spend many "angler days" on the water every year and find the fishing to be good: we like to fish for lake trout, we like to eat lake trout, and we like to have plentiful "action" - that's a big deal with young anglers in the boat.

E-mail E-7-3. Based on observations of the past few years, bull trout have increased in the Flathead River (therefore deceasing lake trout is not needed).

E-mail E-36-3. In case I am not making myself clear. I am not in favor of reducing lake trout numbers. I am in favor of enhancing and improving the Lake trout fishery in Flathead Lake. I am in favor of applying my resource dollars upstream to improve Bull trout and cut throat trout fisheries. The majority of the people that use Flathead Lake feel the same and we are not being represented. And our view is not even being considered. Proof of that is your request for comments not allowing that opinion. Russell Swindall, Kalispell Montana

E-mail E-16-2. I find it preposterous to go through and purposefully kill thousands and thousands of good fighting, good tasting, and good sized game fish, just to for the "chance" that the bull trout and native cutthroat might increase their numbers.

Letter L-7-1. As a Tribal Member who has lived near, in, on, and around Flathead Lake nearly all my life, and am concerned about the plight of bull trout and other Tribal resources, I have the following comments to make concerning the proposal to reduce lake trout numbers by gillnetting. Gillnetting results in the death of all or nearly all captured fish, so how can you be confident that this effort will not actually reduce the populations of those you want to save (bull trout, Cut Throats, & trophy size Macks).

Letter L-8-1. I don't believe there is a solution to increasing the bull trout population on a permanent basis. Certainly the pilot project proposed for the netting of lake trout could produce favorable increases of bull trout in the short term, but then over time you would probably be back to the situation as it exists today. And I feel that the impact on the lake trout fishery would be economically devastating if large scale netting were to occur.

E-mail E-46-1. Thank you for the opportunity to comment on the proposed attempt to remove adequate numbers of lake trout from Flathead Lake to promote the recovery of a strong population of bull trout. It is unfortunate that I can not speak of this particular situation from a strong scientific basis as I have not been privy to the scientific data that would suggest that such an enormous management program would be possible and have a strong likelihood of success resulting in the development of a large and self sustaining population of bull trout and other native species. A commendable biological goal. While I have no experience in the restoration of aquatic species nor biological restoration on such a large scale, I have had some experience in the restoration of an endangered habitat and of endangered plants and animals along with dealing with many species of exotics. While engaged in this process, I have had the opportunity to give this process a lot of thought along

with work on the ground. The biologist in me tells me that the goal is noble but the pragmatist in me tells me that this may be yet another attempt to unwind a change in the ecology that is only completed, as many of my restoration colleagues have stated, “when the money the money runs out”. Typically, on such a large scale, the biological results are mixed and of less than desired benefit. It also seems that the larger the scale the more this is true. One has to consider that the lake is artificial in the first place, exotic species have been introduced to the lake from the mysis to the lake trout and many in between. The food web, species interaction and the influence of increased human population on the lake may have irreversibly changed the ecology of the lake. Whether we like it or not, when an ecosystem this large has been altered this significantly over the time period involved it is likely that it has evolved into a new ecosystem that accommodates the new players and some of the old players may lose out. These changes may be scientifically studied and reported but changing them is another matter. I assume that you have strong scientific indications that would support the economics and techniques that would be employed.

E-mail E-74-2. Gillnets would not work in your conditions. Gillnets work well where there is a current or narrow place the fish travel for spawning or schooling and not in open waters such as the lake affords.

E-mail E-34-2. Currently bull trout and West Slope Cutthroat Trout are species of concern and the effort seems to be a massive reduction of lake trout. There are no ideas out there that predict the growth of the bull trout or WSCT populations that will remove them from peril and again allow us to have a fishable population. That seems to be the ‘ideal’ goal, but no one knows if it will work. All the current efforts are ‘hopeful’ at best.

E-mail E-65-1. I have been watching the gillnetting proposal since it first hit the papers. I have also been fishing Western Montana waters and especially Flathead Lake for over 50 years. I have seen the demise of the Kokanee, rise of Lake Superior whitefish to the massive biomass level it now occupies, the introduction of mysis shrimp and the proliferation of Lake trout (Macks) as a direct result. I have also seen basically the total periphery of the lake developed, mostly for private use. Flathead Lake is not now and can never be the same as it was, no matter the good intentions, desires of any group or wishful thinking.

E-mail E-47-1. Let me begin by saying adamantly that I am completely against the “plan” concerning Flathead Lake and the mackinaw in it. However, the reasons that I am unfavorable of it is not necessarily because of the primary desire to bring back some of the native species. That is a noble cause. What causes me to disagree is when it comes to the issues of process, leadership, and the lack of logic. While there are self-defensive claims that the plan is based upon strategy, this is not so. As a matter of fact, logic, science and experience would dictate that what is being planned is foolish and will not work.

E-mail E-65-2. I agree with reducing the numbers of lake trout but have no illusion that there is any way to reduce the level to where bull trout and Cutthroat Trout can be restored to historic levels. There have been too many changes and too much money is involved, from CSDT perspectives, business ventures and interested residents, both tribal and non-tribal folk, in Montana. The current mack days (I don’t fish it so have no ‘dog in the fight’) but it is taking a large number of fish from the Lake and perhaps is making a difference--maybe! In my opinion there is zero chance of gillnetting or any other concentrated plan reducing lake trout on a permanent basic without being prepared to spend

very large sums of money forever. Gillnetting is basically a short term solution that could be successful over the short term but CSKT doesn't have the money to sustain it long enough for Bull and Cutthroat trout to return to former glory. As long as mysis shrimp are in the Lake, Macks will prosper and regain dominance as soon as pressure is reduced on them. Major and permanent Mack reduction simply isn't going to and can't happen and I think the powers that be know it! It's not logical--and yes I do have a Biology degree with wildlife/fisheries management option although I've never practiced the profession.

E-mail E-34-6. There are other lakes in the area where BT and WSCT are doing fine; we don't need to try and make Flathead Lake the same pristine lake it once was particularly when no one knows if any modification would be successful. Jon A Dahlberg, Kalispell

Missoula —14 April 2010 (verbal) Mm-16. What if bull trout don't come back?

Response
Our analysis tells us that it is possible to improve conditions for native trout species in Flathead Lake and its tributaries while maintaining fishing opportunities for lake trout. In addition, we are bound by Federal laws and Tribal policies to fulfill these obligations.

Annual counts of spawning nests—termed redds—provide the data for enumeration of the number of adults spawning in a particular year. The total numbers of bull trout redds counted have declined by over 50% since the highest counts in the early 1980s. The decline in the North Fork Flathead system has been greater than the decline in the Middle Fork system. Three of four spawning streams inventoried in 2011 had less than 10 redds each. Such low counts are indicative of a population at risk.

We believe that we have crafted a reasonable range of alternatives to meet the goals and objectives of our guidance documents (Appendix 1), which guide our management of fisheries on Flathead Lake. We have also analyzed the effects of each of the alternatives on lake trout, bull trout, westslope cutthroat trout, lake whitefish, and invertebrates, including *Mysis*. The results are in Chapter 3 of the DEIS.

Kalispell —13 April 2010 (written) K-9-5. Lake trout numbers have been stable at about 440,000. Why not manage for that number? The lake is still functional. Why __ (can't read—apail) the existing lake trout fishery?

Polson —12 April 2010 (verbal) Pm-1. Don't we have a moral obligation to keep lake trout?

Polson —12 April 2010 (verbal) Pm-5. Is it against the ESA to wipe out lake trout for bull trout?

Kalispell —13 April 2010 (verbal) Km-18. Is there a size of lake trout you want to target, to reduce down to?

Kalispell —13 April 2010 (verbal) Km-25. How many lake trout do you have to take—60,000?

E-mail E-61-1. Fishing report for Flathead Lake for Saturday May 15th, 2010. I spent the 8 hours on Flathead Lake on Saturday and wanted to report. I watched 25 boats jigging in the Yellow Bay area where rumor had spread that this is where people were catching fish. I witnessed 4 fish caught on other boats in 8 hours. We caught 4 fish on our boat in 8 hours. Three under 2 pounds and one at 5 pounds. Two friends fishing on the North end of the Lake caught none and did not hear of a fish being caught and did not witness a fish being caught. These people and myself were spending time and hard earned money to maybe catch a few fish. This is a normal good day of fishing on Flathead today. I remember when that would have been considered a terrible day. Nobody was trying to catch a bull trout. What will we fish for when the Lake trout are gone. You made the statement at one of the last meetings that the Lake trout fishery would not be harmed and the lake trout population could not crash. It already has. Russell Swindall, Kalispell.

Kalispell —13 April 2010 (verbal) Km-26. If lake trout start maturing younger, aren't we going to have to start over again?

E-mail E-30-13. Lastly, those groups who would belittle the lake trouts value to a fishery do NOT represent Montanans who just want to catch fish. Comments that call lake trout names and suggest it's like "hauling in a log" or that they are "worthless" bring NOTHING to the debate. The lake trout is PRIZED in many areas of North America as a sport fish and food fish. The MAJORITY of fish we catch in Montana, weather its ice or open water fishing, are not native to the state or the water we fish them in. (The lake trout IS native to Montana waters.) Kokanee, Rainbow, Browns, Perch, Pike, Lake Whitefish, etc. ALL add value to fishing and fisheries. Ask the retailers where their sales are...Purists and elitists who belittle one species over another should get out more...or keep their separatist, intolerant opinions in check during a debate such as this. Flathead Lake will NEVER be what it was before human hands meddled, and the more we meddle, the worse it seems to get. Respectfully, Mike Howe, Kalispell, MT

E-mail E-57-5. I am very opposed to idea of eradicating a game fish because it is not the one some people prefer.

E-mail E-37-3. We also do not want to cause animosisty among our community and non-Tribal members. Flathead Lake and its fish, all species, belong to ALL of us!!!!! Please use a common sense approach to this program. Thank You, Chancy Jeschke

Response

Goals of the Co-management Plan are to Increase and protect native trout populations (bull trout and westslope cutthroat trout) and balance trade-offs between native species conservation and nonnative species reduction to maintain a viable recreational/subsistence fishery. We believe, based on our analysis that we can do both (see Chapter 3 of the DEIS).

Lake trout are not a protected species under the Endangered Species Act, and it is not our goal to eliminate lake trout from Flathead Lake. Our goal is to reduce the population to a level that will benefit native trout. We do not believe it is possible, given our current technology and abilities, to eradicate lake trout from Flathead Lake.

Our DEIS has been very much shaped by the public scoping comments we have received during this process. Indeed, NEPA was designed, in part, as a tool for incorporating public comments into planning and decision-making. The NEPA process does not, however, operate by majority rule or voting.

Many factors affect the success of finding fish and wildlife species on any given day. Single events do not provide scientifically reliable population estimates. We have contracted with several of the leading authorities in fisheries population modeling to help us interpret our lake trout and bull trout population data. None of the members of our Interdisciplinary Team dispute our description of the current condition of the lake trout population in Flathead Lake. In our assessment, lake trout are very near to record high population numbers, and are likely at the carrying capacity for Flathead Lake (Appendices 6 and 9).

Issues

Angling

Missoula —14 April 2010 (verbal) Mm-12. If your goal is 50,000 angler days, but that is geared toward lake trout, would that shift to other species?

Response

As lake trout fishing opportunities decline, we expect there would increased angler trips to fish for other species or to fish different nearby waters.

E-mail E-2-6. While some lake trout anglers have expressed a concern that gillnetting will cause the lake trout population to crash to the point where angling opportunities would suffer, this is highly unlikely. To demonstrate this point, the National Park Service has conducted an aggressive lake trout gillnetting program in Yellowstone Lake since 1995 in an attempt to restore native Yellowstone cutthroat trout, yet still there are no signs the lake trout population has been curtailed. Even in the highly unlikely event that the lake trout population in Flathead Lake declined below objectives as a result of gillnetting and/or other factors, it would be easy to stop netting and allow the population to quickly rebound. Due to their high fecundity (an adult female typically carries up to 9,000 eggs), lake trout are capable of expanding very rapidly.

Response

Lake trout have caused a large decline of Yellowstone cutthroat trout in Yellowstone Lake (Koel et al. 2005). The fear that lake trout will extirpate cutthroat trout from Yellowstone Lake motivated the National Park Service to conduct an aggressive control strategy that began in 1994, and was expanded in 2010 based on monitoring that indicated efforts needed to be increased to overcome the expanding lake trout population (Gresswell 2009). Managers have learned how and where to conduct netting to be maximize efficiency. Improved efficiency coupled with increased effort are expected to reverse the lake trout expansion in Yellowstone Lake (Bigelow 2011).

Impacts on Other Fish Species

Kalispell —13 April 2010 (written) K-6-7. What about whitefish? Important to many people.

Kalispell —13 April 2010 (written) K-6-2. Impact on other species. Will ratios remain the same?

Polson —12 April 2010 (verbal) Pm-6. Would you make up the difference with perch and lake whitefish.

Kalispell —13 April 2010 (verbal) Km-16. What's wrong with rainbow and brown trout?

Kalispell —13 April 2010 (verbal) Km-20. If we decrease lake trout, what are the effects onto other fish?

Polson—12 April 2010 Pm-4. Sturgeon—aren't they affecting bull trout (I think, it was hard to hear).

Letter L-8.2. Also, what would be the impact upon the Kokanee, whitefish, and perch? It would be nice to have some biological opinions before proceeding.

Response
The effects of the alternatives on lake whitefish, westslope cutthroat trout, and bull trout are analyzed in Chapter 3 of the DEIS.

E-mail E-7-6. Not sure that lake trout are eating all that many bull trout in Flathead Lake. Lots of lake whitefish for them to feed on; see this in the stomachs of fish caught. The fish situation in Flathead lake is a lot more complicated than just lake trout vs. bull trout, think of *Mysis* and lake whitefish, etc. Whitefish and pike minnow in the lower river need to be considered; they are eating young bull trout in the river before they get to the lake; whitefish population could explode in the lake and river if lake trout are removed.

Response
The best available science on this system as well as that for other, similar systems suggests lake trout are the limiting factor for native trout in the lake, especially bull trout. There are many examples of introduced lake trout populations negatively influencing native trout. Within their endemic range where lake trout and bull trout are both present, they typically segregate, with lake trout occupying lower-elevation lakes and bull trout occupying higher-elevation lakes (Donald and Alger 1993). Lake trout eliminated bull trout in Heron Lake in Alberta not long after lake trout were introduced (Donald and Alger 1993). There are also examples in Glacier Park where lake trout have increased greatly while bull trout have decreased greatly over the same period (Downs et al. 2011, Fredenberg 2002, and Meeuwig 2008). The declines of bull trout were greatest in Logging Lake where no bull trout were sampled in 2010 (Downs et al. 2011). Bull trout also declined following an increase in lake trout in Priest Lake, Idaho (Venard and Scarnecchia 2005). The lake trout population there increased in the 1970s following

the introduction of *Mysis*, and by the 1990s, the bull trout population was nearly extirpated. In Flathead Lake the relative abundances of bull trout and lake trout have reversed. The bull trout population has dropped precipitously while the lake trout population has increased just as dramatically over the same time period.

While whitefish and pikeminnow may take some bull trout, our data indicate that the loss is negligible. The diet of lake whitefish in Flathead Lake is dominated by chironomids (midges), *Mysis,* and clams (Beauchamp 2006, Tohtz 1993). Lake whitefish do prey heavily on juvenile yellow perch in some years, which increases the catchability of lake whitefish by anglers.

There are no sturgeon in Flathead Lake.

Mysis

Kalispell —13 April 2010 (verbal) Km-21. No action—meddling by F&G (with *Mysis*) is what destroyed the fishery in the first place. Why can't we just let evolution take its course?

E-mail E-15-1. Unless the source which made lake trout increase (*Mysis* shrimp) is managed as well you are not going to help bull trout populations. Manage what you have—an excellent fishery arguably the best lake trout fishery in America. Terry Krogstad

Letter L-14-1. Dr. Jack Stanford of the Yellow Bay Biological Research Station in his "State of the Lake 2009" states the following (among other things) about introduction of mysid ("opossum") shrimp in early 1980's: "Juvenile lake trout feed very effectively on the abundant mysids allowing substantial annual recruitment of adult fish that was not possible in the pre-mysid period." Should not brain-storming ways of reducing or eliminating-eradicating the mysids be on a par with looking at other ways of decreasing lake trout? Respectfully submitted, Edwin Speelman.

Letter L-18-2. *Mysis* Shrimp. The introduction of *mysis* shrimp totally collapsed the Kokanee salmon fishery. Until the lake trout learned to feed off of them it almost collapsed the bull trout & lake trout fishery. What is going to happen to *mysis* shrimp with a major reduction in lake trout population. Are *mysis* shrimp potentially a larger issue than lake trout?

E-mail E-33-12. Develop a monitoring plan to ensure that *mysis* populations do not skyrocket or other non-native fish fill the niche that lake trout currently occupy in the lake. Lake trout, bull trout and westslope cutthroat trout coexisted with kokanee in Flathead Lake for decades until *mysis* shrimp were introduced, is there a means to reduce or remove *mysis*?

Kalispell—13 April 2010 (written) K-2. Self-sustaining commercial *mysis* shrimp harvest as in Canada.

Missoula**—14 April 2010 (written)** Mm-4. Explosion of lake trout occurred with *mysis* shrimp. What about reducing *mysis* shrimp?

Missoula**—14 April 2010 (written)** Mm-5. If lake trout are reduced, then would *mysis* increase, and how would that affect bull trout?

Response
We agree that the introduction of *Mysis* has complicated the Flathead Lake system. However, in our assessment, it is possible to improve conditions for native trout species, while maintaining fishing opportunities for lake trout. We are bound by Federal laws and Tribal policies to fulfill these obligations. Currently, we are not aware of cost-effective methods of removing *Mysis* from Flathead Lake, but we are always looking for opportunities to remove *Mysis*.

If lake trout populations are reduced, *Mysis* could be expected to increase. However, the implementation of any of the action alternatives will not cause zooplankton or phytoplankton densities to change beyond the range that has existed in Flathead Lake over the last 27 years. *Mysis* are also preyed upon by other fish species, including lake whitefish.

Weather

Kalispell —13 April 2010 (verbal) Km-7. What are the effects of weather? Person stated he thought bull trout had increased in the River.

Response
The Flathead River Basin is likely to undergo changes in the future related to global climate change that will be detrimental to native fish (Rieman et al. 2007). Numerous changes are predicted, and the cumulative effect of climate change in addition to predation by lake trout represents a substantial long-term threat to westslope cutthroat trout and bull trout populations. Reducing the mortality rate of native trout that results from predation by lake trout would reduce the total future cumulative effects of climate change. The effects of climate change are discussed in more detail in Chapter 3.

Wasted Meat

E-mail E-16-3. I was raised to respect the game laws, and at a higher level, to respect the game animal itself. We limit our “keepers” to be legal; we use the allowed tackle (number of rods, hooks, type of bait, etc.). How is it that the CSKT can decide unilaterally to go out and “kill” all of these fish supposedly for the betterment of the state’s residents? Bottom line - -- this just isn’t right. I’ll be honest and say that I’m speculative of even the value of writing this comment. Although this decision appears to be preordained, I truly hope you’re not just going through the motions and asking for our opinions - - - and not even listening to them. I hope you will take note of what the anglers in this state want to see. We don’t want to see the waste removal of these fantastic game fish. Respectfully, Mark F. Bratz, Kalispell, MT

Letter L-13-1. What use is going to be made of the fish caught by gillnetting, I feel that wanton waste will be very common with netting as the nets I understand will only be pulled once in each 24-hr period, a lot of fish will come up spoiled.

Letter L-15-7. In regards to netting, I have read where netting fish has taken place including outlying States. The outcome in the end is that there is a lot of un-use of the fish for fertilizer, eating, or whatever purpose and leaves the areas that are being netted unbearable due to what

the decayed product has done to the area. Flathead Lake Shoreline as you know is well lived-in and is, on a whole, a tourist attraction for Montana. No one is going to want to see or smell or become involved in the day to day outcome of thousands of fish not handled properly—What is your plan—because it hasn't been really talked up to the Sportsmen and Women who are buying the licenses, paying tournament fees, or just enjoying the scenery as a tourist who spends dollars in all the local areas around the "Lake". A better informational program would be an asset to you as a group if you want support. –If you don't want support—keep people in the dark and you will have "loud" questions all the time. Respectfully submitted, Viola G. Hoover, Whitefish, MT

E-mail E-57-4. I also know that gillnetting has a very significant detrimental impact on the quality of fish due to my experience in Alaska with salmon. We could not export gillnet caught fish to Japan because of the quality. Are we wasting the fish or are they eaten by people who are unaware of their poor quality?

Response
All of the action alternatives include measures to properly handle the fish and supply them to local food banks as is currently done during our Mack Days fishing contest. We disagree that the flesh would be of poor quality, based on example of gillnetting lake trout in Swan Lake.

Lake Trout Diet

Missoula—14 April 2010 Mm-14. Salmon was a high caloric prey item (for lake trout). How can bull trout provide the nutrition for lake trout?

Response
The diet of lake trout is discussed in detail in Appendix 4.

Pollution

Missoula—14 April 2010 Mm-15 Did bull trout decline due to different chemicals (in the lake)?

Response
Chemicals in the lake have not been the major factor in bull trout declines in the Flathead Basin. The decline of bull trout is discussed in Chapter 3 of the DEIS.

E-mail E-25-3. The Flathead's headwaters and rivers supply clean, cold water to Flathead Lake, and provide drinking water for thousands of residents. Plus, the streams, rivers and lakes in the Flathead basin offer unparalleled recreational opportunities that infuse millions of

dollars into local communities. For instance, the scenic North Fork and Middle Fork rivers of the Flathead support over 40,000 angler days each year and are nationally recognized for providing a high-quality, native trout recreational fishery. That's why it's disappointing that the meager native trout populations in Flathead Lake aren't on par with the other natural assets in this unique watershed. While the majority of recreational angling in Flathead Lake—at about 50,000 angler days a year—is focused on lake trout currently, we are hopeful that someday bull trout can be restored to levels that allow people to once again catch these celebrated native fish.

E-mail E-49-5. One anecdote I wish to communicate is about lake trout in Lake George, New York, being wiped out by DDT spraying for spruce budworm in 1953-1957. Bald eagles and peregrines were severely affected by the DDT, but not any other aquatic species, only the top aquatic predator the lake trout. When it was obvious the lake trout in Lake George had been greatly reduced in numbers, some of the fish were caught and spawn taken with the end in view of rearing them in a hatchery for restocking. The eggs hatched OK but all the fry died while they were absorbing the yolk sacks. There was zero reproduction. Lake trout from the Finger Lakes, deep glacially carved lakes in central New York, were caught and the spawn was stocked in Lake George and they survived and did well. They are there to this day. I am not suggesting that anything like that would be appropriate for Flathead Lake but I do want to relate that because it happened back east and you may not know about it. It should be of scientific interest that only the top aquatic predator was extincted in that situation, as a result of biological magnification to that trophic level. www.springerlink.com/content/pj88004733314348

Response
Thank you for the information. While some piscicides can be used effectively in smaller lakes that do not contain endangered or threatened species, it would not be feasible, practical, or responsible in Flathead Lake. Use of DDT of course would not be legal.

Fertilizer

Letter L-7-6. What is the plan for dead fish disposal? Netting will yield thousands of pounds of fish which if creatively used, can make a big difference in the quality of life on the reservation, while improving the fishery. Will some be made available for local consumption? Can other legitimate uses, like our Permaculture effort on Round Butte Road, be assured of an annual. Supply. We're raising a large garden to be fertilized with compost derived from fish, leaves, sawdust, old hay, etc; food to be made available to appropriate Tribal programs. Other potential uses for the catch include pet food, oil, fertilizer, etc.

Compost

E-mail E-19-7. Another suggestion on the economic side of things is that some additional money could be made to go towards the fishing events, by composting the waste that is left over from the cleaning of the fish. It is an easy and very unobtrusive process. The compost could be sold locally. There is a lot of information available on the Web of this happening in many locations. Here is a link to one such study: http://afdf.org/past_research/composting_fish_byproducts.pdf

Response
Fish captured in gillnets will be processed and donated to area food banks. Waste that is leftover from cleaning the fish will be made available to local farmers or growers, who will use it for compost and fertilizer. This program is in place now during our Mack Days fishing contest.

Staffing

Letter L-13-5. Who will oversee this operation—I do not trust the Tribe or the MFWP with this task, especially the MFWP.

Response
The Tribes would oversee and staff implementation of the proposed action.

Ad Hoc Makeup

E-mail E-7-1. If there is a group of people who will be planning the fish management actions, it's important to include a sports fishing interest on the committee.

Response
Anglers are well represented on the Citizen Ad Hoc Group.

Fish Oil

Letter L-17-5. Fish oil is a big thing in the health industry and lake trout has the third highest EPA plus DHA in grams behind mackerel and herring. This could be a huge market. A great ad campaign could be utilized. Ron Lambrecht

Response
To our knowledge there is not a market to support commercial fishing for fish oil at this time.

Genetics

Kalispell —13 April 2010 (verbal) Km-22. What about genetic engineering or changing the reproductive rate of lake trout (as an option)?

Response
These are promising ideas but we currently do not have the technology to implement these population reduction methods.

Kokanee Salmon

Missoula —14 April 2010 (verbal) Mm-18. Is bringing back the salmon an option?

Response
We did try to bring back kokanee salmon after the population plummeted, but due to the high predation rates by lake trout we were unsuccessful. Bringing kokanee back is not considered a viable option by fisheries managers.

Fishing Regulations

E-mail E-9-4. Artificial lures and flies with no more than one hook per lure and no more than two hooks per line. You cannot release a fish that is gut hooked with a worm. Enforcement is also important. As a Flathead River guide of 11 years I have seen local traffic with stringers of native fish in the Flathead River on a regular basis.

Response
Changing fishing regulations occurs under a different process, which on the Flathead Indian Reservation starts with the Flathead Reservation Fish and Wildlife Advisory Board. Board meetings occur every quarter. Violations of fishing regulations should be reported immediately to either Tribal or State Fish and Game wardens.

Stomach Analysis – Food Chain approach

Letter L-20-4. Encourage fishermen to do stomach analysis of lake trout & report findings to see if the food chain can be interrupted.

Response
The Tribes and their consultants have regularly collected data on lake trout food habits during our annual spring monitoring and seasonal gillnet sampling surveys (see Appendix 4). The data are collected in a manner that allows scientific analysis of lake trout food habits.

Divers

E-mail E-12-3. Divers with suction dredges could suck up 10's of thousands eggs in the shallow beds in a short time but this would take several years of working the beds at the right time of the year to accomplish a goal.

Response
We have analyzed two tools to affect spawning lake trout and their embryos: electrofishing and using electrodes to destroy embryos. Lake trout adults are vulnerable to electrofishing when they move into shallow water to spawn during autumn, and this tool has been effectively employed as a way of capturing adult lake trout in Lake Pend Oreille and in Yellowstone and Swan Lakes. Costs are moderate, and bycatch risk is low. The primary limitation is that it is only effective to a depth of about 10 feet. Consequently, we would only be able to electrofish for lake trout in the very narrow shoreline zone. This tool could have utility in Flathead Lake, but we do not propose to employ it during this planning period because we do not consider it to be any more cost-effective than the combination of gillnetting and angling.

A developing tool for killing lake trout embryos is the use of electric current deployed in an array of electrodes towed by a boat over known spawning areas. To date we have not used this tool in Flathead Lake. It could have utility in the lake, but is not ideal because of the large extent of potential spawning habitat. While we have not quantified spawning habitat in Flathead Lake, we consider the essential elements of spawning habitat to be present in excess of fifty miles of shoreline. In addition, the efficacy of this tool has not been determined for embryos placed well into the interstitial spaces of ideal cobble substrate. This tool and others, such as dredging, will be reviewed in the future as the technologies develop, though we do not propose to deploy them in Flathead Lake during this planning period.

Letter L-18-1. On April 13, I attended the public meeting in Kalispell of CSKT lake trout eradication program. I admire your desire to improve the Flathead Lake fishery & agree something needs to be done. I wonder if the eradication of lake trout goes far enough. All issues of this magnitude begin with a cause & effect relationship. In this case the cause is “no bull trout” the effect is “kill lake trout”. There is no doubt that lake trout are part of a systemic problem, but suggest you also delve into other potential issues that may contribute to the cause. There is not as many reed beds as we have to have to grow bull trout. Has anyone considered the impact that northern pike may be playing on the destruction of reed beds over many years. Cause & effect. Phosphorus. This is a chemical element in fertilizer leaching into the lake. A study several years ago indicated this was a problem to the environment & water quality at Flathead Lake. Are bull trout more vulnerable than lake trout to environmental changes to their survival? Cause & effect. Whitefish & Perch. At one time it was quoted that 80% of biomass in lake were whitefish. If 400,000 lake trout exist then there was 2,000,000 whitefish. Are we witnessing another fishery collapse? What is happening? We know what the effect is what’s the cause? This my be a bigger issue coming at us than the lake trout. Cause & effect. Your efforts in the bull trout issue needs & is being addressed, but please consider that other causes may be impacting as greatly as the lake trout. Thank you. Steve Olson, Kalispell, MT

Response
The best available science indicates that bull trout and westslope cutthroat trout declines in the Flathead system are the result of lake trout increases that have cascaded through the Flathead Lake foodweb (Bull Trout Study Group 1997; Beauchamp 2006; Flathead Lake Co-Management Plan Expert Panel 1998). Consequently, our proposed action is focused on reducing lake trout numbers.

Drought

Letter L-13-12 (5). One of the reasons bull trout redds are down is low water in spawning streams—there has been a drought for several years—see if bulls are spawning in main forks of the River.

Response

Drought is not something we can control. We can address it, however, by maintaining the habitat in upper reaches of streams in good to excellent condition. The Forest Service and MFWP have worked hard to do that in the Flathead. Thus, while drought can affect water temperatures in streams with low flows and low amounts of cover, this is not generally the case in the Flathead Basin. In our assessment, decreases in recent redd counts are due to factors other than drought. Temperature is discussed in the Cumulative Effects section of Chapter 3 of the DEIS.

Compare with pre-mysis days

E-mail E-69-2. On the economic front, evaluations of the economic advantages of a “no action” proposal should contrast the current situation with the pre mysis days when 60K angler days were routine. Could a lowering of the lake trout population to the levels of those days bring back the kokanee fishery?

Response

The economic effects of the alternatives are described in Chapter 3 of the DEIS. The pre-Mysis days are not the current condition and are not a proposed action. Therefore, under NEPA, it would not be appropriate to analyze those conditions.

Past experiments with stocking Flathead Lake with kokanee showed that it is not possible to re-establish kokanee in the Flathead Lake as long as lake trout predominate as a top predator. There is no reason to believe that our results would be any different now.

Population estimates/creel surveys

Letter L-13-3. Creel census counts in MT are not accurate. I have lived in MT for 46 yrs and have fished all of those years and have had my creel checked 4 times!

Letter L-13-11 (4). Develop a more accurate creel count. No one knows how many macs are being caught during the summer months—maybe a drop box system at each boat launch on the lake.

Letter L-15-6. When out fishing in the many lakes in Western Montana, MFWP are not too visible and as far as receiving a letter requesting fish tallies etc., I have been with a license many many years and have not received one. So where is the actual input coming from. Tournaments? Special Interest Clubs? The average fisherman or woman are not contacted.

Kalispell—13 April 2010 (written) K-9-10. You say you don't (underlined) want to reduce angler days and fishing success. How do you measure success for anglers and fishing success? I fish the lake 35+ days per year and have never had a creel count or hours per fish. You don't have a basis for comparison!

E-mail E-26-2. I would like to see a more accurate way of measuring outfitter numbers of harvest.

Response
Data we receive from MFWP from mail-in cards on creel numbers are used to estimate angler days and not fish population numbers. In our assessment, these data are reliable for angler use because we spot check the lake through airplane flights and count the numbers of boats throughout the season. The two methods parallel each other well, so we feel confident that the MFWP data can be used appropriately to estimate angler days. Moreover, we have many years of this information, so we can use it as an historical baseline.

To estimate lake trout population numbers, we use other methods. See Appendices 4, 6, and 9.

Our fish population models are derived from the analysis of years of local data, and run the model using accepted and peer-reviewed protocols. Our modeling scientist is a leader in the nation for this type of analysis. We are confident that we are using the best available science in our analysis.

Economics

E-mail E-67-3. A reduction in the lake trout fishery might be interpreted by some people as a negative impact, however, I would suggest that a reduction in lake trout can actually be a positive recreational impact. Reducing lake trout could potentially result in more cutthroat trout in the system, especially large, migratory cutthroats that migrate from the lake up the North and Middle forks, providing a trophy catch and release angling opportunity in the rivers. Also, recovering bull trout will potentially result in bull trout angling opportunities, similar to the angling opportunities currently allowed in Hungry Horse Reservoir and the South Fork of the Flathead. Additionally, several tributaries to the North Fork and Middle Fork are currently closed to ALL fishing. By recovering bull trout, fishing on these streams could once again be allowed, resulting in more angling opportunity. In my view, reducing lake trout numbers to allow bull trout and westslope trout could result in a greater net (excuse the pun) fishing opportunity in the system overall and I suggest that the EA analyze this possibility. Similarly, maintaining the status qou - as in a "no action alternative" - where bull trout and cutthroat trout populations remain supressed by lake trout would result in the current negative recreation fishing impacts (i.e. fishing closures and angling restrictions) anglers are encumbered by today on the North and Middle Forks and tributary streams.

Polson —12 April 2010 (written) P-3-2. For leverage the claim is what? Because the bull trout is no longer endangered they can't use that. I heard this reasoning. "We just want the bull trout to have more room to swim around in." So, they expect us to accept putting a fishery that

has great recreational and economic value to the area for the sake of a species that has no recreation or economic value. I'm not willing to make that sacrifice. For ten years large fish which are a very small part of the overall population had a slot limit of 30 to 36 inches where they had to be released to maintain a trophy fishery. A larger part of the draw of recreational fishery is these trophies. People who come here from not only this country but as far away as Turkey and South Africa to enjoy what the lake has to offer, bring money to restaurants, motels, charter guide service, tackle shops, grocery stores, filling stations, licenses, the list goes on and on. If they go ahead with this with no regard for how they damage the local economy just like they jammed the wolves down our throats and have done grave damage to our recreation hunting industry. I say enough is enough.

E-mail E-4-2. The support of this measure (removal of non-natives) will not only provide a high quality angling experience for locals, but also help our struggling local economies by bringing in tourists from all over to experience all the amazing things this area has to offer. While the angling of those in search of predatory lake trout may suffer temporarily, we will see it pay off for years to come. I thank you for your time and service to the area. Sincerely, Richard Todd Wharton, Whitefish, MT

Letter L-3-1. Your EA should review costs/ success/ failures on Yellowstone Lake-gillnetting of lake trout. Same for Pend Oreille Lake.

Letter L-11-4. Also, has there been any research to determine the economic impact of reduced Lake trout populations. It seems that with increased sport and commercial fishing exposure that those persons participating and spending dollars will definitely aid our struggling economy in this area.

E-mail E-19-6. Flathead Lake is once again a great fishery that is being enjoyed by many people. I also think that as time goes by it will only get better, but only if things are left as they are. Also I hope that you will consider the economic impact that the fishery has on the entire Flathead Valley.

E-mail E-27-15. Montana anglers and non-resident visitors alike have for years generated substantial economic benefits for the state when fishing for bull trout and westslope cutthroat in the North, Middle, and Main Flathead River. The South Fork Flathead River alone provides an excellent example of what healthy populations of bull trout and westslope cutthroat provide to our area economically. Economic values for the North, Middle, and Main Flathead River are demonstrated in numerous studies dating back to 1987, and show, when applied to increasing angler days on the Flathead River, as shown in the most recent Montana MFWP estimates (2007), that the economic impact for the region is substantial, and continues to increase.

E-mail E-32-5. Flathead Lake is a world class lake trout fishery. I believe any lake trout reduction will impact the recreational fishery and the economy of local communities. Impacts could be cumulative and significant. At the public meeting it was stated that the current level of recreational fishing would be maintained, however no method of doing this was presented.

E-mail E-40-6. Lets all continue to work on "low economic impact" solutions to a complicated problem set that could economically benefit both Tribal and Non-Tribal citizens. Thank you. Sincerely, Barry Roose, Bigfork, MT

Letter L-3-6. (This comment was received before the scoping period opened.) EA should address all costs of gillnetting, plus continuing annual costs to keep lake trout suppressed. Thanks.

E-mail E-8-2. The lake trout had been forced to change diet and as a result, became very unhealthy. They had no food and looked scrawny and skinney. Then, after a few years, they rebounded by feeding on the misis shrimp as well as perch and other non game fish in the lake. As a result, they have become a very desirable food fare. The meat is pink and without fat. I eat them regularly and they are good grilled, baked or deepfat fried. People cannot believe they are eating lake trout when I prepare it. Nature has helped provide another food fare that is in high demand. The lake superior white fish. At this time the fishing is as good as it was in the 70's. Anglers catch lake trout, perch and whitefish that all provide recreation for families and visitors. I personally donate to charities every year and all equiped fishing trip to catch large lake trout. I cannot describe the excitement and joy it gives to children and adults to reel in a big lunker that in most cases, is the larges fish they have ever caught.

Kalispell —13 April 2010 (verbal) Km-23. Lake Pend Oreille costs 435,000 for netting and 500,000 for angler contests. How will this project be funded if your current budget is only 200,000? BPA?, other Federal Programs?

E-mail E-46-2. Aside from the biological goal, it would seem that such an undertaking would have a serious negative affects on the local economy and the loss of a strong fishery for lake trout. As a personal note, I am relocating to the Bitteroot Valley of Montana and had intended to purchase a boat to fish Flathead. I have often fished Flathead in the past. I think I will wait until I determine what will be done to the lake's fishery before taking that step. Thank you for considering my comments. Sincerely, Ronald Plakke, Ph.D. Zoology

E-mail E-49-6. One problem with just managing lake trout and other fish as aquatic resources is the political/economic situation. Lake trout are desirable sport fish (for some people) and they are the mainstay for the charter boat operators in the Flathead. They are excellent sport fish, even if they aren't very good eating. A lot of people like to catch them and they are the economic lifeblood for chart boat operators.

E-mail E-50-3. The study should include specific action steps and show the positive financial ramifications the native species have up in the river system. Take a look at Lakestream Fly Shop and their annual number of guided trips. This brings in a huge amount of revenue into the valley and is spread throughout many different individuals and industries.

E-mail E-57-1. After attending a public forum on gillnetting of lake trout in Flathead Lake, I have decided that the practice will pose a huge threat to the tourism economy for the Flathead. Just as everyone knows that Fish, Wildlife and Parks destroyed the salmon fisheries; likewise they will know that the Confederated Salish & Kootenai Tribes destroyed the lake trout fisheries. We presently have a world class fishery at Flathead Lake and many people make their living by providing fishing charters. We are very fortunate to have a lake where we can take our kids and grandkids and catch fish almost every time.

E-mail E-58-3. I believe that by netting you will be able to increase the harvest, but I don't know at what cost. I do believe if you implement netting you will have a negative public impact and create sour note with the local communities and people that are involved with sport fishing. So now you have my two cents worth. Thank you. Paul Soukup

E-mail E-59-7. The Flathead Lake fishery is much too valuable to destroy, even temporarily. Work on the smaller, less complex, systems, save money and leave Flathead alone. Thank You for the opportunity to comment, Scott Rumsey, Retired Fisheries Biologist

E-mail E-47-3. On a practical side... I would rather take my children out and catch a few lake trout than to take them out for two days to catch one bull trout. They will lose interest, and the fishing sport on Flathead Lake will cease to exist. I predict that if you move ahead as planned, in 5 years the fishery here will be a miserable example of bad leadership that was solely directed by a small interest group that simply "got their way". (wolves vs. elk) The minority may like it, but the majority will not. Thanks for your time and consideration. Sincerely, Shawn Madsen

E-mail E-48-3. Controlling lake trout will add value to the economy by way of increasing angling opportunities for those that have no interest in lake trout fishing. Sincerely, Alex Russell, Bozeman, MT

E-mail E-5-3. Research should also include the river system above the lake, including the value of recreational and outfitted fishing for native trout. Deep pocketed folks pay big bucks for that, even if the boat dealers would like you think they are the only game in town. Thanks for the chance to comment. Paul Queneau, Missoula, MT

Response
Chapter 3 of the DEIS and Appendix 10 include an analysis of the economic impacts of the alternatives.

Attachment A

EXECUTIVE SUMMARY - ASSESSMENT OF METHODS FOR REMOVAL OR SUPPRESSION OF INTRODUCED FISH TO AID IN BULL TROUT RECOVERY

Introduced brook, brown and lake trout have contributed to the decline of bull trout in Montana. Removal or suppression of these introduced species may play a role in recovery of bull trout in some circumstances. This paper discusses the removal or suppression of introduced fish as one aspect of the recovery process for bull trout in Montana.

The protection of habitats supporting bull trout will be the most effective means of maintaining a competitive advantage for bull trout over introduced species. Habitat protection in core areas and nodal habitats should be a primary emphasis of any bull trout restoration program. While this does not assure the exclusion of introduced species, it is a logical first step in bull trout restoration. Before removal or suppression of introduced species should be undertaken, further introductions of these species should be discontinued.

Goals of the removal or suppression projects should be well developed and should include a determination of whether the effort will attempt to totally remove or just suppress the target species. A panel should be established to review all proposed suppression and removal projects.

A review of the use of toxicants, trapping and netting, electrofishing, and angling as removal agents indicates that they may help in site-specific situations such as small streams and lakes. But none, even in combination, will be practical on a large scale for bull trout recovery under most circumstances. Complete removal of introduced fishes will be possible in only a few site specific instances. Even if total removal of introduced species is achieved, it may not result in bull trout recovery.

Habitat manipulation to favor bull trout is probably not possible when introduced species are present and habitat restoration probably would aid in bull trout recovery.

Five situations are identified where removal and suppression should be considered. They are not listed in order of priority:

1. Where recent invasions of introduced species have occurred or when the target species is restricted to a small area or is not well established but has a high potential for spreading.

2. Where it is necessary to protect core areas and nodal habitats.

3. Where a bull trout population is in immediate danger of extinction.

4. Where preservation of native species is a priority.

5. Where innovative experimental projects will further the knowledge of how this tool might be most effective. While all removal projects are experimental in nature, this refers to innovative projects that attempt to learn more about techniques and population effects of projects. New and innovative ideas and methods will have to be developed before introduced species control will be successful, particularly in large, complex lakes and streams.

The potential for negative impacts on non-target fauna is discussed and a checklist is included that should be reviewed before any suppression or removal project is undertaken.

CHECKLIST FOR REMOVAL OR SUPPRESSION

The following questions should be answered before any suppression or removal program is initiated:

I. Assess the need for removal or suppression of introduced species:
A. Is there another alternative that may also protect bull trout?

II. Clarify goals and measures for success:
A. What life history form of bull trout will benefit?

B. What is the expected response of bull trout? Is the habitat available to support the expected response?

C. What is the spatial scale being considered? Is this project site-specific or does it relate to a larger area?

D. Is this a suppression or removal effort? If it is suppression, what are the long-term commitments?

E. What will be the measure of success or failure?

III. Evaluate how the removal or suppression fits into the recovery program:
A. How does this project fit into the genetic plan for the drainage?

B. Is a recovery plan in place? How does this project factor into that plan?

IV. Planning the effort:
A. Have possible problems been anticipated? Have contingencies for accidents been explored?

B. Are there resources available for long term implementation and monitoring?

C. What is the potential for reinvasion or compensatory population response by the target species and how will this be addressed?

D. What non-target fauna exist and what are the expected impacts to them?

E. How will fish disposal be handled?

F. What might be the public response/support/opposition?

G. What kind of NEPA (National Environmental Policy Act) or MEPA (Montana Environmental Protection Act) document is necessary?

H. Is there potential for offsite mortality? How will it be taken care of?

I. Is the body of water a source for domestic or livestock uses? Have all adjacent landowners been contacted?

J. Have all necessary permits been obtained (Water Quality, U.S. Forest Service, etc.)? Montana Bull Trout Scientific Group, March 1996

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Appendix 4

4a. Trophic Interactions of Nonnative Lake Trout and Lake Whitefish in the Flathead Lake Foodweb

4b. Trophic Interactions of Nonnative Lake Trout in the Flathead Lake Foodweb Under Different Population-Suppression Scenarios for Lake Trout

Appendix 4a

Trophic Interactions of Nonnative Lake Trout and Lake Whitefish in the Flathead Lake Foodweb

Trophic Interactions of Nonnative Lake Trout and Lake Whitefish in the Flathead Lake Food Web

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April 2006

Report to the Confederated Salish-Kootenai Tribes

1 The Unit is jointly sponsored by US Geological Survey-Biological Resources Division, University of Washington, and Washington Departments of Fish and Wildlife, Ecology, and Natural Resources

Trophic Interactions of Nonnative Lake Trout and Lake Whitefish in the Flathead Lake Food Web

Abstract---Nonnative lake trout, lake whitefish, and *Mysis relicta* became the predominant species in the Flathead Lake food web during the mid-1980s. This change in food web structure complicated predator-prey interactions, causing the kokanee population to crash, and was implicated in significant declines of sensitive, threatened and endangered native fishes (e.g., bull trout, westslope cutthroat trout, pygmy whitefish). We quantified the trophic interactions of the lake trout and lake whitefish by using population abundance, annual growth, and seasonal diet, depth distribution, temperature data for lake trout and lake whitefish during June 1998-August 2001 in bioenergetics model simulations of size-structured, seasonal consumption rates on key prey species. These simulations identified forage species that contributed most to the annual energy budget of lake trout and lake whitefish, and quantified seasonal predation patterns on native fishes (pygmy whitefish, bull trout, westslope cutthroat trout) and key non-native species (lake trout, lake whitefish, yellow perch, and mysids).

Lake trout fed heavily on mysids, fish, and other benthic invertebrates. Mysids were the most important component of the energy budget for lake trout $\leq$ 625 mm total length (TL). Piscivory was measurable in lake trout > 200 mm TL, and increased progressively with predator size until fish became the predominant prey for lake trout > 625 mm TL. The primary prey fishes were lake whitefish and yellow perch, followed by pygmy whitefish, lake trout, and other salmonine fishes. Predation on lake whitefish began with lake trout >375 mm TL remained high during all seasons. Predation on yellow perch also began with lake trout > 375 mm TL, but was heaviest during fall-winter and peaked with 501-750 mm TL lake trout. Predation on pygmy whitefish was exhibited by 200-500 mm lake trout and was greatest during spring-fall. Predation on westslope cutthroat trout occurred during summer-fall by lake trout >375 mm TL, whereas predation on bull trout was concentrated primarily in October by lake trout $\geq$ 626 mm TL. Cannibalism was exhibited by lake trout > 200 mm TL and was heaviest by 501-625 mm TL lake trout.

Lake whitefish fed almost exclusively on invertebrates. Juvenile lake whitefish (age 0-1; TL < 200 mm) relied heavily on *Daphnia,* primarily during summer-fall. Older lake whitefish (age 2-7; 200-650mm) fed particularly heavily on chironomids, followed by mysids, *Daphnia*, and other invertebrates.

Bioenergetics model simulations indicated that the lake trout population consumed a greater biomass of mysids (1,216 $MT \cdot yr^{-1}$) than did lake whitefish (985 $MT \cdot yr^{-1}$). Consumption by a size-structured unit population of 1,000 lake trout (ages 1-30) consumed 760 kg of mysids per year compared to 210 $kg \cdot yr^{-1}$ by 1,000 age 0-7 lake whitefish. However, since lake trout also consumed lake whitefish, the net effect of removing 1,000 lake trout (with a size structure mirroring the population) would be an increase in mysid biomass of 659 kg, or an increase in areal density of approximately 0.13 $mysids \cdot m^{-2}$.

The combined predation by the lake trout and lake whitefish populations consumed an estimated 55% (2,186 MT) of the estimated annual mysid production; however, the remaining surplus production (1,815 MT) represented 2.74 times the estimated standing stock biomass of mysids. Therefore, unless other significant sources of mortality exist (e.g., predation by yellow perch, etc.), the mysid population would be expected to increase dramatically. Because considerable uncertainty was associated with the estimates for mysid production, any inferences drawn from the production-based calculations should be considered cautiously.

Introduction

Introductions of non-native lake trout *Salvelinus namaycush*, lake whitefish *Coregonus clupeaformis*, and the invasion of opossum shrimp *Mysis relicta* have drastically altered the fish and invertebrate community in Flathead Lake, Montana. Although lake trout were introduced in the early 1900s, populations remained low until 1980, when *Mysis relicta* were discovered in the lake. Between the early 1980s and mid-1990s, catch rates of lake trout in gill net surveys increased 14-fold, while catch rates of native bull trout *Salvelinus confluentus*, westslope cutthroat trout *Oncorhynchus clarki lewisi*, and pygmy whitefish *Prosopium coulteri* declined by factors of 5-10 (Deleray et al. 1999). *Daphnia* density declined as mysid populations increased during the early-mid 1980s (Beattie and Clancey 1991; Spencer et al. 1991, 1999), and the kokanee population declined precipitously from an annual average of 1 million harvested plus spawning adults, to a few thousand adults detected annually thereafter (Beattie and Clancy 1991; Deleray et al. 1999). Although the kokanee decline was originally attributed to competition from mysids, subsequent analysis concluded that predation by the rapidly expanding lake trout population was responsible (Beauchamp 1996). Mysids may have triggered the rapid expansion in the lake trout population by enhancing survival of juvenile lake trout. Beauchamp (1996) speculated that the diel vertical migration behavior of mysids provided a consistent food source, replenished daily, enabling juvenile lake trout to feed in relatively safe, localized foraging areas, with reduced risk of cannibalism. Improved juvenile survival likely increased lake trout recruitment significantly, thus expanding the population of this non-native apex predator. Co-managers of the Flathead Lake fishery considered a program to reduce lake trout abundance or size structure, but were concerned about direct and indirect effects of a lake trout reduction on the native fishes and their zooplankton food base.

The Flathead Lake food web has undergone a dramatic shift from a pelagic energy pathway dominated by kokanee, to an assemblage dominated by more benthically-oriented, nonnative consumers (e.g., lake trout, lake whitefish). This change in food web structure has significant implications for predator-prey interactions among non-native and native species. For example, given the historical importance of kokanee in the diets of lake trout and bull trout (Leathe and Graham 1982; Beauchamp 1996), the loss of this highly abundant prey resource could intensify lake trout predation on sensitive native fishes (e.g., bull trout, westslope cutthroat trout, pygmy whitefish) and on the *Mysis* population. This shift in predation pressure presents an interesting management dilemma given that increased predation on native fishes is undesirable, whereas a reduced *Mysis* population would be desirable.

We quantified the trophic interactions of lake trout, lake whitefish in Flathead Lake during 1998-2001. The objectives of this study were to: 1) describe the size-structured, seasonal diet patterns of lake trout and lake whitefish; 2) estimate population-level predation rates by lake trout on native and non-native fishes and mysids; 3) estimated population-level predation rates by lake whitefish on mysids and other key prey; 4) identify the strong interactors in the Flathead Lake food web and evaluate the possibility that shifts in predatory demand have or may result in higher predation levels on native salmonines and introduced mysids. We used seasonal diet and distribution data for all fish species collected from Flathead Lake, Montana during 1998-2001, to assess seasonal patterns of predation, particularly with respect to predation on native fishes (e.g., bull trout, westslope cutthroat trout), and *Mysis*. A series of bioenergetic modeling

simulations were designed to assess the potential impact of lakewide predatory demand (scaled up to the population level) on prey fishes and mysids. The simulations allowed us to integrate information regarding the size structure of the various predator populations, species-specific seasonal diet shifts, temporal changes in thermal experience by the predators, such that we were able to estimate predation rates on key prey species and growth efficiency of the predators during this period. By combining estimates of species-specific prey consumption (as opposed to focusing on a single predator species), we gained a much better understanding of system-wide predator-prey dynamics and food web structure, allowing us to make focused management recommendations.

Study Area

Flathead Lake is a large oligo-mesotrophic lake (chl a < 2.0μ/L; Ellis et al. 2001) in northwestern Montana with surface area of 510 km^2, mean depth of 50 m and maximum depth of 113 m (Zackheim 1983). Kerr Dam, built in 1938 and located 7 km downstream of the natural outlet, regulates the top 3 m of lake elevation to provide hydroelectric power, flood control, and recreational opportunities: the lake surface is annually dropped to a prescribed low pool elevation of 879.3 m by 15 April, increased to 881.5 m by 30 May, then raised to full pool elevation by 15 June and maintained through the first week in September (Deleray et al. 1999). The fisheries resources of the lake are co-managed by the Confederated Salish and Kootenai Tribe in the southern half of the lake and Montana Fish, Wildlife and Parks in the northern half.

A diverse range of native and introduced fishes and invertebrates inhabit the lake. The non-native species that have become abundant and play a potentially ecologically significant role in the lake include lake trout, lake whitefish, yellow perch *Perca flavescens*, and *Mysis relicta*. The major piscivores include the native bull trout, northern pikeminnow *Ptychocheilus oregonensis*, and non-native lake trout. Species at intermediate trophic levels in the lake include non-native lake whitefish, mysids, yellow perch, and rainbow trout *Oncorhynchus mykiss*, and native westslope cutthroat trout, mountain whitefish *Prosopium williamsoni*, pygmy whitefish *Prosopium coulteri*, largescale sucker *Catastomus macrocheilus*, longnose sucker *C. catostomus*, peamouth *Mylocheilus caurinus*, redside shiner *Richardsonius balteatus*, and slimy sculpin *Cottus cognatus*. The primary crustacean zooplankton include mysids, the copepods *Leptodiaptomus ashlandi*, *Epischura nevadensis*, and *Diacyclops thomasi*, and cladocerans *Daphnia thorata*, *D. pulicaria*, *Bosmina longirostrus*. Less information was available for the benthic invertebrate community; however, chironomids were common.

Methods

Fish sampling and diet processing

Fish samples were collected from both annual spring monitoring and seasonal gill net sampling surveys conducted from May 1998 through August 2001 by Montana Fish Wildlife and Parks in the northern region and the Confederated Salish and Kootenai Tribe southern regions of Flathead Lake. During the spring monitoring program, a standard set of floating and sinking gill nets were fished at fixed sites in each of five areas during late April and early May while the lake was still isothermal (Deleray et al. 1999). Horizontal sinking gill nets were fished overnight, from afternoon to mid-morning hours, in five areas with a combination of fixed and random sites in each area. At each site, standard sinking multi-strand nylon nets were 38.1 m long and 1.8 m

deep and consisted of five panels of bar mesh sizes 19, 25, 32, 38, and 51 mm. All nets were set perpendicular to shore in gangs of two nets at depths of 10-35 m.

For the seasonal sampling program, sinking gill net sets were randomly stratified among five geographic areas and five depth strata with netting effort allocated in proportion to the relative availability of area within each strata: littoral zone (8 sets), bottom depth < 30 m (10 sets), 30-60 m depths (14 sets), 60-90 m depths (13 sets), and depths > 90 m (3 sets). Each net consisted of 10 randomly arranged mesh sizes, ranging from 19-76 mm (3/4" to 3") bar measure 6-mm (1/4") increments. The summer and winter sets, and the additional spring sets were also done randomly and with the 10 mesh nets.

Nets were retrieved during the morning and fish were kept on ice until they could be processed. For all species, total length, and weight were recorded. For game fishes and northern pikeminnow, depth of capture and maturity were recorded; stomach contents and scales or otoliths were taken for age and growth analysis. Stomach samples were also collected from a representative subsample of the non-game species.

Diet Analysis

Stomach contents were examined using a dissecting microscope and separated into fish and invertebrate components. Prey fishes were generally identified to species (often based upon vertebrae and other diagnostic bones). When identification to species was not possible, fish were typically identified to family, but some remained in an unidentified fish category. Of the 78 unidentifiable fish prey, 37 could be identified to salmonines (whitefishes, char, or trout), 7 to trout or char; 30 of the 78 unidentifiable samples were available for genetic examination, and 26 of these 30 were identified (see section below). We measured standard, total, or vertebral lengths of prey fish when possible (based upon the condition of the partially digested fish). Fish eggs were also counted and weighed. Invertebrate prey were also identified to the functional taxonomic groups including *Mysis*, *Daphnia*, copepods, bivalves, chironomids, other insects, and a broad range of rarer taxa that were pooled into an "other invertebrates" category. For each stomach sample, the mass of each prey category was blotted dry and weighed to the nearest 0.01 g. The proportional wet-weight contribution of each prey category was computed for each non-empty stomach, and these proportions were averaged within each season-by-size class cell for each species of consumer.

Diet composition was summarized by season and size class of consumer. We examined scattergrams of predator length versus the diet proportions of major prey categories to stratify the diet analyses by size classes. For lake trout, only two invertebrate prey groups were categorized: mysids and a general invertebrate category in which all other invertebrates were combined. The weight of each prey category was converted to a proportion of the total weight of food within each stomach, and the proportions from each non-empty stomach were averaged for each season for each size class of consumer.

Genetic Identification of Prey Fishes

Diet analysis revealed several cases of predation by lake trout on native bull trout (4 out of 497 non-empty lake trout stomachs contained identifiable bull trout). Initial bioenergetics modeling simulations indicated that even these seemingly low predation rates could translate into severe mortality for bull trout in the lake. Meanwhile, stomach samples from 96 lake trout contained unidentifiable prey fish; many were identified as salmonine prey from bones (whitefish, trout, or char species), but no further taxonomic resolution was possible. Because estimates of predation on bull trout were based on very few identifiable samples of bull trout in

stomach samples, identification of as many of the remaining samples as possible would significantly reduce uncertainty associated with potential for extrapolation errors in current estimates of predation on bull trout by lake trout.

Baseline samples--In order to genetically identify unknown prey items, representatives of the most common fish species inhabiting Flathead were collected to create a reference baseline (**Table 1**). In most cases, several individuals from each species were assayed to characterize the intra-specific genetic variation.

DNA extraction--DNA was isolated for both baseline and prey samples using DNeasy Tissue Kit (Qiagen) following the manufacturer's protocol for mouse tails. As the DNA extracted from the prey tissues are likely degraded, a smaller elution volume (100 µl x 2 elutions) was used to concentrate the yield.

PCR--Two mitochondrial DNA markers were employed to identify species (i) a 368 base pair portion of NADH3/COIII (Domanico and Phillips, 1995) (hereafter ND3) and/or (ii) 270 base pair section of the 16S ribosomal gene (Parker and Kornfield, 1996). The ND3 locus was designed for Pacific salmon (*Oncorhynchus*) and does not amplify non-salmonid and whitefish species (Schwenke et al unpublished). However, it is more polymorphic among members of *Oncorhynchus* and *Salvelinus* and thus better discriminates these species (Purcell et al. 2004).

ND3 and 16S were amplified separately in 50 µl reactions each with the same reagent conditions of 1X *Taq* buffer (Promega), 2.5 mM $MgCl_2$, 0.2 mM of each dNTP (Promega), 0.1 µM of each primer, 1X bovine serum albumin (NE BioLabs), 1.25 U *Taq polymerase* (Promega) and approximately 1 to 30 ng DNA template. Both markers utilized the following thermal profile: an initial denature step of 94°C for 3 min, 35 amplification cycles of 94°C 40 sec, 55°C for 40 sec, 72°C for 40 sec, and a final extension of 72°C for 10 min. The PCR product quality and yield was checked by visualization on a SYBER Gold (Molecular Probes) stained 2% agarose gel. The remaining PCR product was washed and filtered using Montage PCR_{96} Cleanup Plates (Millipore) following the manufacturer's protocol. A 5 µl PCR sequencing reaction was performed on the cleaned product using 1µl BigDye v.3.1 (Applied Biosystems), 3.2 pmol primer, 0.5X sequencing buffer (Applied Biosystems) and approximately 10 ng PCR template, for both forward and reverse primers. The sequencing PCR consisted of 30 cycles of 96°C for 30 sec, 50°C for 5 sec, and 60°C for 4 min. The sequencing PCR products were purified using CleanSEQ Dye Terminator Removal System (Agencourt Bioscience). Sequence data was collected on an ABI 3100 Sequencer following standard procedures. Finally, sequences were aligned and analyzed in Sequencher 4.5 (Gene Codes Corp).

Bioenergetic modeling simulations

Bioenergetic modeling simulations were applied to lake trout and lake whitefish to estimate seasonal consumption patterns by the two predominant non-native fishes.
We used the bioenergetics model (Hanson et al. 1997) parameterized for lake trout (Stewart et al. 1983) and for lake whitefish (Rudstam et al. 1994, modified by Madenjian et al. 2006) in conjunction with species-specific seasonal diet data, size distributions, annual growth rates, and thermal history data for lake trout and lake whitefish in Flathead Lake. Simulations began in spring with 1 April representing day 1 of the 365-d simulations.

Annual Growth

The gillnet data from this study provided seasonal size and age distributions of lake trout and lake whitefish for all size class-by-season cells. These size/age distributions were combined with annual simulations for each age class to generate size-structured, population-level consumption estimates for lake trout and lake whitefish. Unfortunately, few fish smaller than 200 mm were sampled. These smaller size classes can be important because they are more abundant than older, larger fish, and typically exhibit very different diet compositions than older, larger individuals.

We modeled lake trout growth for ages 1-21 using annual growth increments **(Table 2)**, based on length-at-age data from otoliths (Deleray et al. 1999; Stafford et al. 2002) and a length-weight regression for lake trout in Flathead Lake ($r^2 = 0.978$; $P < 0.001$; $N = 426$).

$$Wt(g) = 0.0000055*TL^{3.054}$$

To account for the potential influence of spawning on growth and consumption, we assumed spawning weight losses for lake trout of 5% of the body mass for ages 5-7 and 8% for age 8 and older (averaged over both sexes for lake trout) based on size and age at maturity data for lake trout in Lake Tahoe after mysids became established (D. Beauchamp, unpublished data). Spawning losses were subtracted from the body weight of mature lake trout on day 198 (15 October) of the bioenergetic simulations for lake trout > 375 mm (ages 5 and older).

For lake whitefish, growth increments **(Table 3)** were identified by tracking length frequency modes in the spring gill net samples for ages 2-6, and total lengths were converted to weights using a length-weight regression generated from fish sampled during this study ($r^2 = 0.982$; $P < 0.001$; $N = 308$).

$$Wt(g) = 0.0000029*TL^{3.167}$$

Adult lake whitefish were assumed to lose an average 5.2% body mass for ages ≥5 years spawning on simulation day 129 (15 November), based on data from lake whitefish in Lake Michigan (Madenjian et al. 2006).

Thermal Experience

To generate the thermal history for input into the model, the seasonal depth distribution for each size class of lake trout and lake whitefish was coupled with vertical temperature profiles to produce depth-averaged monthly temperature patterns for each species and size class. The proportion of the seasonal catch per unit effort in each depth stratum was multiplied by the mean monthly temperature within each depth stratum, and these products were summed over all depths to produce a weighted monthly temperature experienced by that size class. However, we were unable to obtain temperature data for the period of June 1998 – June 1999. Thus, thermal histories used in this study for lake trout and lake whitefish **(Table 4)** were computed by coupling observed depth distributions from this sampling effort with the depth-specific temperature data used by Beauchamp (1996) to estimate the thermal experience for lake trout. Seasonal depth distributions used in this study represented combined data from fish capture in the northern and southern regions.

Diet and Prey Energy Density Inputs

Seasonal changes in proportional diet composition (see Results) for different size classes of lake trout (**Table 5**) and lake whitefish (**Table 6**) were used in bioenergetics model simulations. With the exception of the 100-200 mm size class for lake trout, the diet composition for each size class of lake trout or lake whitefish was applied to multiple ages. The diet

proportions were allowed to shift daily during simulations by linear interpolation from the proportions entered on a specified simulation day to the next specified date in the diet input file.

For lake trout prey, seasonal energy densities (J/g) were held constant throughout the year except for lake whitefish which varied seasonally using a size-specific, seasonal relationship (Rudstam et al. 1994): 6,280 J/g in January-March, 10,695 J/g in April-June, and 8,456 J/g July-December. For all other prey, constant energy densities were assigned as follows: 5,834 J/g for cutthroat trout and all unidentified trout; 5,890 J/g for bull trout and lake trout; 4,186 J/g for yellow perch, cyprinids, sculpin, and other nongame forage fish; 2,800 J/g for *Daphnia*; 3,474 J/g for mysids; and a composite value of 3,430 J/g for other invertebrates (**Table 7**).

For lake whitefish, energy densities of all prey groups were held constant throughout the year: fish eggs 4186 J/g, mysids 3474 J/g, *Daphnia* 3800 J/g, copepods 2260 J/g, chironomid pupae and other insects 3400 J/g, bivalves 2200 J/g, other invertebrates and miscellaneous prey were both 3430 J/g.

Estimates of population-level predatory demand

Lake trout abundance was estimated by expanding the estimated annual sport harvest of 12,800 age 6 lake trout to ages 1-30, based on an annual survival rate of S=75% for ages 4-30, and S=50% for ages 1-3. We assumed that harvest accounted for all mortality in ages 4-30 lake trout. Age-specific catch rates from gill nets were adjusted for size-selectivity (Rudstam et al. 1985). After this adjustment, age-6 lake trout were the youngest age that was fully recruited to the gill nets used. We regressed the $\log_e$-transformed standardized gill net catch rate against age for ages 6-15 ($r^2 = 0.98$; $P < 0.00001$; **Figure 1**); the slope = -0.288 represented the instantaneous annual mortality of Z = 0.288; therefore, $S = e^{-0.288}$= 75% annual survival and annual mortality = 25%. By assuming that harvest accounted for all mortality, the age-6 harvest of 12,800 = 25% of the age-6 population, so 12,800/0.25 = 51,200 age-6 lake trout in Flathead lake at the beginning of each year. Age-6 abundance was expanded to ages 4-30 by applying an annual survival rate of 75%. An assumed survival rate of 50% for ages 1-3 was used to expand the abundance of age-4 lake trout to abundance for ages 1-3. This estimation procedure yielded an estimate of 273,000 age 5-30 lake trout (TL > 400 mm; **Table 2)**. A comparable abundance estimate by Deleray et al. (1999) was 235,024 (95% CI = 151,415 to 467,149) age-5 and older lake trout (total length > 400 mm). This estimate was based on the average of Schnabel mark-recapture estimates which alternatively included or omitted an assumed 20% annual mortality of marked fish and 0-30% annual tag loss (Deleray et al. 1999).

Lake whitefish abundance was estimated from a hydroacoustic and pelagic gill net survey in August 2003. A BioSonics echosounder with 200 kHz, 6.8^{o} full-angle splitbeam transducer was operated at 3 pings$\cdot s^{-1}$ with a minimum target strength threshold of -60 dB (approximately representing post-larval fish ≥ 20 mm TL; Love 1977). The transducer was towed an average 5.2 knots at a depth of 0.5 m. We conducted 10 transects at night during August 11-12, 2003: 6 perpendicular to shore and 3 zig-zag transects in the main basin, plus a zig-zag transect in Big Arm Bay (**Figure 2**). These transects were confined to regions of the lake where bottom depth ≥ 10 m. An exploratory transect was also run through Polson Bay, but was omitted from analysis because of the shallowness of the bay and depth constraints of the hydroacoustic gear. A full moon and clear skies were present during the survey, and these conditions might have caused the coldwater pelagic fishes to move deeper or form schools (Luecke and Wurtsbaugh 1993), thus potentially affecting the accuracy of the abundance estimates. Water transparency was high (Secchi depth = 14 m), and the lake was strongly stratified with epilimnetic temperatures of 18-

21°C in depths of 0-9 m followed by a sharp thermocline with 3° m^{-1} decline in temperature through the 10-15 m metalimnion, and 5-6°C hypolimnion over 15-100 m depths (B. Ellis, Flathead Lake Biological Station, University of Montana, Polson, Montana, personal communication).

Acoustic target densities were estimated for each 5-m depth interval within each transect and averaged among transects (**Figure 3**). The abundance of fish ≥ 20 mm TL was estimated within each 5-m depth interval by expanding depth-specific density estimates by the volume of water within the area of each depth interval where the bottom depth was deeper than 10 m, based on a hypsographic curve for the lake (Deleray et al. 1999). We were unable to stratify fish densities by size, because a wiring problem in the transducer prevented reliable estimates of target strength, so the hydroacoustic data were analyzed using an echo-counting method pooled over all sizes of fish. The whitefish species complex was assumed to be numerically dominated by lake whitefish, and the whitefish fraction of the catch in pelagic gill nets (**Figure 3**) was multiplied by the total pelagic fish abundance in the epilimnion (17% of 7.2 million fish), metalimnion (59% of 2.8 million), and hypolimnion (45% of 3.9 million), thus producing an estimated abundance of 4.6 million pelagic whitefish (ages 0-8; TL ≥ 20 mm), or 1.7 million age 2-8 pelagic whitefish (TL > 150 mm). This estimate compared favorably to an estimate of 1.2 million pelagic whitefish from a hydroacoustic-gillnetting survey during August 1995.

Size structure of lake whitefish was estimated by regressing the $\log_e$ number of each age class (age 2-8) from samples during 1986-1989 reported in Tohtz (1993). These years were selected because they followed the rapid increase in abundance of piscivorous-sized lake trout, as indicated by the abrupt crash in kokanee during 1985-1986 (Beattie and Clancy 1991; Beauchamp 1996). Thus, we assumed that any restructuring of the lake whitefish size and age pattern from predation would be reflected by samples from these years. The regression yielded an estimated annual survival rate of S = 60% ($r^2 = 0.75$; P = 0.007; **Figure 1**). The size-structured abundance, when fitted to an abundance of 4.6 million age 0-8 lake whitefish and assuming a constant annual survival of 60% for all ages, resulted in an abundance of 1.9 million age-0 and 32,000 age-8 lake whitefish (**Table 3**).

Estimating Biomass and Production of Lake Trout, Lake Whitefish, and Mysids

The biomass and production of lake trout, lake whitefish, and mysids were estimated for comparison to predation losses. The mean standing stock biomass was computed as the sum of the products of the geometric means for the initial and final abundances (N_t and N_{t+1}) and body masses (W_t and W_{t+1}) for each age class of lake trout (Table 2) and lake whitefish (Table 3). Annual production rates for each age of fish P_t were estimated as:

$$P_t = G_t \cdot B_t$$

where $G_t = \log_e(W_{t+1}/W_t)$ and Bt = average biomass of age t fish during the year. Annual production for the population was calculated by summing P_t over ages t = 1 to 30 for lake trout and ages 0-7 for lake whitefish.

More assumptions were required to estimate production and biomass of mysids, so more uncertainty was associated with these estimates and subsequent calculations using these estimates. The mean mysid density in the lake was 44 mysids·m^{-2} during summer surveys in 1998-2000 (Ellis et al. 2001). We confined this density to the area of the lake where the bottom depth exceeded 20 m (337 km^2), based on reported maximum thermal tolerances of ≤13-14°C for *Mysis relicta* (DeGraeve and Reynolds 1975; Martinez and Bergersen 1991). The monthly average dry energy content of mysids during May-December 1992 and 1993 (from Figure 7 in

Chess and Stanford 1998) were converted to wet body mass by assuming a constant energy density of 3747 J·g-1 wet body mass. From December through May, we assumed that the body mass and energy density of mysids did not change: W_t = 0.00027 g in April and 0.06939 g during December-March.. The resulting April-March (11-month) growth rate was converted into an annual growth rate $G = \log_e(0.06939/0.00027)\cdot 12/11 = 6.066$. A simplifying assumption of a constant density of 44 mysids·m^{-2} through the year was combined with the annual growth trajectory (as described for lake trout and lake whitefish above) to calculate an estimated mean standing stock biomass of 662 metric tons (MT). The annual growth rate was combined with standing stock biomass to calculate an annual production rate for mysids of 4,016 MT·yr^{-1}.

Because the numerical density and energy density of mysids could change both ontogenetically and seasonally, the true biomass and production of mysids could vary considerably from the dynamics assumed here. Nonetheless, in the absence of more information these calculations provide a reference level of biomass and production for comparison to the annual consumption rates estimated for their primary predators. These comparisons could be systematically adjusted as improved information regarding seasonal density, growth and production of mysids becomes available.

Results

Genetic Identification of Prey Fishes

All baseline samples amplified at 16S and the number of intraspecific polymorphisms were detected (**Table 1**). All the species surveyed could be unambiguously discriminated with 16S; however, it exhibited low levels of divergence among salmonid taxa. For example, only a single base pair discriminated between bull trout and lake trout. For this reason, a ND3 baseline for members of the genera *Oncorhynchus* and *Salvelinus* inhabiting Flathead Lake were screened, and additional ND3 data from a broader geographic scale were incorporated (Schwenke et al. unpublished; **Table 1**). The ND3 baseline increased the number of parsimoniously informative bases greatly. To continue the bull trout and lake trout example comparison, ND3 showed 6 polymorphisms that were diagnostic between these two species.

Prey samples

Of the 30 prey samples, 4 failed to amplify at either locus, 26 amplified at 16S, and 7 amplified at ND3 in addition to 16S. Twenty of the samples were unambiguously identified to one of the reference species using 16S or both 16S and ND3: 10 lake white fish, 6 lake trout, 3 yellow perch (*Perca flavescens*), 1 kokanee (*Oncorhynchus nerka*) and 1 peamouth (*Mylocheilus caurinus*). In addition, 4 samples were concordant with the largescale sucker (*Catostomus macrocheilus*) 16S reference samples, but some ambiguities due to marginal sequence quality were observed. These samples were discordant with all other reference taxa making their classification as *Catostomus macrocheilus* reasonably certain. Finally, one prey was not unequivocally identifiable as it was 2.67% divergent from its most homologous reference sample, the prickly sculpin (*Cottus asper*). This prey item likely represents one of the sculpin species inhabiting Flathead Lake, but for which tissue was not readily available for genetic analysis.

Size-structured Seasonal Diet Composition

Mysids and other invertebrates dominated the diets of 100-500 mm TL lake trout, but lake trout became progressively more piscivorous with increasing size (**Table 5**). No identifiable prey fish species represented more than 9% of the diet during any season for lake trout < 500 mm

TL. Pygmy whitefish and lake trout entered the diet of lake trout > 200 mm TL, followed by lake whitefish, yellow perch, and westslope cutthroat trout for predators > 375 mm TL. Lake whitefish became the single most important prey species for lake trout >625 mm TL (8-67% of the diet by weight) followed by a mix of salmoniform fishes, other fishes, and invertebrates (**Table 5**). Sensitive native fishes like pygmy whitefish appeared in the diets of lake trout > 200 mm TL during summer or fall; westslope cutthroat trout represented 4% of the diet for 376-500 mm lake trout during fall, but increased to 24-33% during fall for lake trout >625 mm TL; bull trout composed 12% of the diet for 626-750 mm lake trout during fall and 4% of the diet for lake trout >750 mm TL during spring.

Lake whitefish primarily ate *Daphnia*, chironomid pupae, mysids, and other benthic invertebrates; fish eggs represented only 1% of the diet, and only during winter or spring (**Table 6)**. For smaller lake whitefish, *Daphnia* were especially important during summer-fall, whereas chironomids, mysids, and other benthic invertebrates became progressively more important in the diet of larger consumers.

Bioenergetic modeling simulations of consumption

Consumption by the Lake Trout Population

Seasonal consumption on different prey varied among size classes in response to the combined effects of size-specific dynamics in growth, diet, per capita consumption rate, and abundance of lake trout. Despite the numerical superiority of small lake trout (**Table 2**), model simulations indicated that total consumption by 100-200 mm lake trout was considerably lower than by the 201-375 mm size class (due to higher per capita consumption by larger fish), but was comparable to consumption by the 376-500 mm and 501-625 mm size classes; consumption was lowest for lake trout >625 mm, because the effect of declining abundance was stronger than the increasing per capita consumption rates (**Table 7).** Mysids contributed most to the seasonal and annual energy budgets of lake trout up to 625 mm, but represented a minor fraction of the prey biomass eaten by lake trout 625-1000 mm **(Figure 4**). Piscivory began modestly with 200-375 mm lake trout and peaked with the 500-750 mm size classes, but predation on different prey fish species differed among size classes of predators (**Figure 5**). Most predation on pygmy whitefish was imposed by 201-500 mm lake trout (spring-fall). All size classes of lake trout >375 mm consumed significant biomass of lake whitefish throughout the year; with peak predation exerted by the 626-750 mm size class. Predation on yellow perch was particularly heavy by 500-750 mm lake trout and was primarily concentrated during fall-winter. Cannibalism began with 201-375 lake trout and was particularly high during spring-summer with 501-625 mm predators. Lake trout >375 mm consumed significant biomass of westslope cutthroat trout, primarily during summer and fall. Predation on bull trout was confined to the 626-750 mm size class of lake trout during October-November and to lake trout > 750 mm during April. The size of prey fishes consumed by lake trout increased with increasing body size of the predator; the length of most prey fishes were ≤ 40% the body length of lake trout, but some lake whitefish were slightly over 50% of the length of the lake trout that had eaten them (**Figure 6**).

The size-structured population-level consumption of lake trout > 100 mm TL (ages 1-30) annually removed over 1200 metric tonnes (MT) of mysids and 308 MT of other invertebrates, and 328 MT of fish prey **(Table 8)**. Population-level predation rates by lake trout on sensitive prey species included 2,260 kg of bull trout, 32,227 kg of pygmy whitefish, and 12,596 kg of westslope cutthroat trout. Lake trout predation annually removed an estimated biomass (descending order) of 77 MT of lake whitefish, 68 MT of yellow perch, 32 MT of pygmy

whitefish, 25 MT of lake trout, 19 MT of cyprinids, 13 MT of catastomids, 13 MT of westslope cutthroat trout, 7 MT of cottids, and 2 MT of bull trout. In addition, 3 MT of unidentified trout or char, 27 MT of unidentified salmonines (trout, char, or whitefishes), and 41 MT of other unidentifiable nonsalmonine fishes were consumed annually by lake trout.

Consumption by the Lake Whitefish Population

Simulated consumption rates were highest during summer and lowest during winter for all size classes of lake whitefish, and the larger size classes collectively ate more prey biomass, despite being much less abundant (**Figure 7**). For lake whitefish <200 mm TL, *Daphnia* contributed the most to the annual energy budget and were primarily consumed during summer-fall; for the 201-370 mm size class, chironomids, *Daphnia*, and mysids were most important; and for lake whitefish >370 mm, chironomids, mysids, and other prey consumed during all seasons contributed most to the annual energy budget. Consumption demand by lake whitefish increased with fish size, demonstrating the importance of accurate estimates of the size and age structure of the consumer population.

When simulated consumption was summed across all size classes and seasons, the lake whitefish population annually consumed 985 MT of mysids, 780 MT of *Daphnia*, 36 MT of copepods, 2,1843 MT of chironomids, 200 MT of other insects, 427 MT bivalves, 114 MT of other benthic invertebrates, 530 MT of other prey, and 12 MT of fish eggs **(Table 9)**.

Lake Trout – Lake Whitefish – Mysid Interactions

Lake trout predation was a strong enough interaction to potentially regulate its own population (through cannibalism) as well as recruitment of lake whitefish, but the combined effect of predation by lake trout and lake whitefish on mysid dynamics was less clear. Lake trout > 375 mm TL became significant predators on lake whitefish (**Figure 5**), but no strong relationship was evident between the size of lake trout and the size of lake whitefish eaten (**Figure 6**). Lake trout consumed 14% of the biomass and 19% of the estimated annual production of lake whitefish population. When applied to specific age classes of prey, annual predation rates by lake trout exceeded the combined standing stock biomass for ages 0-1 lake trout and for ages 0-1 lake whitefish (**Figure 8**). When extended to older prey, lake trout predation represented 60% of the biomass of age 0-2 lake whitefish and 45% of age 0-2 lake trout. Predation impacts declined as progressively older ages were included as prey. However, since the body mass of these prey changed significantly during the predation period, predation rates were also compared to the production rates of single and combined age classes of prey. Predation by lake trout could be entirely absorbed by the annual production of single age classes for ages 0-2 lake whitefish (C/P_t = 65-85%) and ages 0-1 lake trout (C/P_t = 50-60%), whereas older age classes required that some of the predation demand be absorbed by production from younger conspecifics (**Figure 9**).

Lake trout and lake whitefish both fed heavily on mysids, but lake trout also fed heavily on lake whitefish, creating a complex combination of direct and indirect trophic interactions among these three introduced species and other species in the food web. Nearly all of the mysids consumed annually by lake trout were eaten by fish ≤625 mm TL, whereas nearly all of the mysids consumed by lake whitefish were eaten by fish ≥200 mm TL (**Figure 10**). Lake trout ate more mysids than did lake whitefish on a per capita basis. Consumption by a size-structured unit population of 1,000 lake trout (ages 1-30) consumed 760 kg of mysids per year compared to 210 kg of mysids consumed annually by 1,000 age 0-7 lake whitefish. However, since 1,000 lake

trout also consumed 48.4 kg of lake whitefish per year at a mean size of 100 g each, 484 more lake whitefish would survive to consume an additional 101.4 kg mysids per year, thus partially counteracting the reduction in direct mysid predation by lake trout. Overall, the net effect of removing 1,000 lake trout from the population would result in an estimated net increase in mysid biomass of 659 kg, or an increase of 0.13 mysids·m^{-2}.

The combined annual predation on mysids by lake trout (1,216 MT) and lake whitefish (985 MT) consumed over three times the estimated average standing stock biomass of mysids (662 MT), but this predation rate only represented a fraction of the estimated annual production rate of 4,016 MT·yr^{-1} for mysids. Lake trout consumed an estimated 30% of the annual mysid production compared to 25% consumed by lake whitefish. The combined predation by the lake trout and lake whitefish populations consumed an estimated 55% (2,186 MT) of the estimated annual mysid production; however, the remaining surplus production (1,815 MT) represented 2.74 times the estimated standing stock biomass of mysids. Therefore, unless additional, significant sources of mortality exist (e.g., predation by yellow perch, etc.), the mysid population would be expected to increase dramatically. Because considerable uncertainty was associated with the estimates for mysid production, any inferences drawn from the production-based calculations should be considered cautiously.

Discussion

Non-native lake trout and lake whitefish were both major consumers in the Flathead Lake food web. Lake trout were an important top predator, whereas both lake trout and lake whitefish relied heavily on mysids and benthic invertebrates. Lake trout were heavily dependent on mysids which contributed 71% of the total energy budget for consumers <625 mm TL. Larger lake trout > 625 mm TL shifted to piscivory, and mysids contributed only 6% of the prey biomass. Predation by lake trout potentially regulated populations of key native and non-native fishes in Flathead Lake, but their direct and indirect impact on mysids was less clear. Lake trout predation accounted for significant percentages of the biomass and annual production rates of lake whitefish and mysids, suggesting that lake trout predation was a significant source of mortality. Cannibalism also appeared to be an important self-regulating mechanism for lake trout. Lake trout consumed considerable biomass of native pygmy whitefish, westslope cutthroat trout, and bull trout, but more information about the abundance, biomass, and production of these prey was needed to interpret the significance of predation losses in terms of mortality rates for these species. Despite reasonable sample sizes for seasonal diets among size classes of lake trout, the low frequency of occurrence of westslope cutthroat trout and bull trout in the diet of lake trout lead to volatile predation estimates in model simulations, due to stochastic variability in the proportion of these relatively rare prey in the diet. Genetic identification of the most important unidentifiable prey fish samples substantially reduced the uncertainty regarding the potential volatility of the predation estimates on native fishes.

The seasonal, size-structured feeding diet patterns of lake trout provide opportunities for potentially managing their impacts on native fishes, non-native fishes, and mysids by manipulating the size structure of the lake trout population. For instance, bull trout predation was only evident for lake trout > 625 mm TL. These larger lake trout also exhibited heavy predation on lake whitefish and relatively high predation on westslope cutthroat trout, whereas mysid predation was minimal and cannibalism rates were much lower than by smaller lake trout.

Therefore, differentially reducing the abundance of lake trout > 625 mm TL could simultaneously relieve predation mortality on bull trout, westslope cutthroat trout, and lake whitefish while minimizing reductions in cannibalism, and perhaps increasing mysid mortality by increasing the survival of the larger size classes of lake whitefish which eat the greatest biomass of mysids. A substantive decline in mysids could enable recovery of depressed cladoceran populations and potentially enhance recruitment of native fishes.

The combined predation by lake trout and lake whitefish exceeded the standing stock biomass of mysids in the lake, but only removed an estimated 55% of annual production. Because of the high production to biomass ratio for mysids, the remaining surplus production would lead to a nearly 3-fold increase in the current biomass of mysids in the lake. This suggests that, in addition to predation by lake trout and lake whitefish, other significant sources of mortality (e.g., predation by yellow perch) likely contribute to regulating the dynamics of mysid population. However, because considerable uncertainty was associated with estimates for mysid production, any inferences drawn from the production-based calculations should be considered cautiously.

The change in food web structure also altered predator-prey interactions in this system. Since the 1980s, the emerging dominance of lake trout, lake whitefish, and mysids, and the concurrent crash of the kokanee population have dramatically shifted the energy flow to higher trophic levels from the previous pelagic pathways (zooplankton-kokanee-piscivores) to a more benthic pathway (chironomids-lake whitefish-lake trout) or bentho-pelagic pathway (benthos and zooplankton-mysids-lake whitefish and smaller lake trout-lake trout). The effect of higher non-native fish consumption on benthos, especially lake whitefish feeding on chironomids, on native fishes like westslope cutthroat trout, juvenile bull trout, and cyprinids, is currently unknown, but increased competition for these food resources could reduce feeding, growth, and potentially survival or reproduction.

Yellow perch were the second most important prey fish species in the energy budget of lake trout. This suggests that their current abundance in the lake is high; therefore, it will be important to understand their ecological role in the food web. In similar lakes, age 0-1 yellow perch are highly planktivorous, whereas older life stages feed predominantly on benthic invertebrates (including chironomids and mysids) and small fish, especially larval or juvenile sculpins and yellow perch (McIntyre et al. in press). Given this trophic ontogeny, yellow perch could potentially serve as an important mysid predator or as a competitor with mysids and other planktivorous fishes.

Future sampling efforts would also benefit from using a broader array of sampling gear to capture representative size classes for each major species, including age 0-1 lake trout, lake whitefish, pygmy whitefish, and yellow perch. Smaller-mesh gill nets, beach seines, fyke nets, midwater trawls, and/or minnow traps may be required to effectively sample species and size classes in appropriate seasonal habitats. Given the potentially large cohorts associated with younger age classes, characterization of their seasonal distribution and feeding patterns will be important, particularly with respect to regulating mysids and potential competition with native planktivorous and invertebrate-feeding fishes. Any future research should also focus on carefully documenting seasonal and spatial patterns of predation on pygmy whitefish, westslope cutthroat trout and bull trout, especially regarding seasonal migrations into or out of the lake by juveniles or adults.

Acknowledgments

Funding, samples, and catch data for this project were provided by the Confederated Salish & Kootenai Tribe. Barry Hanson offered valuable technical, logistical, and administrative assistance. Jason Van Tassell, Mike Mazur, Carl East, Rick Orme, Andy Jones, Matt Helm, Jon Flinders, Adrienne Marler, Mistie Hammer assisted in lab processing.

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Table 1. Number of individuals for each species genetically screened at 16S and ND3 (brackets indicated the number of intraspecific polymorphisms).

Species	**16S**	**ND3**	***Sample Locations***
kokanee	2 (0)	30 (4)	Flathead Lake +
cutthroat trout	3 (1)	62 (8)	Flathead Lake +
rainbow trout	2 (0)	64 (3)	Flathead Lake +
lake trout	4 (0)	6 (1)	Flathead Lake +
bull trout	8 (2)	14 (2)	Flathead Lake +
northern pikeminnow	6 (0)	n/a	Flathead Lake
peamouth	6 (0)	n/a	Flathead Lake
pygmy whitefish	5 (0)	n/a	Flathead Lake
lake whitefish	6 (0)	n/a	Flathead Lake
mountain whitefish	4 (1)	n/a	Flathead Lake, Lake Washington
largescale sucker	6 (1)	n/a	Flathead Lake, Lake Chelan
longnose sucker	6 (0)	n/a	Flathead Lake
yellow perch	6 (0)	n/a	Flathead Lake
prickly sculpin	1	n/a	Lake Washington

n/a – does not amplify with Domanico and Phillips (1995) ND3 primers

+ ND3 data combines Flathead Lake samples with sequence data from broader geographic survey by Schwenke et al. unpublished

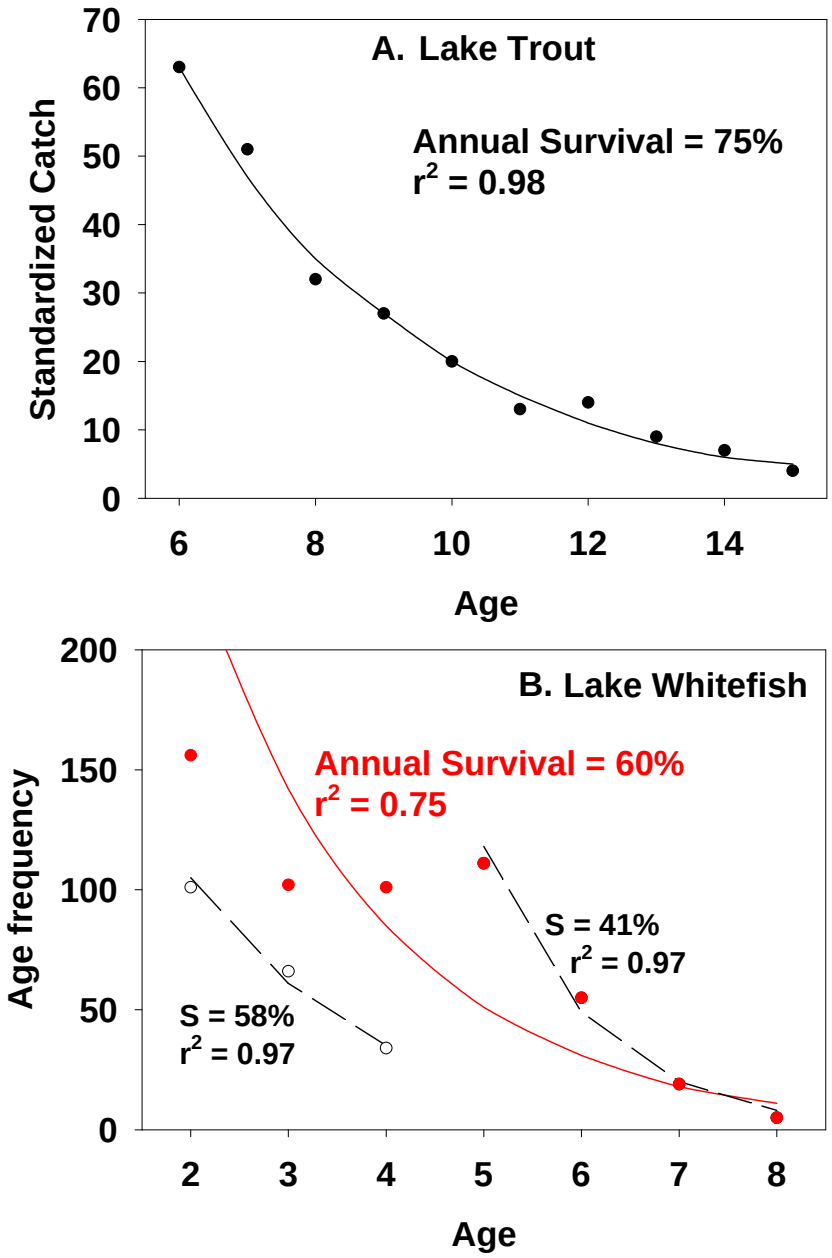

Figure 1. Survival estimates for A. lake trout and B. lake whitefish in Flathead Lake. Regression lines were fitted to standardized catch of lake trout after adjusting for size-selectivity of gill nets, and to age frequency data for lake whitefish from Tohtz (1993) after mysids became established.

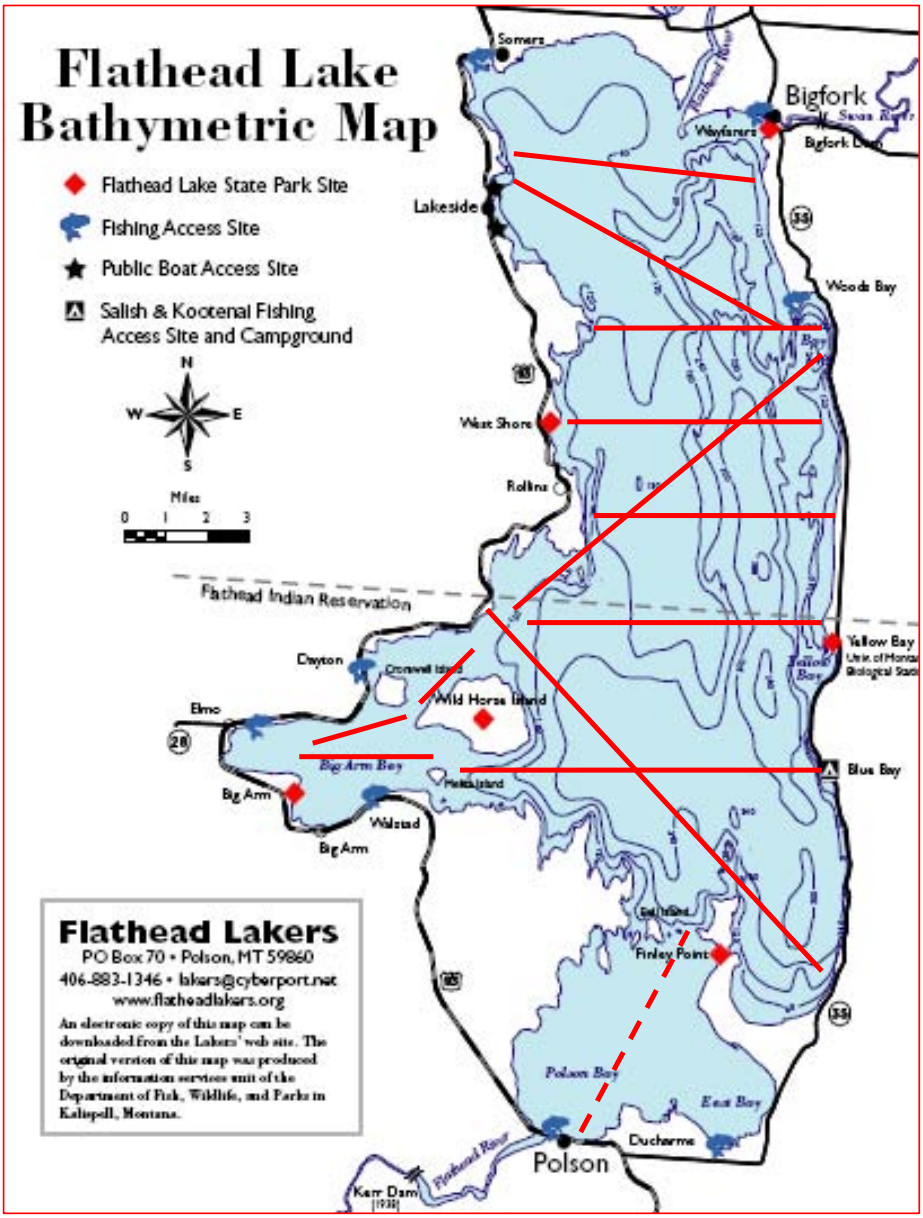

Figure 2. Transects used during a night hydroacoustic survey during August 11-12, 2003 are indicated as solid lines. The dashed in Polson Bay represents an exploratory transect that was omitted from the analysis because of depth limitations.

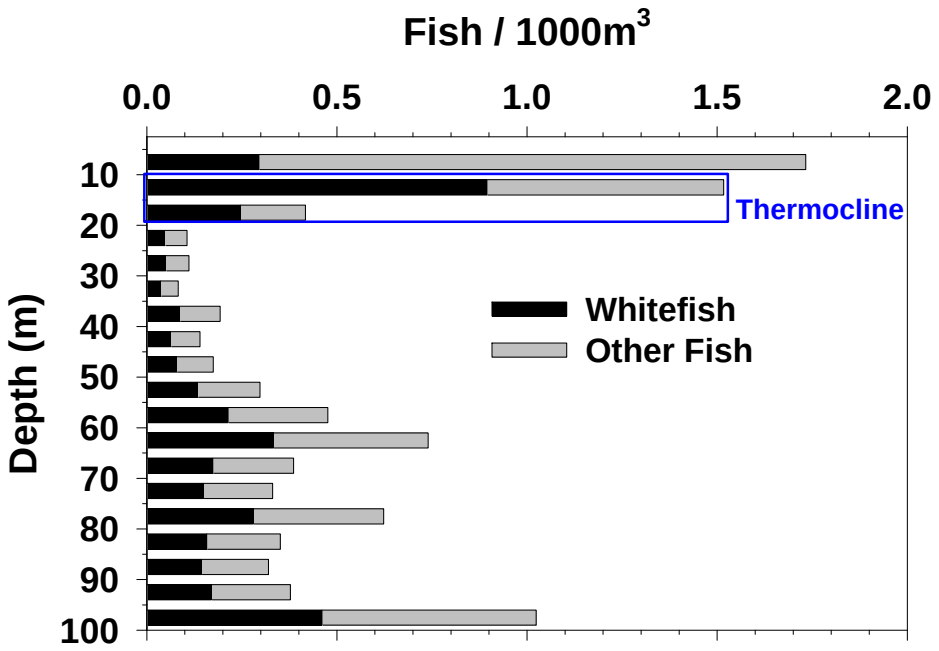

Figure 3. Depth-specific densities of coregonids (lake and pygmy whitefishes) and other fishes, estimated from a hydroacoustic survey and depth-specific gill net sampling in limnetic and slope zones of Flathead Lake during August 2003. The thermocline at 10-20 m is indicated.

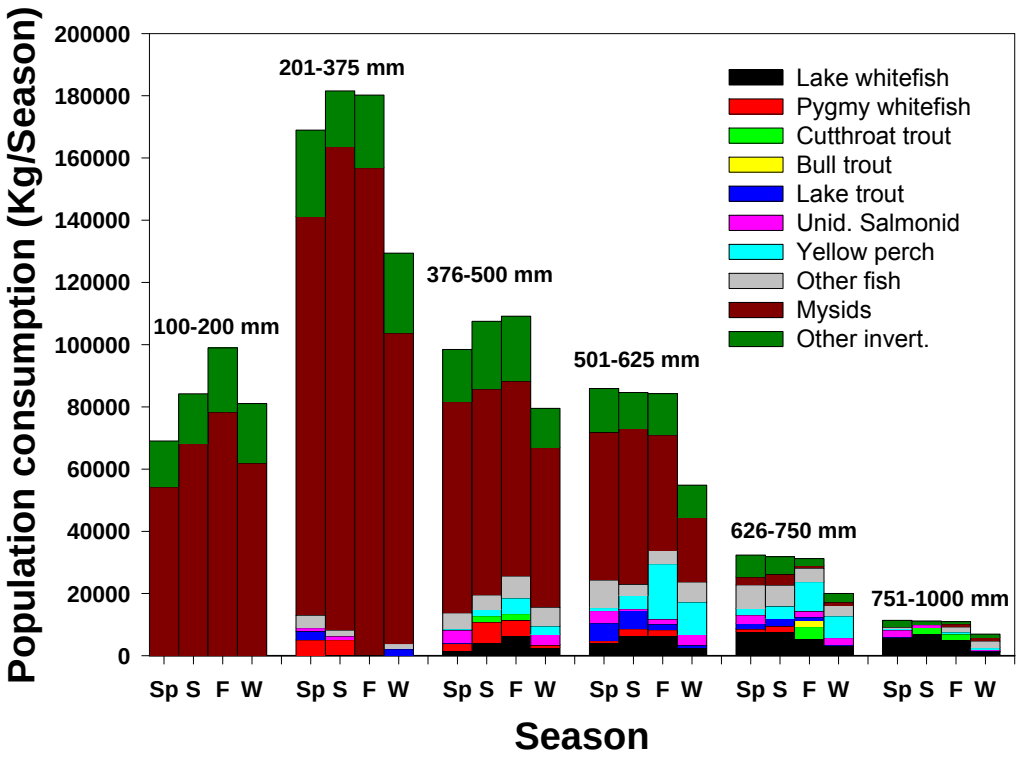

Figure 4. Seasonal, population-level consumption of all major prey categories by different size classes of lake trout in Flathead Lake during 1998-2001.

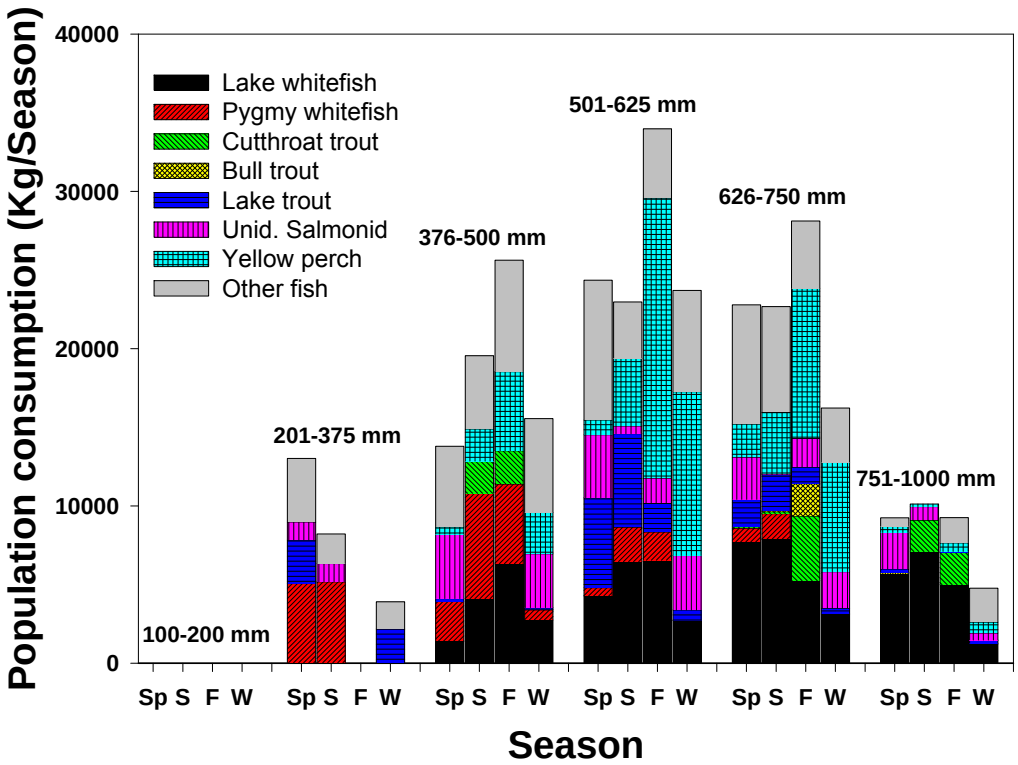

Figure 5. Seasonal, population-level consumption of prey fishes by different size classes of lake trout in Flathead Lake during 1998-2001. Invertebrate prey from the previous figure have been removed to highlight predation patterns on prey fishes.

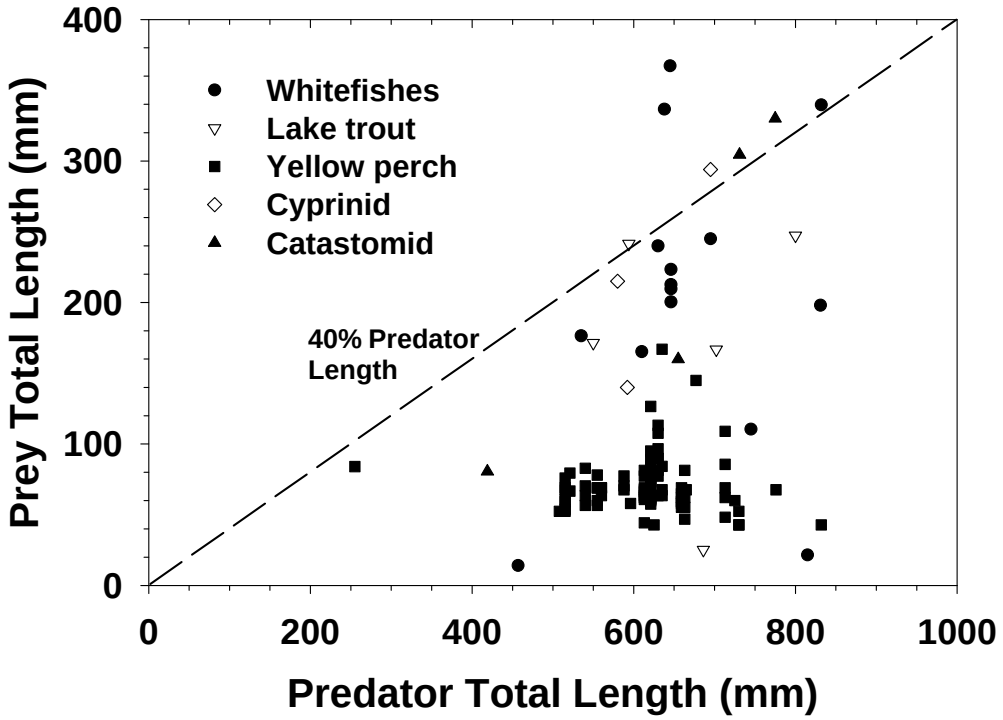

Figure 6. Total length of prey fishes eaten by different sizes of lake trout during 1998-2001.

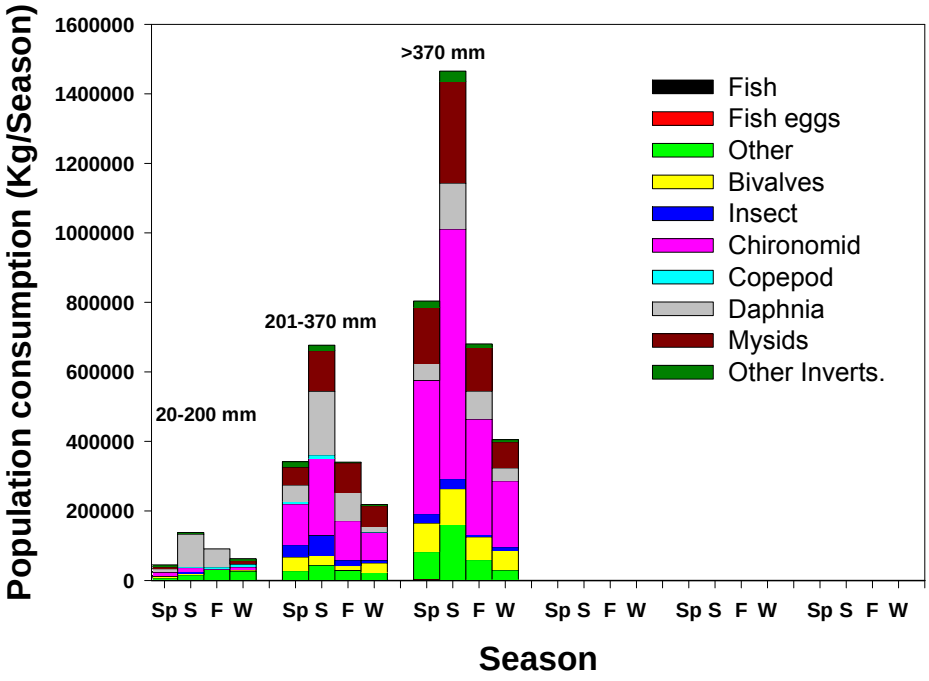

Figure 7. Seasonal, population-level consumption of all major prey categories by different size classes of lake whitefish in Flathead Lake during 1998-2001.

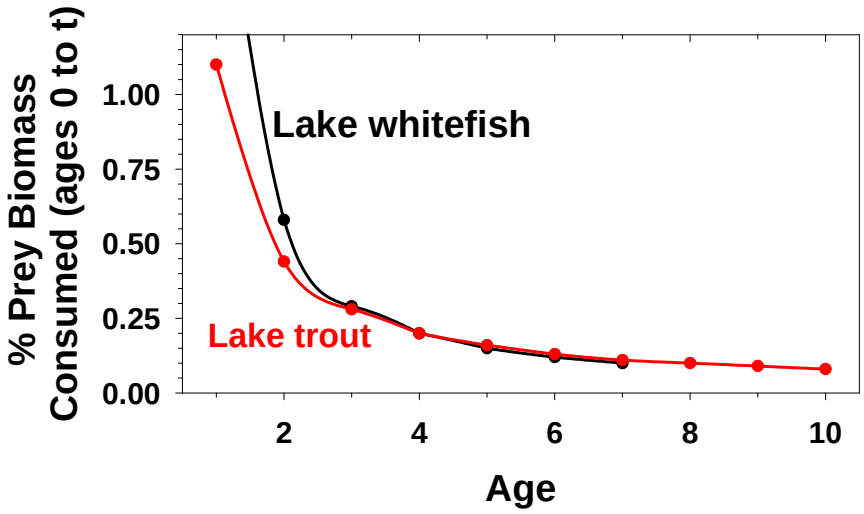

Figure 8. The effects of lake trout predation on lake whitefish and lake trout: the annual predation by lake trout is graphed as a percentage of the standing stock biomass of age t and younger lake whitefish and lake trout. The graph suggests that lake trout predation could consume the entire biomass of ages 0-1 lake trout and lake whitefish, but only 60% of the biomass of age 0-2 lake whitefish and 45% of age 0-2 lake trout. These curves do not account for the annual production generated by the different age classes of prey (see next figure).

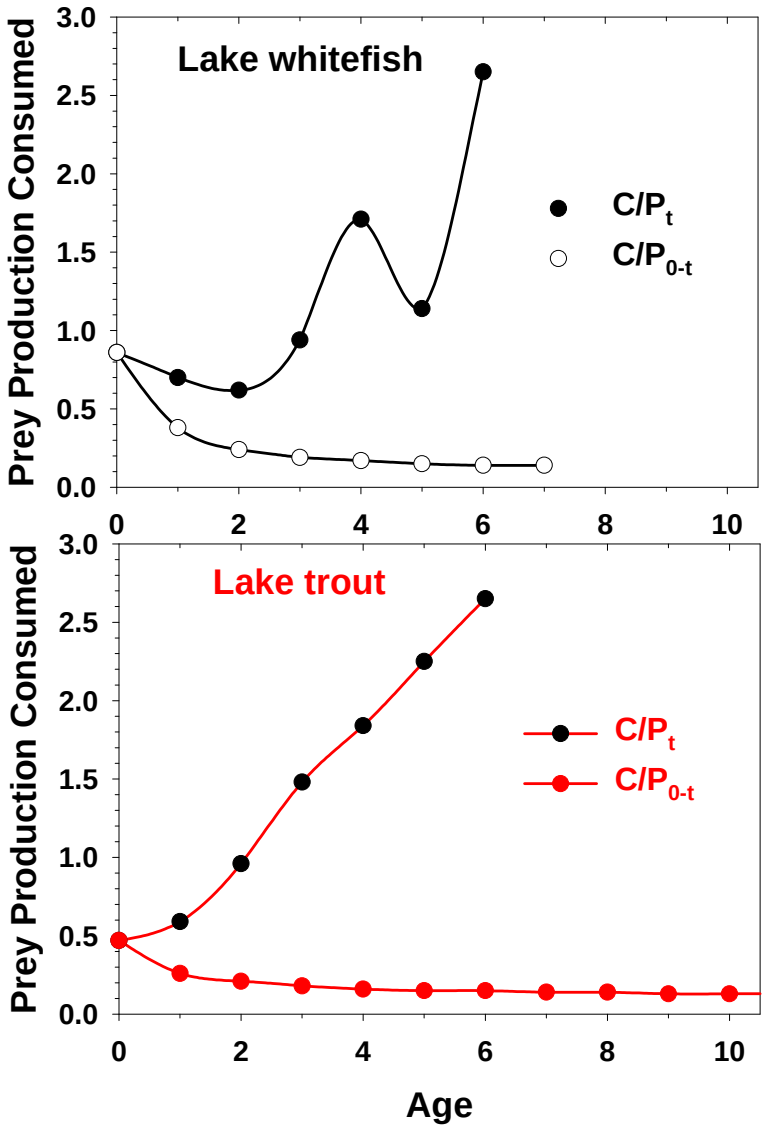

Figure 9. The effects of lake trout predation on lake whitefish (upper panel) and cannibalism (lower panel): annual prey-specific predation by lake trout is graphed both as a percentage of the annual production by each age class of lake whitefish and lake trout (C/P_t) and for age t and younger prey (C/P_{0-t}). The graph suggests that annual production by individual age classes 0-2 lake whitefish and 0-1 lake trout can entirely absorb predation by lake trout, whereas older age classes of prey would need to rely on production by younger conspecifics to absorb some of the predation demand.

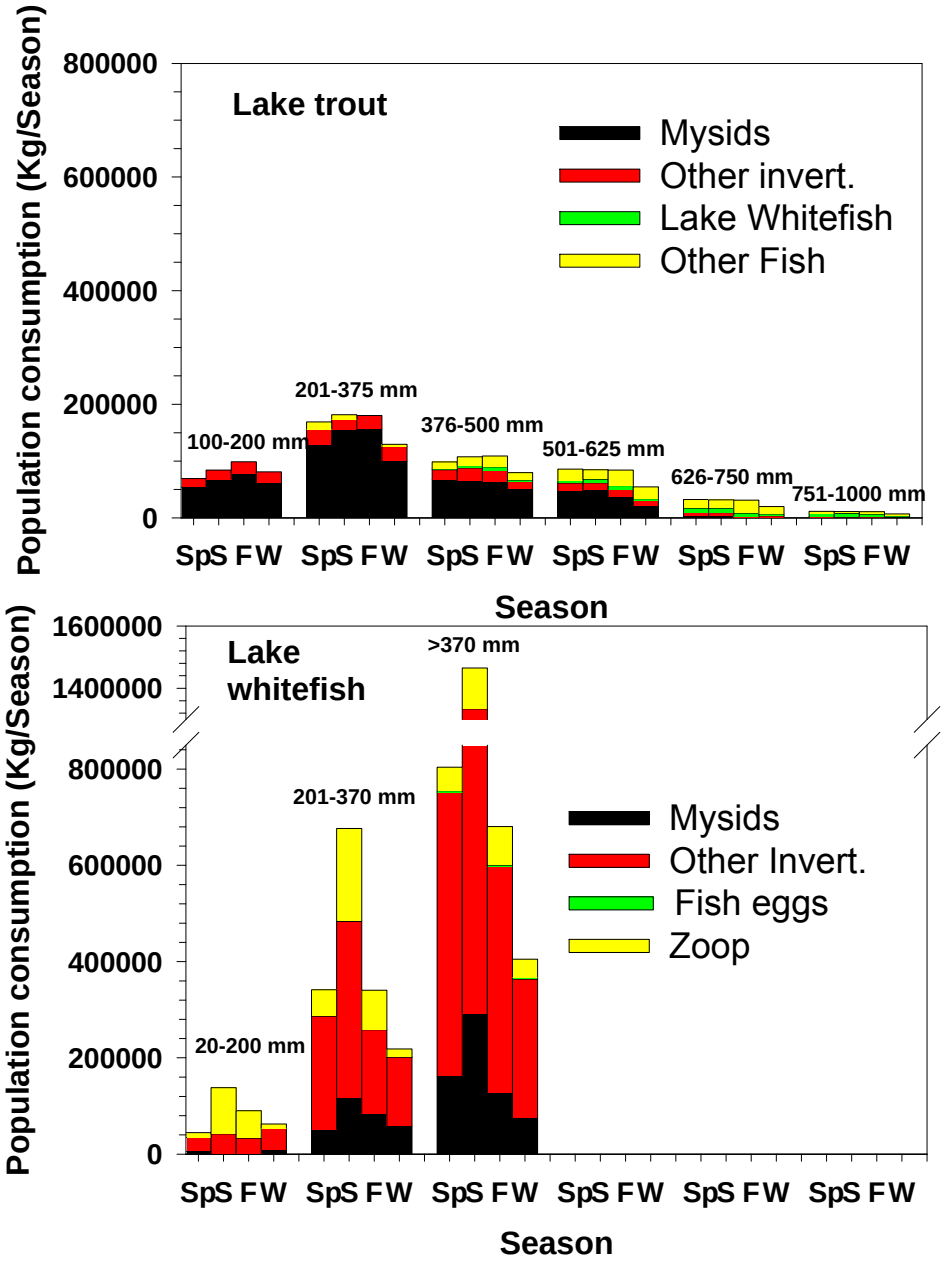

Figure 10. Comparative seasonal, population-level consumption of common prey types by different size classes of lake trout and lake whitefish.

APPENDIX

Flathead Lake hydroacoustic survey (August 11-14, 2003).

August 11, 2003 (2200-0430)-Conducted hydroacoustic survey of Flathead Lake: 4 long zig zag transects from Skidoo Bay in the SE to the point north of Big Arm Bay to Woods Bay (in NE near the Raven Brew Pub) to the point north of Lakeside (is this the right name?) in the NW. A nearly full moon rose in mostly clear skies during the first quarter of the first transect. Lake transparency (Secchi depth =14 m) was remarkably clear for August, and *Daphnia* were relatively abundant (B. Ellis, personal communication) The lake was strongly stratified with surface temperatures of 21°C, epilimnetic temperatures at 19-21°C. A very sharp thermocline began at 9 m with up to a 3° drop/m. A BioSonics 200 kHz splitbeam (6.8^{o} beam angle) transducer was deployed 0.5 m deep and towed at 5.2 knots.

Fish target densities were light to moderate for most transects. A consistent moderate density of targets (mostly -44 to –38 dB) occurred at 60-70 m depths and were suspended 1-10 m above the bottom. When depths became shallower, these targets were located closer to the bottom and then disappeared at bottom depths < 55-60 m.

A second layer of targets was suspended at 10$\pm$2 m and occurred sporadically in the southern 2 transects, but became very consistent in the last transect from Woods Bay to Lakeside.

Fish were sparse in intermediate depths with low densities appearing sporadically in 20-50 m, but were generally centered around 30 m.

Several factors may have affected distributions of pelagic fish during this survey and should be considered when gillnetting to obtain species identification of the acoustic targets. Nocturnal fish distributions were likely influenced by the full moon. A common response by planktivorous fishes is to move deeper or perhaps re-aggregate into schools. A *Hexagenia* hatch was underway, and anglers reported that the lake whitefish were feeding heavily on them. This episodic feeding behavior might aslo have induced a shift in spatial distribution of fishes.

YOY yellow perch, ~30-70 mm, were numerous in nearshore regions in the upper 2 m of the water column and were also reported near the surface more than a km offshore (B. Ellis, pers. comm.). Just offshore of the Blue Bay Marina, before and during early dusk, whole schools of this sized fish were observed jumping in a manner suggesting avoidance response to predatory fish.

Summary of Data Needs and Uncertainties

The frequency of occurrence of bull trout in the diet of piscivorous lake trout can be a useful metric. If 36,500 age 3 bull trout enter the lake, there are also 36,300 lake trout > 625 mm TL available to eat them, so about one for each predator over the year. At a 2-day digestion time and 6 months of potential predation (fall and winter) we would see about 1 bull trout in every 90 gut samples. 4 out of 136 lake trout > 625 mm TL contained bull trout over all seasons. Seasonally, 2 out of 77 lake trout > 625 mm TL in spring and 2 out of 20 lake trout > 625 mm TL in fall contained bull trout. If lake trout generally eat prey fish 50% of their own total length, then a 290-300 mm TL age 3 bull trout can't be eaten by lake trout much smaller than 625 mm anyway. Fraley and Shepard (1989) reported that 49% of the bull trout migrants were age 2 and 32% were age 3, so the age 2 bull trout (about 234 mm TL) would certainly be susceptible to more of the smaller predators (e.g.,153,500 piscivorous lake trout >468 mm TL in the population and large enough to eat a 234 mm TL age 2 bull trout).

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Food Habits of Flathead Lake Fishes

Other fishes-- For some fishes, diet data were pooled across size classes or seasons when sample sizes were inadequate to permit seasonal or size-specific stratification (**Table A1**). Bull trout (N = 13) were highly piscivorous and consumed lake whitefish, unidentified salmonine fishes, yellow perch, suckers, and cyprinids. Rainbow trout (N = 5 during winter-spring) ate sculpins, unidentified fish, and aquatic insects; westslope cutthroat trout (N = 9 during spring) and hybrid rainbow x cutthroat trout (N = 3 during spring) ate aquatic insects and other invertebrates. Northern pikeminnow stomachs (N = 29) contained primarily unidentified salmonids, unidentified fish, and other invertebrates. Yellow perch (N = 11 during spring) ate predominantly smaller yellow perch (54%) and benthic invertebrates (45.5%), but very few mysids (0.5%). Longnose and largescale suckers, mountain and pygmy whitefish, and peamouth fed exclusively on invertebrates.

Appendix 4b

Trophic Interactions of Nonnative Lake Trout in the Flathead Lake Food Web Under Different Population-Suppression Scenarios for Lake Trout

Trophic Interactions of Nonnative Lake Trout in the Flathead Lake Food Web Under Different Population Suppression Scenarios for Lake Trout

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March 2012

Report to the Confederated Salish-Kootenai Tribes

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[2] E.R. Schoen is employed by the University of Washington

[3] The Unit is jointly sponsored by US Geological Survey-Biological Resources Division, University of Washington, and Washington Departments of Fish and Wildlife, Ecology, and Natural Resources

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INTRODUCTION

Nonnative lake trout, lake whitefish, and *Mysis relicta* became the predominant species in the Flathead Lake food web during the mid-1980s. This change in food web structure altered predator-prey interactions, causing the kokanee population to crash, and was implicated in significant declines of sensitive, threatened and endangered native fishes (e.g., bull trout, westslope cutthroat trout, pygmy whitefish). Given the apparent strong top-down control exerted by lake trout and mediated by mysids (Ellis et al. 2011), the food web dynamics of Flathead Lake will likely continue to change in response to changes in the lake trout population. Recently, the feasibility of suppressing lake trout has been considered, and a population model was developed by M. Hansen (Hansen 2011 Draft Report) to predict the age- and size-structured abundance of lake trout that might result from suppression scenarios that reduced lake trout by 25%, 50%, and 90% from an established baseline condition (**Table 1**). In addition, new estimates for the size-at-age of lake trout were generated from otolith-based age analysis from samples collected during 2005-2008 to provide updated growth rates for the contemporary population.

Based on these new population abundance, size structure, and suppression scenarios, we simulated the corresponding predicted trophic interactions of lake trout. The primary objectives of this analysis were to: 1) estimate the number of bull trout lost to predation by lake trout under baseline conditions and compare the predicted predation mortality that resulted under each of the lake trout suppression scenarios; and 2) estimate the relative change in mysid densities associated with the baseline and each lake trout suppression scenario.

METHODS

The updated age-specific abundance, size, and maturity of lake trout were combined with previously reported data on size-specific seasonal diet, and thermal experience for lake trout sampled during June 1998-August 2001 (Beauchamp et al. 2006) to generate bioenergetic model simulations of size-structured, seasonal consumption rates on key prey species. These simulations identified forage species that contributed most to the annual energy budget of lake trout, and quantified seasonal predation patterns on native fishes (pygmy whitefish, bull trout, westslope cutthroat trout) and key non-native species (lake trout, lake whitefish, yellow perch, and mysids).

The age-specific inputs used in bioenergetics modeling simulations for lake trout consumption included contemporary size-at-age and size-specific maturity data, abundance under baseline conditions and different suppression scenarios (**Table 1**). The bioenergetics model estimated the amount of consumption (g of prey per year) that was required to satisfy the observed growth (in body mass) for each age class of lake trout, given the and thermal experience (**Table 2**) and seasonal changes in size-specific diet (**Table 3**) that were determined from sampling conducted during June 1998-August 2001 (reported previously in Beauchamp et al. 2006).

Consumption rates were fitted to annual growth increments expressed in terms of the body mass for each age of lake trout (ages 1-30) estimated at the beginning of each year with 365-d simulations starting April 1st and ending March 31st to approximate the presumed completion of annulus formation on otoliths. The size-at-age data were generated from fitting a von Bertalanffy growth model to back-calculated size-at-age data from otoliths collected during 2005-2008 (N = 267; C. Stafford, unpublished data) and represented combined population of lean and dwarf growth morphs (M. Hansen, personal communication):

$$TL_t = 968.5 \cdot (1 - e^{-0.06596 \cdot (t+1.767)}).$$

Total length (TL, mm) was converted to weight (W, g) using the regression (N = 426, r^2 = 0.978; Beauchamp et al. 2006):

$$W = 0.0000055 \cdot TL^{3.054}.$$

The length frequency distributions from lake trout sampled during 1998-2010 (**Figure 1**) provided the background context for investigating current conditions and potential future

suppression scenarios. The size-specific abundance of lake trout was estimated for baseline conditions from mark-recapture studies, and reflected the current size structure of the population, reconstructed from gear selectivity-adjusted length frequency distributions of gill net-captured (October 18-November 9, 2006) and angling (2007-2008) samples of lake trout (M. Hansen, Draft Report). The "baseline" scenario reflected the observed uneven decline in abundance among age classes and included a disproportionately large number of older, larger individuals. A second simulated "status quo" scenario approximated a similar total abundance of ages 1-30 lake trout, but abundance progressively declined with age and provided a direct comparison between "status quo" (no active suppression measures) and increasing levels of suppression to reduce the population by 25%, 50%, and 90%. Under increasing levels of suppression, age-specific abundance declined such that total abundance was reduced and the size structure shifted to smaller fish (**Table 1**). The model simulations accounted for the average combined energy losses from spawning of males and females by assigning an average 3% loss of body mass for ages 10-11, increasing to 5% for ages 12-15, and 8% for ages 16-30.

Results and Discussion

Changes in age- and size-specific biomass of lake trout provides a useful visualization for how the size structure, abundance, and predatory demand associated with different size classes of lake trout might change under different suppression scenarios (**Figure 2**). The biomass of larger, highly piscivorous lake trout was much higher in the current baseline situation compared to the smoothed long term status quo condition, even though both scenarios represent similar abundances of lake trout.

The age-specific bioenergetics simulations indicated that the annually-averaged feeding rates were relatively high (59-85% of the theoretical maximum consumption rate, Cmax) for lake trout up to 625 mm TL, then declined to 38-47% Cmax for larger size classes (**Table 4**). This shift in feeding rate corresponded with a marked increase in piscivory by larger lake trout: fish prey represented 0-28% of the annual diet for lake trout 100-625 mm TL, whereas fish prey represented 78-84% of the annual diet of larger lake trout (626-1000 mm TL; **Table 3**).

Although lake trout consumed some lake whitefish larger than 50% of their own body length, most prey fishes consumed were generally ≤ 40% of the predators' TL (**Figure 3**). The sizes of spiny-rayed yellow perch found in stomachs were generally only 10-20% of the predators' length, and the majority of yellow perch found in stomachs were ≤ 100 mm TL, whereas other prey fish species were generally larger (**Figure 4a**).

Although the sizes of bull trout found in stomach samples were not reported, reconstructions from the mass of the remains for three of the four samples resulted in minimum reconstructed prey lengths of 199-245 mm TL, which translated into 25-35% of their consumers' TL (**Figure 3**). The remains for a fourth bull trout weighed much less (the minimum reconstructed size estimate was 78 mm TL); however, because the extent of digestion was not documented, we were uncertain whether the remaining mass represented a relatively intact fish or a highly digested fragment.

Ideally, downstream migrant trapping data would provide the timing and size distribution of juvenile bull trout entering the lake, but such data were unavailable. However, the minimum size of bull trout captured incidentally by the sport fishery or gill nets was 183 mm TL with the modal size around 200 mm TL and second smallest mode around 250 mm TL (**Figure 4b**); these sizes agree reasonably well with the minimum reconstructed sizes of three of the four bull trout taken from lake trout stomachs **(Figure 4a**). The weighted mean size of prey sized bull trout ≤ 300 mm TL was 229 mm TL and 89 g during spring and 232 mm TL (92 g) in fall, the seasons when bull trout were found in the stomachs of lake trout. These results support the assumption that juvenile bull trout initially migrate to Flathead Lake at an approximate size of 200 mm TL and are primarily vulnerable to lake trout predation during their first year after lake entry. However, the estimated predation losses described below rely heavily on this assumption. This uncertainty could be addressed directly through a downstream migrant trapping program to quantify the timing, relative abundance, and size distribution of juvenile bull trout entering the lake. Ideally, trapping would enable implanting acoustic tags, including some depth-sensing tags, in outmigrants to enable tracking of their early movement and distribution patterns in the lake. This information would provide valuable insights into the seasonal overlap with and vulnerability of bull trout to predators in the lake.

Lake trout predation impacts under different suppression scenarios

The annual population-level consumption on all prey categories combined was similar for the baseline (2,258 metric tons [MT] of prey) and status quo (2,232 MT) scenarios followed in declining order by the suppression scenarios of 25% (1,461 MT), 50% (917 MT), and 90% (167 MT) reductions in lake trout (**Table 5**). The baseline scenario generated considerably higher predation on fish prey (695 MT of fish prey) than the status quo scenario (545 MT), because a larger fraction of the baseline population was composed of the highly piscivorous size range (626-1000 mm TL) of lake trout. The importance of this difference in size structure of lake trout becomes even more apparent when examined in terms of predation losses for bull trout. Assuming an average 90-g body mass for bull trout consumed by lake trout, the numerical loss under the baseline scenario would be approximately 79,000 bull trout per year, compared to about 45,000 bull trout lost under the status quo scenario, 12,000 lost under 25% suppression, 4,400 lost at 50% suppression, and less than 400 lost at 90% suppression (**Table 5**).

In the baseline scenario, the more piscivorous population of lake trout consumed a somewhat lower biomass of mysids (1,200 MT/yr) than the status quo scenario (1,300 MT/yr). Annual mysid predation would decline steadily under the lake trout suppression scenarios of 25% (960 MT), 50% (620 MT), and 90% (120 MT) from direct predation by lake trout (**Table 5**). Lake trout also consume large numbers of lake whitefish which also feed on mysids; however, mysids are a secondary prey for lake whitefish. Beauchamp et al. (2006) estimated that the lake trout population consumed more mysid biomass than did lake whitefish, and concluded that the net effect of removing 1,000 age 1-30 lake trout (with a size structure mirroring the population) would be an increase in mysid biomass of 659 kg, or an increase in areal density of approximately 0.13 mysids$\cdot$m^{-2}. Therefore, a reduction of 100,000 lake trout would roughly translate into an increase of 13 mysids $\cdot$m^{-2}. To put this prediction in perspective, following the initial explosion of mysids in the lake, mean densities in the fall have ranged between 19 and 90 mysids $\cdot$m^{-2} with the majority of densities falling between 36 and 46 mysids $\cdot$m^{-2} (**Figure 5**).

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Table 1. Age-specific inputs used in bioenergetics modeling simulations for lake trout consumption under different suppression scenarios. The total length-at-age data were generated from fitting von Bertalanffy growth model to back-calculated size-at-age data from otoliths collected during 2005-2008 (includes lean and dwarf morphs). Spawning losses, as a percentage of body mass, begin at age-10 and increase until both sexes fully mature at age-16. Mass-dependent energy density was computed from Hanson et al. 1997). The size-specific thermal experience and diet inputs associated with age are indicated (refer to Tables 2 & 3).

Age	TL (mm) 2005-2008	Initial Wt (g)	Final Wt (g)	Size class (mm)	Nt baseline Mark-Recapture	Nt Simulated baseline: Status quo	Nt 25% Suppress	Nt 50% Suppress	Nt 90% Suppress	Spawning Loss %BWt	Lake trout energy density (J/g) 2005-2008	Thermal experience input-size categories	Diet input size categories
1	162	30.5	71.1	100-199	254,961	259,185	218,369	151,203	29,165		5,795	100-199	100-199
2	213	71.1	132.6	200-375	212,344	221,728	186,277	130,540	25,877		5,920	200-375	200-375
3	261	132.6	215.7	200-375	176,850	190,288	160,567	110,722	22,261		6,109	200-375	200-375
4	306	215.7	320.0	200-375	123,963	161,269	135,154	93,046	18,906		6,365	200-375	200-375
5	349	320.0	444.3	376-500	84,775	135,005	110,374	74,364	14,707		6,687	376-500	376-500
6	388	444.3	586.8	376-500	110,899	110,853	86,366	57,585	10,919		7,070	376-500	376-500
7	425	586.8	745.4	376-500	87,004	89,057	64,491	41,484	7,597		7,509	376-500	376-500
8	460	745.4	918.0	376-500	45,552	70,597	47,268	28,906	5,007		7,998	376-500	376-500
9	492	918.0	1102.2	376-500	59,513	55,193	33,710	19,495	3,054		8,529	376-500	376-500
10	523	1102.2	1295.8	501-625	41,278	42,666	23,202	12,352	1,795	3%	9,097	501-1000	501-625
11	551	1295.8	1496.6	501-625	36,993	32,755	15,923	7,991	1,066	3%	9,693	501-1000	501-625
12	578	1496.6	1702.7	501-625	16,911	25,086	10,865	5,072	608	5%	10,257	501-1000	501-625
13	603	1702.7	1912.1	501-625	23,433	19,247	7,400	3,274	344	5%	10,418	501-1000	501-625
14	626	1912.1	2123.2	626-750	19,544	14,757	5,096	2,104	209	5%	10,581	501-1000	626-750
15	648	2123.2	2334.6	626-750	9,670	11,478	3,514	1,360	122	5%	10,745	501-1000	626-750
16	668	2334.6	2544.9	626-750	16,623	8,726	2,383	858	69	8%	10,910	501-1000	626-750
17	688	2544.9	2753.0	626-750	19,170	6,722	1,621	550	39	8%	11,073	501-1000	626-750
18	706	2753.0	2957.9	626-750	7,688	5,214	1,133	359	23	8%	11,236	501-1000	626-750
19	722	2957.9	3158.9	626-750	10,232	4,063	801	240	14	8%	11,395	501-1000	626-750
20	738	3158.9	3355.1	626-750	8,577	3,171	569	159	8	8%	11,551	501-1000	626-750
21	753	3355.1	3546.0	751-1000	6,065	2,510	411	110	5	8%	11,704	501-1000	751-1000
22	767	3546.0	3731.3	751-1000	5,013	2,097	334	88	3	8%	11,853	501-1000	751-1000
23	779	3731.3	3910.6	751-1000	2,265	1,781	282	74	2	8%	11,997	501-1000	751-1000
24	792	3910.6	4083.5	751-1000	1,758	1,510	237	60	2	8%	12,137	501-1000	751-1000
25	803	4083.5	4250.1	751-1000	4,128	1,285	200	51	1	8%	12,271	501-1000	751-1000
26	813	4250.1	4410.0	751-1000	2,162	1,092	167	42	1	8%	12,401	501-1000	751-1000
27	823	4410.0	4563.4	751-1000	3,369	924	140	35	1	8%	12,526	501-1000	751-1000
28	833	4563.4	4710.3	751-1000	1,758	785	117	28	-	8%	12,645	501-1000	751-1000
29	841	4710.3	4850.6	751-1000	716	669	99	24	-	8%	12,759	501-1000	751-1000
30	849	4850.6		751-1000	138	567	83	19	-	8%	12,869	501-1000	751-1000

Table 2. Thermal experience (^{o}C) for lake trout used in bioenergetic simulations, based on size-specific depth distributions from 1998-2001 and vertical temperature profiles from 1990.

Month	Day of Simulation	Lake trout size (mm)			
		100-199	200-375	376-500	501-1000
April	1	3.5	3.5	3.5	3.7
May	31	4.2	4.4	4.4	5.8
June	62	4.7	5.1	5.1	7.1
July	92	5.0	5.3	5.3	5.4
August	123	4.9	5.3	5.3	5.4
September	154	5.1	5.5	5.5	5.5
October	184	5.2	5.7	6.4	9.3
November	215	6.4	6.6	6.7	6.7
December	245	5.0	5.1	5.1	5.0
January	276	3.7	3.6	3.6	3.4
February	307	2.9	2.8	2.8	2.6
March 1	335	2.7	2.8	2.8	2.8
March 31	365	3.5	3.5	3.5	3.7

Table 3. Seasonal diet composition by weight for each size-age class of lake trout in Flathead Lake during 1998-2001 and used as input to bioenergetics model simulations. April 1st represents day 1 of the simulation for each age class. N indicates the sample size in each size-season combination. Blank sample sizes indicate that the diet composition for most or all prey was held constant from an adjacent input date to prevent interpolation of specific prey proportions beyond specified periods.

Size-age	Season	Simul-ation day	Lake whitefish	Pygmy whitefish	Westslope cutthroat trout	Bull trout	Lake trout	Unid. trout or char	Unid. Salmonid-Coregonid	Yellow perch	Cyprinid	Sculpin	Sucker	Other fish	Mysids	Other inverts.	N
100-200	Spr	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.750	0.250	2
Age 1	Sum	91	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.818	0.182	11
	Fall	181	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.805	0.195	2
	End	365	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.750	0.250	
200-375	Spr	1	0.000	0.000	0.000	0.000	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.742	0.197	29
Age 2-4	Sum	91	0.000	0.058	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.000	0.000	0.021	0.773	0.134	14
	Fall	181	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.936	0.064	38
	Win	271	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.800	0.200	5
	End	365	0.000	0.000	0.000	0.000	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.742	0.197	
376-500	Spr	1	0.029	0.000	0.000	0.000	0.004	0.001	0.085	0.010	0.000	0.000	0.000	0.054	0.617	0.200	67
Age 5-7	Sum	91	0.000	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.000	0.000	0.757	0.143	20
	Fall	181	0.074	0.074	0.037	0.000	0.000	0.000	0.000	0.037	0.037	0.000	0.000	0.000	0.483	0.258	27
	Win	271	0.040	0.016	0.000	0.000	0.000	0.000	0.000	0.056	0.000	0.000	0.000	0.096	0.674	0.118	25
	End	365	0.029	0.000	0.000	0.000	0.004	0.001	0.085	0.010	0.000	0.000	0.000	0.054	0.617	0.200	
501-625	Spr	1	0.070	0.000	0.000	0.000	0.024	0.024	0.073	0.000	0.014	0.008	0.033	0.153	0.382	0.219	42
Age 8-11	Sum	91	0.031	0.012	0.000	0.000	0.106	0.000	0.000	0.021	0.000	0.000	0.000	0.007	0.710	0.113	19
	Fall	181	0.116	0.038	0.000	0.000	0.039	0.000	0.011	0.077	0.015	0.000	0.050	0.008	0.488	0.158	26
	Win	271	0.029	0.000	0.000	0.000	0.000	0.000	0.029	0.382	0.000	0.000	0.000	0.026	0.377	0.157	34
	End	365	0.070	0.000	0.000	0.000	0.024	0.024	0.073	0.000	0.014	0.008	0.033	0.153	0.382	0.219	
626-750	Spr	1	0.228	0.000	0.006	0.000	0.033	0.049	0.124	0.001	0.028	0.032	0.097	0.100	0.042	0.259	36
Age 12-16	Sum	91	0.248	0.052	0.000	0.000	0.073	0.000	0.000	0.125	0.212	0.000	0.000	0.000	0.111	0.179	8
	Sum	180	0.248	0.052	0.000	0.000	0.073	0.000	0.000	0.125	0.212	0.000	0.000	0.000	0.111	0.179	
	Fall	181	0.235	0.000	0.235	0.118	0.059	0.000	0.059	0.000	0.058	0.001	0.059	0.058	0.000	0.118	17
	Win	271	0.082	0.000	0.000	0.000	0.000	0.000	0.058	0.696	0.041	0.000	0.036	0.011	0.060	0.016	17
	End	365	0.228	0.000	0.006	0.000	0.033	0.049	0.124	0.001	0.028	0.032	0.097	0.100	0.042	0.259	
751-1000	Spr	1	0.148	0.000	0.000	0.035	0.085	0.071	0.265	0.049	0.048	0.000	0.098	0.070	0.002	0.129	41
Age >16	Spr	45	0.600	0.000	0.000	0.000	0.000	0.000	0.167	0.031	0.000	0.000	0.000	0.000	0.001	0.201	
	Sum	91	0.600	0.000	0.000	0.000	0.000	0.000	0.167	0.031	0.000	0.000	0.000	0.000	0.001	0.201	5
	Fall	181	0.667	0.000	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
	Win	271	0.183	0.000	0.000	0.000	0.016	0.000	0.000	0.112	0.000	0.000	0.111	0.222	0.212	0.144	9
	End	365	0.148	0.000	0.000	0.000	0.085	0.106	0.265	0.049	0.048	0.000	0.098	0.070	0.002	0.129	

Table 4. Results of bioenergetics model simulations for the average individual from each age class, indicating the average annual feeding rate (%Cmax), total annual consumption of prey, growth efficiency (G/C), and the average daily ration as a percentage

Age	TL (mm) 2005-2008	Initial Wt (g)	Final Wt (g)	Size class (mm)	P-value (%Cmax)	Consumption g/year	Growth Efficiency	Avg. Ration %BWt/d
1	162	30.5	71.1	100-199	0.853	475	8.5%	2.8%
2	213	71.1	132.6	200-375	0.794	751	8.2%	2.1%
3	261	132.6	215.7	200-375	0.782	1077	7.7%	1.7%
4	306	215.7	320.0	200-375	0.773	1436	7.3%	1.5%
5	349	320.0	444.3	376-500	0.666	1588	7.8%	1.2%
6	388	444.3	586.8	376-500	0.661	1941	7.3%	1.0%
7	425	586.8	745.4	376-500	0.654	2293	6.9%	0.9%
8	460	745.4	918.0	376-500	0.649	2657	6.5%	0.9%
9	492	918.0	1102.2	376-500	0.643	3013	6.1%	0.8%
10	523	1102.2	1295.8	501-625	0.592	3381	5.7%	0.8%
11	551	1295.8	1496.6	501-625	0.589	3741	5.4%	0.7%
12	578	1496.6	1702.7	501-625	0.605	4232	4.9%	0.7%
13	603	1702.7	1912.1	501-625	0.604	4594	4.6%	0.7%
14	626	1912.1	2123.2	626-750	0.442	3648	5.8%	0.5%
15	648	2123.2	2334.6	626-750	0.442	3903	5.4%	0.5%
16	668	2334.6	2544.9	626-750	0.466	4394	4.8%	0.5%
17	688	2544.9	2753.0	626-750	0.466	4654	4.5%	0.5%
18	706	2753.0	2957.9	626-750	0.467	4905	4.2%	0.5%
19	722	2957.9	3158.9	626-750	0.467	5146	3.9%	0.5%
20	738	3158.9	3355.1	626-750	0.467	5377	3.6%	0.5%
21	753	3355.1	3546.0	751-1000	0.375	4524	4.2%	0.4%
22	767	3546.0	3731.3	751-1000	0.376	4694	3.9%	0.4%
23	779	3731.3	3910.6	751-1000	0.376	4860	3.7%	0.3%
24	792	3910.6	4083.5	751-1000	0.376	5013	3.5%	0.3%
25	803	4083.5	4250.1	751-1000	0.376	5159	3.2%	0.3%
26	813	4250.1	4410.0	751-1000	0.376	5301	3.0%	0.3%
27	823	4410.0	4563.4	751-1000	0.376	5434	2.8%	0.3%
28	833	4563.4	4710.3	751-1000	0.377	5560	2.6%	0.3%
29	841	4710.3	4850.6	751-1000	0.377	5682	2.5%	0.3%
30	849	4850.6		751-1000	0.377	5682		

Table 5. Annual population-level consumption of (MT/yr) by lake trout under each suppression scenario. Numerical predation loss of bull trout assumes an average prey weight of 90 g.

Scenario	Avg Spr predator Abundance	Lake whitefish	Pygmy whitefish	Cutthroat trout	Bull trout	Lake trout	Unid. Trout	Unid. Salmonid	Yellow perch	Cyprinid	Sculpin	Sucker	Other fish	Mysids	Other invert.
Baseline	558,725	189.3	49.7	34.6	7.1	42.2	8.1	56.6	143.6	53.2	13.2	28.0	69.5	1,193.7	368.6
Status quo sim	596,310	131.4	52.0	23.4	4.0	34.5	5.5	45.3	113.2	36.3	13.7	19.6	65.8	1,316.9	370.1
25% suppression	479,019	52.9	35.1	10.0	1.1	15.7	1.9	22.4	50.3	14.7	9.0	6.9	38.8	956.6	245.0
50% suppression	325,643	27.2	22.1	5.4	0.4	8.2	0.9	12.6	25.9	7.5	5.6	3.1	23.1	620.7	154.1
90% suppression	62,989	4.0	4.0	0.9	0.0	1.2	0.1	2.1	3.8	1.1	1.0	0.4	4.0	116.2	28.0

Scenario	Number of 90-g Bull trout eaten/year
Baseline	79,141
Status quo sim	44,774
25% suppression	12,024
50% suppression	4,394
90% suppression	367

Appendix Table A1. Population-level seasonal and annual consumption rates of prey by each size class of lake trout under current abundance and size structure versus population suppression scenarios: Status quo, 20%, 50% & 90% reductions.

Baseline scenario					**Population-level consumption (kg/season)**													
Size	Season	Mean Weight (g)	Mean Temp	**Average of Nt baseline Mark-Recapture**	Lake whitefish	Pygmy whitefish	Cutthroat trout	Bull trout	Lake trout	Unid. Trout	Unid. Salmonid	Yellow perch	Cyprinid	Sculpin	Sucker	Other fish	Mysids	Other invert.
100-200	Spr	34.6	4.4	**248,467**	-	-	-	-	-	-	-	-	-	-	-	-	17,803	4,857
	Sum	43.9	5.0	**235,848**	-	-	-	-	-	-	-	-	-	-	-	-	21,980	5,113
	Aut	56.2	5.4	**223,935**	-	-	-	-	-	-	-	-	-	-	-	-	25,141	6,619
	Win	66.8	3.1	**212,381**	-	-	-	-	-	-	-	-	-	-	-	-	20,612	6,369
200-375	Spr	148.9	4.6	**166,695**	-	3,312	-	-	1,769	-	742	-	-	-	-	2,604	82,746	17,902
	Sum	173.7	5.4	**158,229**	-	3,554	-	-	-	-	797	-	-	-	-	1,287	108,148	12,367
	Aut	198.7	5.5	**150,237**	-	-	-	-	-	-	-	-	-	-	-	-	117,189	17,541
	Win	216.2	3.1	**142,485**	-	-	-	-	1,791	-	-	-	-	-	-	1,422	80,922	20,836
376-500	Spr	461.3	4.6	**91,826**	1,678	3,108	-	-	231	58	4,917	579	-	3,108	-	3,124	82,742	20,458
	Sum	497.1	5.5	**87,162**	5,052	8,253	2,526	-	-	-	-	2,526	2,526	3,201	-	-	81,433	26,769
	Aut	555.0	5.7	**82,760**	8,058	6,458	2,695	-	-	-	-	6,431	2,695	-	-	6,404	80,142	26,664
	Win	584.8	3.1	**78,490**	3,573	829	-	-	207	52	4,397	3,419	-	-	-	7,769	66,849	16,462
501-625	Spr	1234.4	5.4	**36,330**	6,528	2,441	-	-	7,627	1,325	6,695	1,554	754	2,169	1,778	10,407	108,508	29,884
	Sum	1297.2	5.8	**34,485**	11,308	7,441	1,390	-	7,838	-	656	7,073	2,284	1,772	2,981	841	110,989	30,055
	Aut	1361.6	6.1	**32,743**	13,216	5,918	1,462	-	2,482	-	2,171	27,746	2,417	-	3,183	5,280	93,502	32,455
	Win	1394.5	3.0	**31,054**	5,673	444	-	-	1,026	944	6,225	16,208	534	305	1,259	10,971	64,494	23,062
626-750	Spr	2585.4	5.8	**12,739**	24,174	2,745	292	-	5,458	2,382	6,027	6,648	12,553	1,555	4,715	4,860	7,901	22,039
	Sum	2733.1	6.0	**12,092**	25,081	5,181	374	188	7,367	-	94	12,453	21,213	2	94	92	11,058	18,021
	Aut	2733.7	6.2	**11,481**	16,947	-	13,295	6,676	3,338	-	5,921	30,998	5,107	57	4,941	3,771	2,672	7,388
	Win	2741.3	3.0	**10,889**	10,267	-	199	-	1,096	1,628	6,024	22,889	2,277	1,063	4,405	3,683	3,366	9,129
751-1000	Spr	4175.4	5.8	**2,667**	17,109	-	-	259	629	525	6,418	1,190	355	-	725	518	41	6,319
	Sum	4409.9	6.0	**2,532**	21,643	-	6,060	-	-	-	2,646	491	-	-	-	-	16	3,184
	Aut	4371.9	6.2	**2,404**	15,379	-	6,320	-	238	-	-	1,664	-	-	1,649	3,299	3,150	2,140
	Win	4311.3	3.0	**2,280**	3,610	-	-	-	1,105	1,161	2,903	1,754	526	-	2,280	3,180	2,326	2,978

Status quo scenario

Size	Season	Mean Weight (g)	Mean Temp	**Simulated Status Quo Nt**	Lake whitefish	Pygmy whitefish	Cutthroat trout	Bull trout	Lake trout	Unid. Trout	Unid. Salmonid	Yellow perch	Cyprinid	Sculpin	Sucker	Other fish	Mysids	Other invert.
100-200	Spr	34.6	4.4	**252,583**	-	-	-	-	-	-	-	-	-	-	-	-	18,097	4,938
	Sum	43.9	5.0	**239,755**	-	-	-	-	-	-	-	-	-	-	-	-	22,344	5,198
	Aut	56.2	5.4	**227,644**	-	-	-	-	-	-	-	-	-	-	-	-	25,557	6,728
	Win	66.8	3.1	**215,899**	-	-	-	-	-	-	-	-	-	-	-	-	20,953	6,474
200-375	Spr	148.9	4.6	**186,227**	-	3,791	-	-	2,026	-	850	-	-	-	-	2,982	94,745	20,499
	Sum	173.7	5.4	**176,769**	-	4,063	-	-	-	-	911	-	-	-	-	1,471	123,607	14,136
	Aut	198.7	5.5	**167,841**	-	-	-	-	-	-	-	-	-	-	-	-	133,745	20,016
	Win	216.2	3.1	**159,181**	-	-	-	-	2,042	-	-	-	-	-	-	1,621	92,257	23,755
376-500	Spr	461.3	4.6	**108,795**	1,931	3,579	-	-	266	67	5,661	666	-	3,579	-	3,596	95,275	23,555
	Sum	497.1	5.5	**103,269**	5,826	9,514	2,913	-	-	-	-	2,913	2,913	3,689	-	-	93,871	30,861
	Aut	555.0	5.7	**98,053**	9,303	7,454	3,111	-	-	-	-	7,425	3,111	-	-	7,395	92,528	30,782
	Win	584.8	3.1	**92,994**	4,129	958	-	-	239	60	5,082	3,951	-	-	-	8,977	77,246	19,023
501-625	Spr	1234.4	5.4	**39,881**	6,746	2,755	-	-	7,719	1,343	7,220	1,623	761	2,481	1,794	10,796	117,286	32,083
	Sum	1297.2	5.8	**37,856**	11,882	8,277	1,637	-	7,910	-	662	7,373	2,540	2,087	3,009	849	119,595	32,822
	Aut	1361.6	6.1	**35,944**	14,077	6,565	1,723	-	2,505	-	2,190	28,588	2,687	-	3,212	5,914	101,706	35,200
	Win	1394.5	3.0	**34,089**	6,050	523	-	-	1,055	957	6,681	16,667	539	308	1,271	11,778	71,163	24,770
626-750	Spr	2585.4	5.8	**7,536**	13,722	1,558	166	-	3,098	1,352	3,421	3,773	7,125	883	2,676	2,759	4,485	12,510
	Sum	2733.1	6.0	**7,153**	14,237	2,941	212	107	4,181	-	53	7,069	12,041	1	53	52	6,277	10,229
	Aut	2733.7	6.2	**6,792**	9,642	-	7,562	3,797	1,899	-	3,370	17,654	2,906	32	2,812	2,146	1,522	4,203
	Win	2741.3	3.0	**6,441**	5,846	-	113	-	624	927	3,430	13,035	1,296	605	2,508	2,097	1,917	5,198
751-1000	Spr	4175.4	5.8	**1,288**	8,306	-	-	126	305	255	3,116	578	172	-	352	252	20	3,068
	Sum	4409.9	6.0	**1,223**	10,506	-	2,941	-	-	-	1,284	238	-	-	-	-	8	1,546
	Aut	4371.9	6.2	**1,161**	7,464	-	3,068	-	115	-	-	808	-	-	800	1,601	1,529	1,038
	Win	4311.3	3.0	**1,101**	1,752	-	-	-	536	564	1,409	851	255	-	1,107	1,543	1,129	1,445

25% suppression scenario

Size	Season	Mean Weight (g)	Mean Temp	**Nt 25% Suppress**	Lake whitefish	Pygmy whitefish	Cutthroat trout	Bull trout	Lake trout	Unid. Trout	Unid. Salmonid	Yellow perch	Cyprinid	Sculpin	Sucker	Other fish	Mysids	Other invert.
100-200	Spr	34.6	4.4	**212,807**	-	-	-	-	-	-	-	-	-	-	-	-	15,248	4,160
	Sum	43.9	5.0	**201,999**	-	-	-	-	-	-	-	-	-	-	-	-	18,826	4,380
	Aut	56.2	5.4	**191,796**	-	-	-	-	-	-	-	-	-	-	-	-	21,533	5,669
	Win	66.8	3.1	**181,900**	-	-	-	-	-	-	-	-	-	-	-	-	17,654	5,455
200-375	Spr	148.9	4.6	**156,573**	-	3,186	-	-	1,703	-	714	-	-	-	-	2,506	79,639	17,231
	Sum	173.7	5.4	**148,621**	-	3,415	-	-	-	-	765	-	-	-	-	1,237	103,901	11,883
	Aut	198.7	5.5	**141,114**	-	-	-	-	-	-	-	-	-	-	-	-	112,424	16,825
	Win	216.2	3.1	**133,833**	-	-	-	-	1,716	-	-	-	-	-	-	1,363	77,551	19,968
376-500	Spr	461.3	4.6	**84,859**	1,495	2,770	-	-	206	52	4,381	515	-	2,770	-	2,783	73,742	18,231
	Sum	497.1	5.5	**80,549**	4,511	7,367	2,255	-	-	-	-	2,255	2,255	2,856	-	-	72,678	23,895
	Aut	555.0	5.7	**76,480**	7,206	5,774	2,409	-	-	-	-	5,751	2,409	-	-	5,728	71,671	23,842
	Win	584.8	3.1	**72,534**	3,199	742	-	-	185	46	3,937	3,061	-	-	-	6,955	59,848	14,739
501-625	Spr	1234.4	5.4	**22,474**	3,373	1,648	-	-	3,671	641	3,960	831	359	1,519	847	5,448	64,639	17,439
	Sum	1297.2	5.8	**21,332**	6,167	4,818	1,051	-	3,736	-	313	3,760	1,477	1,339	1,421	401	65,464	18,449
	Aut	1361.6	6.1	**20,255**	7,524	3,801	1,106	-	1,184	-	1,035	14,208	1,561	-	1,518	3,485	56,720	19,519
	Win	1394.5	3.0	**19,210**	3,242	336	-	-	521	458	3,627	8,246	255	146	601	6,398	40,776	13,467
626-750	Spr	2585.4	5.8	**2,104**	3,729	423	45	-	842	367	930	1,026	1,937	240	727	750	1,219	3,400
	Sum	2733.1	6.0	**1,998**	3,870	799	58	29	1,137	-	14	1,921	3,273	0	14	14	1,706	2,781
	Aut	2733.7	6.2	**1,897**	2,625	-	2,058	1,034	517	-	917	4,809	791	9	765	584	415	1,144
	Win	2741.3	3.0	**1,799**	1,592	-	31	-	170	252	934	3,551	353	165	683	571	522	1,416
751-1000	Spr	4175.4	5.8	**202**	1,297	-	-	20	48	40	487	90	27	-	55	39	3	479
	Sum	4409.9	6.0	**191**	1,641	-	459	-	-	-	201	37	-	-	-	-	1	241
	Aut	4371.9	6.2	**182**	1,166	-	479	-	18	-	-	126	-	-	125	250	239	162
	Win	4311.3	3.0	**172**	274	-	-	-	84	88	220	133	40	-	173	241	176	226

50% suppression scenario

Size	Season	Mean Weight (g)	Mean Temp	**Average of Nt 50% Suppress**	Lake whitefish	Pygmy whitefish	Cutthroat trout	Bull trout	Lake trout	Unid. Trout	Unid. Salmonid	Yellow perch	Cyprinid	Sculpin	Sucker	Other fish	Mysids	Other invert.
100-200	Spr	34.6	4.4	**147,352**	-	-	-	-	-	-	-	-	-	-	-	-	10,558	2,881
	Sum	43.9	5.0	**139,868**	-	-	-	-	-	-	-	-	-	-	-	-	13,035	3,032
	Aut	56.2	5.4	**132,803**	-	-	-	-	-	-	-	-	-	-	-	-	14,910	3,925
	Win	66.8	3.1	**125,951**	-	-	-	-	-	-	-	-	-	-	-	-	12,224	3,777
200-375	Spr	148.9	4.6	**108,597**	-	2,205	-	-	1,179	-	494	-	-	-	-	1,735	55,117	11,925
	Sum	173.7	5.4	**103,082**	-	2,364	-	-	-	-	530	-	-	-	-	856	71,920	8,225
	Aut	198.7	5.5	**97,875**	-	-	-	-	-	-	-	-	-	-	-	-	77,829	11,648
	Win	216.2	3.1	**92,825**	-	-	-	-	1,188	-	-	-	-	-	-	944	53,692	13,825
376-500	Spr	461.3	4.6	**56,338**	990	1,834	-	-	137	34	2,901	341	-	1,834	-	1,843	48,820	12,070
	Sum	497.1	5.5	**53,477**	2,987	4,878	1,493	-	-	-	-	1,493	1,493	1,891	-	-	48,122	15,821
	Aut	555.0	5.7	**50,776**	4,772	3,823	1,596	-	-	-	-	3,808	1,596	-	-	3,794	47,462	15,789
	Win	584.8	3.1	**48,156**	2,119	492	-	-	123	31	2,608	2,027	-	-	-	4,606	39,637	9,761
501-625	Spr	1234.4	5.4	**12,521**	1,745	950	-	-	1,831	320	2,174	437	178	885	420	2,836	35,586	9,522
	Sum	1297.2	5.8	**11,885**	3,271	2,736	627	-	1,853	-	155	1,971	838	799	705	199	35,893	10,274
	Aut	1361.6	6.1	**11,285**	4,065	2,152	660	-	588	-	514	7,316	886	-	753	1,992	31,441	10,784
	Win	1394.5	3.0	**10,702**	1,754	200	-	-	267	229	1,979	4,232	127	72	298	3,491	22,955	7,353
626-750	Spr	2585.4	5.8	**784**	1,369	155	17	-	309	135	341	377	711	88	267	275	448	1,248
	Sum	2733.1	6.0	**744**	1,421	293	21	11	417	-	5	706	1,202	0	5	5	626	1,021
	Aut	2733.7	6.2	**706**	965	-	756	380	190	-	337	1,767	291	3	281	215	152	420
	Win	2741.3	3.0	**670**	585	-	11	-	62	93	343	1,305	130	61	251	210	192	520
751-1000	Spr	4175.4	5.8	**52**	332	-	-	5	12	10	124	23	7	-	14	10	1	123
	Sum	4409.9	6.0	**49**	420	-	118	-	-	-	51	10	-	-	-	-	0	62
	Aut	4371.9	6.2	**47**	298	-	123	-	5	-	-	32	-	-	32	64	61	42
	Win	4311.3	3.0	**44**	70	-	-	-	21	23	56	34	10	-	44	62	45	58

90% suppression scenario

Size	Season	Mean Weight (g)	Mean Temp	**Average of Nt 90% Suppress**	Lake whitefish	Pygmy whitefish	Cutthroat trout	Bull trout	Lake trout	Unid. Trout	Unid. Salmonid	Yellow perch	Cyprinid	Sculpin	Sucker	Other fish	Mysids	Other invert.
100-200	Spr	34.6	4.4	**28,422**	-	-	-	-	-	-	-	-	-	-	-	-	2,036	556
	Sum	43.9	5.0	**26,978**	-	-	-	-	-	-	-	-	-	-	-	-	2,514	585
	Aut	56.2	5.4	**25,615**	-	-	-	-	-	-	-	-	-	-	-	-	2,876	757
	Win	66.8	3.1	**24,294**	-	-	-	-	-	-	-	-	-	-	-	-	2,358	728
200-375	Spr	148.9	4.6	**21,779**	-	444	-	-	237	-	99	-	-	-	-	349	11,086	2,399
	Sum	173.7	5.4	**20,673**	-	475	-	-	-	-	107	-	-	-	-	172	14,463	1,654
	Aut	198.7	5.5	**19,628**	-	-	-	-	-	-	-	-	-	-	-	-	15,648	2,342
	Win	216.2	3.1	**18,616**	-	-	-	-	239	-	-	-	-	-	-	190	10,794	2,779
376-500	Spr	461.3	4.6	**10,792**	189	350	-	-	26	7	553	65	-	350	-	351	9,306	2,301
	Sum	497.1	5.5	**10,244**	569	930	285	-	-	-	-	285	285	360	-	-	9,174	3,016
	Aut	555.0	5.7	**9,726**	910	729	304	-	-	-	-	726	304	-	-	723	9,051	3,011
	Win	584.8	3.1	**9,225**	404	94	-	-	23	6	497	387	-	-	-	879	7,560	1,862
501-625	Spr	1234.4	5.4	**1,928**	244	152	-	-	242	43	329	62	23	143	55	400	5,397	1,430
	Sum	1297.2	5.8	**1,830**	473	431	104	-	243	-	20	281	132	133	93	26	5,417	1,580
	Aut	1361.6	6.1	**1,738**	602	338	110	-	77	-	68	1,016	139	-	99	316	4,809	1,643
	Win	1394.5	3.0	**1,648**	260	33	-	-	37	31	297	585	17	10	39	524	3,576	1,104
626-750	Spr	2585.4	5.8	**67**	115	13	1	-	26	11	29	32	60	7	22	23	38	105
	Sum	2733.1	6.0	**64**	120	25	2	1	35	-	0	59	101	0	0	0	53	86
	Aut	2733.7	6.2	**61**	81	-	64	32	16	-	28	149	25	0	24	18	13	35
	Win	2741.3	3.0	**58**	49	-	1	-	5	8	29	110	11	5	21	18	16	44
751-1000	Spr	4175.4	5.8	**1**	9	-	-	0	0	0	3	1	0	-	0	0	0	3
	Sum	4409.9	6.0	**1**	11	-	3	-	-	-	1	0	-	-	-	-	0	2
	Aut	4371.9	6.2	**1**	8	-	3	-	0	-	-	1	-	-	1	2	2	1
	Win	4311.3	3.0	**1**	2	-	-	-	1	1	2	1	0	-	1	2	1	2

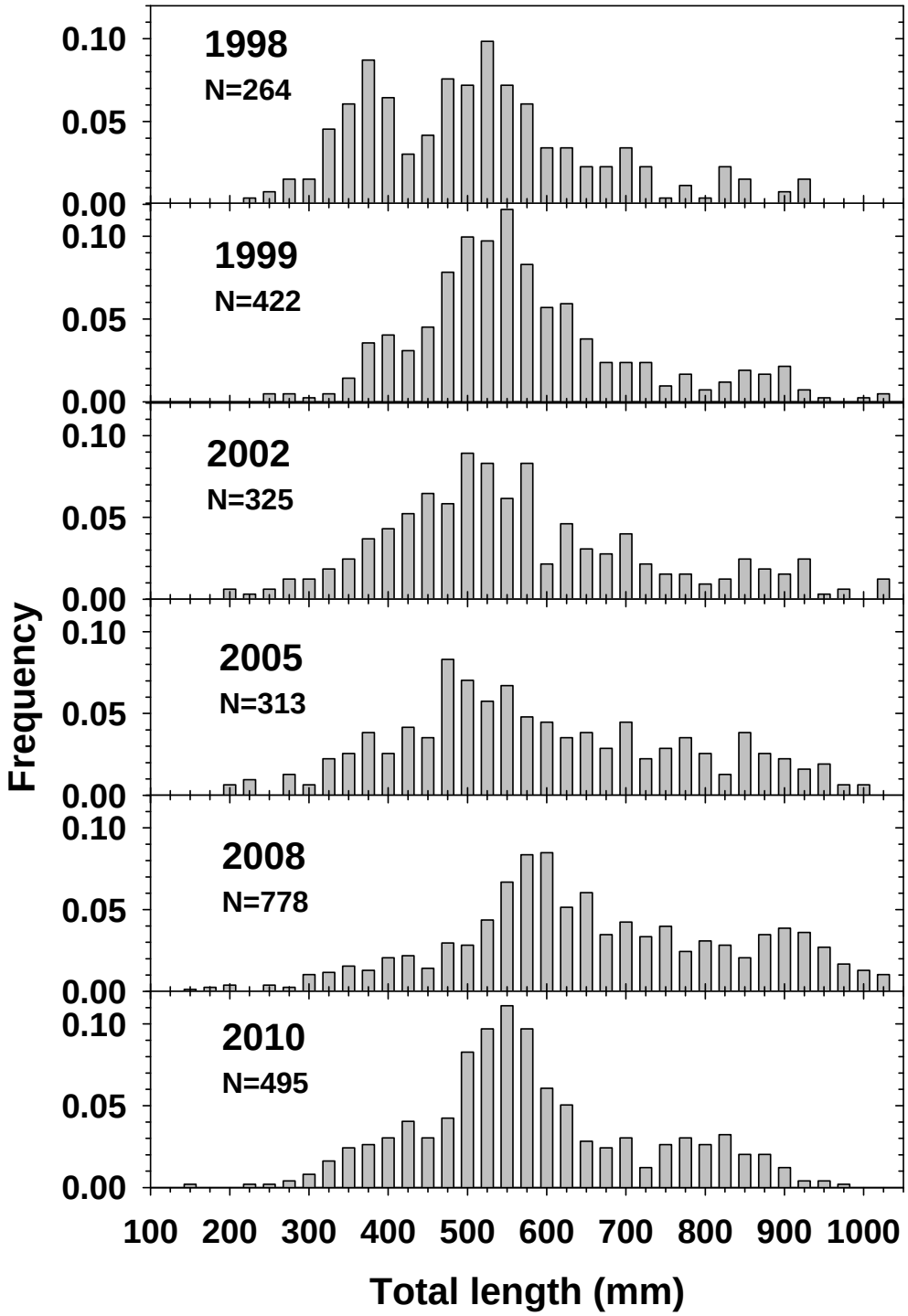


Figure 1. Length frequencies of lake trout sampled in Flathead Lake between 1998 and 2010.

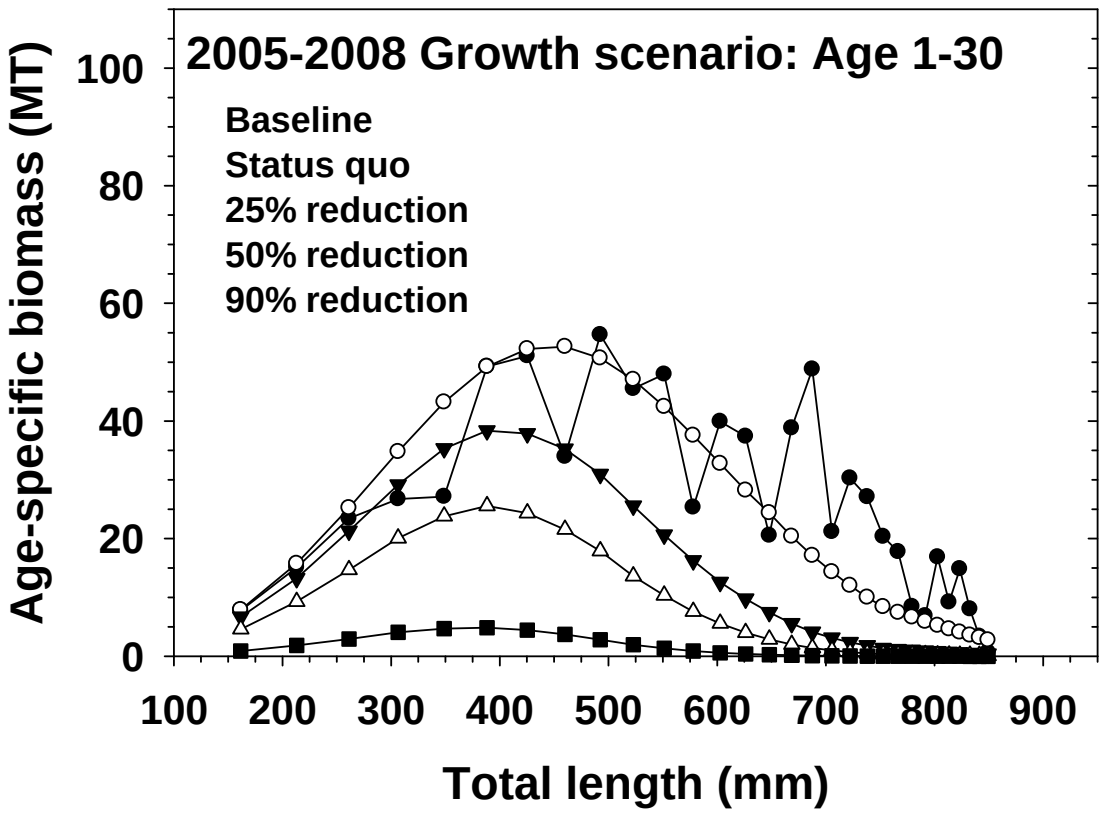


Figure 2. Age- and size-specific biomass of lake trout in Flathead Lake under current (Baseline) conditions compared to a long-term smoothed average of current conditions without additional suppression effort (Status quo) and suppression efforts targeting 25%, 50%, and 90% reductions in lake trout abundance.

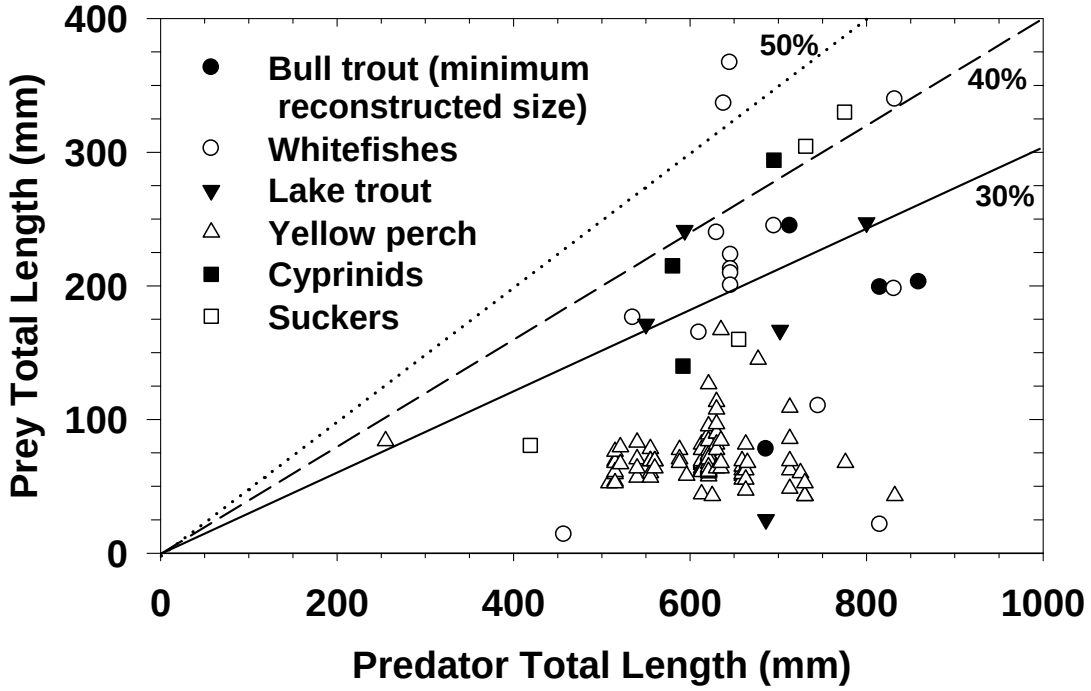


Figure 3. Total length of relatively intact prey fishes eaten by different sizes of lake trout during 1998-2001. The diagonal references line indicate where the total length of prey equals 30%, 40%, or 50% of the total length of predatory lake trout. Bull trout sizes were not reported in raw diet data, so minimum estimates of total lengths were reconstructed by applying a length-weight regression to the mass of bull trout remains found in each stomach. Three of the four bull trout reconstructions ranged 199-245 mm TL. The fourth minimum reconstruction was estimated as 78 mm TL. This much smaller size might have resulted from erroneously trying to reconstruct TL from a highly digested fragment of a bull trout. However, because no clarifying notes were associated with this sample, this reconstructed size is included on the graph with the caveats provided above.

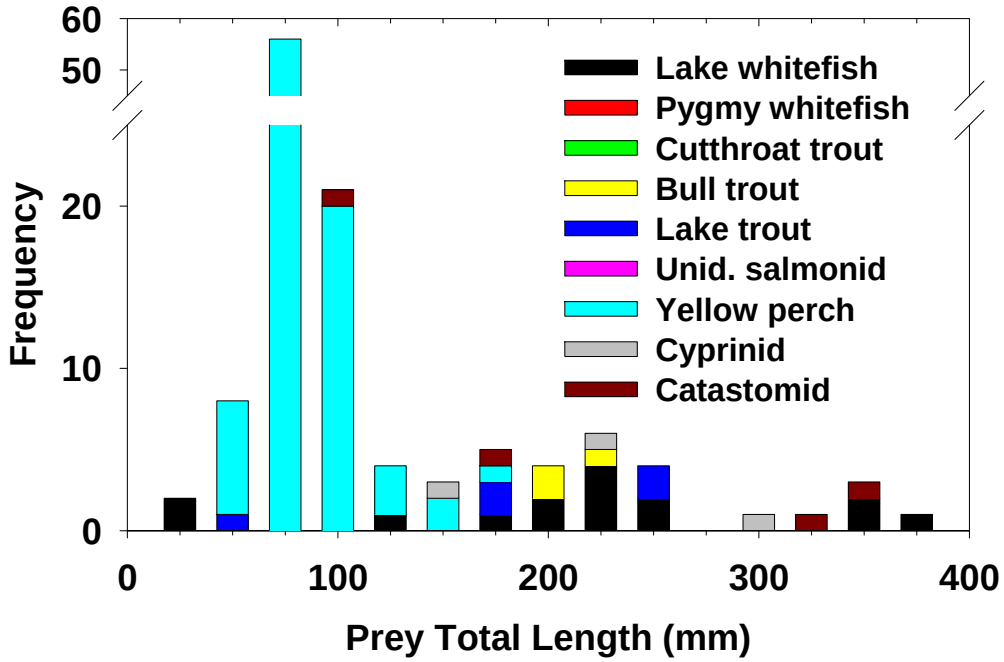


Figure 4a. Length frequencies for relatively intact prey fish species found in the stomachs of lake trout.

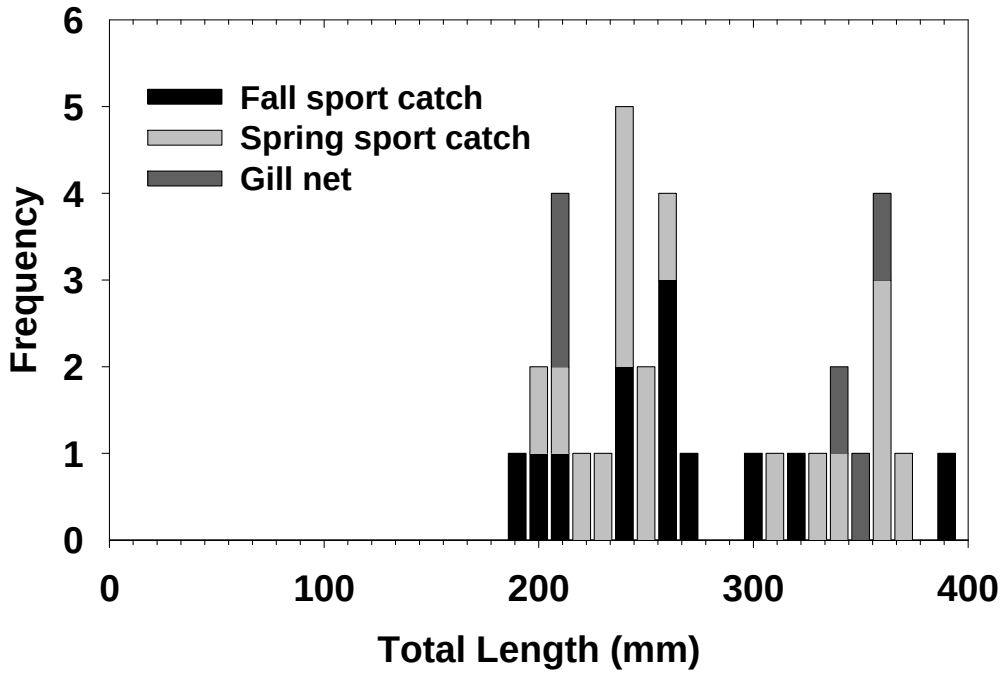


Figure 4b. Length frequency histograms of bull trout ≤ 400 mm TL captured incidentally during the spring and fall lake trout derbies in 2010-2011 and in gill nets samples during 1998-2000.

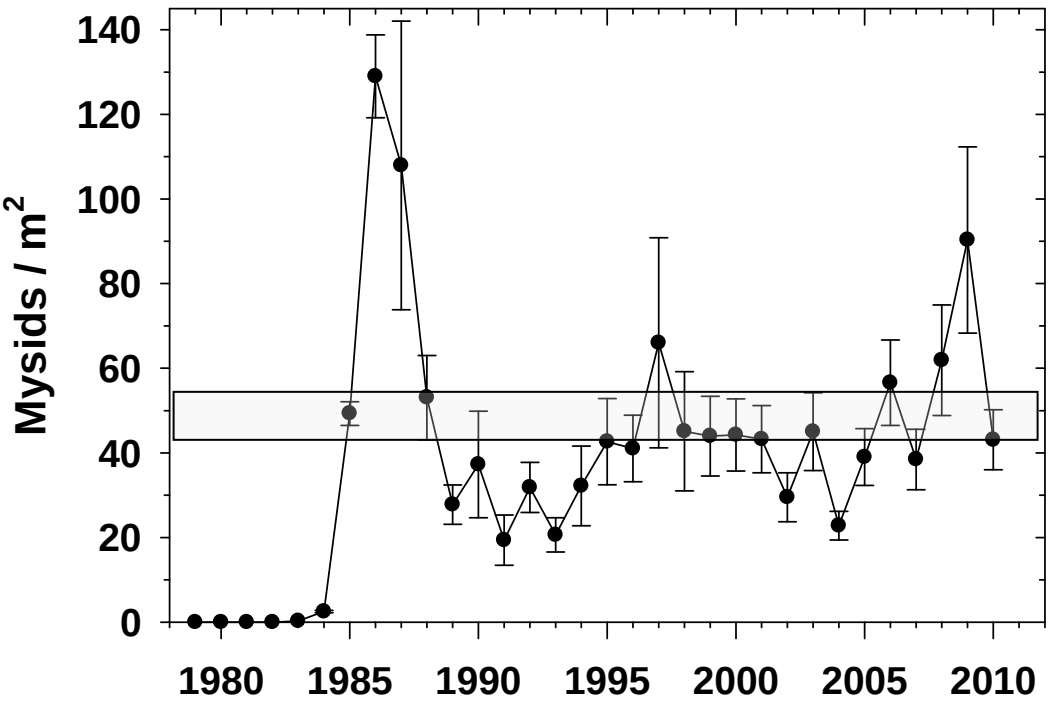
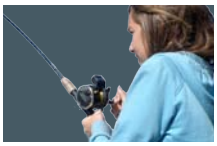


Figure 5. Time series of mean mysid density from fall surveys (modified from Ellis et al. 2011). The vertical height of the rectangle represents the increase of 13 mysids·m^{-2} that is predicted to result from a reduction of 100,000 lake trout.

Appendix 5

Potential Methods to Harvest Lake Trout in Flathead Lake



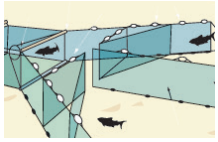
GENERAL HARVEST

MACK DAYS CONTESTS

BOUNTY FISHING

COMMERCIAL FISHING

GILLNETTING



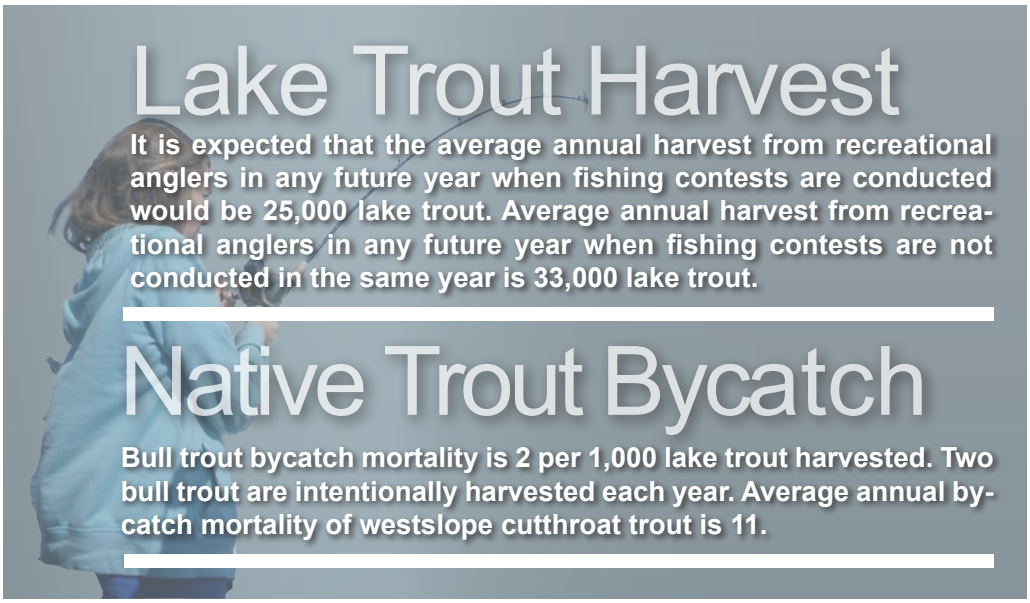
TRAPNETTING

Introduction

This appendix summarizes the methods that could be used to harvest lake trout in Flathead Lake to achieve the objectives of the action alternatives. Methods are discussed for general harvest, Mack Days fishing contests, bounty fishing, commercial fishing, gillnetting, and trapnetting.

General Harvest

Current Condition



Between 2000 and 2010, the general fishing harvest varied from about 20,000 to over 37,000 lake trout per year (Evarts 2010). The variability is the product of many factors, including the growing influence of Mack Days. The average recreational lake trout harvest between 1999 and 2003, prior to substantial influence of Mack Days, was 33,000 (CSKT files). We therefore set 33,000 lake trout as the reasonable expectation of annual harvest when there are no fishing contests. In contrast, the average recreational lake trout harvest between 2004 and 2008 (2009 through 2011 were incomplete survey years) was 25,000 (CSKT files). We therefore set 25,000 lake trout as the reasonable expectation of annual general harvest in years when there are fishing contests.

These estimates have been generated annually by standard methods, including randomized aerial counts and access-based roving interviews with anglers throughout the year (Evarts et al. 1994). Prior to 2004, we estimated total harvest by applying our standard method throughout the year, even during fishing contests. But beginning in 2004, because of the expanding contribution of the fishing contests and because we determined that non-contest fishing on those days was negligible and because we know the exact harvest from the contests (people submit their fish for prizes), we changed our method. We suspended the randomized creel survey during Mack Days and separated the total harvest into two parts: (1) an estimate (by standard methods) for periods when Mack Days was not underway, and (2) the known harvest during Mack Days events (Evarts 2010). We also observed that as the fishing contests grew in scope and duration, the recreational harvest declined. We concluded that the contests modify anglers' behavior such that many shift all or a portion of the days they choose to fish Flathead Lake to days that they can participate in the contests. The result is fewer days fished during the general season and more days fished during Mack Days. Between 2006 and 2010, the average general harvest was about 8,000 fish fewer than it was prior to the fishing contests.

Historical Condition

The Flathead Lake and River Fisheries Co-Management Plan identified recreational harvest as the first of a group of tools to be used to reduce lake trout numbers. Together with the state (the Tribes and MFWP are co-managers of the Flathead Lake fishery), we began to encourage greater recreational harvest in 2004 by increasing the bag limit from 15 to 20. We again, with MFWP, increased bag limits in 2006, from 20 to 50, and again in 2010 from 50 to 100. We also increased the number of rods allowed per angler from one to two in 2004. Evarts (1998) determined that increasing bag limits in excess of three lake trout would not increase the total general harvest, because anglers rarely catch and keep more than three lake trout.

In 2005, the Tribes decreased the cost of a license to fish the Flathead Reservation portion of Flathead Lake by establishing an inexpensive annual license specific to the lake. This new license increased sales, but we cannot attribute any increase in recreational harvest directly to the additional license sales. We do not expect potential future increases in harvest to be large because individual harvest is restricted by the typically low level of demand by anglers to consume lake trout. For example, the average harvest per angling party that caught lake trout during the period of 2005 to 2010 was 1.4 fish per trip (CSKT files). The primary goal of increasing limits, rods, and license sales was not to influence the general harvest but to heighten awareness (i.e. public education) and to allow the expansion of harvest of lake trout within Mack Days contests. That is, increased bag limits and rod numbers allowed anglers, who are fishing competitively, to maximize their harvest for reasons independent of their own consumption patterns.

Potential

There are essentially three ways to increase the harvest by recreational angling: (1) increase angler activity, (2) increase skill level, and (3) increase harvest rate. We do not, however, expect that recreational angling has much of a potential to significantly increase the harvest over either the short term or long term.

Increase Angler Activity

We expect there to be only marginal growth in the number of anglers choosing to target lake trout. This is partly because large lake trout, being top-level predators, accumulate mercury in their tissues and as a consequence are subject to state and tribal consumption advisories. Another factor is the relatively high cost associated with lake trout angling (anglers generally need a boat to be successful).

Increase the Level of Angler Skills

There is definite potential for angling skills to improve, and managers are working to facilitate that through education with brochures, videos, and angling guides. For example, the Tribes have produced a video and a series of handbooks or primers to educate anglers in techniques to catch lake trout. In the first two weeks that the videos were available on the Mack Days website, 504 unique visitors watched one or more of the angling movies. In all there were 670 visits to angling video pages, and the average time of each visit was about 7 minutes, about the average length of the thirty clips on the website. However, while these efforts may increase angler success, it seems unlikely that overall lake trout harvest would be increased in a meaningful way. Given the excellent opportunities to catch lake trout currently, a substantial number of anglers would need to increase their skill level and devote considerably more effort to catching fish in order to raise the overall harvest level.

Increase Harvest Rates

Even if angling success increases in the future, it would only result in a marginal increase in harvest if the demand for consuming lake trout does not increase. Based on the last 10 years of record, we do not expect an increase in retention-rate for anglers, and therefore we expect only marginal increases in the harvest.

Bycatch

Bull Trout

Bycatch of bull trout is inevitable in the general fishery, especially because bull trout are vulnerable to the angling methods used for lake trout. We lack the data to estimate bycatch of bull trout by direct methods,

but are able to estimate it for planning purposes by using related data that are available. From 2000 through 2008 during annual creel surveys we interviewed over 10,000 anglers fishing on Flathead Lake and estimated an average of 684 (+163) bull trout caught and released each year in the general fishery over that period (CSKT files). Between 1999 and 2004 annual harvest of lake trout averaged 33,000 fish. Based on these data we estimate the catch rate of bull trout by the general public to be about 21 bull trout per 1,000 lake trout harvested. We further estimate that current harvest by the general public has decreased since 2004 to about 25,000 lake trout because of expanded Mack Days (Evarts 2010), accounting for a bycatch of 525 bull trout per year.

Bycatch mortality results from injuries sustained from hooking and handling, as well as from mistaken identification. We lack empirical data to estimate the percent of bull trout that survive after release. However, release mortality of about 10% has been measured for lake trout (Loftus et al. 1988, Persons and Hirsch 1994). Assuming a similar mortality applies to bull trout, there would be a hooking mortality of about 53 bull trout per year of the 525 bull trout bycatch per year.

Also during 2000 to 2008, we documented 10 bull trout caught and illegally kept (CSKT files). This harvest may have been the result of ignorance of the regulations, mistaken identification, or intentional. We do not have data immediately available to generate estimates of illegal activity. The illegal acts we documented are random events that are not part of the larger creel survey and therefore cannot be expanded as can the reports of incidental catches. The illegal acts we documented represent minimal rates because additional illegal harvests very likely occurred that we did not document. Although arbitrary, in the absence of better data and for planning purposes, we double the documented rate of illegal harvest to 2 per year. The total bycatch mortality we estimate from the sum of post-release and intentional mortality by the general public is 55 bull trout per year.

Westslope Cutthroat Trout

Because westslope cutthroat trout are vulnerable to some of the angling methods used for lake trout, some albeit small, bycatch of westslope cutthroat trout is inevitable in the general fishery. Between 2000 and 2008, an average of 110 (+81) westslope cutthroat trout were caught per year by anglers (CSKT files). We do not have any empirical data to indicate the percent of those fish that survived after release. Assuming release mortality of 10%, there would be an annual bycatch hooking mortality of 11 fish. In over 10,000 angler interviews between 2000 and 2008, we documented the harvest of only one westslope cutthroat trout (CSKT files). These harvests can be explained by angler's ignorance of both the regulations and species identification, and some may be intentional. Although illegal harvest is likely occurring, it is likely very small, and for analysis purposes we assume that it is zero.

Lake Whitefish

The annual harvest of lake whitefish varies greatly and depends on the presence of conditions that make them vulnerable to anglers. The great majority of lake whitefish caught are intentionally harvested. The incidental bycatch of lake whitefish by lake trout anglers is assumed to be less than one percent, which is highly insignificant to the lake whitefish population.

Costs

There are no costs associated with the general recreational harvest of lake trout that are relevant to the action alternatives.

Fishing Contests

Current Condition

Strategy 5A/Task 3 of the Flathead Lake and River Fisheries Co-Management Plan identifies the use of subsidized fishing contests as the second tool to suppress lake trout numbers. In 2002, the Tribes developed an incentive-based fishing event, called Mack Days, to implement the strategy. In the first Mack Days contest, $2,000 was offered in prizes and 80 participants harvested 888 lake trout. The format of the contests has been modified a number of times in response to angler suggestions, and that has helped to increased participation, effectiveness, and total harvest. There is no cost for anglers to enter, and the only fish accepted are lake trout under 30 inches long, which is consistent with the existing regulations. A website, www.mackdays.com, is used to inform anglers and track individual results, and local newspapers actively report on the event. The contests are structured to maximize incentives for anglers to catch more fish, rewarding the top anglers the most with lottery prizes and bonuses based on the number of fish caught. Typically, 50% of the total harvest in each contest has come from the top 20 or so anglers, despite the fact that the number of participants may be well over 400.

Harvest within the contests increased at an average rate of about 80% annually between 2002 and 2011 (Figure 1). In 2010, the contests ran for eleven three-day weekends in the spring and seven three-day weekends in the fall. Total prize money grew from $2,000 to nearly $200,000 from 2002 to 2011 (Figure 1). While the contests are responsible for an increase in the total annual harvest, they tend to cause lake trout harvest during the general fishing season to drop.

Lake trout caught during the spring events are typically smaller (by about three inches) than those caught during the general harvest throughout the year (Figure 2). Lake trout caught during the fall contests more closely mimic the catches during the general harvest (Figure 3).

The Mack Days contests are conducted in a manner to minimize the waste of fish. Anglers are allowed to keep their catch after checking them into the contest, but most donate them to the contest. Temporary staff are hired by CSKT to fillet the fish received, which are then frozen and later distributed to food banks in surrounding communities. Only fish less than 25 inches long are distributed because of concerns about mercury contamination (Stafford et al. 2004).

Most Mack Days participants live within 75 miles of Flathead Lake. In the two contests during 2010, 38% came from the Mission Valley, 27% from the Flathead valley, and 17% from Missoula. In the two Mack

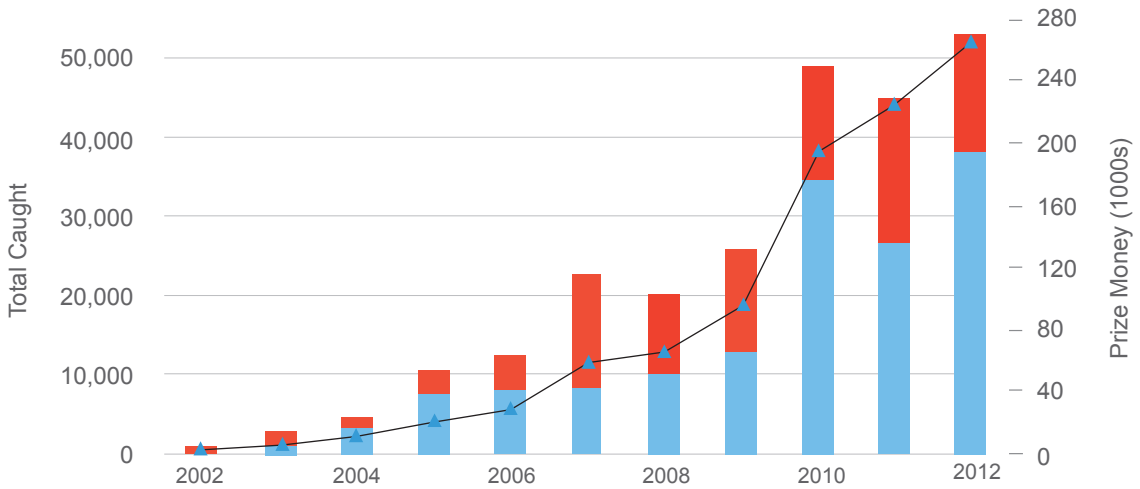


Figure 1. Number of lake trout harvested in Spring Mack Days (blue) and Fall Mack Days (red) and prize money (black line with diamonds), 2002 to 2011, Flathead Lake, MT.

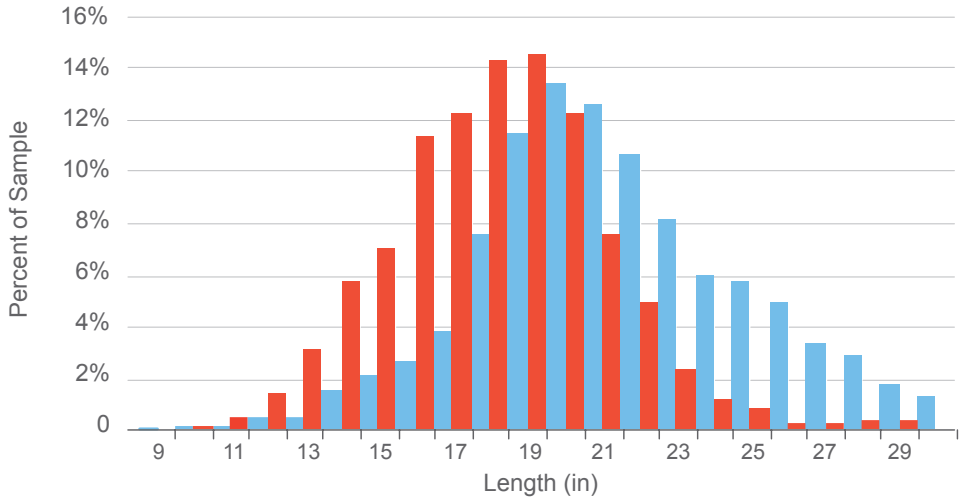


Figure 2. Lake trout, by length class, caught during Spring Mack Days contests 2005 to 2009 (red), and general harvest 2006 to 2010 (blue), Flathead Lake, MT.

Days contests in 2010, a total of 298 anglers won prizes and the average amount per winning angler was $571.00. The highest individual prize total in 2011 was $12,625.

The number of anglers participating in the contests has increased greatly from 2004 to 2011 (Figure 4). However, the average number of fish caught per day per angler has shown no consistent trend (Figure 4). Over the same period, the total harvest has increased proportionally with the increase in participation. These data suggest that the primary factor determining the number of fish harvested in each contest is the number of anglers participating.

Potential

The pace of growth has been fairly uniform over the ten years since the contests began, with the number of fish harvested nearly doubling annually. However, we do not know if the contests reached their peak in 2012, or if there is substantial growth remaining to be realized. In 2010, the spring and fall contests gener-

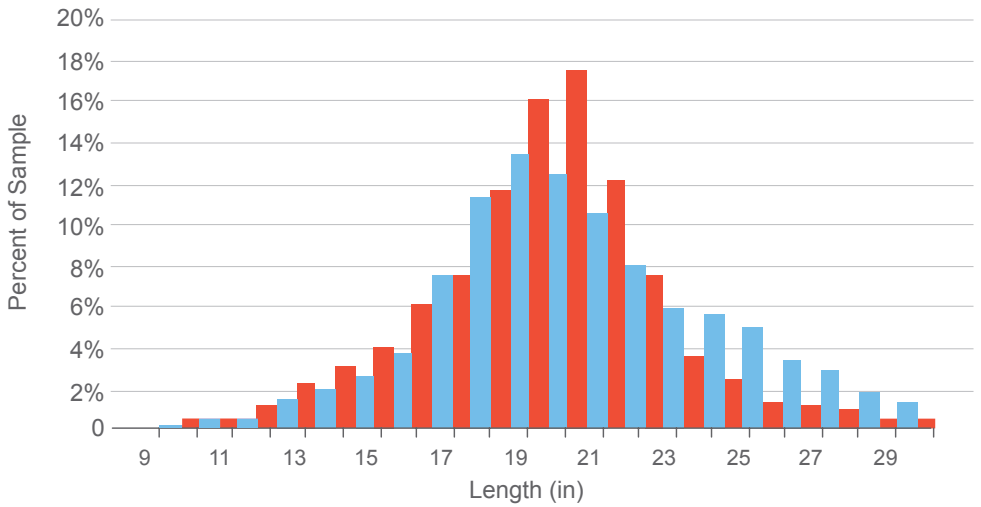


Figure 3. Lake trout, by length class, caught during Fall Mack Days contests 2006 to 2010 (red), and general harvest 2006 to 2010 (blue), Flathead Lake, MT.

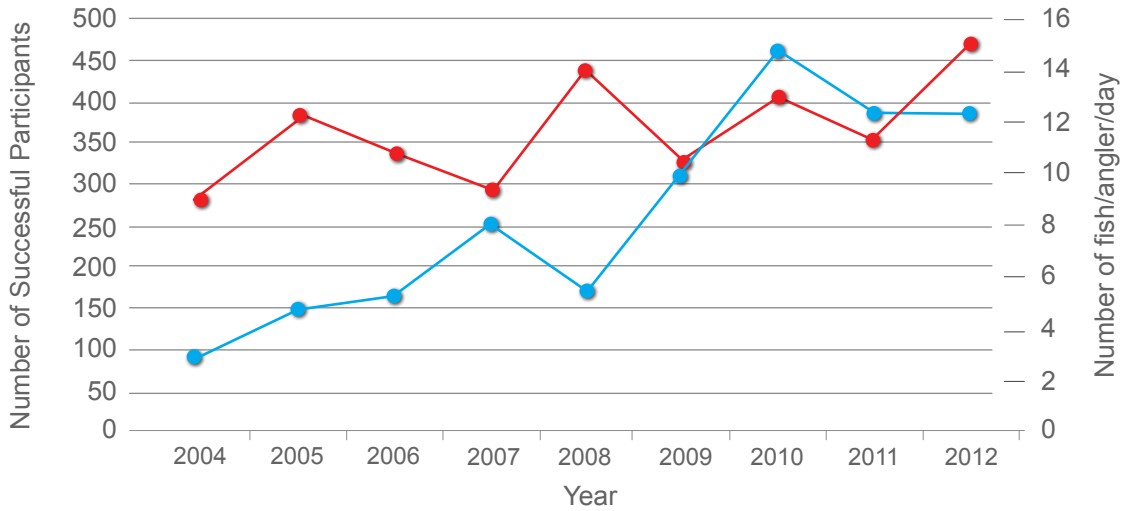


Figure 4. The number of anglers participating in Spring Mack Days (blue), and the average number of fish caught per participant per day (red), 2004 to 2010, Flathead Lake, MT.

ated a harvest of over 49,000 fish. In 2011 the total Mack Days harvest declined to 45,000 fish, indicating the possibility that the contests have reached their capacity, but in 2012 the harvest increased again to over 50,000. Future growth potential remains for: (1) increases in the number of participants by increasing public awareness of the events and increasing prize money, (2) increases in the skill of anglers, and (3) increases in the daily harvest attributable to the change in bag limit from 50 to 100 fish.

Currently, the level of participation in Mack Days is lower than that for many other contests conducted in the Flathead Valley, which suggests that there is potential to increase Mack Days participation in the future. To improve the overall success of the anglers, we have initiated efforts to develop tools such as instructional videos and brochures and web-based fishing forecasts. In the first two weeks after release of new lake trout fishing videos on the Mack Days website, 504 unique visitors watched one or more of the angling movies. In all there were 670 visits to angling video pages, and the average time of each visit was about 7 minutes,

about the average length of the thirty clips on the website. We believe these measures will increase the success of both novice and experienced anglers and result in additional growth in Mack Days participation and harvest. The increase in the bag limit from 50 to 100 fish in 2010 increased the total harvest in 2011 by 988 lake trout. In spring 2011, there were 25 angler-days in which greater than 50 lake trout were caught. During fall 2011, there were 57 angler-days in which 50 fish were exceeded. We do not consider it likely that the effect of the 100-fish bag limit will increase substantially in the future.

Bycatch

Bull trout

Bycatch of bull trout by anglers in the fishing contests results in mortality from two causes. One is the delayed post-release mortality that is the result of injuries sustained from being hooked and handled. This mortality is referred to as hooking mortality, and although we do not have specific data for hooking mortality of bull trout in Flathead Lake, data from other systems indicates that about 10% is typical in a fishery dominated by jigging (Loftus et al. 1988, Persons and Hirsch 1994). Assuming that the rate of bull trout incidentally caught by Mack Days anglers is equal to that measured during the general harvest (see previous section), there would be 21 bull trout caught per 1,000 lake trout harvested. Further, if 10% of those bull trout die from wounds and handling, there would likely be 2.1 bull trout mortalities after release for every 1,000 lake trout harvested.

The other form of mortality is intentional, when anglers fail to identify their catch as bull trout and mistakenly keep them. The incidence of these cases has been highly variable in recent years. Prior to 2010, we recorded approximately one bull trout mistakenly submitted to the contest for every 10,000 lake trout submitted. During 2011, however, this number increased to approximately 1 bull trout per 1,800 lake trout submitted (Table 1.) We were able to partially correct this problem after we alerted participants directly and through the Mack Days website. There is the potential to reduce the rate of this type of mortality through additional education, but there is also the potential to increase it as new and possibly less well-informed anglers participate in the contests. For analysis purposes, if we assume the average rate of mistaken bycatch measured from 2010-2102 (Table 1) continues in the future, there will likely continue to be one intentional (mistaken identity) bull trout mortality per 3,125 lake trout harvested during Mack Days contests.

We estimate the total bycatch mortality from catch and release (2.1 bull trout per 1,000 lake trout caught) and from mistaken identity (0.3 bull trout per 1,000 lake trout caught) would be 2.4 bull trout per 1,000 lake trout harvested.

Table 1. Bull trout mistakenly identified as lake trout and submitted to Mack Days contests, 2010 to 2012.

Year	Spring Mack Days	Fall Mack Days	Total	Mack Days Harvest	Lake trout harvested per bull trout mortality	Bull trout mortalities
per 1000 lake trout	6	0	6	48,914	8,152	0.12
2011	12	13	25	44,847	1,794	0.56
2012	10	6	16	52,717	3,295	0.30
Total	28	19	47	146,478	13,241	0.32

Westslope cutthroat trout

There has been no documented bycatch of westslope cutthroat trout during the contests. A small amount of bycatch is likely in the fall when many anglers fish in shallow water near shore (where westslope cutthroat are likely to occur), but the quantity is considered too low to be of concern.

Lake whitefish

The incidental bycatch of lake whitefish during the contests is very low. Occasionally anglers have presented lake whitefish for donation, but the incidence has been too low to document. Lake whitefish are easily recognizable and therefore mistaken identity is nearly nonexistent.

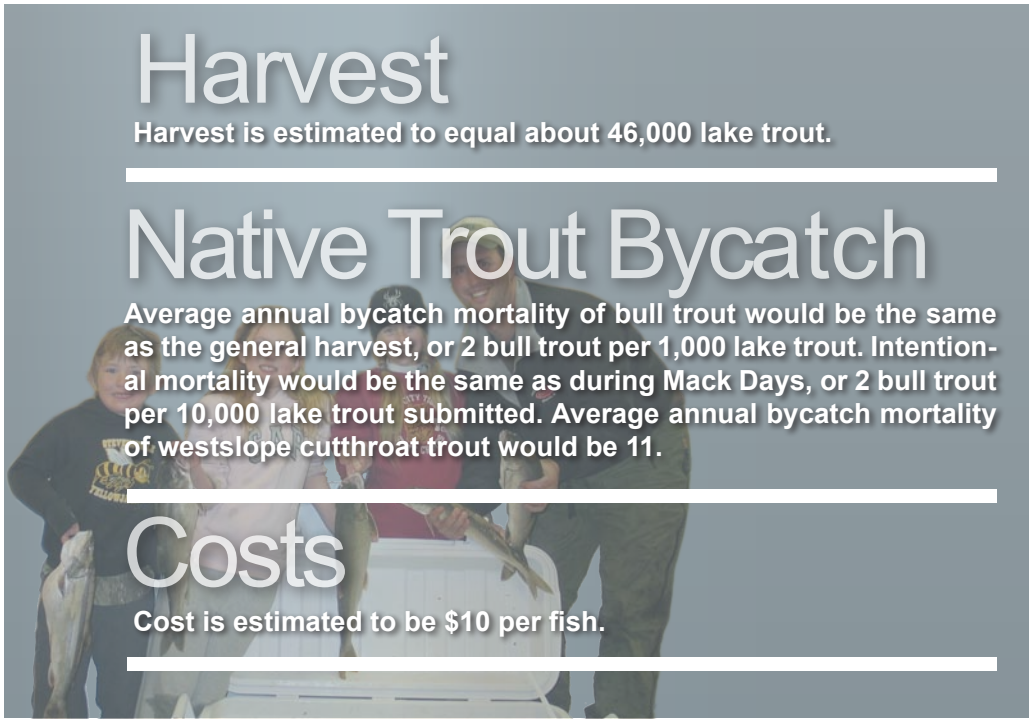
Costs

The cost of conducting fishing contests has risen since their inception as we have added incentives to encourage larger harvests. About 70% of the cost of conducting the contests goes toward prizes, 15% toward labor to oversee the event and process fish, and 15% toward materials and administration. The average annual cost of the events in 2011 and 2012 was about $350,000. The total harvest in those years was nearly 100,000 lake trout for a total cost of about $700,000, or about $7 per fish.

Bounty

Current Condition

Bounty fishing is a management tool in which anglers receive a predetermined amount of money for each lake trout of a specific size. Bounty programs have a long history, but have recently increased in popularity as various managers have employed them to remove species that are conflicting with management objectives. Two prime examples are at Lake Pend Oreille for lake trout (http://fishandgame.idaho.gov/fish/misc/pendoreille_cash.cfm) and on the Columbia River for northern pikeminnow (http://www.pikeminnow.org/).



At Lake Pend Oreille, anglers have harvested about 10,000 lake trout per year for $15 per fish. On the Columbia River, recent harvests have been about 150,000 northern pikeminnow per year for about $6 per fish. Each program is considered by its managers to be successful in reducing predation on target fish populations.

During public scoping, many comments received expressed support for a bounty program (Appendix 3). Bounty fishing for lake trout on Flathead Lake has not been available as a management because it is not legal. During 2011, MFWP introduced a bill in the legislature to legalize bounty-fishing for lake trout on Flathead Lake. It was withdrawn, however, before a committee vote was cast in the face of opposition. No bounty bill was introduced in the 2013 legislature. Therefore, this tool is not available at least until the next legislative session in 2015, when another bill may be introduced.

Potential

Implementation of a bounty would require planning and coordination with the other tools, especially the fishing contests. A bounty program is probably not compatible with fishing contests, unless the two were scheduled at distinctly different time periods. While a bounty program would likely generate substantial harvest, it is unlikely that bounty participants would continue to participate in Mack Days contests at current rates. Just as fishing contests have drawn some harvest away from the general recreational harvest, a bounty would probably draw an even larger percentage of harvest from the fishing contests. That is, an angler would likely choose to fish for a bounty at any time during the year rather than during limited fishing contests. We would have to analyze the issue further to determine if fishing contests and a bounty program could be conducted effectively in the same year or if a bounty program would replace the contests.

There are unique factors associated with the Mack Days fishing contest—publicity, excitement, competition, and camaraderie among anglers—that might make it a more effective tool than a bounty.

As mentioned, a bounty program is not fully available as an option at least until the next legislative session in 2015 because it is not currently legal on the Montana portion (north half) of Flathead Lake. There is the possibility that the Tribes could develop a bounty fishery on the Reservation portion (south half) of the lake, however, it would probably be less successful than a lake-wide bounty. Hence, the best strategy is to re-submit a “bounty bill” to the 2015 Montana legislature.

It is speculative to estimate the harvest potential of a bounty system. A bounty could be conducted on more days per year than the fishing contests, but it would likely have a very low daily harvest rate. The harvest rate would also be proportional to the bounty offered, so it would depend on the funding available. We assume that unless a much higher bounty is offered, that the potential harvest would be comparable to the fishing contests, or 46,000 lake trout per year.

Bycatch

Bull trout

Because bull trout are vulnerable to the angling methods used for lake trout, some bycatch of bull trout is inevitable in a bounty fishery. Using the same methods as in the general angling section above, we estimate annual bycatch mortality to be 2 bull trout for every 1,000 lake trout harvested.

Westslope cutthroat trout

Using the same methods as in the general angling section above, we estimate an annual bycatch mortality of 11 westslope cutthroat trout for every 1,000 lake trout harvested.

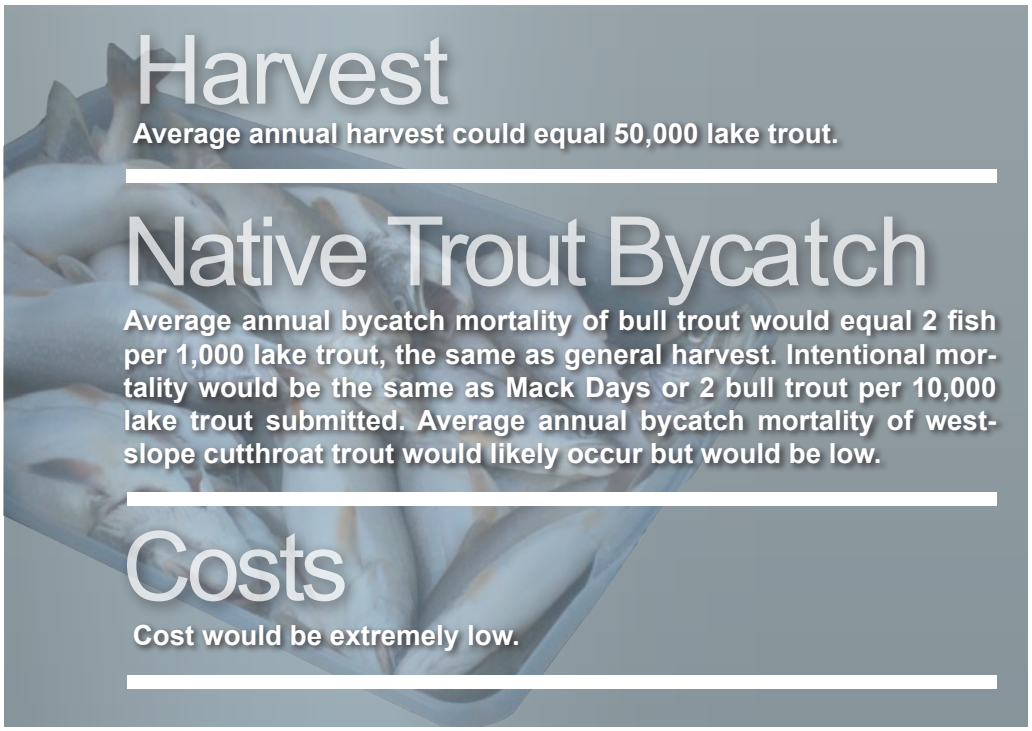
Costs

Estimating costs is difficult because we do not have local examples of a bounty. We assume a bounty would have to offer a larger incentive than that offered by the current fishing contests because the contests benefit from secondary factors such as competition and publicity. Administering a bounty would also be costlier than contests because the volume of fish per day would be lower and more variable, and a bounty could occur year-round. Bounties in neighboring states vary from $6 for northern pikeminnow to $15 for lake trout in Lake Pend Oreille. In Caribbean waters, bounties ranging from $10 to $50 per fish have been offered for lionfish (Caye Caulker Chronicle 2009). Local anglers have indicated their willingness to harvest lake trout for $5 per fish (Lehner 2010). We assume a bounty would be effective at $8 per fish and that the costs of administering the program and processing the fish would be twice as expensive as in Mack Days because of reduced labor efficiency and scale. Overhead costs in Mack Days are about $1 per fish, so we assume overhead costs in a bounty program would be $2 per fish.

Commercial Fishing

Current Condition

Commercial fishing is a management tool that would allow anglers to legally sell the lake trout they catch from Flathead Lake to a commercial buyer who would process and sell the fish to the public. Commercial fishing for lake trout on Flathead Lake was not available during the first ten years of the Co-Management Plan. In 2011, MFWP introduced a bill in the legislature to legalize commercial fishing for lake trout on Flathead Lake, but it was withdrawn before a committee vote was cast.



A commercial buyer and fish processor does not currently exist in the Flathead Valley, and one would have to be developed before this tool would be effective. Some impediments to development include the requirement of processors and sellers to conform to health and safety regulations in order to ensure that the harvested fish meet human consumption requirements. A commercial fishery for lake whitefish was in place for many years but is no longer in operation. The market price to anglers for lake whitefish was $0.50 per pound of whole fish. Lake whitefish opportunities have been seasonal. Lake trout would provide a more consistent year-round fishery except during summer because of the difficulty in preventing spoilage of harvested fish during warm temperatures.

Potential

This tool is not available in the near future (at least until the next legislative session) because it is not currently legal on the Montana portion of Flathead Lake. There is the possibility that the Tribes could develop a commercial fishery on the Reservation portion of the lake, although it would probably be less successful than one conducted lake-wide. There has been interest expressed in small-scale operations to smoke fish, which would add value to the product and potentially increase the profitability. We consider it unlikely that a commercial processor would develop independently, rather it would probably require an agency-directed subsidy.

Limitations are that it requires that a buyer and processor develop locally. It is dependent on local demand for processed lake trout and limited in scope by the market prices for lake trout, which are generated in the Midwest by large processors operating under a different economy of scale than is feasible locally. In addition, the potential would be influenced by the use of other management tools (i.e. bounties or fishing contests) during the same period. Anglers would likely favor the method that was the most profitable.

There is substantial uncertainty in predicting the harvest that could be generated in a commercial fishery. As a business venture, there is no guarantee of success. We consider an optimistic projection of harvest to be 75,000 fish per year.

Bycatch

Bull trout

Bycatch of bull trout by anglers in a commercial fishery would result in hooking mortality and intentional mortality similar to the harvest methods listed above. We estimate annual bycatch mortality to be 2 bull trout for every 1,000 lake trout harvested and intentional bull trout mortality to be 1 per 10,000 lake trout harvested.

Westslope Cutthroat trout

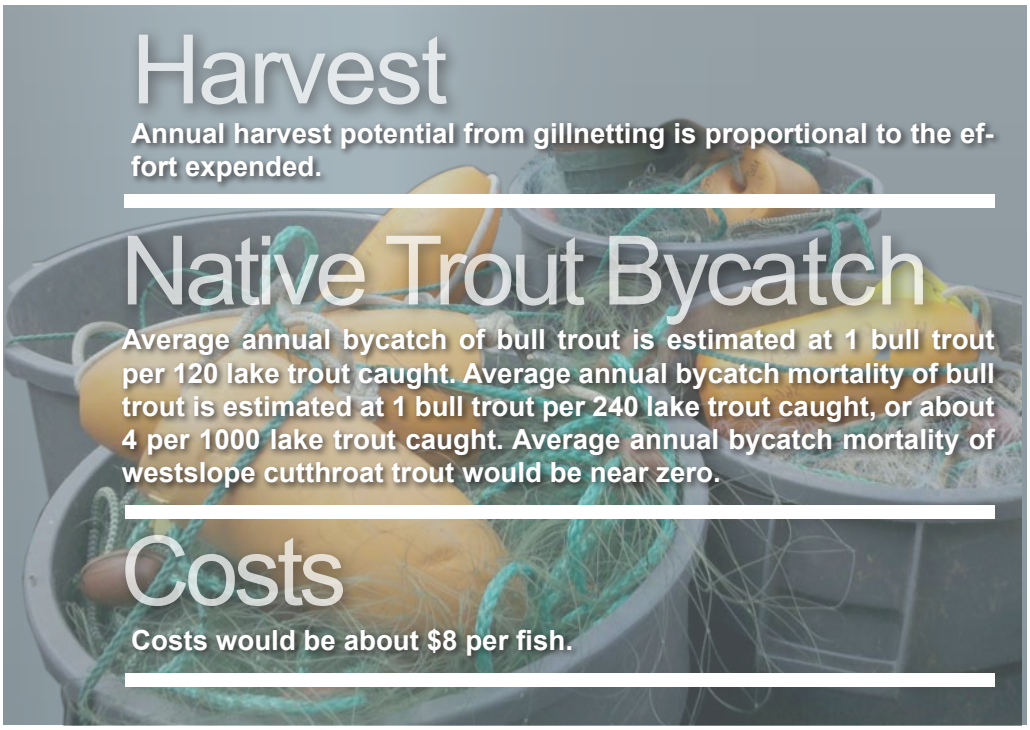
Average annual bycatch mortality of westslope cutthroat trout would likely be lower than in the general harvest because anglers will be largely focused on lake trout. However a percentage of commercial anglers would probably be more casual and secondarily utilize the commercial opportunity, and these anglers are more likely to have incidental catch of westslope cutthroat.

Costs

There would be no costs to the agencies except for a small amount to administer and oversee the program. The agencies could subsidize a commercial operation if this tool was chosen, and costs would be driven by whatever subsidy was chosen.

Gillnetting

Current Condition



Gillnets are made of mono or multifilament threads woven into meshes of various sizes, depending on the size of fish targeted for capture. The top line floats, and the bottom line is weighted to keep the net on the bottom of the lake, where it resembles a fence, usually about 6 to 8 feet high. Generally, fish are captured during the periods when they are most active and visibility is poorest, which is dusk and dawn. Typically they do not see the net and attempt to swim through it, getting caught by their gills. Gillnets are generally set perpendicular to the shore and strung end-to-end in “gangs” that can extend over a great distance. The top of the net is typically well below the surface, so it is not a boating hazard. But trolling gear can easily snag a net, especially when trolling in deep water. Gillnets are marked with buoys at one or both ends.

Use of gillnets as a tool to control lake trout has not been employed during the first ten years of the Co-Management Plan, although they have been used experimentally in Flathead Lake for over 100 years. They are capable of targeting specific size groups of lake trout, based on the size of mesh used. These relationships are well established in practice, but are also imperfect because lake trout can be caught by their teeth,which means large fish can be caught in small meshes. Gillnets have been used extensively by commercial anglers for lake trout across the North American range of the species. They are also being used in many other regional lakes in noncommercial applications to reduce lake trout numbers, such as in Lake Pend Oreille and Swan, Quartz, and Yellowstone lakes (Hansen et al. 2010; Rosenthal 2011; NPS 2009).

Gillnets have been deployed in Flathead Lake for sampling purposes for many decades by both the MFWP and CSKT. Those efforts have provided extensive information of utility in designing a suppression program. For example, the data generated are useful for determining target locations, depths, and seasons. When our experimental goal has been to sample the highest density of lake trout possible, we have captured about 15 lake trout per 100 feet of net (CSKT files).

Potential

The potential harvest from gillnets is proportional to the quantity of nets deployed and the skill of the netting crew. Additionally, gillnets can target specific size ranges of lake trout, based on the size of meshes

used. Gillnetting can be more effective than other tools because the harvest can be pre-planned based on the established rate of capture from previous netting. If future catch rates are comparable to those measured during experimental netting, then approximately 6,500 feet of net would need to be deployed for every 1,000 lake trout captured.

Bycatch

Lake whitefish

Bycatch refers to the capture of non-target fish while targeting lake trout. Lake whitefish would be the most abundant species in the bycatch of a lake trout gillnetting program. Lake whitefish are so abundant and widely dispersed that it would be difficult to avoid them. In standard sampling by gillnetting in the fall, we catch about 2.5 times as many lake whitefish as lake trout. With practice, a gillnetting program may be able to reduce lake whitefish bycatch to a rate twice that of lake trout.

Westslope cutthroat trout

The bycatch of native fishes is an unavoidable and negative short-term effect from using gillnets to reduce lake trout numbers. Bycatch of westslope cutthroat trout could be almost entirely avoided because cutthroat trout are rarely found at the depths that lake trout would be targeted with nets.

Bull trout

Bull trout would inevitably be caught in gillnets, even when targeting areas that have low bull trout numbers. We believe, however, that we could minimize bycatch by carefully selecting locations, seasons, and mesh sizes. To date, bull trout catches in gillnets in Flathead Lake have most often been in nets set at depths of less than 80 feet (Figure 5) and near shore (Figure 6). In standard, randomized gillnetting conducted by the Tribes and MFWP in all depths and locations, the catch rate has been about one bull trout for every 80 lake trout caught. Targeted netting has been conducted on a small scale and experimental basis, and no bull trout have been caught (CSKT files), indicating we could design gillnetting sets to reduce bull trout bycatch to the lowest amount practicable.

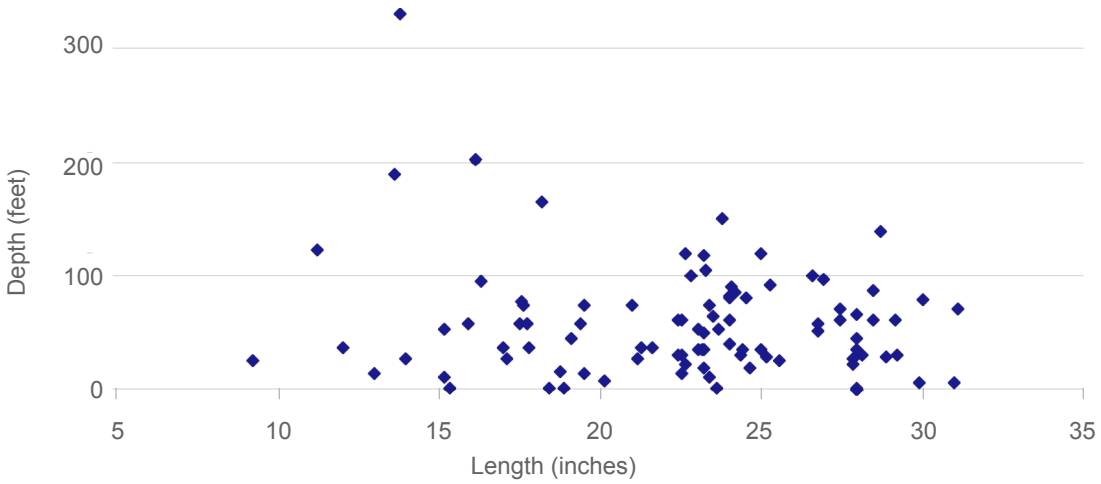


Figure 5. Bull trout length and depth-of-capture in gillnets set predominantly during fall, Flathead Lake, 1998 to 2010.

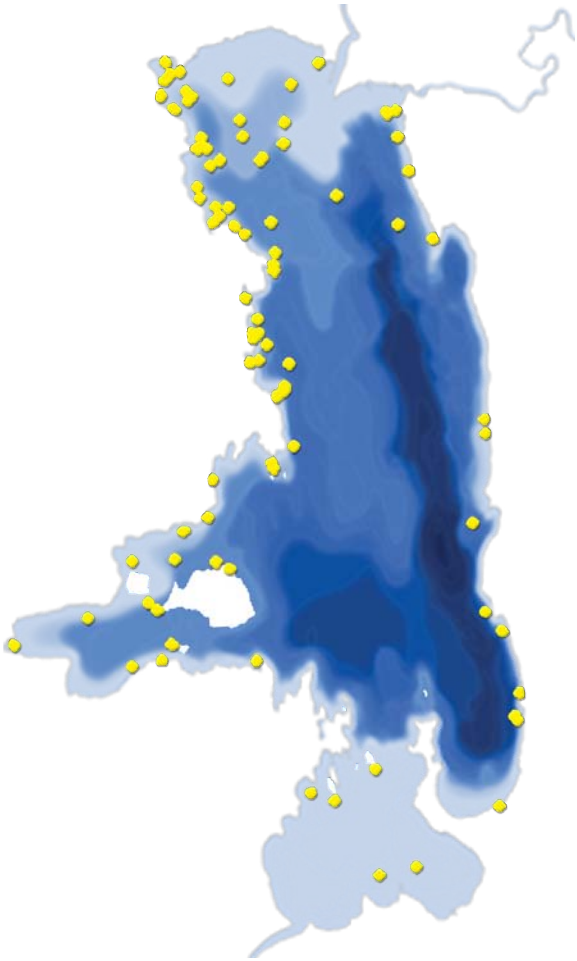


Figure 6. Locations of captured bull trout in gillnets set predominantly in the fall in Flathead Lake, 1998 through 2010.

In Swan Lake, where bull trout densities are much higher and lake trout densities much lower than in Flathead Lake, the bycatch of bull trout during experimental netting in 2010 was one bull trout to every 33.5 lake trout caught (Rosenthal 2011). In Lake Pend Oreille, where bull trout densities are also much higher and lake trout densities much lower than in Flathead Lake, bycatch of bull trout during lake trout control netting in 2009 was about one bull trout to every 17 lake trout caught (Wahl et al. 2011).

Bull trout bycatch can be further reduced by applying additional knowledge acquired during gillnetting and adapting to situations as they occur. Protocols would be developed to guide the adaptive process that would include identification of prohibited netting locations and seasons. It is probable that bycatch rates of bull trout in a targeted program would be less than what we currently experience in random gillnet sampling where we catch one bull trout to every 80 lake trout. It is also extremely unlikely that a targeted program could completely avoid capture of bull trout. If we estimate that a targeted program would be 50% more effective at avoiding bull trout than our current random netting, which includes known bull trout locations, than we would capture one bull trout to every 120 lake trout.

Not all bull trout incidentally captured in gillnets would die. The extent of mortality in gillnets is determined by the length of time in the net and the degree of entanglement. Mortality can be minimized by employing methods to hasten their recovery after removal from the net. Mortality rates of bull trout captured in gillnets during annual sampling in Flathead Lake is estimated to be 55% (CSKT files). Mortality rates of bull trout captured in gillnets in Swan Lake averaged 40% (Rosenthal 2011) and were reduced by the use of chilled and oxygenated recovery water. We estimate the same rate of mortality for gillnetted bull trout in Flathead Lake.

Costs

The costs of gillnetting are driven by the rate of capture, which is dependent on the skill of the netting crew and the location and density of the lake trout population. Start-up costs can be expensive because it requires specialized boats and collection gear. We estimate that operating costs would be $0.55 per foot of gillnet deployed for labor, and $0.25 per foot of gillnet deployed for fuel, boat, and materials, for a total cost of $0.80 per foot of gillnet deployed.

We estimate capture rates of 0.15 lake trout per foot of gillnet deployed for a cost per fish of $5.60 for capture. We assume an additional $2 per lake trout for processing, which is higher than past costs and includes accounting for the large number of lake whitefish that would also be caught. The total gillnetting cost is about $8 per fish.

Trapnetting

Current Condition

Trapnetting has been extensively used in the Great Lakes but has never been tried in Flathead Lake. Trapnets have a long lead net and two wing nets to either side of the lead, which is connected to a "pot". The lead and wing nets hang down to the bottom of the lake and are supported by floats on the top of the net. Fish on either side of the lead net are diverted along the net into a narrow opening between the ends of the two wing nets, which curl inward to form a heart-shaped enclosure that funnels the fish toward a tunnel into the net's pot from which they are lifted by the fishermen.

Harvest

Average annual harvest potential from trapnetting is proportional to the effort expended, but is more limited than gillnetting.

Native Trout Bycatch

Average annual bycatch mortality of bull trout and westslope cutthroat trout would be near zero.

Costs

Costs would range from about $4 to $8 per fish.

Trapnets are generally limited to water shallower than 80 feet and tend to be ineffective at catching fish less than 20 inches long (Peterson and Maiolie 2005). Because of the labor demands involved in relocating nets, they are usually fished in one location for the entire season. Their placement is typically restricted to areas in which the lake bed is relatively flat. In Flathead Lake that means trapnetting would generally be limited to South Bay and Big Arm Bay.

Potential

The potential harvest from trapnets is proportional to the quantity of nets deployed and the skill of the netting crew. Harvest targets are nearly as achievable by trapnetting as by gillnetting because the outputs can be pre-planned based on the established rate of capture from previous netting.

In Lake Pend Oreille, with a lake trout population roughly one tenth the size of the population in Flathead Lake, trapnets averaged roughly one lake trout per night per trap (Hansen et al. 2006). In contrast, in the Lake Michigan, trapnets have been known to produce hundreds of lake trout per haul (Fredenberg 1998).

Bycatch

Bycatch refers to the capture of non-target fish while targeting lake trout. Trapnetting usually has large bycatches, especially of lake whitefish. Bycatch mortality is minimized in trapnets because fish are retained in the pot, rather than trapped by their gills as in a gillnet. When the pot is retrieved by the fishermen, all non-target fish are released, usually with very low rates of mortality.

Costs

Costs are relatively high, but depend on catch rates, which vary by location. Catch rates would have to exceed at least 50 lake trout per haul to be competitive with gillnetting. Assuming a catch rate of 50 lake trout per haul and the ability of a four person crew to tend four traps per day, costs would be about $4 per fish. If catch rates were 10 to 20 fish per haul, then costs would increase to about $8 to $12 per fish.

Strengths and Limitations

Trapnetting has the potential to be a very effective suppression tool, although it lacks the versatility of gillnetting. The limitations of this tool are:

- The fact that it is most efficiently deployed in a single location per season
- It is not effective at catching small-sized fish (<20 inches), and
- It cannot be deployed in depths greater than 80 feet.

Its greatest strength is that it causes so little bycatch mortality. For these reasons, this tool would likely be deployed to the greatest extent possible, but would necessarily be a companion tool to gillnetting rather than a replacement.

Electrofishing

Current condition

Lake trout adults are vulnerable to electrofishing when they move into shallow water to spawn during autumn. This tool has been effectively employed as a way of capturing adult lake trout in Lake Pend Oreille and in Yellowstone and Swan lakes. Costs are moderate, and bycatch risk is low.

The primary limitation of electrofishing is that it is only effective to a depth of about 10 feet. Therefore, we would only be able to electrofish for lake trout in the very narrow shoreline zone. Managers have used this tool primarily to remove reproductive adults in recently expanding lake trout populations.

Potential

This tool could have utility in Flathead Lake, but we do not propose to employ it during this planning period because we do not consider it to be any more cost-effective than the combination of gillnetting and angling.

Destruction of Lake trout Embryos

Current condition

A developing tool for killing lake trout embryos is the use of electric current deployed in an array of electrodes towed by a boat over known spawning areas. To date we have not used this tool in Flathead Lake.

Potential

This tool could have utility in Flathead Lake, but is not ideal because of the large extent of potential spawning habitat in Flathead Lake. While we have not quantified spawning habitat in Flathead Lake, we consider the essential elements of spawning habitat to be present in more than fifty miles of shoreline. In addition, the efficacy of this tool has not been determined for embryos placed well into the interstitial spaces of ideal cobble substrate. This tool will be reviewed in the future as the technology develops. We do not propose to deploy it in Flathead Lake during this planning period.

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Appendix 6

LAKE TROUT POPULATION DYNAMICS IN FLATHEAD LAKE, MONTANA

Lake Trout Population Dynamics in Flathead Lake, Montana

April 7
2013

A report on progress toward assignments described in *Article II (Scope of Work/Service) of Contractor Agreements 10–061, 11–079, 12–151*, and 13–079 between the Confederated Salish and Kootenai Tribes of the Flathead Nation and Dr. Michael J. Hansen (contractor).

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Lake Trout Population Dynamics in Flathead Lake, Montana

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Background

The assignment was broadly described in Article II (Scope of Work/Service) of three annual Contractor Agreements 10–061, 11–079, 12–151, and 13–079 between the Confederated Salish and Kootenai Tribes of the Flathead Nation and Dr. Michael J. Hansen (contractor). In general, the assignment was to review mark-recapture studies (Section 1), standardized gillnetting surveys (Section 2), and age-growth samples (Section 3) for use in developing a stochastic age-structured lake trout population model to simulate lake trout population response to a range of harvest levels and mortality rates (Section 4). Each of these tasks is introduced below and described in detail in separate sections:

- Section 1 describes mark-recapture estimates of lake trout abundance in Flathead Lake during 2007–2008, 2010–2011, 2011–2012, and 2012–2013. Mark-recapture estimates were used to judge status of the lake trout population and also to set starting abundance for the age-structured stochastic simulation model (Part III).
- Section 2 describes metrics of relative abundance, size structure, body condition, mortality, and maturity from standardized annual autumn gill-net surveys in Flathead Lake during 1998–2012. The survey was designed to sample all possible sizes of lake trout in all possible areas and depths of the lake. Lake trout population density, size structure, body condition, mortality, and maturity were tested for trends through time as density-dependent responses to proposed suppression alternatives.
- Section 3 describes analyses of lake trout growth in Flathead Lake, Montana during three periods from which otolith samples were collected. To determine if growth of lake trout changed among years in which age was estimated, I compared length-age models among samples, including a sample from a period overlapping the expansion of *Mysis* and more recent samples from 2005 and 2008. Results were needed to determine if a single or multiple age-length keys were needed for modeling lake trout population dynamics.
- Section 4 describes a stochastic age-structured simulation model for simulating management objectives to suppress lake trout abundance by 25%, 50%, and 75% using angling, trap netting, and gillnetting. The baseline for reduction was defined as the number of age-8-and-older lake trout estimated by mark-recapture to be present prior to population suppression during 2008–2012. I also estimated the number of bull trout that would be saved from lake trout predation for each level of population suppression.
- Section 5 describes a power analysis of gillnet assessment and mark-recapture surveys to detect proposed 25%, 50%, and 75% reductions in adult lake trout abundance. The power analysis focused on relative abundance (geometric-mean catch/net) of adult (age-8+) lake trout in the gillnet assessment survey and absolute abundance (numbers) of adult (age-8+) lake trout in the mark-recapture survey.

Section 1:

Mark-Recapture Estimates of Lake Trout Abundance in Flathead Lake, Montana

Introduction

The Confederated Salish and Kootenai Tribes undertook mark–recapture studies of lake trout abundance in Flathead Lake during 2007–2008, 2009–2010, 2010–2011, and 2011–2012. Each mark–recapture study relied on a marking period from autumn in the first year through spring in the second year, followed by recapture periods during spring (2010, 2011, and 2012) and autumn in the second year (2008, 2010, 2011, and 2012). Each mark-recapture study was undertaken to estimate lake trout abundance as the starting condition for proposed suppression efforts to be simulated using an age-structured stochastic simulation model (Section 4).

Methods

Field Sampling

Mark-recapture sampling was completed in 2007–2008, 2009–2010, 2010–2011, and 2011–2012. Angling and gillnetting were used for capturing, marking, and releasing fish, and angling during tournaments was used for recapture sampling. In 2007–2008, marking was from 5 October 2007 through 10 March 2008 and recapture sampling was during 3–16 October 2008. In 2009–2010, marking was from 28 September 2009 through 9 March 2010 and recapture sampling was from 12 March through 23 May 2010 and again from 1 October through 14 November 2010. In 2010–2011, marking was from 30 September 2010 through 10 March 2011 and recapture sampling was from 11 March through 27 May 2011 and again from 23 September through 11 November 2011. In 2011–2012, marking was from 22 September 2011 through 15 March 2012 and recapture sampling was from 18 March through 8 April 2012 and again from 22 September through 19 October 2012. The mark-recapture estimate of abundance applies to the last day of marking in each year, on which the number of marked fish at large was established.

Fish were marked with 12.5-mm PIT tags inserted with plastic syringes into tissue covering the left gill plate. Tags were inserted at the top of the gill plate in a downward direction for at least 0.5 inches. The adipose fin was clipped as a secondary mark for estimating tag loss. Condition of fish was evaluated subjectively and only fish judged as likely to survive were tagged and released. Captured fish commonly had inflated swim bladders that required recovery to ensure their survival. Fish that were unable to swim after release were placed in a bottomless cage that was submerged to the recompression depth and then allowed to swim away. Fish unable to swim or only able to swim at the surface were retrieved and their tags were removed.

During recapture sampling, each captured fish was checked by anglers and agency staff for clipped adipose fins. To adjust for growth between marking in winter and recapture in autumn, the relationship between length at marking in winter and length at recapture in autumn of marked fish was used to estimate the length at marking for each fish < 600 mm examined for marks in autumn (length in winter and autumn were the same at a length of 600 mm).

Estimation

Recapture samples were obtained through fishing derbies in which all lake trout were removed from the population, so sampling was without replacement (i.e. the same fish could not be observed more than once during recapture sampling), thereby making Chapman's modification of the Petersen estimator applicable (Ricker 1975):

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1$$

A relatively small recapture sample requires that confidence limits on N be estimated using the binomial distribution for R/C, the Poisson distribution for R (rather than the normal distribution, which is only appropriate when R is large, say larger than 50), or maximum likelihood. Therefore, 95% confidence limits for N, $LL(N)$ and $UL(N)$, were computed from exact binomial confidence limits for R/C (L_1 and L_2):

$$LL(\hat{N}) = \frac{(M+1)(C+1)}{(L_2 C+1)} - 1$$

$$UL(\hat{N}) = \frac{(M+1)(C+1)}{(L_1 C+1)} - 1$$

Where L_1 and L_2 were computed from the relationship between the F-distribution and the binomial distribution (equations 24.28 and 24.29 in Zar 1999):

$$L_1 = \frac{R}{R + (C - R + 1)F_{\alpha(2),V1,V2}}$$

$$V1 = 2(C - R + 1)$$

$$V2 = 2R$$

$$L_2 = \frac{(R+1)F_{\alpha(2),V1',V2'}}{C - R + (R+1)F_{\alpha(2),V1',V2'}}$$

$$V1' = 2(R+1) = V2 + 2$$

$$V2' = 2(C - R) = V1 - 2$$

Last, the standard error (SE) and the associated coefficient of variation (CV) of the estimate of N were estimated from the variance (V) of N:

$$CV(\hat{N}) = \frac{SE(\hat{N})}{N}$$

$$SE(\hat{N}) = \sqrt{V(\hat{N})}$$

$$V(\hat{N}) = \frac{(M+1)^2(C+1)(C-R)}{(R+1)^2(R+2)}$$

Estimates of abundance and associated statistics were generated for the pooled sample of all lake trout sampled and for size groupings corresponding to RSD length classes: Stock = 300–499 mm; Quality = 500–649 mm; and Preferred 650–762 mm (Willis et al. 1993). Lake trout longer than the minimum of the slot-length limit (30 inches = 762 mm) were not vulnerable to angling in Flathead Lake, so estimated abundance did not include lake trout longer than 762 mm. The mean mark-recapture estimate of abundance during 2010–2012 was converted into number density (number/ha) for comparison to other lake trout populations in North America. Annual angler harvest in numbers from Mack Days derbies and the regular angling season was converted into yield using the weight-length equation from the standardized autumn gillnetting assessment

fishery (Section 2) and expressed as yield density (kg/ha) for comparison to other lake trout populations in North America.

Mark-Recapture Assumptions

Assumptions of all closed-population mark-recapture models are: (1) the population is closed to additions and deletions (constant *N* assumption); (2) marked and unmarked animals are equally vulnerable to capture (constant catchability assumption); and (3) marked individuals do not lose their marks and are all recognized upon recapture (no tag loss assumption; Pollock et al. 1990). Violations of these assumptions lead to bias of the mark-recapture estimate, either upward or downward, depending on the violation.

Constant N assumption—If mortality or emigration occurs equally for marked and unmarked individuals, the mark-recapture estimate is unbiased. However, if handling causes marked individuals to die at a faster rate than unmarked individuals (post-handling mortality), the estimate will be biased high. To evaluate post-handling mortality, 84 tagged lake trout (35 caught in gillnets and 49 caught by angling) were held for 24–192 hours (average = 67 hours) in an enclosure resting on the bottom at a depth of about 100 ft. Only one lake trout died while being held in the enclosure, which suggests a negligible (1.2%) rate of post-release mortality.

If recruitment or immigration occurs, the estimate of *N* includes all animals present at the time of marking and new individuals that entered the population. In Flathead Lake, recruitment of new individuals is likely, especially in relation to size-specific and age-specific vulnerability to capture. However, the effect of such recruitment is more appropriately discussed within the context of heterogeneity (see below). In contrast to recruitment, immigration of new lake trout into the population between the time of marking and recapture is likely trivial because the lake trout population in Flathead Lake is the largest in the region. Consequently, the effect of immigration on the mark-recapture estimate would be negligible.

Constant catchability assumption —The likelihood of capture cannot vary among fish because of heterogeneity in age, sex, social status, or territoriality. To overcome this problem, sampling effort must be distributed randomly throughout the population during either marking or recapture, or individuals must be given time to mix randomly between marking and recapture. In Flathead Lake, spatial distribution of recapture sampling effort differed between spring and fall angling tournaments (Figure 1.1), which led to higher captures of small lake trout during Spring Mack Days than during marking or Fall Mack Days (Figure 1.2). Young (small) lake trout likely live in deeper water than older (large) lake trout, so were more vulnerable to sampling in spring when 43% of angling effort was in deeper water, based on aerial counts of boats. Therefore, the estimate of lake trout abundance based on recapture samples from Spring Mack Days represents a broader segment of the total population (i.e. more small, young lake trout) than the estimate based on recapture samples from Fall Mack Days. These small (young) fish were present at the time of marking, but were not fully vulnerable to sampling, so the mark-recapture estimate based on Spring Mack Days reflects the total number of lake trout present in the population that were vulnerable to sampling during Spring Mack Days (Pollack et al. 1990).

Marking cannot alter the behavior of animals so they are either more likely to be captured after marking than unmarked individuals (trap happy response) or less likely to be captured after marking than unmarked individuals (trap shy response). To overcome this problem, different capture methods should be used for marking and recapture. In Flathead Lake, marking was by gillnetting and angling, whereas recapture sampling was by angling. Consequently, lake trout

that were captured for marking by angling may have been more or less likely to be captured by angling during recapture sampling. If more likely, the mark-recapture estimate would be biased low. If less likely, the mark-recapture estimate would be biased high.

No tag loss assumption—Tags cannot be lost or tag loss must be estimated. To address this potential problem, double tagging is often used to estimate tag loss so the number of recaptures can be adjusted upward to account for lost tags. The assumption of double tagging is that an individual is exceedingly unlikely to lose both tags (likelihood = 0), so loss of one tag will always be observed. Unfortunately, tag loss cannot be estimated in Flathead Lake because adipose fins have been removed for other studies, which prevents estimation of PIT-tag loss from lake trout without an adipose fin and without a PIT tag.

All tags must be observed during recapture sampling. To address this potential problem, tags or marks should be used that are not easily missed by observers and observers should be trained to observe tags. As described above, each captured fish was checked by anglers and by agency staff for clipped adipose fins, so marked fish were not likely missed upon recapture.

Results

Mark-recapture studies produced samples of numbers marked (M) ranging from 856 to 1,356, numbers examined for marks (C) ranging from 10,108 to 38,085, and numbers recaptured ranging from 21 to 82. Angling and gillnetting from 5 October 2007 through 10 March 2008 produced a sample of 856 lake trout marked (*M*), and angling during Fall Mack Days (3–16 October 2008) produced a sample of 10,108 lake trout examined for marks (*C*), of which 21 were previously marked (*R*). Angling and gillnetting from 28 September 2009 through 9 March 2010 produced a sample of 1,089 marked lake trout (*M*), and angling during Spring Mack Days (12 March – 23 May 2010) produced a sample of 34,696 lake trout examined for marks (*C*), of which 33 were previously marked (*R*). Angling during Fall Mack Days (1 October – 14 November 2010) produced a sample of 14,351 lake trout examined for marks (*C*), of which 31 were previously marked (*R*). Angling and gillnetting from 30 September 2010 through 10 March 2011 produced a sample of 897 marked lake trout (*M*), and angling during Spring Mack Days (11 March – 27 May 2011) produced a sample of 26,214 lake trout examined for marks (*C*), of which 33 were previously marked (*R*). Angling and gillnetting from 30 September 2010 through 22 May 2011 produced a sample of 1,314 marked lake trout (*M*), and angling during Fall Mack Days (23 September – 11 November 2011) produced a sample of 18,475 lake trout examined for marks (*C*), of which 42 were previously marked (*R*). Angling and gillnetting from 22 September 2011 through 15 March 2012 produced a sample of 1,356 marked lake trout (*M*), and angling during Spring Mack Days (18 March through 8 April 2012) produced a sample of 38,085 lake trout examined for marks (*C*), of which 82 were previously marked (*R*). Angling and gillnetting from 22 September 2011 through 15 March 2012 produced a sample of 1,222 marked lake trout (*M*), and angling during Fall Mack Days (22 September through 19 October 2012) produced a sample of 14,632 lake trout examined for marks (*C*), of which 38 were previously marked (*R*).

Greater angling effort was exerted in deeper parts of the lake during Spring Mack Days 2010 than during Fall Mack Days 2010 (Figure 1.1), which led to capture of more small (young) lake trout in spring than were captured in autumn (Figures 1.2, upper panel). Young small lake trout evidently occupied deeper parts of the lake than larger older lake trout, so were more vulnerable to angling during spring than autumn. The same pattern of fishing effort and fish distribution was evidently true in 2008, 2010, and 2011 because the length frequency of lake

trout captured during Fall Mack Days was similar in all three years. Likewise, the length frequency of lake trout captured during Spring Mack Days was generally similar in 2010 and 2011, with many fish smaller than those captured during Fall Mack Days of either year.

The mark-recapture estimate of lake trout abundance was about 0.4-million when based on Fall Mack Days 2008, 1.1-million when based on recaptures during Spring Mack Days 2010, 0.5-million when based on recaptures during Fall Mack Days 2010, 0.7-million when based on Spring Mack Days 2011, 0.6-million when based on Fall Mack Days 2011, 0.6-million when based on Spring Mack Days 2012, and 0.5-million when based on Fall Mack Days 2012 in Flathead Lake (Table 1; Figure 1.3). Differences among estimates were driven by differences in abundance of stock-length lake trout (<500 mm), which were generally lower when based on Fall Mack Days than when based on Spring Mack Days. In contrast, abundance of quality-length lake trout (500–650 mm) varied much less among estimates, none of which differed significantly (i.e. confidence limits overlapped among estimates; Table 1; Figure 1.3). Abundance of preferred-length lake trout (>650 mm) declined from 2010 to 2012, based on recapture samples during Spring Mack Days and Fall Mack Days each year. Length-specific abundance reflected higher vulnerability of small lake trout during Spring Mack Days than during Fall Mack Days (Figures 1.2, lower panel).

Discussion

Abundance of lake trout longer than 500 mm in length did not change significantly between spring 2008 and spring 2012 in Flathead Lake, though angling effort during Spring Mack Days shifted to deeper water where small lake trout (< 500 mm) not previously vulnerable to capture were exploited. This shift in angling effort permitted estimation of a new segment of the lake trout population that was not previously estimable. For example, lake trout shorter than 500-mm were two-times more abundant than lake trout longer than 500-mm, which indicates a large source of recruitment to sustain future exploitation. The shift in angling effort also permitted estimation of a younger segment of the lake trout population than was previously estimable. For example, age structure of the lake trout population estimated from recaptures during Spring Mack Days was four years younger than the age structure of the lake trout population estimated from recaptures during Fall Mack Days. Mark-recapture estimates of lake trout abundance therefore reflect ages 4-and-older when based on recaptures during Spring Mack Days and ages 8-and-older when based on recaptures during Fall Mack Days. In future mark-recapture surveys, deepwater habitat should be sampled during marking to tag a larger fraction of this large segment of the lake trout population.

Lake trout population density in Flathead Lake is relatively high in relation to other native and introduced populations in North America. Compared to introduced lake trout populations in western North America, average spring population density of age-4-and-older lake trout in Flathead Lake during 2010–2012 (15.8 fish/ha; 11.7–22.0 fish/ha; this study) was 17-times higher than peak lake trout abundance in Lake Pend Oreille, Idaho in 2005 (0.9 fish/ha; 95% CI = 0.7–1.4 fish/ha; Hansen et al. 2008), but only 0.7-times as high as in Yellowstone Lake, Wyoming in 2011 (21.5 fish/ha; 95% CI = 18.9–25.3 fish/ha; Syslo et al. 2011). Compared to other lake trout populations in North America, average spring lake trout population density in Flathead Lake was more than 2-times higher than the native restored population in western Lake Superior (7.5 fish/ha; 95% CI = 2.8–12.5 fish/ha; Nieland et al. 2008) and 2.7-times higher than the average density of populations from across North America (Figure 1.4, Upper Panel; Average = 6.3 fish/ha; Range = 0.3–21.5 fish/ha). Similarly, the average yield of

lake trout from Flathead Lake during 2010–2012 (1.31 kg/ha) was 2-times higher than the average yield density of populations from across North America (Figure 1.4, Lower Panel; Average = 0.67 kg/ha; Range = 0.06–5.86 kg/ha). Causes of high lake trout number and yield density in Flathead Lake can only be explained by more research, but regardless of the cause, lake trout suppression in Flathead Lake may require rates of fishing mortality and yield that are higher than expected based on comparisons to native populations (e.g. Healey 1978).

TABLE 1.1.—Mark-recapture estimates of abundance (*N*), 95% confidence limits for *N* (*LL* and *UL*), standard error of *N* (*SE*), and coefficient of variation for *N* (*CV*) for all sizes and three size groups of lake trout on 10 March 2008 (Fall 2008), 9 March 2010 (Spring, Fall 2010), 10 March 2011 (Spring, Fall 2011), and 15 March 2012 (Spring, Fall 2012) in Flathead Lake, Montana.

Group	*N*	*LL*(*N*)	*UL*(*N*)	*SE*(*N*)	*CV*(*N*)
Fall 2008 (recapture sample = 3 – 16 October 2008)					
Pooled	393,791	261,867	618,645	82,022	0.208
<50 cm	192,375	106,462	375,943	57,940	0.301
50–65 cm	147,564	83,782	279,982	42,548	0.288
>65 cm	26,024	9,517	62,846	12,990	0.499
Sum	365,962	199,762	718,771	113,478	0.310
Spring 2010 (recapture sample = 12 March – 23 May 2010)					
Pooled	1,110,106	797,366	1,591,300	187,550	0.169
<50 cm	707,117	456,333	1,151,328	158,054	0.224
50–65 cm	243,018	148,933	421,103	60,698	0.250
>65 cm	95,646	29,133	186,570	55,198	0.577
Sum	1,045,781	634,399	1,759,001	273,950	0.262
Fall 2010 (recapture sample = 1 October – 14 November 2010)					
Pooled	488,864	347,775	708,834	85,006	0.174
<50 cm	244,680	156,172	403,804	56,070	0.229
50–65 cm	177,896	109,046	308,228	44,418	0.250
>65 cm	42,496	9,088	---	30,021	0.706
Sum	465,073	274,307	712,031	130,509	0.281
Spring 2011 (recapture sample = 11 March – 27 May 2011)					
Pooled	692,374	497,348	992,454	116,957	0.169
<50 cm	453,134	310,900	685,702	87,153	0.192
50–65 cm	180,752	85,682	413,302	68,261	0.378
>65 cm	13,650	5,602	33,724	6,094	0.446
Sum	647,535	402,183	1,132,728	161,508	0.249
Fall 2011 (recapture sample = 23 September – 13 November 2011)					
Pooled	565,021	420,715	776,756	85,081	0.151
<50 cm	397,937	269,079	612,802	79,500	0.200
50–65 cm	145,404	93,883	236,679	32,470	0.223
>65 cm	12,449	3,804	24,283	7,172	0.576
Sum	555,789	366,766	873,763	119,142	0.214
Spring 2012 (recapture sample = 18 March – 8 April 2012 2012)					
Pooled	621,176	501,742	778,457	67,702	0.109
<50 cm	432,401	341,059	556,533	52,380	0.121
50–65 cm	169,763	104,049	294,153	42,395	0.250
>65 cm	3,451	1,273	8,333	1,713	0.496
Sum	605,615	446,380	859,020	96,488	0.159
Fall 2012 (recapture sample = 22 September – 19 October 2012)					
Pooled	458,124	336,268	640,381	72,339	0.158
<50 cm	225,569	155,908	338,474	42,548	0.189
50–65 cm	180,099	106,671	325,062	48,091	0.267
>65 cm	11,424	2,451	27,226	7,172	0.576
Sum	417,093	264,823	630,762	98,701	0.237

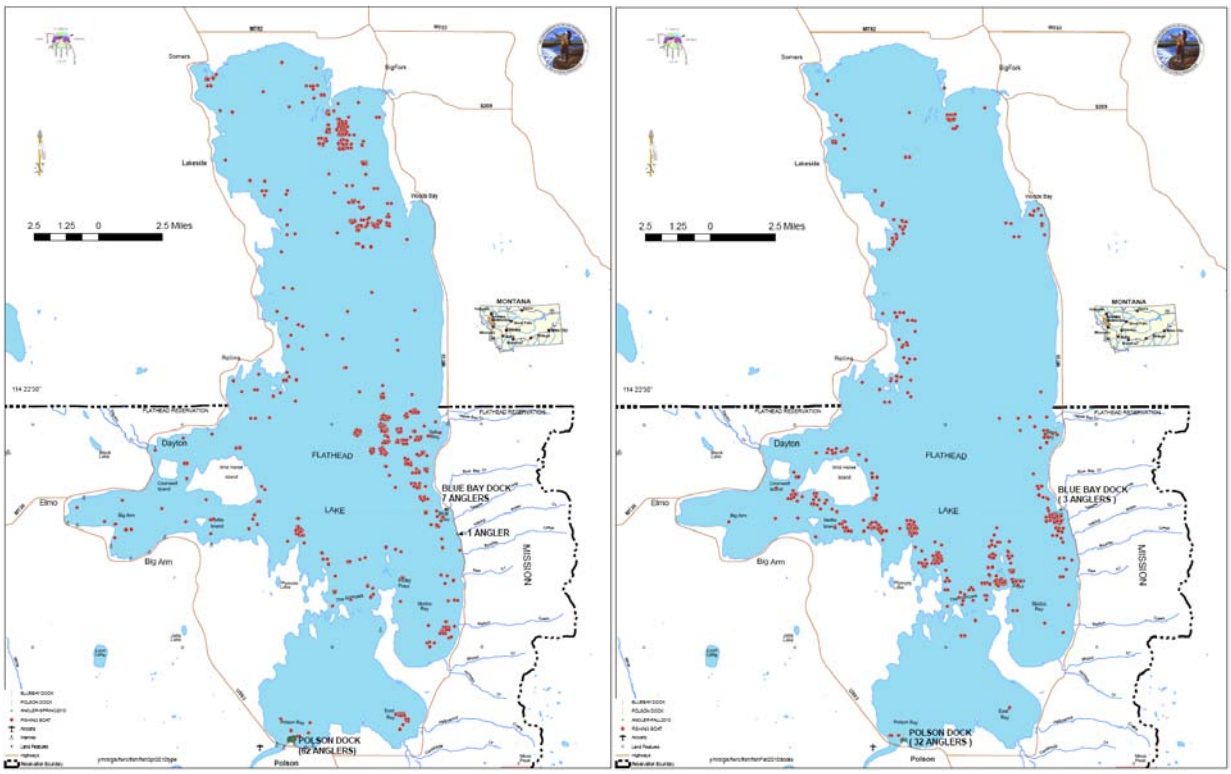


FIGURE 1.1.—Locations of fishing boats identified during aerial surveys conducted during Spring Mack Days (left panel; 12 March – 23 May 2010) and Fall Mack Days (right panel; 1 October – 14 November 2010) 2010 in Flathead Lake, Montana (Source: Barry Hansen).

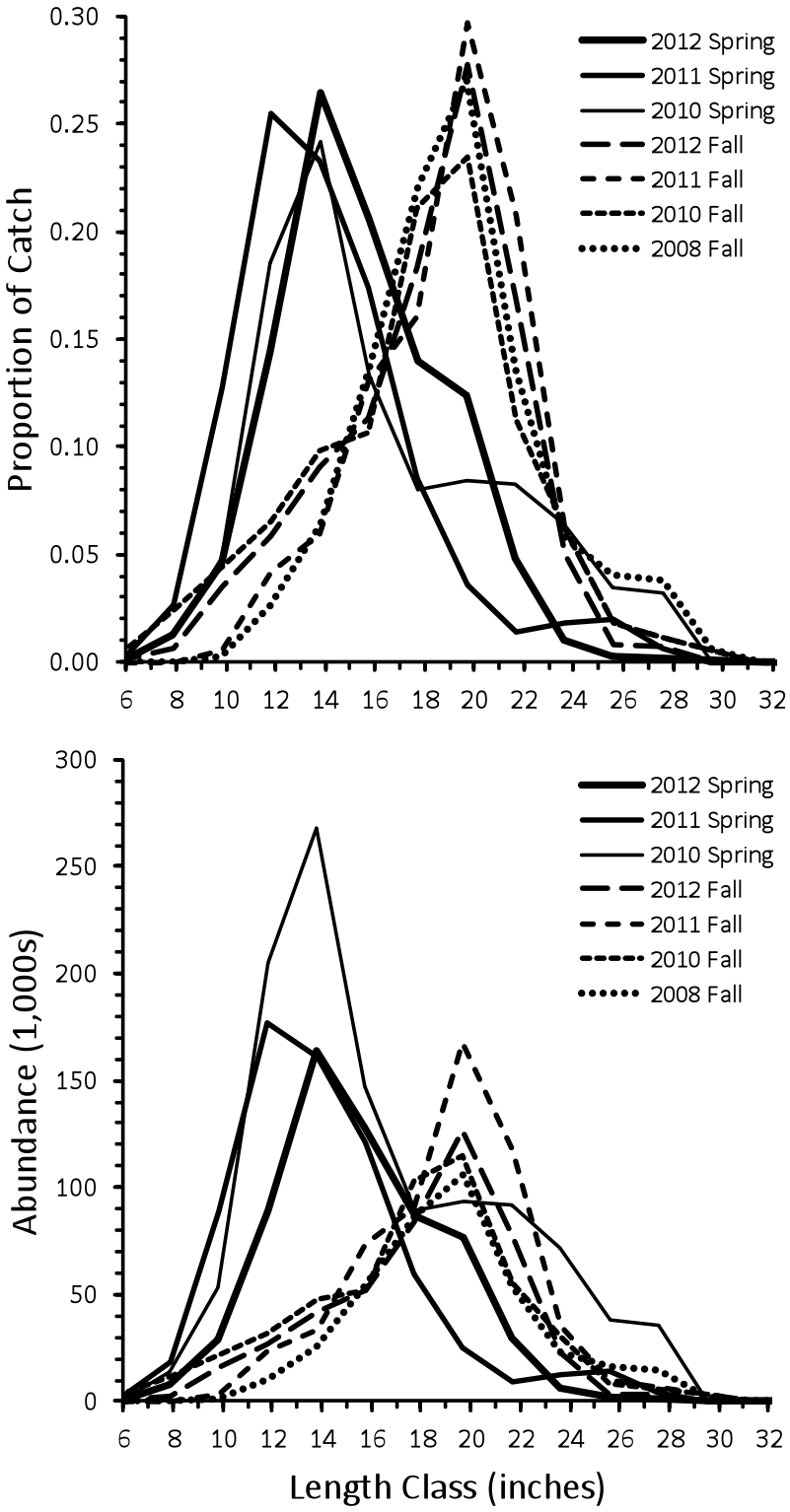
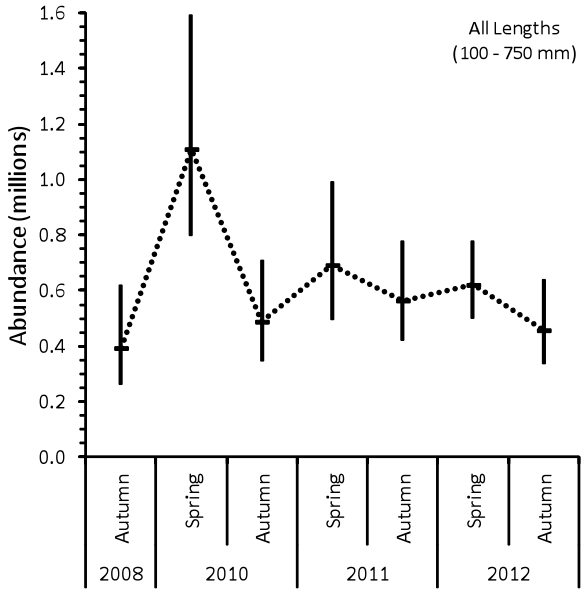
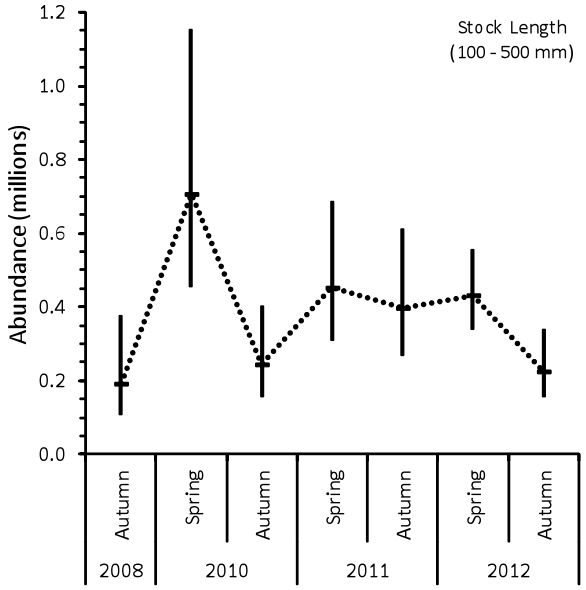


FIGURE 1.2.—Length-frequency of lake trout captured by angling during Fall Mack Days (2008, 2010, 2011, and 2012) and Spring Mack Days (2010, 2011, and 2012; upper panel) and scaled to

the number in the mark-recapture population estimate (lower panel) in Flathead Lake, Montana.


All Lengths
(100 - 750 mm)
Abundance (millions)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Autumn
Spring
Autumn
Spring
Autumn
Spring
Autumn
2008
2010
2011
2012


Stock Length
(100 - 500 mm)
Abundance (millions)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Autumn
Spring
Autumn
Spring
Autumn
Spring
Autumn
2008
2010
2011
2012

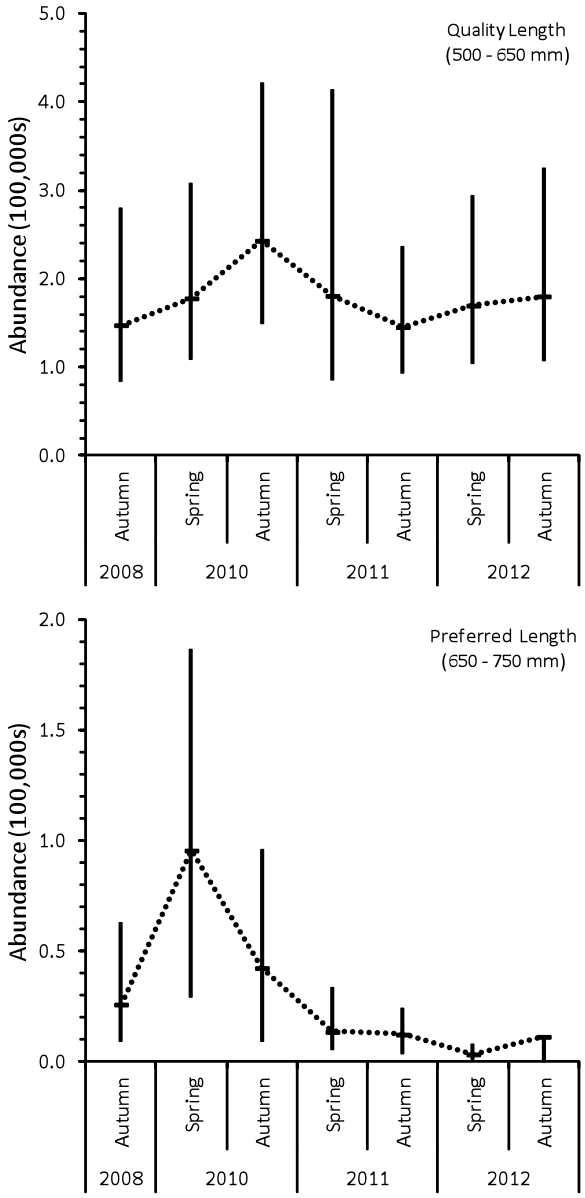


FIGURE 1.3.—Abundance (± 95% confidence limits) of four length classes of lake trout estimated by mark-recapture during Fall Mack Days (2008, 2010, 2011, and 2012) and Spring Mack Days (2010, 2011, and 2012) in Flathead Lake, Montana.

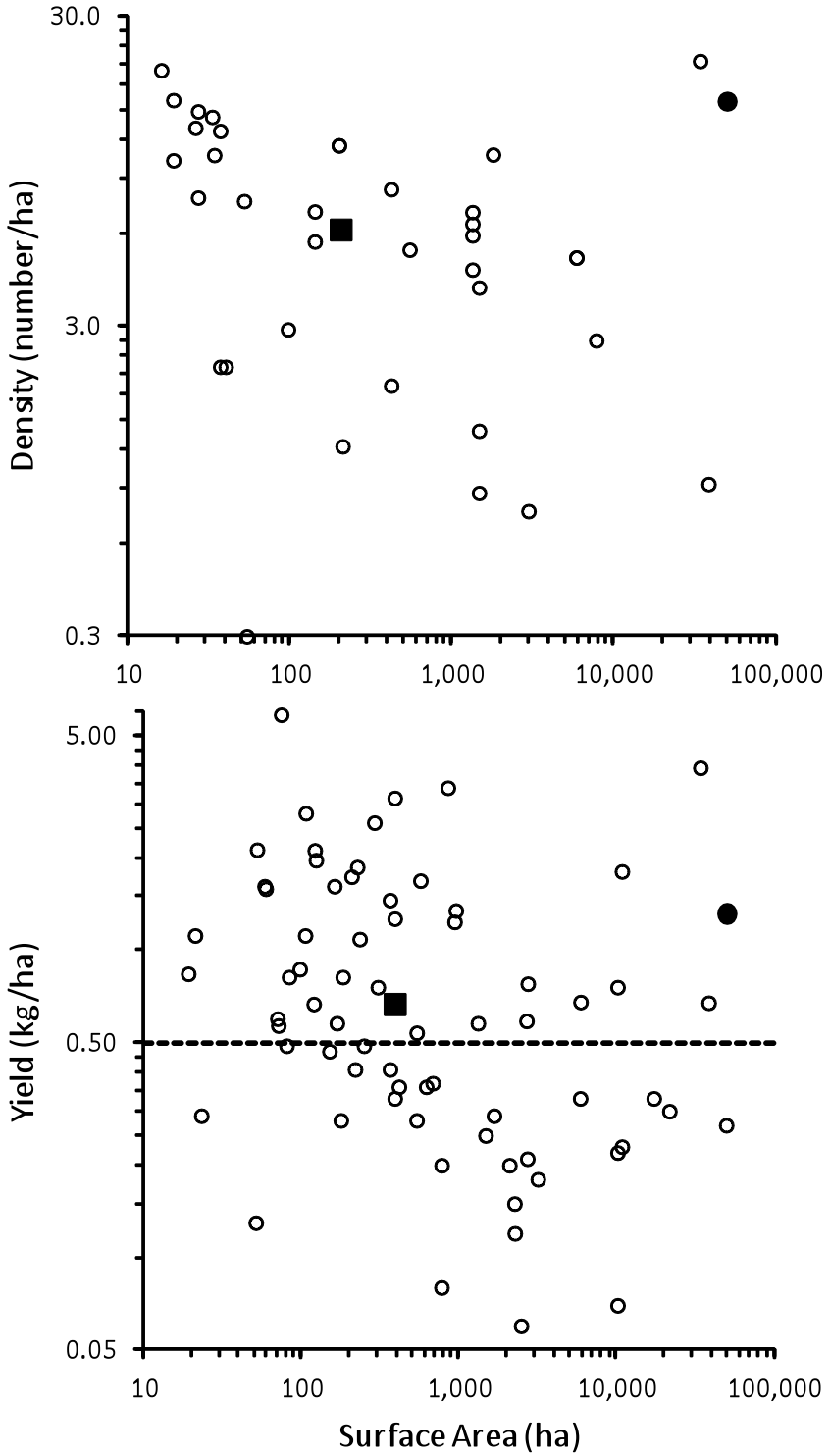


FIGURE 1.4.—Lake trout population density (number/ha; upper panel) and yield (kg/ha; lower panel) in relation to lake surface area (ha) for North American populations (open circles; median = blackened square; Healey 1978; Martin and Olver 1980; Hansen et al. 2008; Syslo et al. In press), and average population density and yield in Flathead Lake, Montana during spring 2010–2012 (blackened circle; this study). The horizontal dashed line (lower panel) was suggested as

the maximum yield to avoid decline of lake trout populations in North America (Healey 1978).

Section 2:

Standardized Gill-Net Surveys of Lake Trout in Flathead Lake, Montana

Introduction

The Confederated Salish and Kootenai Tribes instituted standardized annual gill-net surveys of the lake trout population in Flathead Lake during 1998–2012. The survey was designed to sample all possible sizes of lake trout in all possible areas and depths of the lake. Lake trout population attributes, such as size structure, body condition, size at maturity, and population density (catch per net), could then be used to quantify temporal trends as possible density-dependent responses to fishery management actions. For example, decreasing size structure, increasing body condition, decreasing size at maturity, and decreasing population density (catch per net) are consistent with a lake trout population that is being systematically suppressed through increased fishing mortality. The standardized gill-net survey can therefore be used as an independent tool for evaluating effects of fishery management actions (Section 4).

Methods

A standardized gill-netting survey was deployed to index lake trout population status in Flathead Lake during autumn 1998–2012. Gillnetting effort was distributed throughout the lake in proportion to the amount of surface area in five geographic areas of the lake and up to four depth zones (0–100, 100–200, 200–300, and >300 feet) in each area. Gillnets were constructed of 12 mesh sizes to encompass the range of plausible lake trout lengths (bar-measure panels of 0.38-inch and 0.5-inch – 3.0-inch in 0.25-inch increments). Based on relationships between lake trout length and girth (Hansen et al. 1997), lake trout ranging in total length from 130 mm to 1,086 mm were vulnerable to capture by wedging in the range of meshes used for sampling lake trout in Flathead Lake. Lake trout captured were measured in total length (mm) and weight (g). Gender (male or female) and maturity status (mature or immature) was determined by examining gonads and sex products.

Relative abundance was indexed as geometric mean catch/net ($\pm$ 95% confidence limits) each year during 1998–2012. To estimate mean relative abundance for each year of the gill-net survey, I fit a general linear model with $\log_e$(catch/net + 1) as the dependent variable, and year, area, and depth stratum as independent variables. This approach conforms to the stratified-random sampling design by accounting for variance within sampling strata when estimating mean annual catch/net. To account for zero catches, a constant (+1) was added to each net catch. To normalize log-normally distributed gill-net catch/net for the general linear model, catch/net (+1) was transformed into natural logarithms. Least-squares means ($\pm$ 95% confidence limits) from the general linear model were then back-transformed as the exponent of $\log_e$(catch/net + 1), and the constant (+1) was subtracted, to express relative abundance as geometric-mean catch/net. Annual geometric-mean catch/net was estimated for all fish captured and for the number of fish longer than 460 mm, the length of an adult at age 8 (Section 3).

Population size structure was indexed as the percentage of total catch and catch/net of lake trout longer than 500 mm (20 inches = quality length; Picolo et al. 1993) and 762 mm (30 inches = lower limit of the protected slot-length limit) from gillnet samples each year during autumn 1998–2012. Linear regression of the percentage of total catch and catch/net against year was used to test the hypothesis that size structure did not change as a consequence of the slot-length limit. If the slope of the linear regression did not differ significantly from zero, I assumed

the slot-length limit had no effect on population size structure during 1998–2012. The slot-length limit was intended to produce higher angling catch rates of lake trout 30-inches and longer, so lack of increase in catch/net of such lake trout during standardized gillnet surveys would indicate a failure of the slot-length limit to achieve its management objective.

Body condition was indexed as relative weight of lake trout caught in gillnets each year during 1998–2011. The relative weight index (W_r) compares observed weight of individual fish (W) to a standard weight for the species (W_s), based on a weight-length equation developed from across the species' range ($W_r = W/W_s \times 100$; Murphy et al. 1991; Anderson and Neumann 1996; Pope and Kruse 2007). For example, the standard weight equation for lake trout was developed from weight-length samples for 58 populations from across North America (Piccolo et al. 1993):

$$log_{10}W_s = -5.681 + 3.2462log_{10}TL; [W_s = \text{grams}, TL = \text{mm}]$$

$$log_{10}W_s = -3.778 + 3.2462log_{10}TL; [W_s = \text{pounds}, TL = \text{inches}]$$

Relative weight should be computed only for lake trout longer than 280 mm, the minimum length for which the ratio of the variance to the mean is constant (Piccolo et al. 1993). I first computed W_r for each individual lake trout ($\geq$ 280 mm TL) caught during standardized gillnet surveys, and for which length and weight were measured. I then computed mean W_r ($\pm$ 95% confidence limits) for each year, as an index of body condition during 1998–2012, and tested for a linear trend through time using the same method as for population size structure. In the future, body condition (relative weight) would be expected to increase if lake trout population density is suppressed. Therefore, I used linear regression to determine if relative weight (dependent variable) was related to catch/net (independent variable) during 1998–2012.

Annual mortality (A) was estimated from the descending limb of the age frequency for each year during 1998–2012 (catch-curve method (Ricker 1975). The age frequency of each annual sample was estimated with an age-length key from the length frequency of each annual sample (Ricker 1975). The age-length key was constructed from age-estimate samples in 2005 and 2008 (Sections 3–4). Estimated numbers at age (N_t) were converted into natural logarithms and the slope ($\pm$ 95% confidence limits) of the relationship between $\log_e(N_t)$ and age (t) was estimated using linear regression:

$$log_e(N_t) = log_e(N_0) - Zt$$

In the catch-curve equation, the intercept, $log_e(N_0)$, is the logarithm of the average number of individuals present at age 0, and the slope, Z, is the instantaneous rate of total mortality. The annual mortality rate (+ 95% confidence limits) was estimated as $A = 1 - e^{-Z}$ (Ricker 1975). Annual mortality should increase in the future if the lake trout population is suppressed in Flathead Lake (Section 4). Therefore, to determine if annual mortality changed through time, I used linear regression to test the significance of the slope between A (dependent variable) and year (independent variable) during 1998–2012. For comparison, the age frequency of gillnet samples was compared to the age frequency of angling during 2008–2012.

Length at 50% maturity was estimated from the relationship between the percent of mature lake trout in gill-net samples each year during 1998–2012. The percent of mature lake trout in each annual sample was summarized within 25-mm length classes. Percent mature in each length class (M_l) was then modeled as a function of length class (l; Haddon 2001):

$$M_l = \frac{1}{1 + e^{-log_e(19)\frac{(l-l_{50})}{(l_{95}-l_{50})}}}$$

In the maturity model, l_{50} is the length at which 50% of lake trout were mature and l_{95} is the length at which 95% of lake trout were mature. Annual estimates of l_{50} were used to express maturity for each year during 1998–2012. Length at maturity should decrease as population density decreases, as a density dependent response. Therefore, to determine if length at maturity changed through time, I used linear regression to test the significance of the slope between l_{50} (dependent variable) and year (independent variable) during 1998–2012.

Results

Based on geometric-mean catch/net caught during standardized autumn gillnetting, abundance of lake trout varied without significant upward or downward trend in Flathead Lake during 1998–2011. For all lake trout captured during annual gillnet surveys, geometric-mean catch/net ranged from a low of 2.2 in 2007 to a high of 5.6 in 2008, but catch/net did not trend significantly through time during 1998–2012 (Figure 2.1; left panel). For adult lake trout captured during annual gillnet surveys, geometric-mean catch/net ranged from a low of 1.5 in 2003 to a high of 3.8 in 2008, but catch/net did not trend significantly through time during 1998–2012 (Figure 2.1; right panel).

Population size structure of lake trout was bimodal, with peaks at 500 mm (20 inches) and 850 mm (33 inches), and catch/net of fish longer than 30 inches increased significantly in Flathead Lake during 1998–2012. The length frequency of lake trout vulnerable to capture in standardized gillnets increased from 100 mm (4 inches) to 500 mm (20 inches), declined to 750 mm (30 inches), increased to 850 mm (33 inches), and then declined to 1,125 mm (44 inches; Figure 2.2). Catch/net of lake trout shorter than the minimum of the slot-length limit (≥ 30 inches) did not change significantly during 1998–2012 (Figure 2.3; left panel). In contrast, population density of lake trout longer than the minimum of the slot-length limit (< 30 inches) increased significantly during 1998–2012 (Figure 2.3; right panel).

Based on the relative weight index of lake trout caught during standardized autumn gillnetting, body condition of lake trout in Flathead Lake was low for the species, and varied without trend during 1998–2012. Relative weight of lake trout averaged 83, with 50% of all lake trout falling between 76 and 91 and 95% falling between 65 and 106 (Figure 2.4). Mean annual relative weight ranged from a low of 79 in 2008 to a high of 88 in 2006, but did not trend significantly through time during 1998–2012 (Figure 2.5). Relative weight was inversely related to catch/net of all lake trout (Figure 2.6), as would be expected if body condition was negatively related to population density (i.e. density dependent).

Based on the age frequency of lake trout caught during standardized autumn gillnetting, annual mortality averaged 13.5% and declined significantly through time in Flathead Lake during 1998–2012. Annual mortality was lower when estimated from the age frequency of gillnet samples (A = 13.5%) than when estimated from the age frequency of angling harvest (A = 26.1%; Figure 2.7). Annual mortality declined significantly through time, from nearly 17% in 1998 to less than 13% in 2012 (Figure 2.8). Annual mortality was inversely related to catch/net of lake trout longer than the minimum of the protected slot-length limit (Figure 2.9), as would be expected if total annual mortality caused population density to decline.

Based on the maturity status of lake trout caught during standardized autumn gillnetting, length at 50% maturity averaged 483 mm and varied without significant trend in Flathead Lake during 1998–2012. Across all samples, 50% of lake trout were mature at 483 mm (19.0 inches), which corresponded to an age of 8.7 years (Figure 2.10). Annual estimates of 50% maturity ranged from a low of 451 mm (17.7 inches) in 1999 to a high of 563 mm (22.2 inches) in 2006, but varied without significant trend during 1998–2012 (Figure 2.11). Length at 50% maturity was inversely related to catch/net of all lake trout (Figure 2.12), as would be expected if total annual mortality caused population density to decline, though the functional relationship explained little of the variation.

Discussion

The catch rate of lake trout longer than the minimum of the slot-length limit increased significantly during 1998–2012, which suggests the management objective for the regulation was achieved in Flathead Lake (Isermann and Paukert 2010). Angling catch rate should parallel gill-net catch rate if lake trout are equally vulnerable to both capture methods (Pope et al. 2010), as is suggested by the similarity between length frequencies of lake trout 20–30 inches long caught by angling (Section 1) and gillnetting (Section 2). The increase from 1998 to 2008 was partly offset by a decrease from 2008 to 2012, so angling catch rates of large lake trout (≥ 30 inches) should have declined after 2008 in parallel to gill-net catch rates of large lake trout. The cause of this apparent decline is not clear, and may reflect annual fluctuations caused by varying year-class strength or a decline in population density of large lake trout (Isermann and Paukert 2010).

Relative weight, total annual mortality, and length at 50% maturity of lake trout were inversely related to catch/net during 1998–2012, which suggests lake trout body condition, mortality, and maturity changed as density dependent responses to population density in Flathead Lake (Murphy et al. 1991; Anderson and Neumann 1996; Pope and Kruse 2007). Population density should decline as total annual mortality increases, and body condition of an average fish in a population should increase as population density declines (in the absence of increased prey availability) because prey resources available for each individual should be less at high density than at low density (Murphy et al. 1991; Anderson and Neumann 1996; Pope and Kruse 2007). Increased body condition would eventually lead to faster growth, earlier age (and shorter length) at maturity, and greater fecundity (Murphy et al. 1991; Anderson and Neumann 1996; Pope and Kruse 2007). When population density declines as a consequence of high fishing mortality, body condition foretells coincident changes in growth, age and length at maturity, and fecundity that collectively serve as indices of exploitation stress (Spangler et al. 1977). Collectively, attributes of lake trout caught during standardized autumn gillnetting can be used to monitor effects of lake trout suppression programs enacted on Flathead Lake (Section 4).

Total abundance of lake trout varied without significant trend during 1998–2012, despite a significant increase in abundance of lake trout longer than 30 inches, which suggests angling exploitation was at equilibrium with production of vulnerable-sized lake trout in Flathead Lake (Ricker 1975; Hilborn and Walters 1992; Quinn and Deriso 1999; Allen and Hightower 2010). If true, fishing mortality exerted during 1998–2012 may be at equilibrium with production, and therefore, unlikely to cause persistent changes through time in abundance, size structure, or body condition other than those caused by annual variation in recruitment and survival (Ricker 1975; Hilborn and Walters 1992; Quinn and Deriso 1999; Allen and Hightower 2010). Increased fishing mortality through increased netting may be necessary to suppress lake trout below current abundance, as is presently being considered by fishery managers (Section 4).

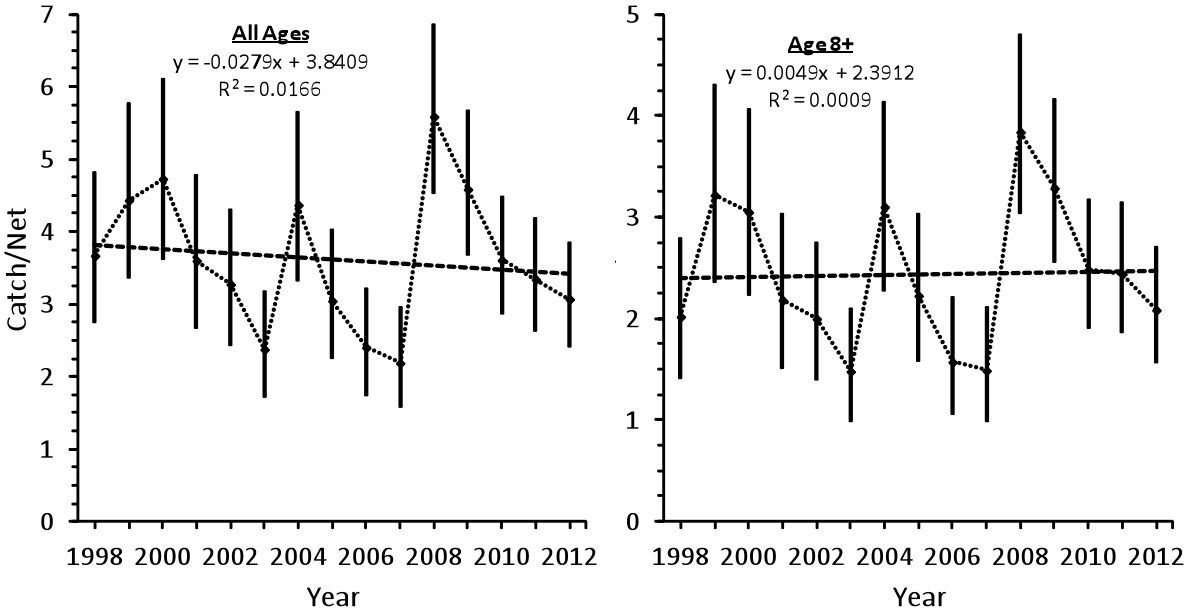


FIGURE 2.1.—Geometric-mean catch/net (± 95% confidence limits) of all lake trout (left panel) and adult lake trout (right panel) in Flathead Lake, Montana during 1998–2012. Dashed lines depict linear trends through time, which are described by equations within each panel.

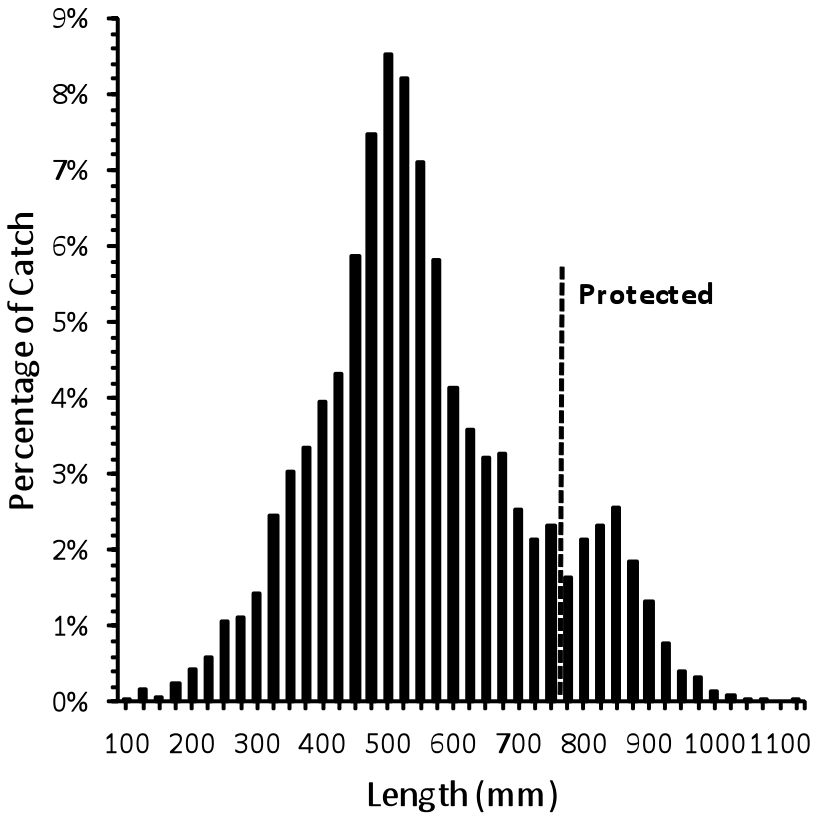


FIGURE 2.2.—Length-frequency of 6,081 lake trout caught in standardized gillnet surveys in Flathead Lake, Montana during 1998–2012.

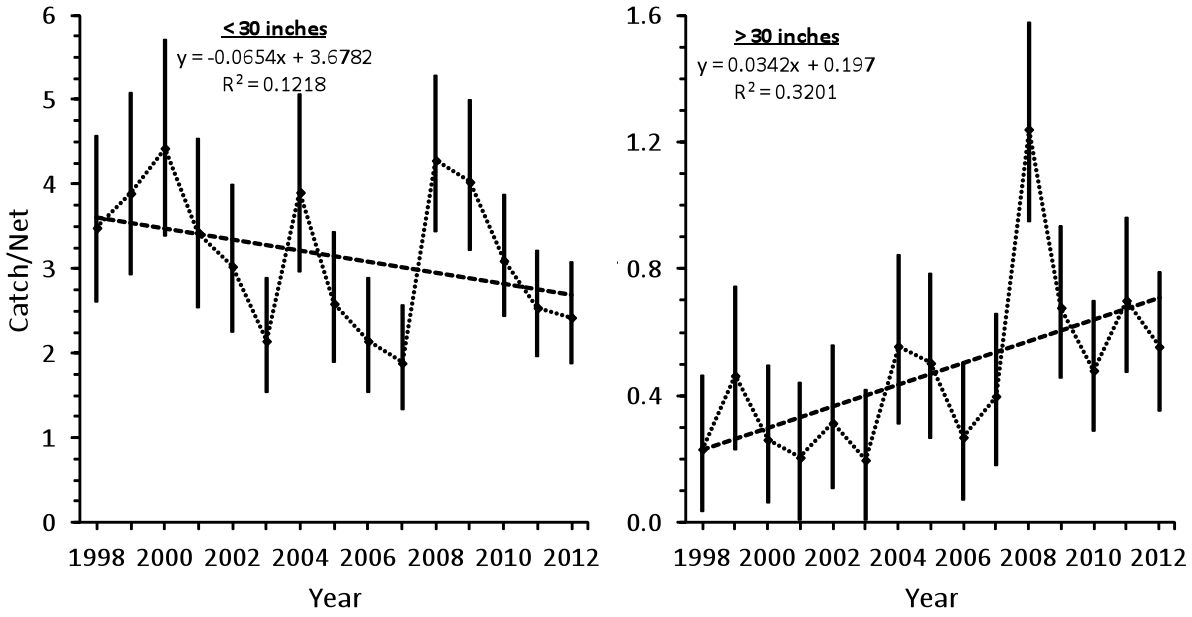


FIGURE 2.3.—Catch/net of lake trout shorter than a protected slot-length limit (left panel) and longer than a protected slot-length limit (right panel) caught in standardized gillnet surveys in Flathead Lake, Montana during 1998–2012.

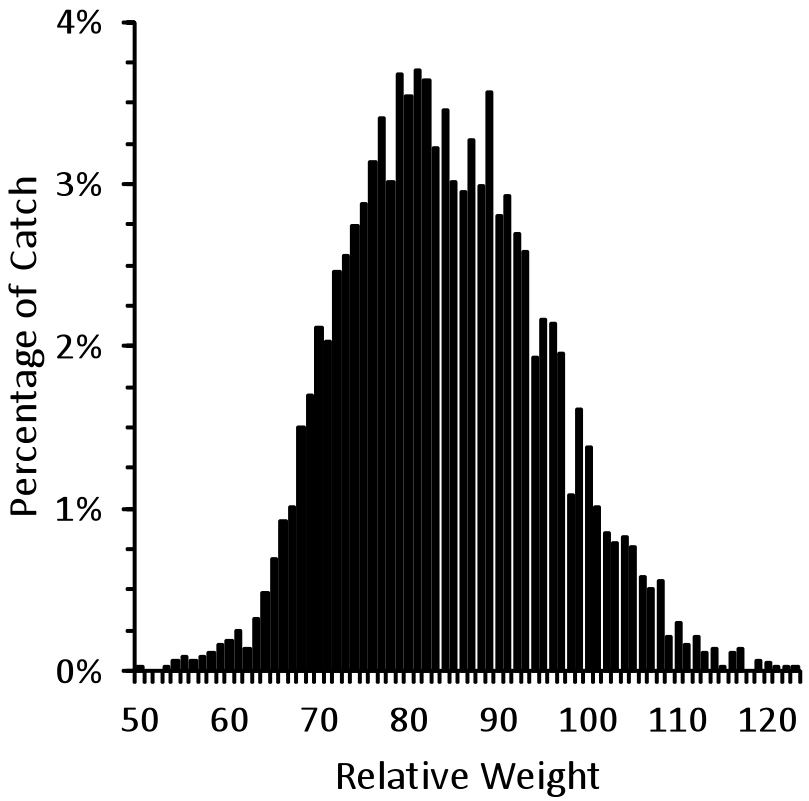


FIGURE 2.4.—Relative weight of 4,347 lake trout caught in standardized-gillnet surveys in Flathead Lake, Montana during 1998–2012.

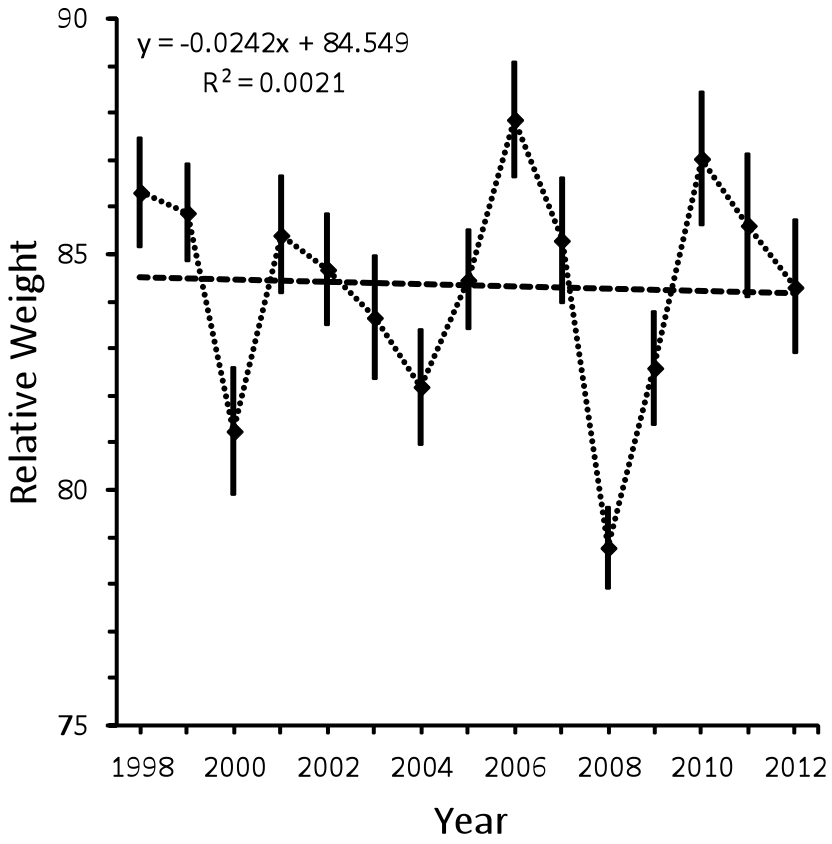


FIGURE 2.5.—Mean annual relative weight (± 95% confidence limits) of lake trout (*N* = 4,347; 179–437 per year) caught in standardized-gillnet surveys in Flathead Lake, Montana during 1998–2012.

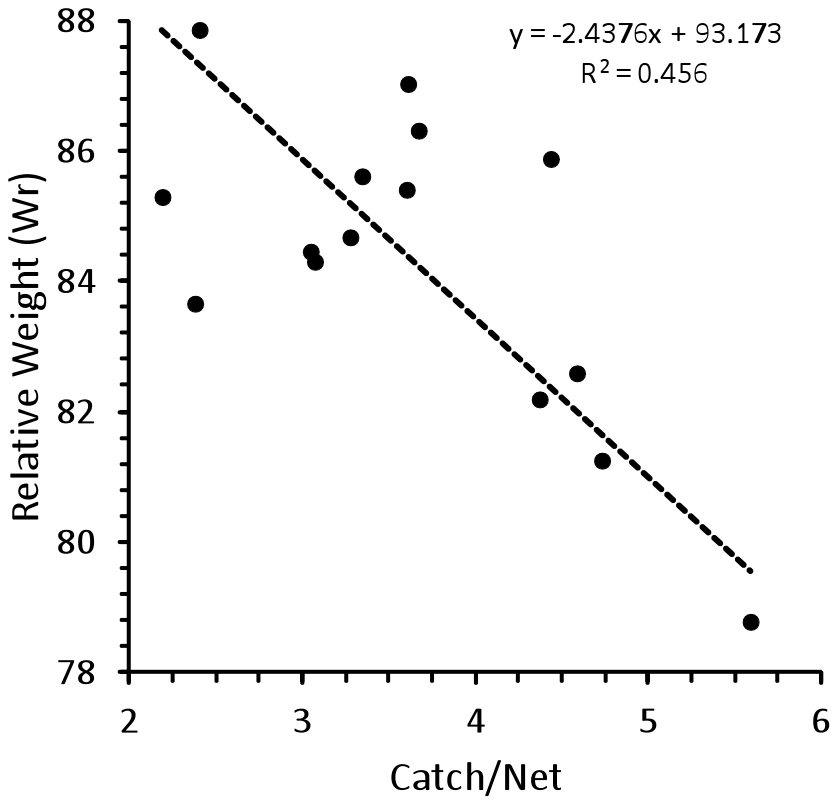


FIGURE 2.6.—Average annual relative weight in relation to geometric-mean annual catch/net (dots), with fitted functional regression relationship (line) for lake trout caught during standardized gillnet surveys in Flathead Lake, Montana during 1998–2012.

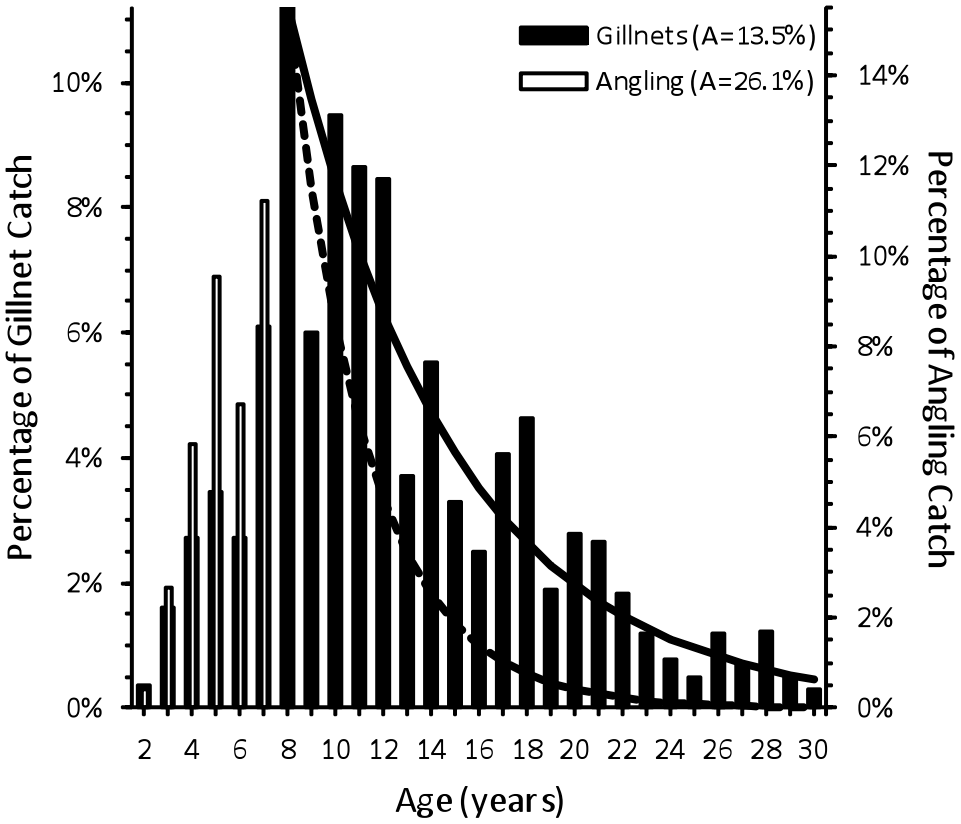


FIGURE 2.7.—Age frequency of lake trout caught in standardized-gillnet surveys during 1998–2012 (black bars) and by angling during 2008–2012 (open bars) in Flathead Lake, Montana. Curves depict average annual mortality estimated from frequencies of ages 8–30 from gillnetting (black line) and ages 8–24 from angling (dashed line).

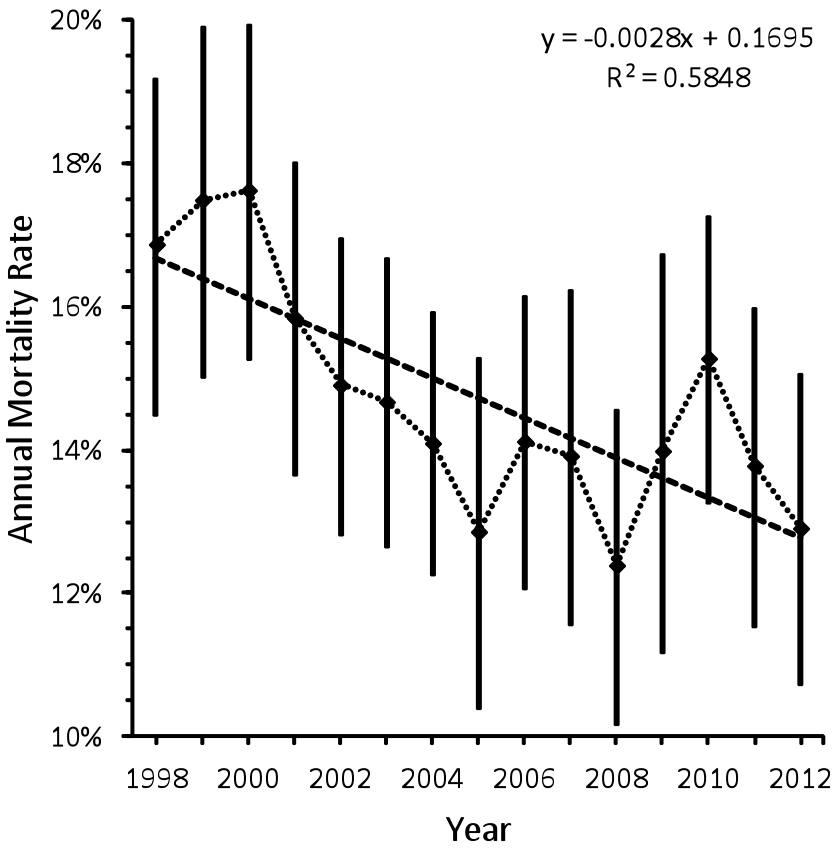


FIGURE 2.8.—Mean annual mortality (± 95% confidence limits) estimated from age frequency samples of lake trout caught in standardized-gillnet surveys in Flathead Lake, Montana during 1998–2012. The dashed line and equation depicts the linear trend through time of annual mortality during 1998–2012.

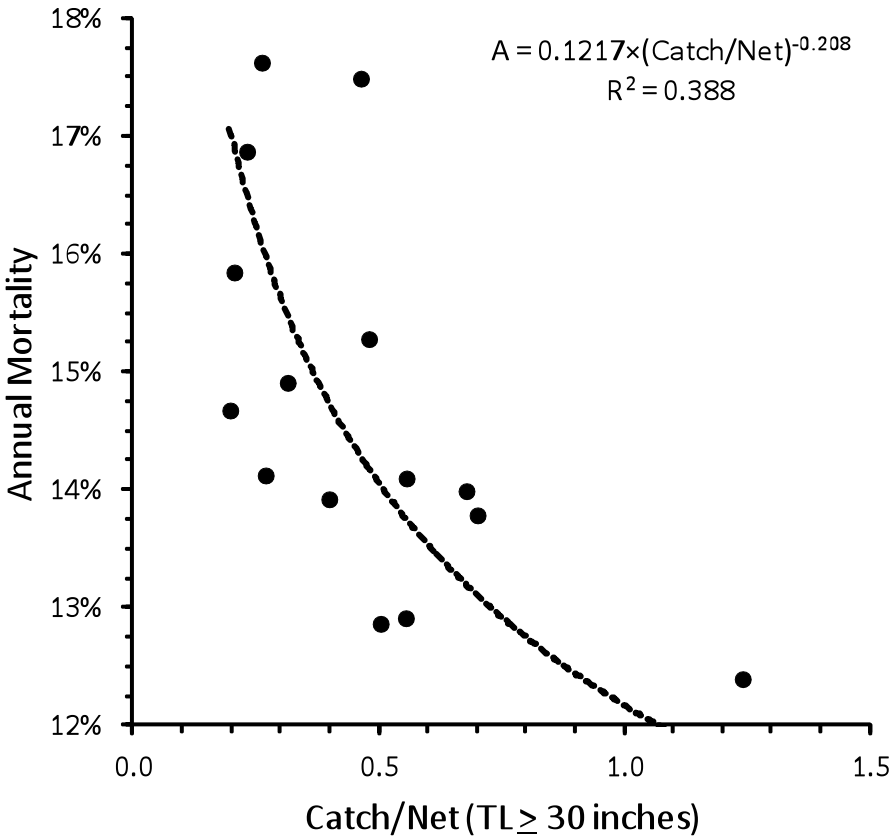


FIGURE 2.9.—Average annual mortality rate in relation to geometric-mean annual catch/net of lake trout ≥ 30 inches TL (dots), with fitted power function (line) for lake trout caught during standardized gillnet surveys in Flathead Lake, Montana during 1998–2012.

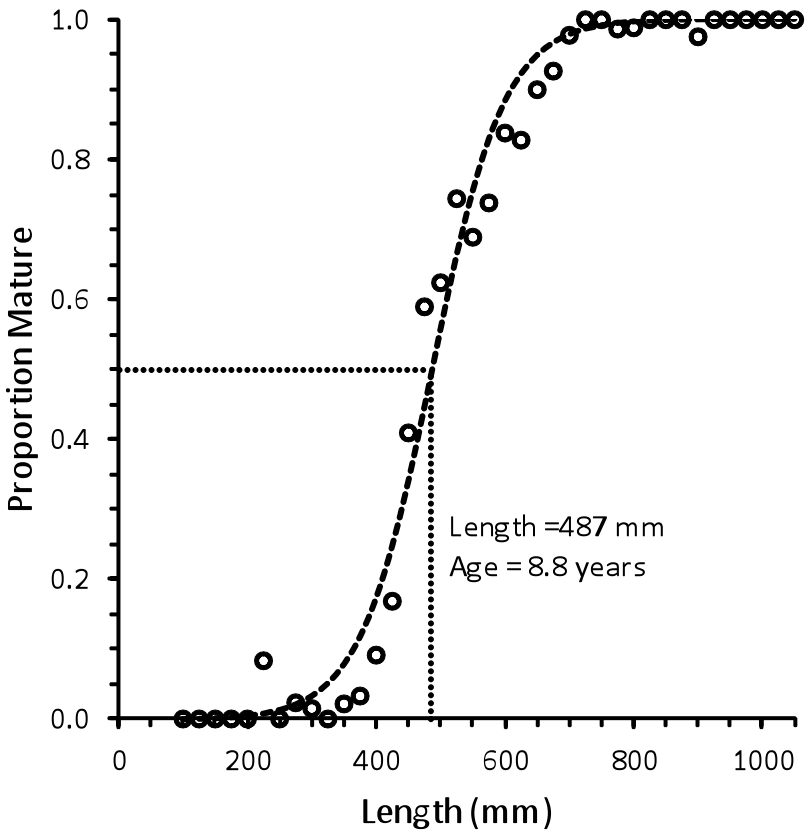


FIGURE 2.10.—Proportion mature in relation to 25-mm length class for lake trout caught in standardized-gillnet surveys in Flathead Lake, Montana during 1998–2012. The dashed line depicts the logistic relationship between proportion mature and length class. Dotted lines depict the length (and associated age) at which 50% of lake trout were mature.

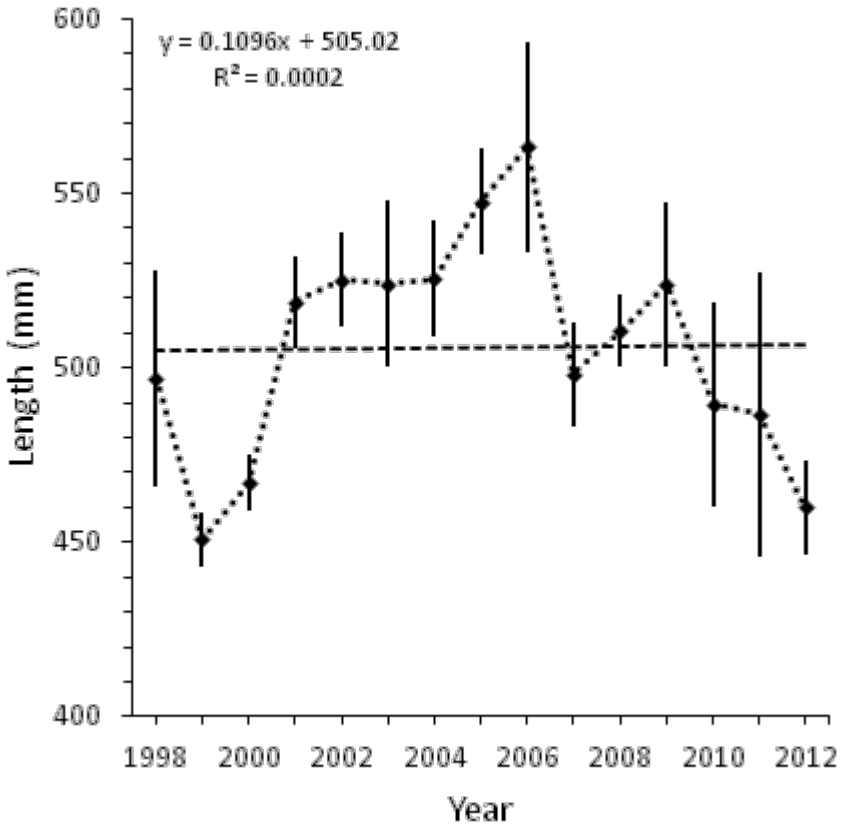


FIGURE 2.11.—Length at which 50% of lake trout were mature (± 95% confidence limits) from standardized-gillnet surveys during 1998–2012 in Flathead Lake, Montana during 1998–2012. The dashed line depicts the linear trend through time in length at 50% maturity. Maturity state was not available for 2003 or 2004.

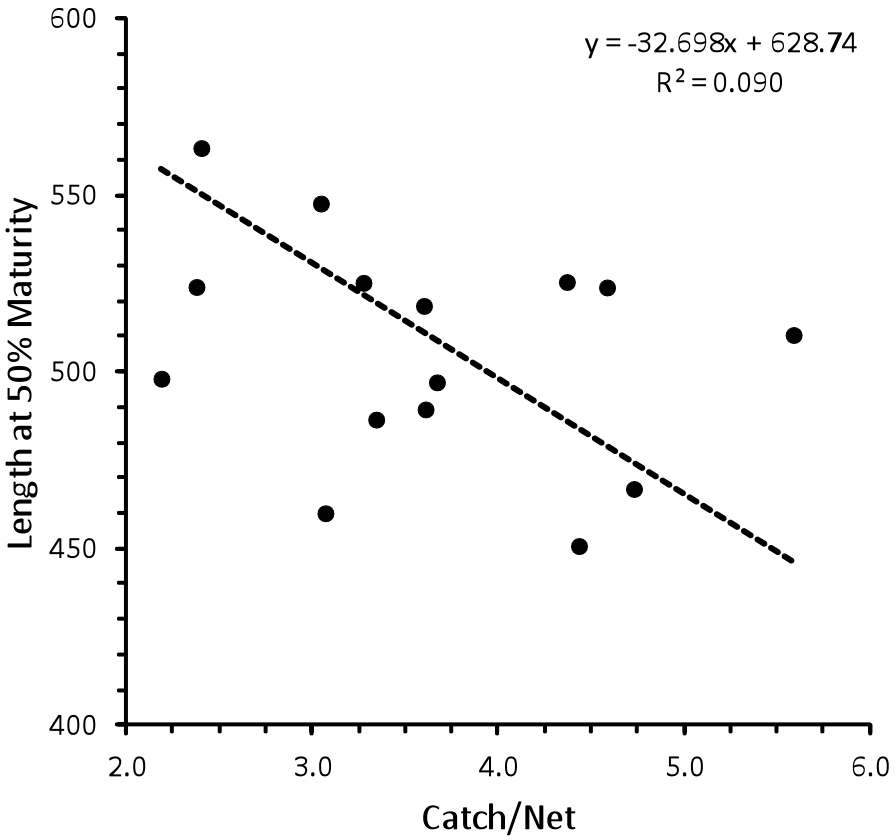


FIGURE 2.12.—Length at 50% maturity in relation to geometric-mean annual catch/net of lake trout (dots), with fitted functional regression relationship (line) for lake trout caught during standardized gillnet surveys in Flathead Lake, Montana during 1998–2012.

Section 3:
Growth of Lake Trout in Flathead Lake, Montana

Introduction

The Confederated Salish and Kootenai Tribes obtained samples of lake trout otoliths for estimating length at age of lake trout in Flathead Lake, Montana. To determine if growth of lake trout in Flathead Lake, Montana changed among years in which age was estimated, I compared length-age models among samples, including a sample from a period overlapping the expansion of *Mysis* (3 December 1986 – 23 August 1995) and more recent samples from 2005 (18 October 2005 – 9 November 2005) and 2008 (7 May 2008 – 27 June 2008 and 14 October 2008 – 2 December 2008). The results were needed to determine if a single or multiple age-length keys were needed for modeling lake trout population dynamics (Section 4).

Methods

I compared growth models based on: (1) back-calculated growth histories between two periods for which otolith increment measurements were available (Pre-1996 and 2005); and (2) length at age of capture among three periods for which age estimates were available (Pre-1996, 2005, and 2008). I used back-calculated growth histories for all available lake trout specimens to model growth as a combination of age and year effects to develop a history of growth estimates from the earliest year of growth for any individual lake trout sampled (1951) through the latest available growth year (2005).

Back-calculated length at age – I modeled lake trout growth from measurements of annuli on otoliths for a sample of 152 lake trout processed by Brothers that were captured between 3 December 1986 and 23 August 1995 (pre-1996) and a sample of 123 lake trout processed by Stafford that were captured between 18 October and 9 November 2005. I first converted increment measurements into radii measurements by adding each incremental measure to the sum of preceding radii, starting with the first radius. I then back-calculated a growth history for each fish using the biological intercept model (Campana 1990), with the biological intercept set at L_0 = 21.673 mm and O_0 = 0.137 mm from equations describing otolith growth for lake trout in their first few months of life (Bronte et al. 1995). To justify the biological intercept model, I tested linearity of the relationship between fish length and otolith radius using a 2nd-order polynomial regression, in which the squared term of the model was a test of linearity.

I estimated parameters of the von Bertalanffy length-age model for growth histories of individual fish using nonlinear regression with additive errors because growth data was for individual fish (Quinn and Deriso 1999):

$$L_t = L_\infty\left(1 - e^{-K(t-t_0)}\right) + \varepsilon$$

The length-age model describes growth of an individual fish as a function of three parameters: L_∞ = the asymptotic length to which an individual lake trout would grow if allowed to grow indefinitely (units = mm); K = the instantaneous rate at which L_t approaches L_∞ (units = 1/years); t_0 = the hypothetical age at which length was zero (units = years); and ε = additive process error. Additive errors are appropriate for modeling back-calculated length at age of individual fish because growth of individual fish is additive through time, so departures of individual years from the mean growth curve are constant with age (Quinn and Deriso 1999). When estimated for a

population, rather than an individual, L_∞ is the average asymptotic length for all individuals in the population and other parameters are similarly defined as averages for all individuals in the population. Therefore, to estimate the average length-age model for the lake trout population in each period (1996 and 2005), I used the geometric mean L_∞ and K and the arithmetic mean t_0 of individual growth parameters for each sample. Final samples included 122 fish from pre-1996 and 113 fish from 2005, because models failed to converge for 6 fish from 2005, 20 fish were too young to estimate model parameters from 1996, and model parameters were poorly estimated (i.e. CV > 0.20) for 2 fish from pre-1996 and 4 fish from 2005. I also fit the length-age model to mean back-calculated length at age, for comparison.

To test for differences in growth among periods, I used F-ratios to test for homogeneity of variance and t-tests to compare parameter estimates between periods (pre-1996 versus 2005). To test for homogeneity of variance between periods, I computed the ratio of variances of each parameter estimate among individual growth curves in each period and computed the likelihood that the resulting F-ratio was due to chance alone with $df_{\text{Pre-1996}} = 121$ and $df_{2005} = 112$ (Zar 1999). To compare growth parameters between periods, I computed t-tests with the numerator as the difference between parameter estimates between the two periods and the denominator as the pooled variance for the two periods (Zar 1999).

Length at age of capture – To enable use of a new sample of lake trout from 2008 for which age was estimated, but for which increments were not measured on otoliths, I fit von Bertalanffy length-age models to data on length at age of capture for lake trout in Flathead Lake, Montana. Data were from three sampling periods, including 3 December 1986 – 23 August 1995 (pre-1996), 18 October 2005 – 9 November 2005 (2005), and 7 May 2008 – 27 June 2008 and 14 October 2008 – 2 December 2008 (2008). Length-age models were fit to length at age of capture for each period (pre-1996, 2005, and 2008), all periods together (pre-1996 + 2005 + 2008), and each pair of periods (pre-1996 + 2005, pre-1996 + 2008, and 2005 + 2008). Length-age models were fit using nonlinear regression with multiplicative errors because growth data was for multiple fish (Quinn and Deriso 1999):

$$L_t = L_\infty(1 - e^{-K(t-t_0)}e^{\varepsilon}$$

For a fish population, the Von Bertalanffy length-age model describes length L at age t (L_t) as a function of the average asymptotic length of a fish in the population L_∞, the instantaneous rate K at which an average fish grows from L_t to L_∞, the hypothetical age t_0 at which length was zero, and multiplicative error ε. Multiplicative errors are appropriate for modeling length at age of capture because growth of individual fish is multiplicative through time, so departures of individual fish from the mean growth curve increase with age (Quinn and Deriso 1999). I also fit the length-age model to mean length at age of capture, for comparison.

To test for differences in growth among periods, I used likelihood-ratio tests to evaluate the likelihood that a full model (separate models for each period) was a more parsimonious descriptor of growth (length at age) than a reduced model (one model for all periods). First, to determine if growth differed among periods, I compared models for each period (1996, 2005, and 2008) to an overall model for all periods (1996 + 2005 + 2008). Next, to identify the year or years that differed in the overall test, I compared models for each pair of periods (full model) to an overall model for each pair of periods (reduced model).

To identify model parameters that accounted for year-specific differences in overall models, I compared L_∞, K, and t_0 between each pair of periods using unpaired t-tests for unequal variances (Zar 1999):

$$t = \frac{X_1 - X_2}{s_{X_1 - X_2}}$$

$$s_{X_1 - X_2} = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

$$df = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{(n_1 - 1)} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{(n_2 - 1)}}$$

In each t-test, X = an estimate of L_∞, K, or t_0 for each period 1 or 2, s = the asymptotic standard error of the parameter estimate, and n = the number of fish used to estimate parameters of the length-age model.

Annual growth index – To develop a history of growth from the earliest year of growth for any lake trout sampled (1951) through the latest available growth year (2005), I computed a growth index as the least-squares mean ($\pm$ 1 standard error) growth increment from a general linear model with measured growth increment at age as the dependent variable and growth year and age class as independent variables. Least-squares mean growth increments were based on fewer than 5 fish prior to 1962, so I restricted analysis to the period 1962–2005. Least-square mean growth increment was transformed into percent deviation from the mean growth increment during the pre-*Mysis* period (1962–1983), so a negative growth index indicated below-average pre-*Mysis* growth and a positive growth index indicated above-average pre-*Mysis* growth.

Results

Otolith radius was linearly related to length of lake trout in Flathead Lake (Figure 3.1). Curvature of the relationship between otolith radius and fish length was not evident because the squared term of the 2nd-order polynomial did not differ significantly from zero (t_{149} = 1.139; P = 0.256). Lack of curvature in the relationship between otolith radius and fish length enables use of a proportional (linear) back-calculation model, like the biological-intercept model (Campana 1990). Non-linearity of this relationship that was previously reported (Figure 3 in Stafford et al. 2002) was not confirmed by my analysis, nor have I found the relationship to be non-linear for any other samples of lake trout otoliths from North America.

Length at age of capture (Figure 3.2; upper two panels) was similar to back-calculated length at age (Figure 3.2; middle two panels), so mean length at age of capture was similar to mean back-calculated length at age (Figure 3.2; lower two panels) for lake trout in Flathead Lake. Therefore, growth parameters differed little between length-age models based on back-calculated length and length at age of capture for the pre-1996 sample (Table 1). In contrast, asymptotic length (L_∞) and annual growth rate (ω) based on back-calculated length at age were notably lower than when based on length at age of capture (Table 1). These latter differences suggest that lake trout included in the 2005 sample were not a random sample from the population.

Growth rate and asymptotic length decreased while growth variation was similar for lake trout in Flathead Lake between 1996 and 2005 (Table 2; Figure 3.3). Asymptotic length (L_∞) declined from 834 mm in pre-1996 to 637 mm in 2005 (t_{233} = 7.390; P < 0.001) because annual growth rate ($\omega = L_\infty \times K$) declined from 108 mm/year in pre-1996 to 86 mm/year in 2005 (t_{233} = 7.052; P < 0.001), while instantaneous growth rate (K) was similar in pre-1996 (0.130/year) and 2005 (0.134/year; t_{233} = 0.628; P = 0.531) and age at length zero (t_0) was similar in pre-1966 (–0.716) and 2005 (–0.778; t_{233} = 0.915; P = 0.361). Growth variation did not differ significantly between periods for L_∞ ($F_{121, 112}$ = 0.870, P = 0.775), ω ($F_{121, 112}$ = 1.328, P = 0.064), K ($F_{121, 112}$ = 0.846, P = 0.817), or t_0 ($F_{121, 112}$ = 1.116, P = 0.278).

Growth of lake trout differed significantly among periods (<1996, 2005, and 2008) in Flathead Lake, Montana (Figure 3.4; $F_{6, 410}$ = 29.67; $P = 1.56 \times 10^{-29}$). Growth differed less between 2005 and 2008 ($F_{3, 261}$ = 2.54; P = 0.057) than between 1996 and 2008 ($F_{3, 260}$ = 31.80; $P = 1.52 \times 10^{-17}$) or between 1996 and 2005 ($F_{3, 299}$ = 55.80; $P = 1.13 \times 10^{-28}$). Asymptotic length was lower in 2005 (L_∞ = 901 mm) than 1996 (L_∞ = 986 mm; t_{216} = 9.21; $P = 2.98 \times 10^{-17}$) or 2008 (L_∞ = 999 mm; t_{256} = 8.13; $P = 1.90 \times 10^{-14}$), but did not differ significantly between 1996 and 2008 (t_{159} = 1.37; P = 0.17). The instantaneous growth rate was higher in 1996 (K = 0.092/year) than either 2005 (K = 0.070/year; t_{236} = 12.13; $P = 1.21 \times 10^{-26}$) or 2008 (K = 0.069/year; t_{202} = 14.76; $P = 6.13 \times 10^{-34}$), but did not differ significantly between 2005 and 2008 (t_{265} = 0.79; P = 0.43). Theoretical age at length zero was lower in 2005 (t_0 = −2.08 years) than 1996 (t_0 = −1.71 years; t_{168} = 4.08; $P = 6.85 \times 10^{-5}$) or 2008 (t_0 = −1.22 years; t_{259} = 7.95; $P = 5.73 \times 10^{-14}$) and lower in 1996 than 2008 (t_{135} = 7.37; $P = 1.58 \times 10^{-11}$).

Growth of lake trout increased steadily before *Mysis* increased and declined steadily after *Mysis* increased in Flathead Lake (Figure 3.5). Growth of lake trout increased during 1962–1983, before *Mysis*, and then declined during 1984–2005, after *Mysis*. The mean annual lake trout growth increment increased significantly during the 22-year period (1962–1983) before Mysis reached noticeable levels of density ($F_{1, 20}$ = 9.76; P = 0.005). In contrast, the mean annual lake trout growth increment decreased significantly during the 22-year period (1984–2005) after *Mysis* reached noticeable levels of density ($F_{1, 20}$ = 24.1; $P = 8.47 \times 10^{-05}$).

Discussion

Lake trout growth indices were relatively consistent among methods and suggested that a large decline in annual growth rate caused a coincident large decline in asymptotic length after *Mysis* colonized Flathead Lake, presumably because lake trout population density increased 14-fold following *Mysis* colonization of the lake (Stafford et al. 2002). Consistent with a density-dependent decline in growth rate (DeVries and Frie 1996; Isely and Grabowski 2007; Allen and Hightower 2010), period-specific estimates of the annual growth rate (ω) declined significantly, just as year-specific growth indices exhibited a steady decline over the 22-year period (1984–2005) following *Mysis* colonization. In contrast, similarity of length-age models based on pre-1996 and 2008 samples were inconsistent with a drastic decline in asymptotic length suggested by other analyses, though a decline in annual growth rate was evident between length-age models based on pre-1996 and 2008 samples. Year-specific estimates of increment growth by lake trout provide a temporal perspective to explain how much growth changed during the period covered by the three age-and-growth samples (pre-1996 and 2005), but would be bolstered by addition of increment measurements for the 2008 sample.

Growth differences among samples were unusual because asymptotic length was similar in pre-1996 and 2008 samples, but shorter in the 2005 sample, whereas the instantaneous growth rate was similar in 2005 and 2008 samples, but faster in the pre-1996 sample. Shorter asymptotic length in 2005 than in either pre-1996 or 2008 may be an artifact of non-random sampling that included more dwarf morphs in 2005 than in either pre-1996 or 2008, or conversely, more lean morphs in the 2008 sample than the 2005 sample. Similarity of asymptotic length in pre-1996 and 2008 suggests that this attribute of the lean lake trout morph has not changed since the increase in *Mysis* density enabled expansion of the lake trout population (assuming samples were representative of the lean morph in both periods). In contrast, faster growth in pre-1996 than in either 2005 or 2008 suggests a density-dependent reduction in somatic growth rate as the lake trout population increased between pre-1996 and 2005–2008, as was also suggested by estimates of annual growth index, at least through 2005. Similar growth rates in 2005 and 2008 suggest that lake trout population density has not changed appreciably during that period. The dwarf morph that was more evident in the 2005 sample may have emerged in response to high inshore population density of the lean morph.

Samples of lake trout age-estimation tissues must be representative of the population to provide accurate indices of growth in Flathead Lake. The 2005 sample exhibited no descending limb of the age frequency, which limited use of the sample in an age-length key. In contrast, the 2008 sample exhibited a normal descending limb of the age frequency, as expected for a random sample of the population age frequency. Future sampling of age-estimation tissues should be obtained from stratified-random gillnet sampling, with depth as a stratum for obtaining sub-samples. Standard rules for non-random sub-sampling within each depth stratum can be used, such as collecting the first 5–10 specimens within each 25-mm length class. Such sampling would enable less ambiguous tests of growth changes for both dwarf and lean morphs. Annual collections of age and growth history would enable estimation of growth as an annual metric of lake trout population status.

TABLE 1.—Asymptotic length (L_∞), annual growth rate (ω), instantaneous growth rate (K) and age at zero length (t_0), along with standard errors (*SE*) and 95% confidence limits (*LL*, *UL*) for von Bertalanffy length-age growth models for lake trout in Flathead Lake, Montana in 1996 (n = 122) and 2005 (n = 113).

1996	Estimate	*SE*	*LL*	*UL*	**2005**	Estimate	*SE*	*LL*	*UL*
Back-Calculated Length at Age – Average of Individuals					Back-Calculated Length at Age – Average of Individuals				
L_∞	833.575	1.026	791.760	877.598	L_∞	637.481	1.026	606.446	670.103
ω	108.082	1.025	103.004	113.411	ω	85.696	1.022	82.054	89.500
K	0.130	1.042	0.119	0.141	K	0.134	1.040	0.124	0.145
t_0	-0.716	0.046	-0.806	-0.626	t_0	-0.778	0.050	-0.877	-0.679
Back-Calculated Length at Age – All Individuals					Back-Calculated Length at Age – All Individuals				
L_∞	886.204	11.631	863.392	909.016	L_∞	728.996	15.306	698.973	759.019
K	0.117	0.003	0.110	0.123	K	0.104	0.005	0.094	0.114
t_0	-0.683	0.042	-0.766	-0.601	t_0	-0.991	0.112	-1.210	-0.772
Mean Back-Calculated Length at Age					Mean Back-Calculated Length at Age				
L_∞	866.876	2.377	862.055	871.698	L_∞	713.300	13.993	683.902	742.698
K	0.128	0.002	0.124	0.132	K	0.110	0.007	0.096	0.124
t_0	-0.521	0.071	-0.664	-0.377	t_0	-0.886	0.185	-1.275	-0.497
Mean Length at Age of Capture					Mean Length at Age of Capture				
L_∞	921.219	20.413	879.404	963.033	L_∞	726.274	47.638	624.737	827.811
K	0.118	0.012	0.093	0.144	K	0.113	0.026	0.057	0.169
t_0	0.073	0.479	-0.908	1.054	t_0	-0.959	0.934	-2.950	1.032
Length at Age of Capture – All Individuals					Length at Age of Capture – All Individuals				
L_∞	985.556	48.517	889.685	1,081.430	L_∞	902.823	105.965	693.446	1,112.200
K	0.092	0.011	0.071	0.113	K	0.070	0.020	0.031	0.109
t_0	-0.712	0.245	-1.197	-0.227	t_0	-2.069	1.091	-4.225	0.086

TABLE 2.—Parameters (ASE = asymptotic standard error; Lower – Upper = 95% confidence limits) for Von Bertalanffy length-age models fit to length at age of capture of lake trout in Flathead Lake, Montana, during Pre-1996 (3 December 1986 – 23 August 1995), 2005 (18 October 2005 – 9 November 2005), and 2008 (7 May 2008 – 27 June 2008 and 14 October 2008 – 2 December 2008) sampling periods.

Parameter	Estimate	ASE	Lower	Upper
Pre-1996	(n = 152)			
L_∞	986	49	890	1,081
K	0.092	0.011	0.071	0.113
t_0	−0.712	0.245	−1.197	−0.227
2005	(n = 153)			
L_∞	903	106	693	1,112
K	0.070	0.020	0.031	0.109
t_0	−2.069	1.091	−4.225	0.086
2008	(n = 114)			
L_∞	999	93	815	1,183
K	0.069	0.014	0.041	0.096
t_0	−1.219	0.683	−2.572	0.134

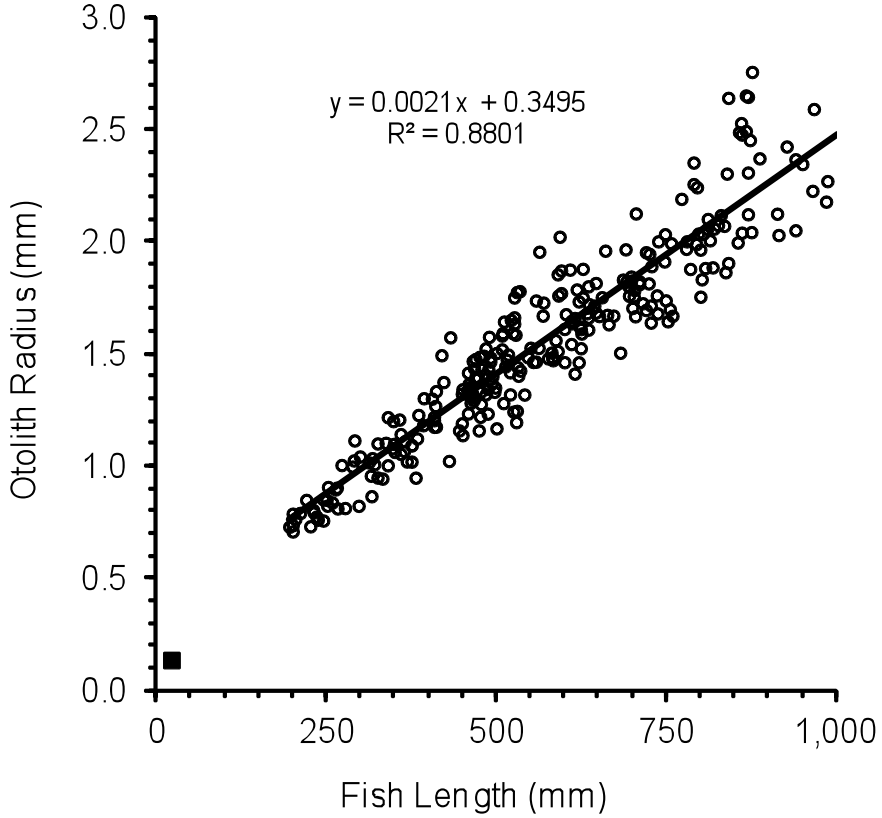


FIGURE 3.1.—Otolith radius as a function of total length for lake trout in Flathead Lake, Montana during pre-1996 (3 December 1986 – 23 August 1995) and 2005 (18 October 2005 – 9 November 2005) sampling periods. A solid square depicts the biological intercept for growth back-calculation.

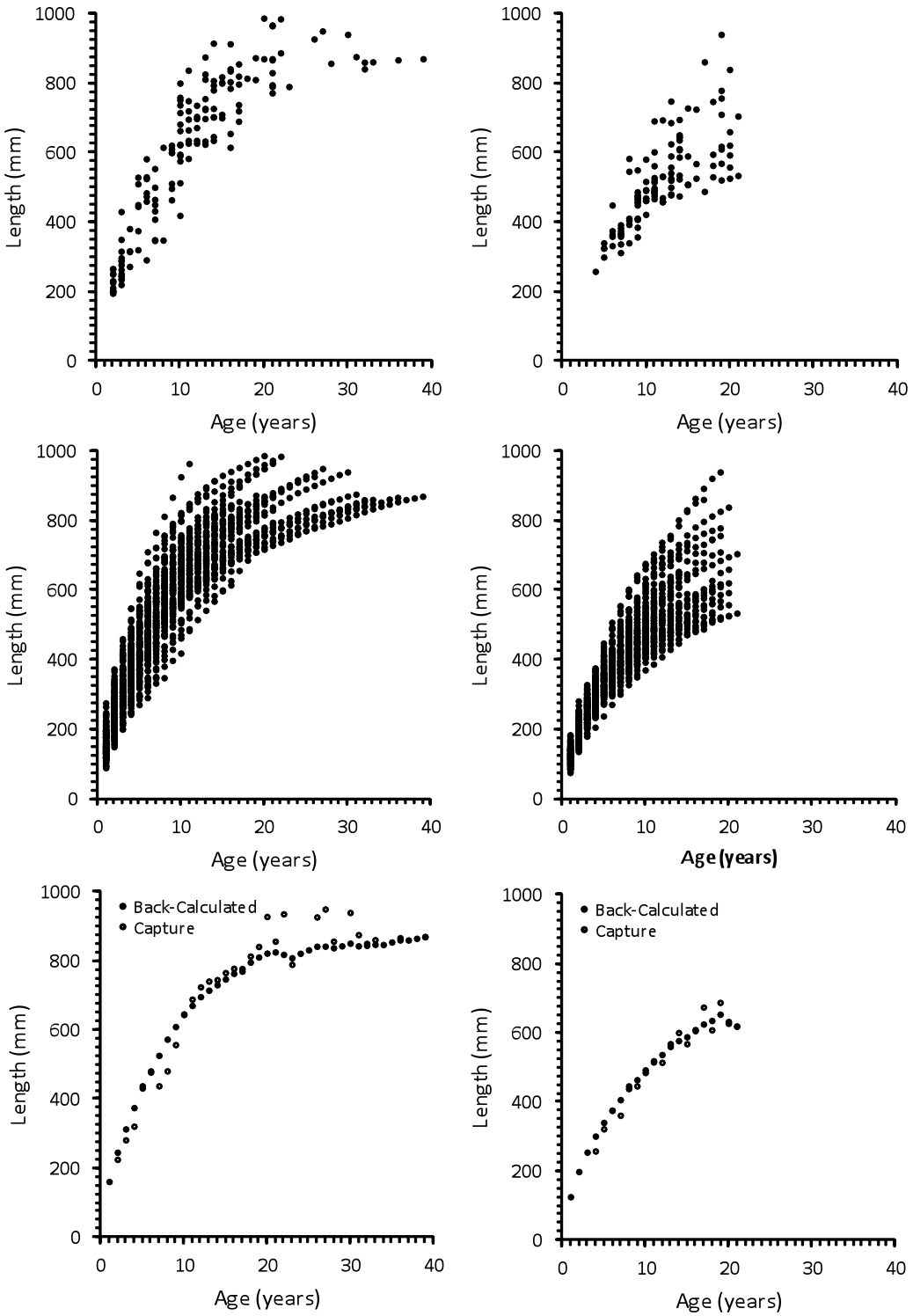


FIGURE 3.2.—Length at age of capture (upper two panels), back-calculated length at age of capture (middle two panels), mean length at age of capture (open dots; lower two panels), and mean back-calculated length at age (black dots; lower two panels) for lake trout in Flathead Lake, Montana during Pre-1996 (left column of panels) and 2005 (right column of panels).

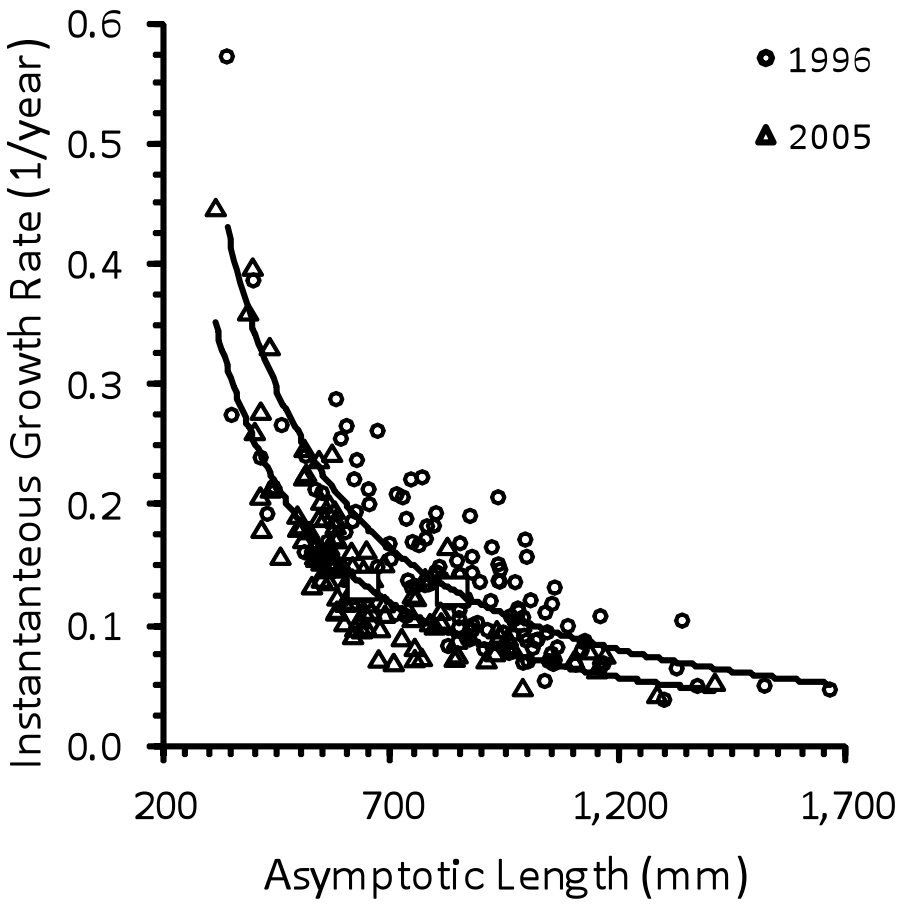


FIGURE 3.3.—Instantaneous growth rate (K) and asymptotic length (L_∞) for von Bertalanffy growth models of individual growth histories for lake trout in Flathead Lake, Montana in pre-1996 (open circles; n = 122) and 2005 (open triangles; n = 113). Curves depict negative power relationships between growth parameters. Open squares depict geometric mean growth parameters, which illustrates an increase in asymptotic length (L_∞) with no change in instantaneous growth rate (K) that infers an increase in the annual growth rate ($\omega = L_\infty \times K$).

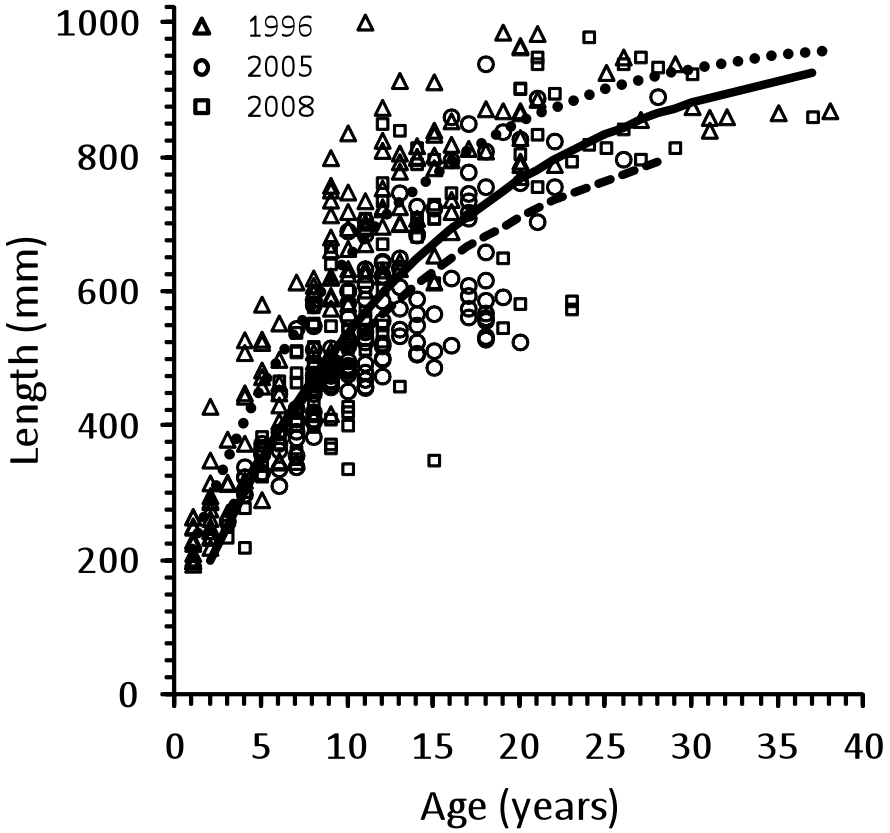


FIGURE 3.4.—Length versus age (symbols) and Von Bertalanffy length-age models (curves) for lake trout in Flathead Lake, Montana, during 3 December 1986 – 23 August 1995 (1996 = triangles and dotted line), 18 October 2005 – 9 November 2005 (2005 = circles and dashed line), and 7 May 2008 – 27 June 2008 and 14 October 2008 – 2 December 2008 (2008 = squares and solid line).

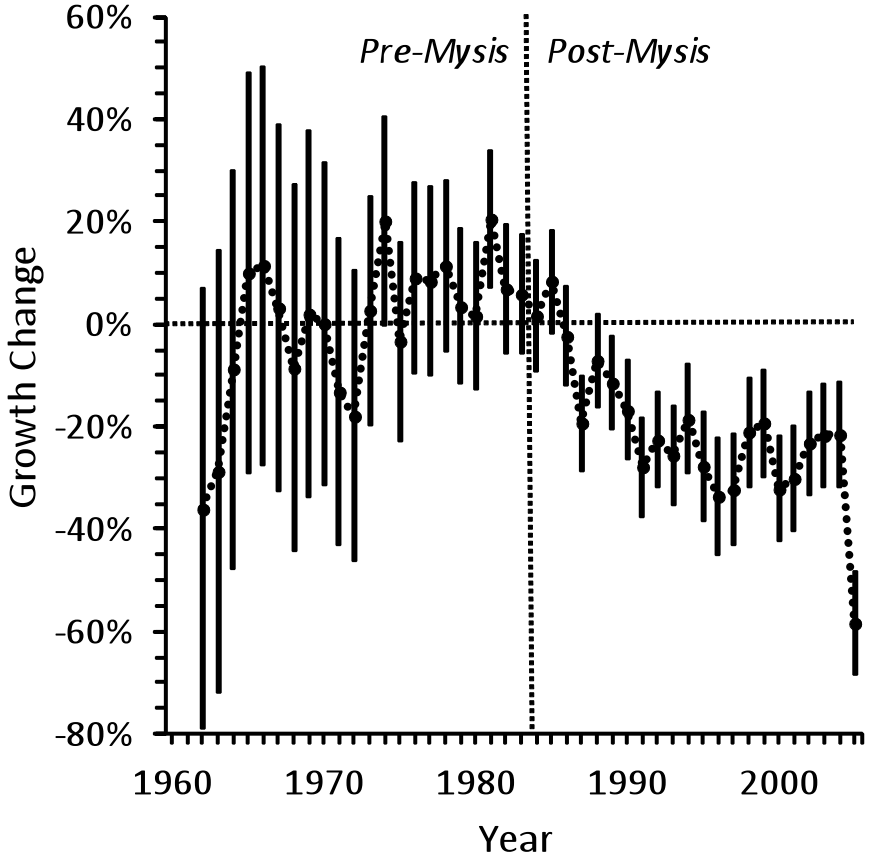


FIGURE 3.5.—Growth index (± 1 standard error) for lake trout in Flathead Lake, Montana, during 1962–2005. The growth index was computed as the least-squares mean from a general linear model with measured growth increment as the dependent variable and growth year and age class as independent variables. Least-square mean growth increment was standardized as a percent deviation from the mean growth increment during 1962–1983, the pre-*Mysis* period, so a negative growth index depicts below-average pre-*Mysis* growth and a positive index depicts above-average pre-*Mysis* growth. Length of error bars is inversely proportional to the number of back-calculated lengths used to estimate the index. Average growth is shown as a solid horizontal dotted line at zero. A vertical dotted line depicts the point after which *Mysis* increased.

Section 4:

Lake Trout Population Modeling in Flathead Lake, Montana

Introduction

The assignment was broadly described in Article II (Scope of Work/Service) of three Contractor Agreements (10–061, 11–079, 12–151, and 13–079) between the Confederated Salish and Kootenai Tribes of the Flathead Nation and Dr. Michael J. Hansen (contractor). In summary, I was tasked to develop a model to simulate effects of fishery management actions to suppress the lake trout population in Flathead Lake. Suppression targets eventually resolved down to 25%, 50%, and 75% reductions in abundance of adult lake trout, defined as age-8-and-older lake trout estimated by mark-recapture to be present in Flathead Lake during 2008–2012 (Section 1). Each level of suppression was also associated with reductions in abundance of lake trout of suitable size (≥ 626 mm; ≥ age 14) to prey on native bull trout, so I also estimated the number of bull trout that would be saved from lake trout predation for each level of population suppression.

Methods

I constructed a stochastic age-structured population model to simulate short-term and long-term effects of a range of management actions on the lake trout population in Flathead Lake (Nieland et al. 2008; Schueller et al. 2008; Hansen et al. 2010). The model assumed an age-specific starting abundance that was derived from length-specific mark-recapture estimates during 2008–2012 (Section 1). Numbers present in each age class were then subjected to fishing mortality that would induce a prescribed reduction (25%, 50%, and 75%) in abundance of adult lake trout, defined as all lake trout age-8 and older. Each age class was subjected to a rate of fishing mortality based on relative vulnerability to angling, as compared to gill-netting (Section 2). Natural mortality was treated as a fixed rate that was estimated indirectly from growth parameters for lake trout in Flathead Lake during 2005–2008 (Section 3). Recruitment of age-0 lake trout was simulated from a stock-recruit model for lake trout in western Lake Superior, scaled down to the smaller size of Flathead Lake. Stochastic variation for short-term simulations was driven by assessment error (i.e., mark-recapture measurement error) and for long-term simulations by stock-recruitment process error and parameter uncertainty. The model did not include implementation error as a source of model uncertainty.

Age-Specific Starting Abundance

Age-specific abundance was estimated from length-specific abundance (Section 1) that was expanded to include lake trout ≥ 30 inches. To account for large lake trout not vulnerable to angling during Mack Days tournaments, I assumed the length frequency of lake trout caught in gillnets during autumn 2008–2010 represented the population of all lake trout ≥ 20 inches (500 mm) in length, particularly those ≥ 30 inches (763 mm) that were not vulnerable to capture by angling. For recapture samples during Fall Mack Days 2008 and 2010 and Spring Mack Days 2010 and 2011, I scaled each length frequency sample to the number of 500–549 mm lake trout caught in autumn gillnetting of the corresponding year. This method enabled recapture samples to include lake trout that were not vulnerable to angling during Mack Days tournaments (i.e., those ≥ 30 inches). This method also accounted for expanded vulnerability of lake trout during Spring Mack Days that were not vulnerable during Fall Mack Days or autumn gill netting, particularly lake trout 14–20 inches (350–500 mm) long.

Each expanded sample length frequency was converted into an expanded sample age frequency using an age-length key derived from samples of 266 lake trout ages used for analysis of growth in 2005 and 2008 (Section 3). The age-length key was constructed by cross-tabulating numbers of lake trout in each age class (column) within each 50-mm length class (row), and then converting counts into proportions of each age class within each 50-mm length class. Population length frequency was then multiplied by proportions within each length class and summed across ages to derive the population age frequency (Figure 4.1). A composite population age frequency was then computed as the mean of all four estimates for lake trout ≥ 500 mm and for the two Spring Mack Days estimates for lake trout < 500 mm (Figure 4.2). The resulting age frequency increased toward a peak at age 4, so numbers of younger ages were estimated from the catch curve for numbers of ages ≥ 4 years (Figure 4.2).

Mortality and Survival

From a starting abundance N_{ij} at age j in year i, the number present $N_{i+1,j+1}$ at the next age j+1 in the next year i+1 was modeled as a function of the total instantaneous mortality rate Z_{ij} for each age class j in year i (Quinn and Deriso 1999; Haddon 2001):

$$N_{i+1,j+1} = N_{ij}e^{-Z_{ij}}$$

The total instantaneous mortality rate Z_{ij} for each age, j, and year, i, was the sum of instantaneous natural mortality (M = assumed constant across all ages and years) and instantaneous fishing mortality (F_{ij}) for each age, j, in year, i:

$$Z_{ij} = F_{ij} + M$$

Instantaneous natural mortality (M = 0.1544) was estimated from Pauly's equation (Quinn and Deriso 1999) using parameters of the Von Bertalanffy length-age model for pre-1996 samples (Section 3) and average monthly air temperature in Flathead Lake (T = 6.4°C). Using pre-1996 samples for estimating natural mortality is conservative by assuming a somatic growth rate that is consistent with low population density.

Total instantaneous fishing mortality F_{ij} for each age j in year i was simulated from the relative selectivity S_j of the gear for lake trout of age j and the fully selected fishing mortality rate F_i that was specified as a model input for each year i:

$$F_{ij} = S_j F_i$$

Fully selected fishing mortality F_i was specified as a model input for each simulation to cover a range of fishing mortality rates F_i = 0.0 – 1.0. Each value of fully selected fishing mortality was simulated for each capture method (gillnetting, trap netting, and angling) in the absence of other capture methods, to evaluate the independent effect of each capture method on population sustainability metrics. In addition, sustainability of the specific allocation of fishing mortality observed during 2006 was simulated.

Age-specific selectivity, $s_j = C_j/N_j$, was estimated for angling during Spring Mack Days and Fall Mack Days from age-specific catches C_j and abundances N_j at age j in Flathead Lake (described above). Length-frequencies of angling harvest during Spring Mack Days and Fall Mack Days were converted to age frequencies using the age-length key described above. Next, relative selectivity, $S_j = s_j/\max(s_j)$, was estimated for Spring Mack Days and Fall Mack Days by dividing age-specific selectivity by the maximum age-specific selectivity (Figure 4.3). To

simulate added mortality by trap netting, fully selected fishing mortality was increased for angling, because angling and trap netting for lake trout have similar-shaped selectivity curves beyond the age of full vulnerability to harvest (Hansen et al. 2010).

Recruitment

The number of age-0 lake trout $N_{i+1,\,j=0}$ that recruited to the population in each year $i + 1$ was predicted from the number of adult lake trout $N_{i,j=8+}$ that spawned in the previous year i using a Ricker stock-recruitment model (Ricker 1975):

$$N_{i+1,\,j=0} = \alpha\left(N_{i,\,j=adult}\right)\left(e^{-\beta N_{i,\,j=adult}}\right)\varepsilon$$

In the stock-recruit model, α = recruits per adult at low adult density, β = the instantaneous rate at which recruits/adult declines with adult density, and ε = multiplicative process error. For the stock-recruit curve, adult lake trout were defined as age-8-and-older based on a maturity curve described below. Model parameters (α, β and ε) were derived from estimates for the lake trout population in eastern Lake Superior during 1980–2001 (Nieland et al. 2008). First, I assumed that the maximum annual reproductive rate α (Myers et al. 1999) and recruitment variability ε are relatively constant within species (Myers 2002). Therefore, I used the same reproductive rate (α = 7.469 recruits/adult) and recruitment variation (ε = 0.3166) for the lake trout population in Flathead Lake that was estimated for the lake trout population in eastern Lake Superior (Nieland et al. 2008). Next, I scaled the estimated number of age-0 lake trout in the model downward using the ratio of estimated numbers of age-4-and-older lake trout in Flathead Lake and eastern Lake Superior (ratio = 0.356645727). Last, to account for parameter uncertainty, parameters of the stock-recruit model were randomly selected from 1,000 parameter sets generated by Markov Chain Monte Carlo simulation from parameters estimated for Lake Superior (Figures 4.4–4.5).

Maturity of lake trout for determining fish to be included as adults in the stock-recruit model was estimated as a logistic function of length, where the proportion of mature fish in each 25-mm length class M_l was related to each length class l:

$$M_l = \frac{1}{1 + e^{-r(l - l_m)}} + \varepsilon_j$$

In the model, M_l = the proportion of mature fish in each length class l, r = the instantaneous rate at which the proportion of adult fish in each length class l approach maturity, l_m = the length at which 50% of the fish were adult, and ε_j = additive process error (Quinn and Deriso 1999). Parameters of the model were estimated with nonlinear least-squares methods, and length at 50% maturity was converted to age at 50% maturity using the growth model for pre-1996 samples (Section 3). Male lake trout matured at a smaller size (491 mm) and younger age (6.8 years) than female lake trout (547 mm and 8.1 years), both of which are typical for the species in other North American populations (Figure 4.6; Healey 1978; Martin and Olver 1980). Therefore, I defined adults as the sum of simulated numbers of age-8-and-older lake trout. This treatment of age at maturity leads to conservative simulation results, because the simulated lake trout population was given greater compensation (younger age at maturity) than is characteristic of high population density, such as in 2005 (males = 9.1 years; females = 11.2 years) or 2008 (males = 8.6 years; females = 10.3 years).

Simulation Metrics

Outputs of proposed lake trout population reduction scenarios included simulated abundance of age classes 1–30 of lake trout, the likelihood of population collapse, and the number of years to population collapse. For short-term simulations, abundance was simulated 1,000 times for year 5, whereas for long-term simulations, abundance was simulated 1,000 times for the average of years 51–200 to reflect the equilibrium effect of each fishing mortality rate. Suppression scenarios were developed by gradually adjusting fully-selected fishing mortality until age-8-and-older lake trout abundance was reduced 25%, 50%, and 75% (Suppression scenarios) from the baseline abundance associated with no change in fishing mortality (Status Quo scenario). Reduced fishing mortality was also simulated for the elimination of all Mack Days tournaments (No Mack Days scenario) and for the elimination of all fishing mortality (No Fishing scenario). Harvest would change in response to abundance for any level of fishing mortality, so harvest associated with each scenario was specified for the start of each simulation. Uncertainty of simulated abundance was quantified as the 2.5 and 97.5 percentiles of average abundance among 1,000 simulations. Population collapse was defined as a 90% decline in abundance of age-8-and-older lake trout. The likelihood of population collapse was quantified as the frequency of a 90% decline in abundance among 1,000 simulations. The number of years to collapse was quantified as the median number of years when population abundance declined to $\leq$10% of present abundance, with 95% confidence intervals defined as for years to collapse.

For each simulated level of lake trout abundance ($\pm$ 95% confidence limits), I estimated bull trout consumption by lake trout from a bioenergetics analysis of predator-prey dynamics in Flathead Lake (Beauchamp and Schoen 2012). First, I developed a simple model that describes the number of bull trout consumed (BT) as a function of the number of suitably sized lake trout ($LT \geq 626$ mm; $\geq$age-14) present ($BT = 0.837738 \times LT^{0.980373}$; $R^2 = 100\%$). Second, I used the model to predict the number of bull trout consumed by the simulated number of lake trout present for each management scenario (described above). Third, I converted the number of bull trout consumed into the biomass (MT = million grams) of 90-gram bull trout consumed (biomass consumed = number of individuals × 90 grams/individual). Fourth, I computed the percentage reduction in bull trout biomass consumed in relation to current consumption, which was nearly the same as consumption for the No Fishing scenario. Last, I estimated an expected increase in bull trout abundance associated with each scenario as percent reduction in bull trout consumed × 5,000 bull trout, the population decline that was associated with lake trout predation when lake trout increased in abundance. The resulting estimate provides a relative measure of increase in bull trout abundance that can be expected from a prescribed level of lake trout suppression.

Results

Within 5 years, total lake trout abundance would change little if subjected to lower levels of fishing mortality, though abundance would increase proportionally more for older ages than for younger ages of lake trout in Flathead Lake (Table 4.1). If fishing ceased, abundance would increase only 6% for age-1+ lake trout, 22% for age-4+ lake trout, 46% for age-8+ lake trout, 56% for age-14+ lake trout, and 18% for age-22+ lake trout. If Spring and Fall Mack Days were ceased, abundance would decrease 1% for age-1+ lake trout, and increase 7% for age-4+ lake trout, 16% for age-8+ lake trout, 19% for age-14+ lake trout, and 4% for age-22+ lake trout. If current fishing rates are sustained without change, starting abundance would decrease 4% for age-1+ lake trout, increase 5% for age-4+ lake trout, decrease 5% for age-8+ lake trout, decrease 17% for age-14+ lake trout, and increase 20% for age-22+ lake trout.

Over the long term, similar to short-term simulations, total lake trout abundance would change little if subjected to lower levels of fishing mortality, whereas abundance would increase greatly for older ages of lake trout in Flathead Lake (Table 4.2; Figure 4.7). If fishing ceased, abundance would increase 6% for age-1+ lake trout, 22% for age-4+ lake trout, 67% for age-8+ lake trout, 193% for age-14+ lake trout, and 334% for age-22+ lake trout. If Spring and Fall Mack Days were ceased, abundance would increase 5% for age-1+ lake trout, 12% for age-4+ lake trout, 29% for age-8+ lake trout, 61% for age-14+ lake trout, and 84% for age-22+ lake trout. If current fishing rates are sustained without change, starting abundance would increase 6% for age-1+ lake trout and 8% for age-4+ lake trout, but would decrease 9% for age-8+ lake trout, 43% for age-14+ lake trout, and 50% for age-22+ lake trout.

Within 5 years, total lake trout abundance would change much less than older age classes of lake trout at increased rates of fishing mortality in Flathead Lake (Table 4.3). At a fishing mortality rate that would suppress age-8+ abundance 25% over the long-term, abundance would decline 3% for age-1+ lake trout, 9% for age-4+ lake trout, 16% for age-8+ lake trout, 20% for age-14+ lake trout, and 9% for age-22+ lake trout. At a fishing mortality rate that would suppress age-8+ abundance 50% over the long-term, abundance would decline 8% for age-1+ lake trout, 15% for age-4+ lake trout, 33% for age-8+ lake trout, 37% for age-14+ lake trout, and 19% for age-22+ lake trout. At a fishing mortality rate that would suppress age-8+ abundance 75% over the long-term, abundance would decline 14% for age-1+ lake trout, 25% for age-4+ lake trout, 45% for age-8+ lake trout, 50% for age-14+ lake trout, and 25% for age-22+ lake trout.

Over the long term, similar to short-term simulations, total lake trout abundance would change much less than older age classes of lake trout at increased rates of fishing mortality in Flathead Lake (Table 4.4; Figure 4.8). At a fishing mortality rate that would suppress age-8+ abundance 25% over the long-term, abundance would decline 9% for age-1+ lake trout, 13% for age-4+ lake trout, 45% for age-14+ lake trout, and 56% for age-22+ lake trout. At a fishing mortality rate that would suppress age-8+ abundance 50% over the long-term, abundance would decline only 25% for age-1+ lake trout, 32% for age-4+ lake trout, 74% for age-14+ lake trout, and 85% for age-22+ lake trout. At a fishing mortality rate that would suppress age-8+ abundance 75% over the long-term, abundance would decline 50% for age-1+ lake trout, 57% for age-4+ lake trout, 91% for age-14+ lake trout, and 96% for age-22+ lake trout.

Lake trout suppression would likely lead to increased bull trout abundance even if fishing mortality is sustained at current levels, with greater increases in bull trout abundance at higher levels of fishing mortality on lake trout in Flathead Lake (Table 4.5). Consumption of bull trout by lake trout would decline 94%, from 72,565 (6.53 MT) to 4,349 (0.39 MT), as numbers of suitably sized (age-14+; $\geq$ 626 mm) lake trout are suppressed from 108,761 with only annual angling harvest (i.e. No Mack Days) to 6,101 under a fishing mortality rate that would suppress age-8+ lake trout by 75%. In response, abundance of bull trout would increase up to 4,700 in comparison to current abundance.

Discussion

Short-term effects of each management scenario were characterized by much greater uncertainty and much lower levels of change than long-term effects because simulated numbers of each age class in one particular year, only 5 years into the future, are more difficult to predict with certainty than average abundance 51–200 years into the future. Uncertainty of short-term

simulations was driven by assessment error (i.e., estimation error of mark-recapture abundance estimates), whereas uncertainty of long-term simulations was driven by process error and parameter uncertainty of the stock-recruit relationship (Nieland et al. 2008). Further, averaging age-specific abundance over many years reduces uncertainty of long-term simulations, when compared to predicted abundance in a single year. In balance, short-term simulations reflect a momentary snapshot of a lake trout population that is moving toward an equilibrium status reflected by long-term simulations. I did not attempt to incorporate implementation error that is associated with inability to enact a target fishing mortality rate and adds another layer of model uncertainty (Nieland et al. 2008).

Short-term and long-term simulations have been useful for judging sustainability of lake trout populations in relation to empirical comparisons with existing populations. Simulated adult lake trout abundance in Flathead Lake declined 90% within 26 years (15–43 years) at a 43% total annual mortality rate (scenario not shown), like other studies of lake trout populations in North America. For example, short-term simulations of the lake trout population in Lake Pend Oreille, Idaho, suggested that incentivized angling and netting could exert enough mortality (> 50%) to collapse the population while simultaneously reducing predation mortality enough to preserve the Kokanee population (Hansen et al. 2010). Similarly, long-term simulations of the lake trout population in Western Lake Superior suggested that the population could sustain a total annual mortality rate no higher than 40% (Nieland et al. 2008), which was lower than the maximum sustainable rate of 50% that was predicted by meta-analysis of native populations in North America (Healey 1978) or the range of total annual mortality for a wide range of populations in North America (A = 50–70%; Martin and Olver 1980).

Lake trout suppression would reduce predation on juvenile bull trout, and ultimately, would lead to higher abundance of adult bull trout in Flathead Lake, as indicated by predator-prey bioenergetics modeling (Beauchamp and Schoen 2012). Reductions in bull trout predation would be relatively higher than reductions in adult lake trout because predation was limited to larger (≥ 626 mm), older (≥ age 14) lake trout than the adults targeted for reduction (≥ age 8; ≥ 460 mm). This indicates that any targeted level of suppression of the adult lake trout population would deliver a much higher level of reduction in predation losses of bull trout. However, bull trout responses to lake trout suppression may be different if the primary interaction between bull trout and lake trout is competition, rather than predation, as was recently suggested by another modeling approach (Ferguson et al. 2012). Large experimental manipulations of lake trout population density would enable mechanisms between lake trout and bull trout to be identified, as has been suggested by co-managers of the fishery in Flathead Lake.

TABLE 4.1.—Short-term (year 5) simulated abundance (± 95% confidence limits = LL – UL) and percent change in abundance from the Status Quo for a lake trout population subjected to no fishing mortality (No Fishing), angling without Mack Days derbies (No Mack Days), and angling with Mack Days derbies (Status Quo) for all lake trout age-1-and-older (N_{1+}), age-4-and-older (N_{4+}), age-8-and-older (adults = N_{8+}), age-14-and-older (bull trout predators = N_{14+}), and age-22-and-older (protected by a slot-length limit = N_{22+}) in Flathead Lake, Montana.

	No Fishing			No Mack Days			Status Quo		
Metric	Estimate	LL	UL	Estimate	LL	UL	Estimate	LL	UL
Mortality	14%			21%			24%		
Effort	0			0.6			1		
Initial Quota	0			29,040			56,771		
Harvest	0	0	0	33,789	19,809	53,067	48,946	28,457	76,246
N_{1+}	1,478,397	691,674	3,679,455	1,319,575	609,878	3,638,416	1,335,969	593,369	3,072,931
% Change	6%	–48%	175%	–1%	–54%	172%	0%	–56%	130%
N_{4+}	960,519	558,239	1,613,723	842,754	467,589	1,444,816	787,747	440,667	1,335,353
% Change	22%	–29%	105%	7%	–41%	83%	0%	–44%	70%
N_{8+}	473,937	297,564	667,322	375,879	232,231	521,975	325,220	199,280	459,656
% Change	46%	–9%	105%	16%	–29%	60%	0%	–39%	41%
N_{14+}	154,069	96,716	215,584	117,247	72,494	164,066	98,579	59,135	135,872
% Change	56%	–2%	119%	19%	–26%	66%	0%	–40%	38%
N_{22+}	30,243	18,700	42,301	26,735	17,375	36,953	25,601	15,514	35,211
% Change	18%	–27%	65%	4%	–32%	44%	0%	–39%	38%
Collapse %	0%			0%			0%		
Years	200	200	200	200	200	200	200	200	200

TABLE 4.2.—Long-term (years 51–200) simulated abundance (± 95% confidence limits = LL – UL) and percent change in abundance from the Status Quo for a lake trout population subjected to no fishing mortality (No Fishing), angling without Mack Days derbies (No Mack Days), and angling with Mack Days derbies (Status Quo) for all lake trout age-1-and-older (N_{1+}), age-4-and-older (N_{4+}), age-8-and-older (adults = N_{8+}), age-14-and-older (bull trout predators = N_{14+}), and age-22-and-older (protected by a slot-length limit = N_{22+}) in Flathead Lake, Montana.

	No Fishing			No Mack Days			Status Quo		
Metric	Estimate	LL	UL	Estimate	LL	UL	Estimate	LL	UL
Mortality	14%			21%			24%		
Effort	0			0.6			1		
Initial Quota	0			29,040			56,771		
Harvest	0	0	0	36,927	33,710	40,780	50,416	45,747	55,635
N_{1+}	1,571,860	1,434,141	1,746,113	1,549,263	1,414,472	1,708,821	1,480,274	1,343,150	1,633,349
% Change	6%	–3%	18%	5%	–4%	15%	0%	–9%	10%
N_{4+}	983,114	897,007	1,093,265	902,710	824,795	996,869	809,074	734,034	892,208
% Change	22%	11%	35%	12%	2%	23%	0%	–9%	10%
N_{8+}	523,261	477,339	581,544	405,116	369,545	447,351	312,890	283,660	345,892
% Change	67%	53%	86%	29%	18%	43%	0%	–9%	11%
N_{14+}	197,613	179,951	219,972	108,761	99,178	119,778	67,348	61,046	74,460
% Change	193%	167%	227%	61%	47%	78%	0%	–9%	11%
N_{22+}	46,507	42,334	51,751	19,719	17,998	21,784	10,708	9,722	11,837
% Change	334%	295%	383%	84%	68%	103%	0%	–9%	11%
Collapse %	0%			0%			0%		
Years	200	200	200	200	200	200	200	200	200

TABLE 4.3.—Short-term (year 5) simulated abundance (± 95% confidence limits = LL – UL) and percent change in abundance from the Status Quo for a lake trout population subjected to no fishing mortality (No Fishing), angling without Mack Days derbies (No Mack Days), and angling with Mack Days derbies (Status Quo) for all lake trout age-1-and-older (N_{1+}), age-4-and-older (N_{4+}), age-8-and-older (adults = N_{8+}), age-14-and-older (bull trout predators = N_{14+}), and age-22-and-older (protected by a slot-length limit = N_{22+}) in Flathead Lake, Montana.

	25% Suppression			50% Suppression			75% Suppression		
Metric	Estimate	LL	UL	Estimate	LL	UL	Estimate	LL	UL
Mortality	29%			33%			38%		
Effort	1.5			2.1			2.7		
Initial Quota	83,459			112,670			142,466		
Harvest	63,823	35,910	104,738	76,210	43,711	125,004	85,191	49,261	130,487
N_{1+}	1,293,545	567,929	3,221,596	1,229,241	570,484	3,057,798	1,151,049	526,543	2,508,318
% Change	–3%	–57%	141%	–8%	–57%	129%	–14%	–61%	88%
N_{4+}	717,219	386,308	1,312,613	666,397	356,577	1,230,184	590,048	324,515	970,565
% Change	–9%	–51%	67%	–15%	–55%	56%	–25%	–59%	23%
N_{8+}	271,702	158,969	385,250	219,425	137,907	305,358	177,642	110,213	246,673
% Change	–16%	–51%	18%	–33%	–58%	–6%	–45%	–66%	–24%
N_{14+}	79,211	46,707	111,099	61,830	38,850	87,471	49,225	31,036	67,529
% Change	–20%	–53%	13%	–37%	–61%	–11%	–50%	–69%	–31%
N_{22+}	23,195	13,438	32,420	20,864	13,385	28,929	19,319	12,415	26,516
% Change	–9%	–48%	27%	–19%	–48%	13%	–25%	–52%	4%
Collapse %	0%			0%			95%		
Years	200	200	200	200	200	200	78	29	200

TABLE 4.4.— Long-term (years 51–200) simulated abundance (± 95% confidence limits = LL – UL) and percent change in abundance from the Status Quo for a lake trout population subjected to no fishing mortality (No Fishing), angling without Mack Days derbies (No Mack Days), and angling with Mack Days derbies (Status Quo) for all lake trout age-1-and-older (N_{1+}), age-4-and-older (N_{4+}), age-8-and-older (adults = N_{8+}), age-14-and-older (bull trout predators = N_{14+}), and age-22-and-older (protected by a slot-length limit = N_{22+}) in Flathead Lake, Montana.

	25% Suppression			50% Suppression			75% Suppression		
Metric	Estimate	LL	UL	Estimate	LL	UL	Estimate	LL	UL
Mortality	29%			33%			38%		
Effort	1.5			2.1			2.7		
Initial Quota	83,459			112,670			142,466		
Harvest	62,049	55,514	69,087	63,806	54,978	73,240	49,522	38,837	60,819
N_{1+}	1,350,493	1,208,832	1,503,268	1,117,149	962,051	1,281,668	742,192	581,550	910,852
% Change	–9%	–18%	2%	–25%	–35%	–13%	–50%	–61%	–38%
N_{4+}	700,007	626,265	778,961	551,937	474,385	633,007	349,727	274,645	429,312
% Change	–13%	–23%	–4%	–32%	–41%	–22%	–57%	–66%	–47%
N_{8+}	232,176	208,183	258,733	155,553	134,076	178,625	83,249	65,275	102,227
% Change	–26%	–33%	–17%	–50%	–57%	–43%	–73%	–79%	–67%
N_{14+}	36,763	32,911	41,008	17,186	14,935	19,653	6,161	4,866	7,609
% Change	–45%	–51%	–39%	–74%	–78%	–71%	–91%	–93%	–89%
N_{22+}	4,670	4,174	5,213	1,659	1,432	1,908	421	329	520
% Change	–56%	–61%	–51%	–85%	–87%	–82%	–96%	–97%	–95%
Collapse %	0%			0%			95%		
Years	200	200	200	200	200	200	78	29	200

TABLE 4.5.—Estimated number (N) of lake trout (LL – UL = 95% confidence limits), bull trout consumed (Number; Biomass = metric tons), percentage change in consumption (% Change), and potential increase in bull trout abundance (Bull Trout Increase) for four proposed levels of lake trout suppression in Flathead Lake, Montana. Percentage reductions in bull trout consumption are referenced against the No Mack Days scenario.

Metric	Value	No Mack Days	Status Quo	25% Suppression	50% suppression	75% suppression
Lake Trout (≥ 626 mm)	Number	108,761	67,348	36,763	17,186	6,161
	LL	99,178	61,046	32,911	14,935	4,866
	UL	119,778	74,460	41,008	19,653	7,609
Bull Trout Consumed	Number	72,565	45,359	25,056	11,889	4,349
	LL	66,291	41,194	22,480	10,361	3,451
	UL	79,765	50,050	27,889	13,560	5,349
Bull Trout Consumed	Biomass	6.53	4.08	2.26	1.07	0.39
	LL	5.97	3.71	2.02	0.93	0.31
	UL	7.18	4.50	2.51	1.22	0.48
% Change	%	0%	-37%	-65%	-84%	-94%
	LL	-9%	-43%	-69%	-86%	-95%
	UL	10%	-31%	-62%	-81%	-93%
Bull Trout Increase	Number	0	1,875	3,274	4,181	4,700
	LL	-496	1,551	3,078	4,066	4,631
	UL	432	2,162	3,451	4,286	4,762

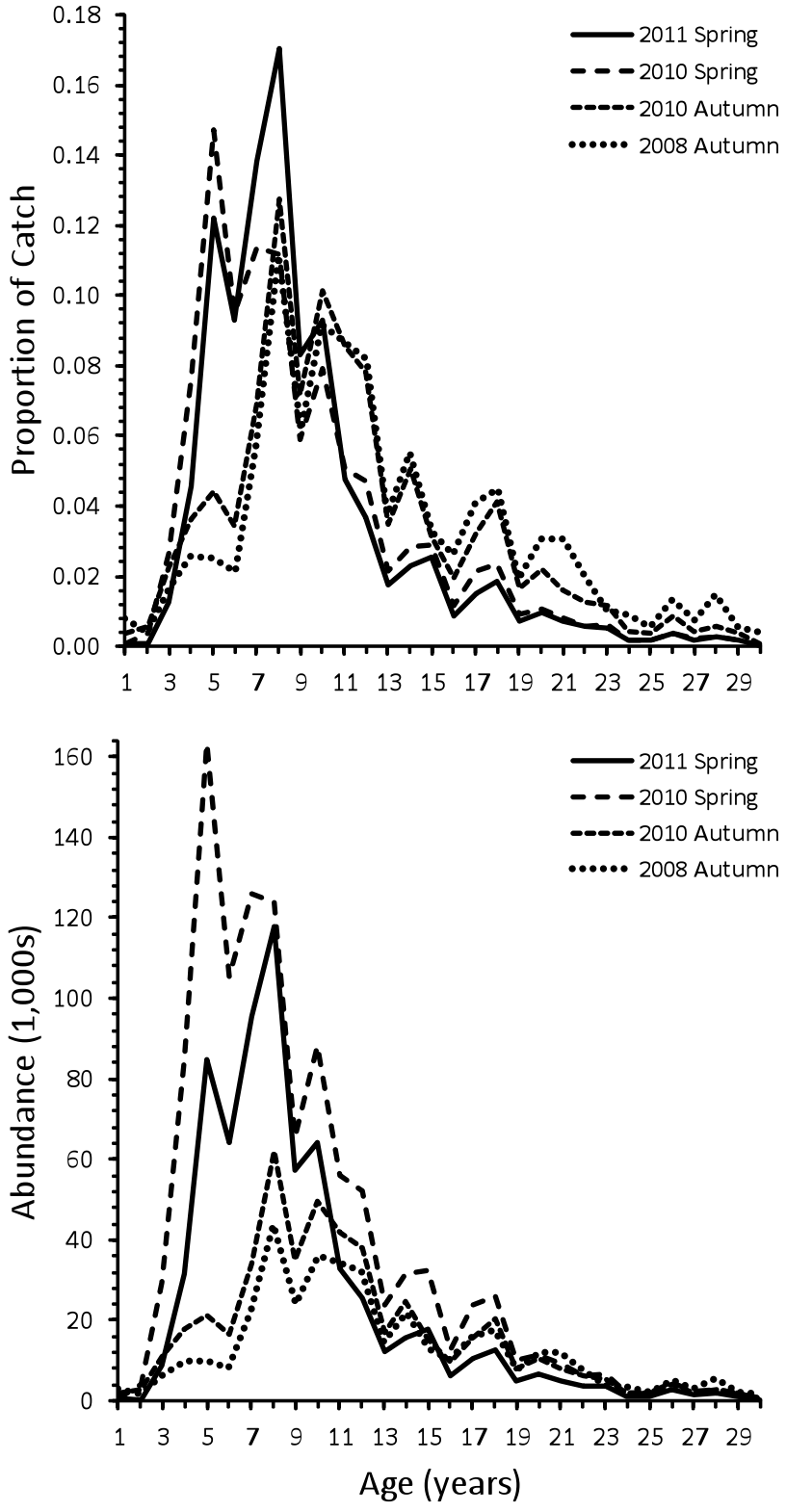

Proportion of Catch
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2011 Spring
2010 Spring
2010 Autumn
2008 Autumn
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
Abundance (1,000s)
160
140
120
100
80
60
40
20
0
2011 Spring
2010 Spring
2010 Autumn
2008 Autumn
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
Age (years)

FIGURE 4.1.—Age-frequency of lake trout captured by angling during Fall Mack Days, 2008 and 2010, and Spring Mack Days, 2010 and 2011, (upper panel), and scaled to the number in the population estimated by mark-recapture (lower panel) in Flathead Lake, Montana.

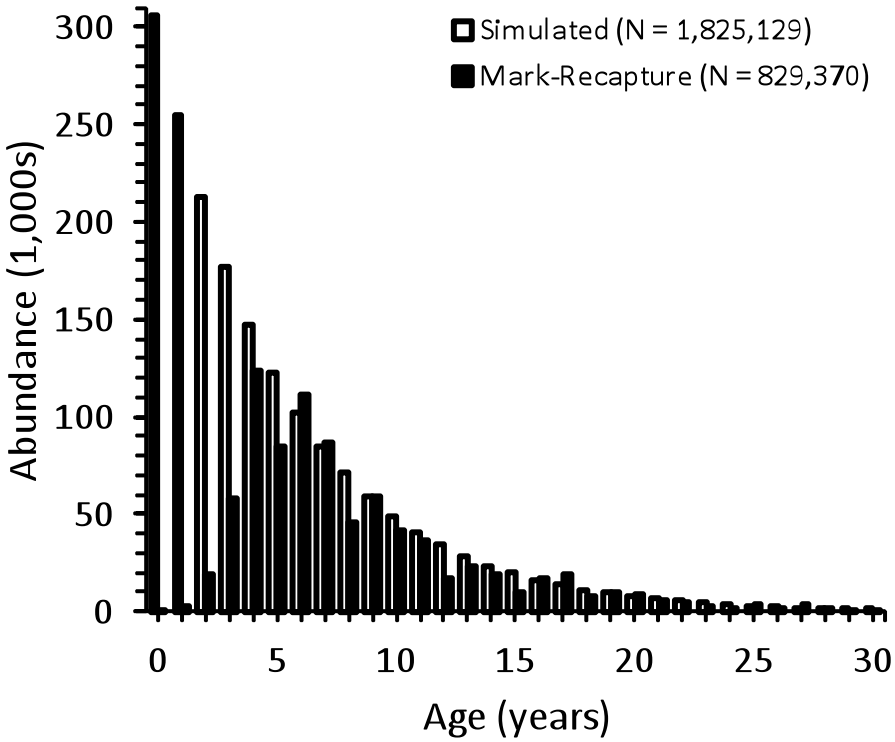


FIGURE 4.2.—Number of lake trout in each age class estimated to be present based on gillnetting and angling in Flathead Lake, Montana during spring 2008–2011.

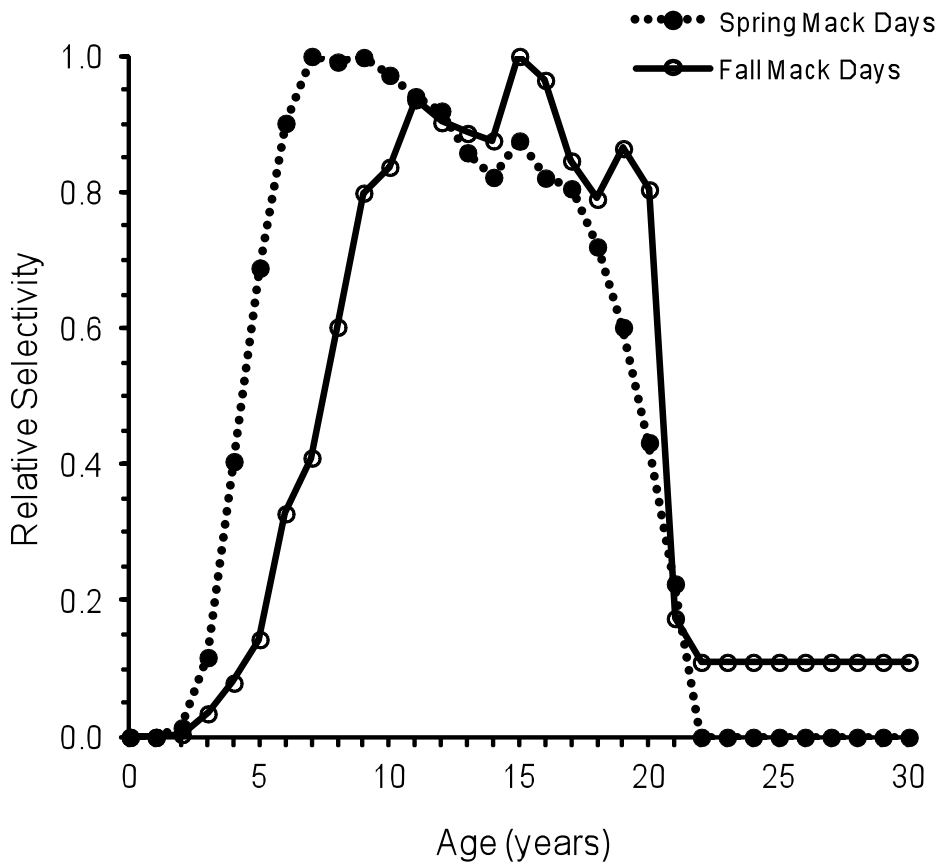


FIGURE 4.3.—Relative selectivity of angling for lake trout during Spring Mack Days and Fall Mack Days in Flathead Lake, Montana.

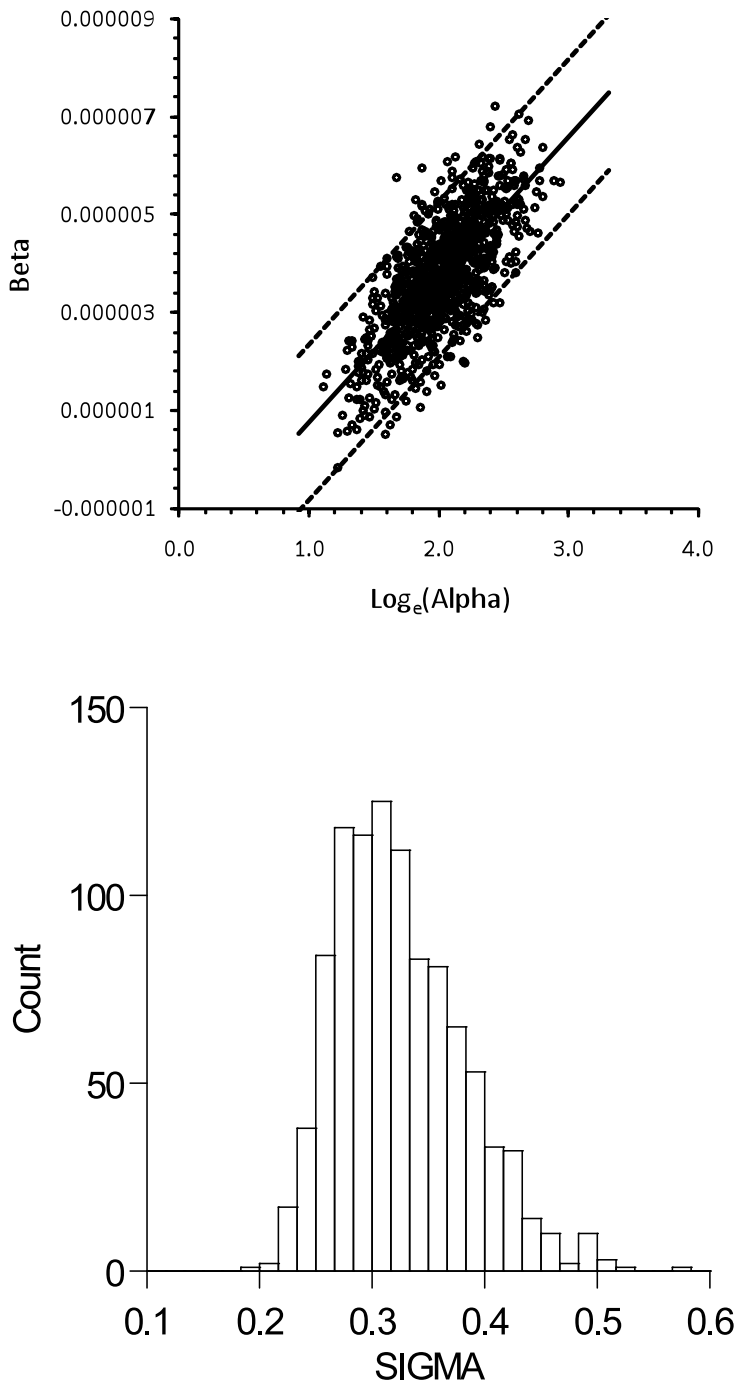


FIGURE 4.4.—Parameters of the Ricker stock-recruit model used to simulate parameter uncertainty (α = alpha and β = beta) and recruitment process error (ε = sigma) when simulating lake trout abundance in Flathead Lake, Montana. Alpha and sigma were randomly selected from their respective distributions and beta was selected from the linear relationship between $\log_e$(alpha) and beta (with error) for each simulation year based on the distribution of 1,000 parameter sets generated by Markov Chain Monte Carlo simulation from parameters estimated for Lake Superior (Nielend et al. 2008).

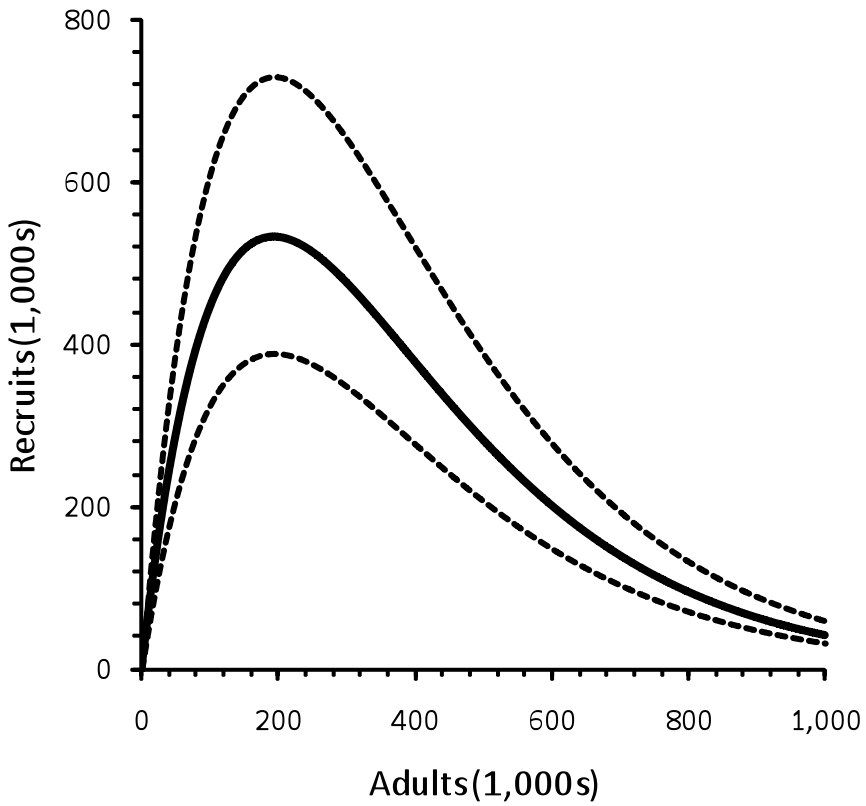


FIGURE 4.5.—Average Ricker stock-recruit model used to simulate lake trout abundance in Flathead Lake, Montana. The model is based on median values of α, β, and ε from Figure 4.4.

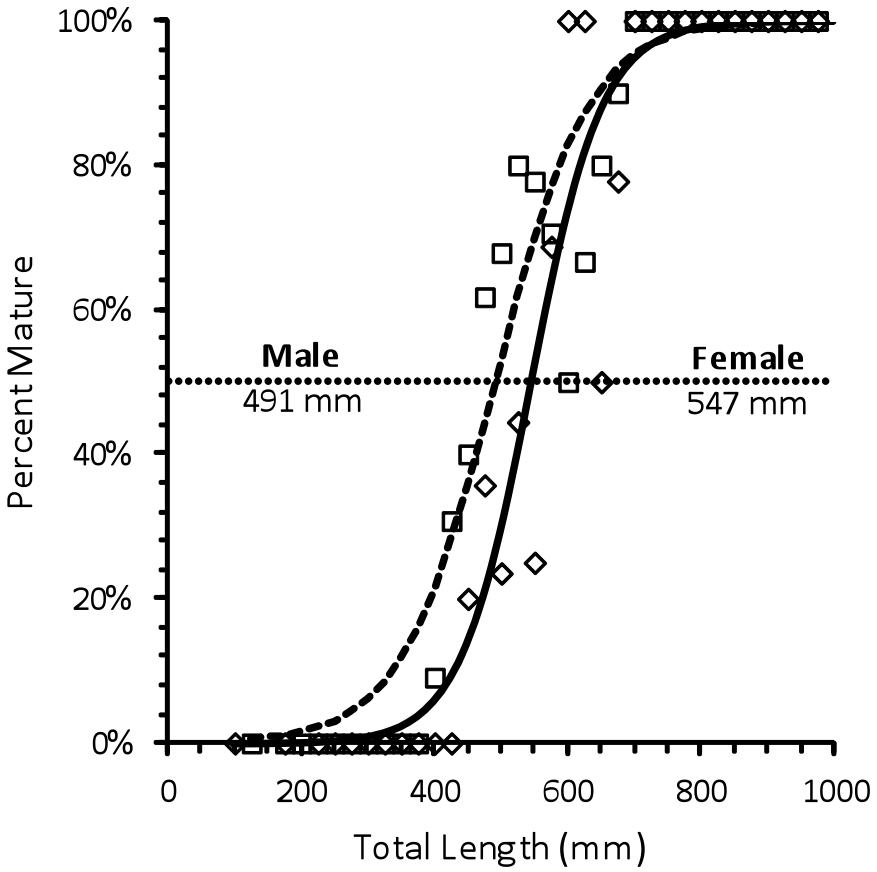


FIGURE 4.6.—Percent mature as a function of total length for male (squares and dashed line) and female (diamonds and solid line) lake trout caught in standardized gillnets in Flathead Lake, Montana. The horizontal line depicts length at 50% mature for male and female lake trout.

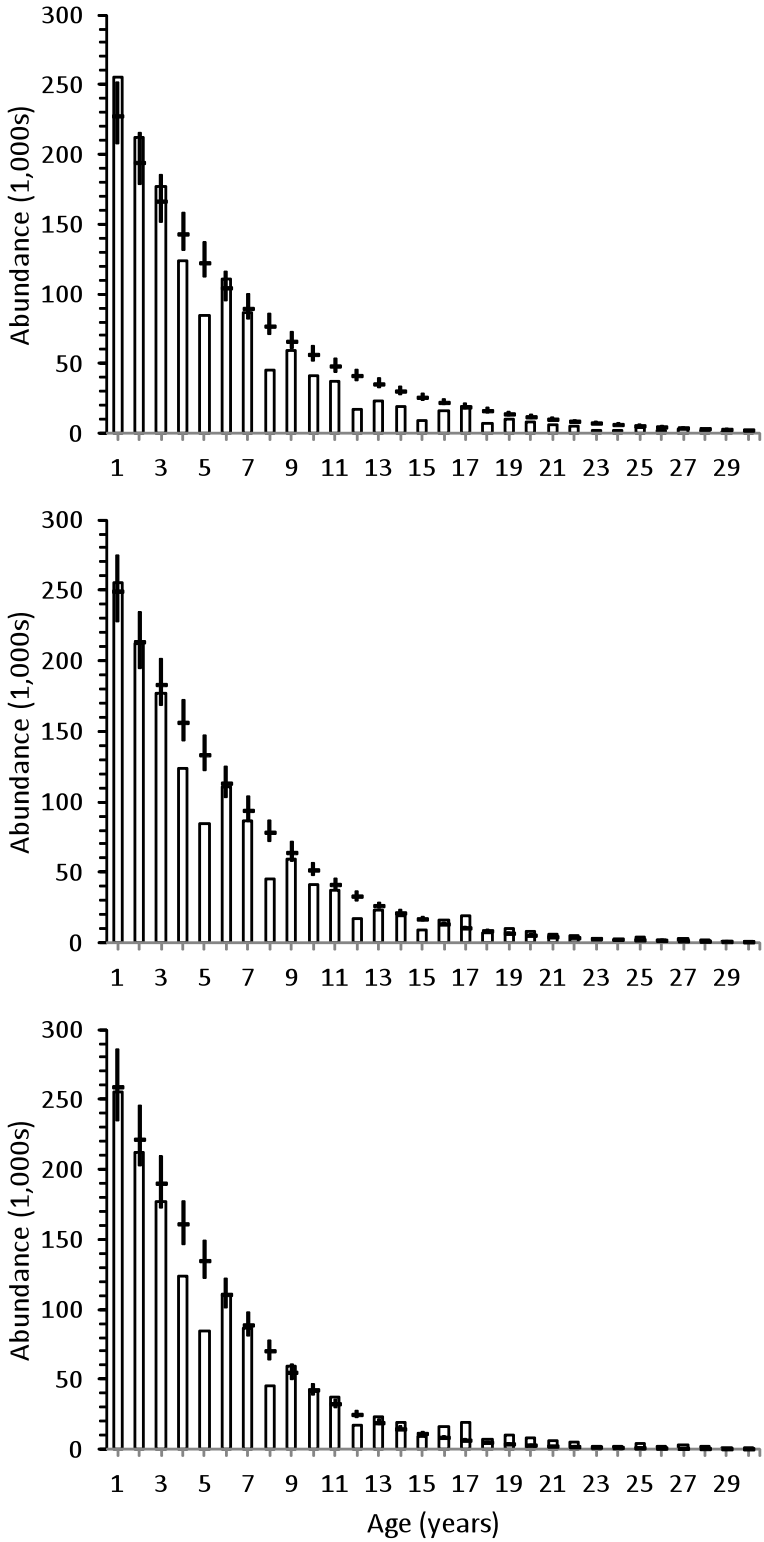


FIGURE 4.7.—Long-term (years 51–200) simulated abundance (± 95% confidence limits = error bars) in relation to starting abundance (open bars) of a lake trout population subjected to no

fishing (upper panel), no Mack Days tournaments (middle panel), and continued angling at present-day levels (lower panel) in Flathead Lake, Montana.

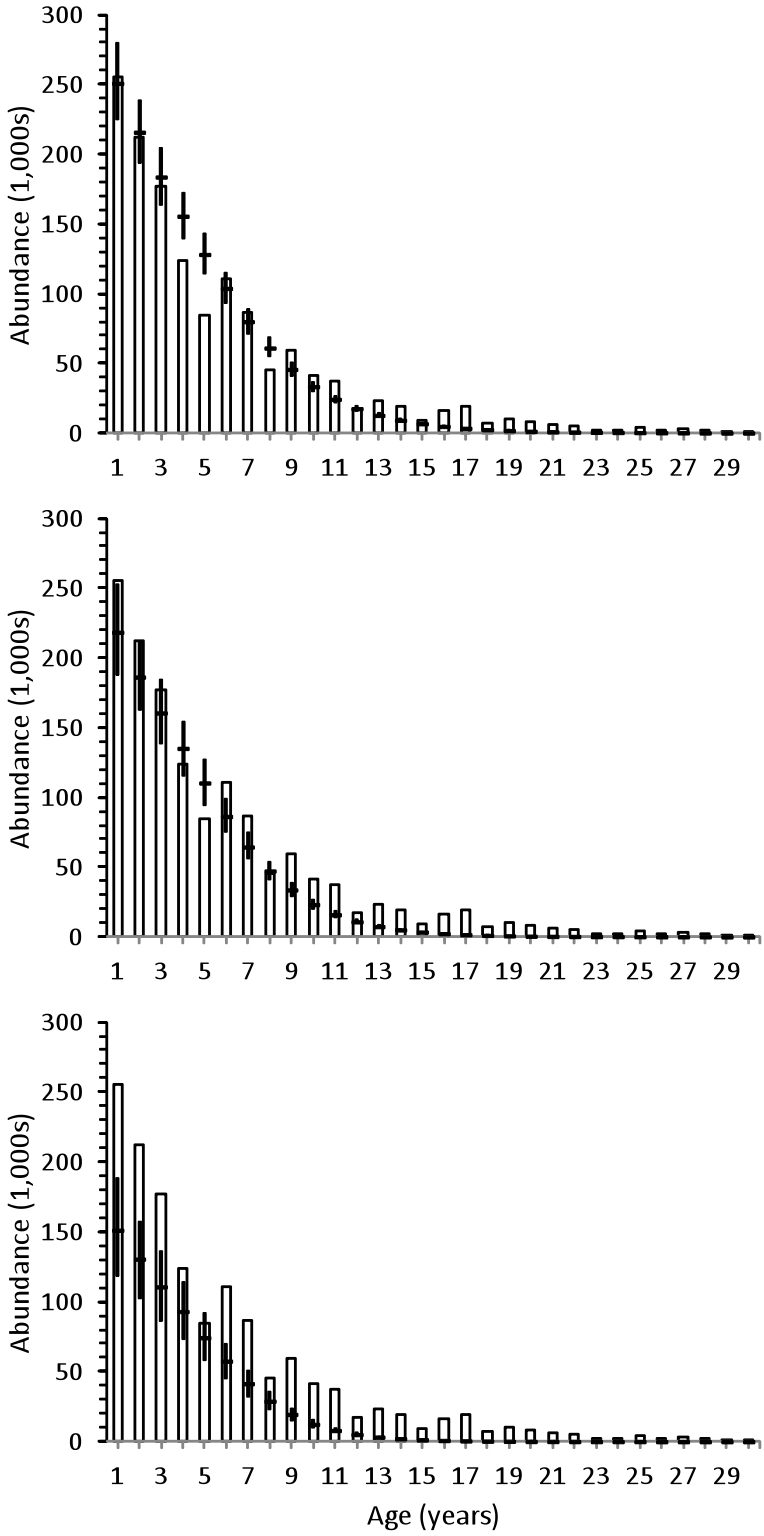


FIGURE 4.8.—Long-term (years 51–200) simulated abundance (± 95% confidence limits = error bars) in relation to starting abundance (open bars) of a lake trout population subjected to fishing mortality to suppress adult (age-8-and-older) abundance by 25% (upper panel), 50% (middle panel), and 75% (lower panel) in Flathead Lake, Montana.

Section 5:

Evaluating Effects of Lake Trout Suppression in Flathead Lake, Montana

Introduction

The preceding sections of this report described mark-recapture surveys (Section 1) and standardized gillnet surveys (Section 2) for evaluating effects of lake trout suppression programs examined with a stochastic age-structured simulation model (Section 4). Lake trout suppression alternatives were thoroughly reviewed in a Draft Environmental Impact Statement (Draft EIS), "Proposed Strategies for Lake Trout Population Reduction to Benefit Native Fish Species Flathead Lake, Montana." The Draft EIS was reviewed by an Interdisciplinary Team (IDT) of experts and stakeholders and by the Independent Scientific Review Panel (ISRP) for the Northwest Power and Conservation Council (NPPC). The ISRP expressed concern that effects of proposed suppression alternatives would not be detectable:

> "The ISRP has substantial concerns about the ability of the proposed sampling program to detect changes in the lake trout population status in the first decade of the program, especially under alternatives with a lower level of suppression (A-C). The description of the post-implementation monitoring is too brief. It is not possible to determine if the proposed monitoring will be able to detect actual, gradual changes in the population yearly or even for intervals of a few years (Review of the Flathead Lake Draft Environmental Impact Statement)."

To respond to this concern, I was tasked to quantify the statistical power to detect each proposed level of lake trout suppression through the Monitoring and Adaptive Management Protocol described in Appendix 8 of the Draft EIS. In particular, I quantified the statistical power of the standardized autumn gillnet assessment fishery and mark-recapture surveys to detect prescribed levels of lake trout suppression (Protocols 4 and 5; Appendix 8; Draft EIS). Proposed suppression alternatives were prescribed as 25%, 50% and 75% reductions in adult lake trout abundance, defined as age-8-and-older (adult) lake trout. Therefore, I quantified the statistical power to detect 25%, 50% and 75% reductions in catch/net of adult lake trout in the gillnet assessment fishery and abundance of adult lake trout in mark-recapture surveys.

Methods

Background.—Statistical power is defined as the probability of rejecting a null hypothesis that is in fact false and should be rejected. Power is quantified as 1 – the probability of committing a Type II error (β), where β is the probability of not rejecting a null hypothesis that is in fact false. Power is inversely related to the probability of committing a Type I error (α), defined as the probability of rejecting a null hypothesis that is fact true. In practice, an investigator usually controls the Type I error rate by setting a defined "acceptable" rate, such as $\alpha = 0.05$. In theory, a sampling program should be designed with an appropriate (minimum) level of sampling intensity (n = sample size) to detect a desired effect (δ = effect size) at a prescribed likelihood of falsely rejecting a true null hypothesis (α), probability of failing to reject a false null hypothesis ($1-\beta$), and variance of the measured effect (s^2 = sample variance):

$$n = \frac{s^2}{\delta^2}\left(t_{\alpha,v} + t_{\beta(1),v}\right)^2$$

In Equation 1 (Zar 1999), unfortunately, the sample size (n) determines the degrees of freedom ($v = n - 1$) for t, so a minimum sample size must be solved numerically (iteratively). Computer programs are often used to estimate minimum sample sizes for various levels of s^2, δ, α, and β.

Many sampling programs are designed within funding or other constraints that do not enable specification of a sampling intensity to achieve such desired ends (δ, α, and β). Rather, many sampling programs are constrained to a fixed level of sampling effort (n) by budgetary or human constraints. For such sampling programs, the previous equation can be rearranged to estimate the minimum detectable effect size:

$$\delta = \sqrt{\frac{s^2}{n}}\left(t_{\alpha,v} + t_{\beta(1),v}\right)$$

In Equation 2 (Zar 1999), the minimum detectable effect size for a prescribed level of sampling intensity also requires the investigator to set acceptable levels of α and β, and to have some knowledge of the variance of the measured effect (s^2), but can be estimated without using numerical methods. If the minimum detectable effect size is found to be lower than desirable, the sampling intensity would need to be increased to a level that can detect the desired effect.

The power ($1 - \beta$) of a prescribed level of sampling intensity (n) to detect a desired effect (δ) at a prescribed likelihood of falsely rejecting a true null hypothesis (α) and variance of the measured effect (s^2) can be estimated by rearranging the previous equation:

$$t_{\beta(1),v} = \frac{\delta}{\sqrt{\frac{s^2}{n}}} - t_{\alpha,v}$$

Equation 3 (Zar 1999) defines a t-statistic for which the probability is equivalent to β and power is defined as 1 – probability of observing $t_{\beta(1),v}$ by chance alone. This method for estimating statistical power is appropriate for responding to the ISRP concern about the ability of the monitoring program to detect effects of suppression alternatives proposed for Flathead Lake.

Gillnet Assessment Fishery.—To estimate power of the standardized gillnet assessment fishery, I defined effect size (δ) as 25%, 50%, and 75% reductions in geometric-mean catch/net of adult (age-8+) lake trout during 1998–2012 (Section 2), sampling variance as the mean-squared error from the GLM used to estimate geometric-mean catch/net ($s^2 = 0.05709$; Section 2), sampling effort as the number of nets set each year within the stratified-random sampling design ($n = 72$ nets), and the Type I error rate at a conventional 2-tailed rate of 5% ($\alpha = 0.05$). Because geometric-mean catch/net was the back-transformed least-squares mean $\log_e$(catch/net + 1), a 25% reduction in geometric-mean catch/net corresponded to a 16% reduction in $\log_e$(catch/net + 1), a 50% reduction in geometric-mean catch/net corresponded to a 36% reduction in $\log_e$(catch/net + 1), and a 75% reduction in geometric-mean catch/net corresponded to a 59% reduction in $\log_e$(catch/net + 1). To define how power varied with sampling effort for the smallest effect size (δ = 25% reduction), I also computed power for a range of sampling effort (n = 62 – 126 nets).

Mark-Recapture Surveys.— To estimate power of mark-recapture surveys, I defined effect size (δ) as 25%, 50%, and 75% reductions in mark-recapture estimates of adult (age-8+) lake trout abundance during 2008–2012 (Section 1), sampling variance (s^2) as the variance of each mark-recapture estimate of adult (age-8+) lake trout abundance during 2008–2012 (Section 1), sampling effort (n) as the number of recaptures associated with each mark-recapture estimate of adult (age-8+) lake trout abundance during 2008–2012 (Section 1), and the Type I error rate at a conventional 2-tailed rate of 5% ($\alpha = 0.05$). Mark-recapture estimates based on samples during Fall Mack Days approximated numbers of age-8+ lake trout (Section 1), so I estimated power to detect 25%, 50% and 75% reductions in Fall Mack Days estimates. I also estimated power for average numbers marked, examined for marks, and recaptured during Fall Mack Days in 2008, 2010, 2011, and 2012.

Results

Gillnet Assessment Fishery.—Power of the gillnet assessment fishery to detect a 25% reduction in geometric-mean adult lake trout catch/net was 57%, whereas power to detect 50% and 75% reductions in geometric-mean catch/net was 100% (Figure 5.1). For increased levels of gillnet sampling effort, power to detect a 25% reduction in adult lake trout catch/net increased steadily to 80% for 122 nets, a 69% increase in sampling effort (Figure 5.2). Catch/net declined by at least 25% in 3 of 15 years during 1998–2012, a period during which abundance was considered to be at equilibrium with fishing and natural mortality. When expressed as 2–4 year moving averages of geometric-mean catch/net, a 2-year moving average declined by at least 25% in only 1 of 15 pairs of years, a 3-year moving average declined by at least 25% in only 1 of 15 sets of years, and a 4-year moving average declined by at least 25% in 0 of 15 sets of years. Therefore, the effect of a 25% suppression program should be measured over at least four years.

Mark-Recapture Surveys.—Power of Fall Mack Days mark-recapture surveys to detect 25%, 50%, and 75% reductions in estimated adult lake trout abundance was 100% (Figure 5.3). Year-to-year variation of Fall Mack Days mark-recapture estimates ranged from −19% to +24%. Therefore, the effect of 25%, 50% or 75% suppression programs could be measured as a single-year change in the Fall Mack Days estimate of abundance.

Discussion

The ISRP concern that the proposed sampling program will be unable to detect proposed changes in the lake trout population in the first decade of the program appears unwarranted, other than for a 25% reduction in adult lake trout abundance measured through the standardized fall gillnet assessment fishery. By relying on both gillnet and mark-recapture surveys, all proposed levels of adult lake trout suppression should be detectable, if sampling effort is maintained at levels used in the reference periods for both surveys. In addition, other metrics of lake trout population decline, such as size structure, body condition, growth, and mortality, also appear promising as components of an integrated assessment program (Sections 2–3).

To maintain similar effort in the standardized autumn gillnet assessment survey, at least 72 nets must be deployed each year. Power to detect a 25% reduction in geometric-mean adult lake trout catch/net can be increased to 80% by deploying 122 nets each year. Costs of this increased level of sampling effort would need to be balanced against the potential gain in power within an assessment program that also includes mark-recapture surveys, and potentially, other metrics, such as size structure, body condition, growth, and mortality (Sections 2–3), which may

be more powerful than geometric-mean catch/net for detecting overall effects of suppression efforts. Development of such metrics for use in the monitoring program is underway.

To maintain similar effort in the mark-recapture survey, enough effort must be deployed to ensure recovery of 33 tagged fish on average each year (0.01% of mean estimated abundance during 2008–2012). Recovery of tagged fish is a complex function of marking and recovery effort, so enough sampling effort will be required to mark 1,120 fish each year (0.24% of mean estimated abundance during 2008–2012) and to examine 14,392 fish for marks during Fall Mack Days derbies (3% of mean estimated abundance during 2008–2012). Given the greater power of the mark-recapture survey to detect a 25% reduction in adult lake trout abundance, sustaining the present level of effort for this part of the assessment program is particularly important to success of the overall suppression program.

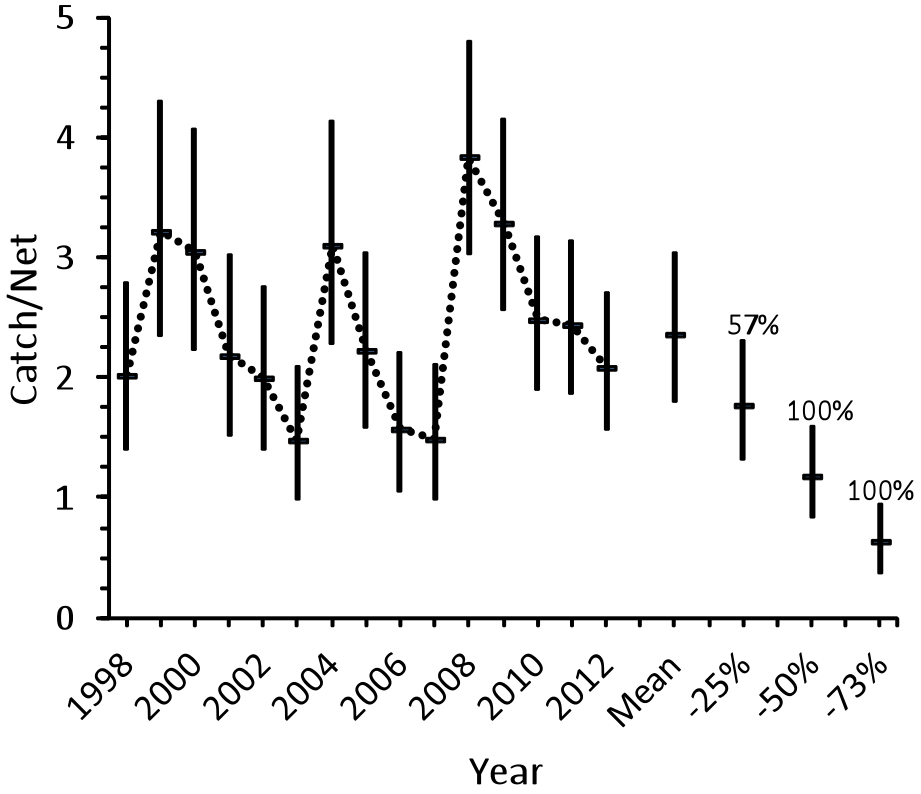


FIGURE 5.1.—Geometric-mean catch/net of adult (age-8+) lake trout during standardized autumn gillnetting during 1998–2012, mean geometric-mean catch/net of adult (age-8+) lake trout during 1998–2012, and 25%, 50%, and 73% reductions in geometric-mean catch/net of adult (age-8+) lake trout in Flathead Lake, Montana. Power to detect each proposed level of reduction is denoted as a percentage above each error-bar.

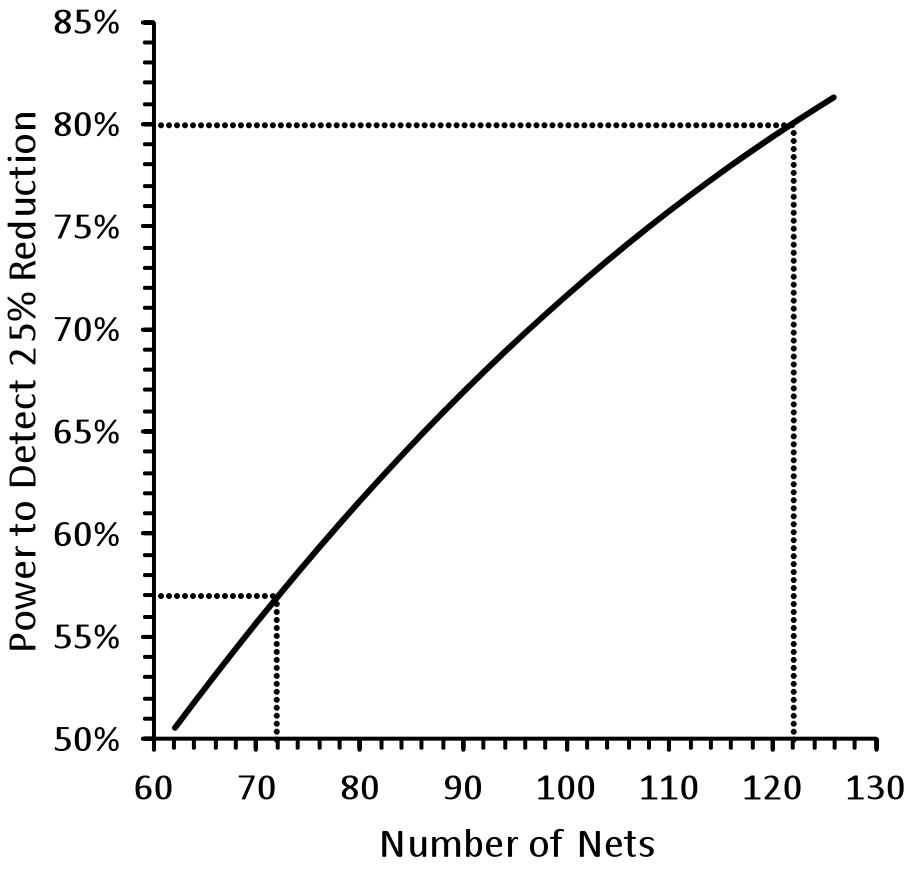


FIGURE 5.2.—Power to detect a 25% reduction in geometric-mean catch/net of age-8-and-older (≥460 mm) lake trout in relation to the number of nets set each year during random-stratified autumn gillnet surveys in Flathead Lake, Montana. The mean-squared error was estimated from a general linear model with $\log_e$(catch/net + 1) as the dependent variable and year (1998–2012), area (5 sampling-area strata), and depth (5 depth strata) as independent variables. Dotted lines depict power for the current level of sampling effort (72 nets per year) and for 80% power (122 nets per year).

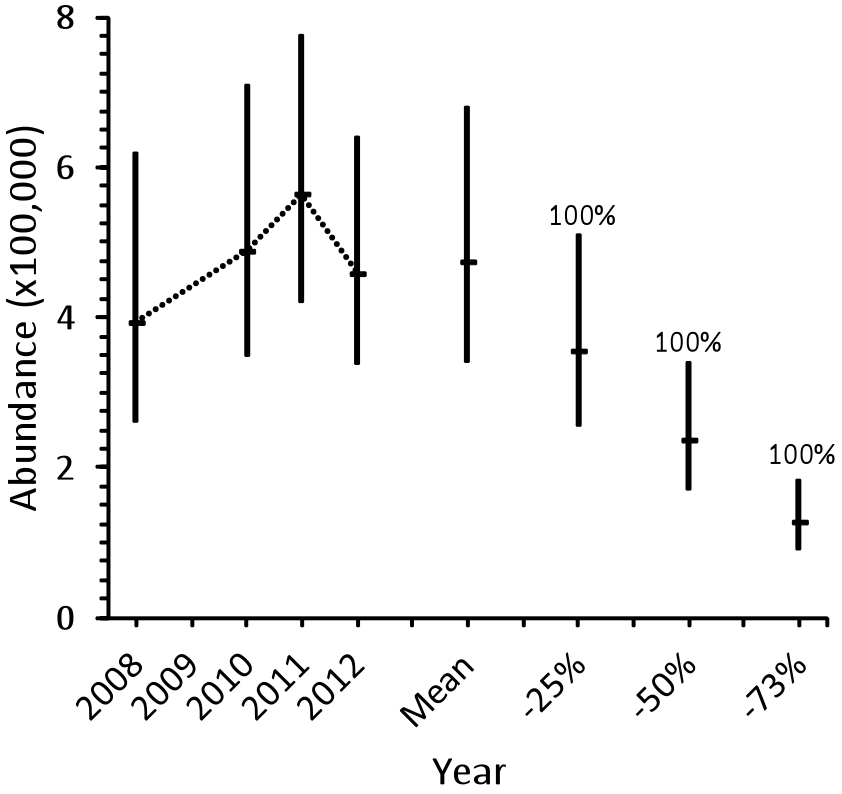


FIGURE 5.3.—Mark-recapture estimates of adult (age-8+) lake trout abundance during 1998–2012, mean mark-recapture estimate of adult (age-8+) lake trout during 1998–2012, and 25%, 50%, and 73% reductions in adult (age-8+) lake trout abundance in Flathead Lake, Montana. Power to detect each proposed level of reduction is denoted as a percentage above each error-bar.

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Appendix 7

Analysis of Two Alternatives Considered But Eliminated

1. Do nothing except general harvest, discontinue Mack Days

Because this alternative did not meet the purpose and need to reduce lake trout numbers, it was dropped from further consideration. If the Tribes wanted to implement only the General Harvest in the future, they would not need to analyze it through a NEPA process. However, because the analysis of the effects of this alternative was of interest to team members, we have included it here.

This alternative represents a reference condition with no active management except general angling regulations to reduce lake trout numbers. In contrast to the other alternatives, Mack Days fishing contests would be discontinued. The slot limit (anglers cannot keep lake trout between 30 and 36 inches) would be retained, and the bag limit for lake trout would be 100 fish.

Environmental Consequences in the Project Area: Lake trout

This alternative would use general angling which is predicted to result in the harvest of 33,000 fish (Table 1). This estimate is based on average annual harvests occurring before the Mack Days contests expanded to their current level. The slot limit would be retained. Bag limits for lake trout would remain at 100 fish per day. Instead of reducing lake trout numbers, this alternative would result in a 5% increase in lake trout abundance.

In the short term (<5 years), total lake trout abundance would increase slightly relative to Alternative A, the No Action alternative. The population would start to change, but the changes would likely be too small to measure in the short term. Over the long term (>50 years), the lake trout population would adjust to the reduction in harvest and would stabilize with a mortality rate of 21% (Figure 1). Individual lake trout growth rates would be slightly slower, body condition poorer, age at maturity older, and the level of predation on other species higher than under Alternative A. The long-term effect of this alternative would be to increase the total lake trout population by about 5% relative to Alternative A (Table 2).

Table 1. Projected annual lake trout harvest and native trout bycatch under the alternative "Do nothing except general harvest, discontinue Mack Days".

Harvest Method	Number	Bycatch Mortality[1]	
		Bull trout	Cutthroat trout
General	33,000	68	11
Total	33,000	68	11

[1] *See Appendix 5 for estimation of bycatch.*

Table 2. Projected lake trout abundance and percent change from current conditions (+ 95% confidence limits) for four age groups from an age-structured stochastic simulation model of Flathead Lake (Appendix 6) under the alternative "Do nothing except general harvest, discontinue Mack Days".

Age Group	Projected abundance	Lower 95% limit	Upper 95% limit	% Change from Status Quo (+ 95% limits)
Short-Term (5 years)				
Ages 1–30	1,319,575	609,878	3,638,416	−1% (−54, +172%)
Ages 4–30	842,754	467,589	1,444,816	+7% (−41, +83%)
Ages 8–30	375,879	232,231	521,975	+16% (−29, +60%)
Ages 22–30	26,735	17,375	36,953	+4% (−32, +44%)
Long-Term (50–200 years)				
Ages 1–30	1,549,263	1,414,472	1,708,821	+5% (−4, +15%)
Ages 4–30	902,710	824,795	996,869	+12% (+2, +23%)
Ages 8–30	405,116	369,545	447,351	+29% (+18, +43%)
Ages 22–30	19,719	17,998	21,784	+84% (+68, +103%)

Trophy lake trout

The short and long-term effects of this alternative are very similar to Alternative A.

Cumulative Effects

The short and long-term effects are very similar to Alternative A.

Overall for This alternative—

- **Lake trout numbers would not be reduced from 2010 levels. Because of smaller harvest than Alternative A, the lake trout population would gradually increase to a 5% higher level.**
- **Negative effects from predation by lake trout would be greater than under Alternative A.**
- **Over the long term, trophy lake trout would gradually decline, similar to Alternative A.**

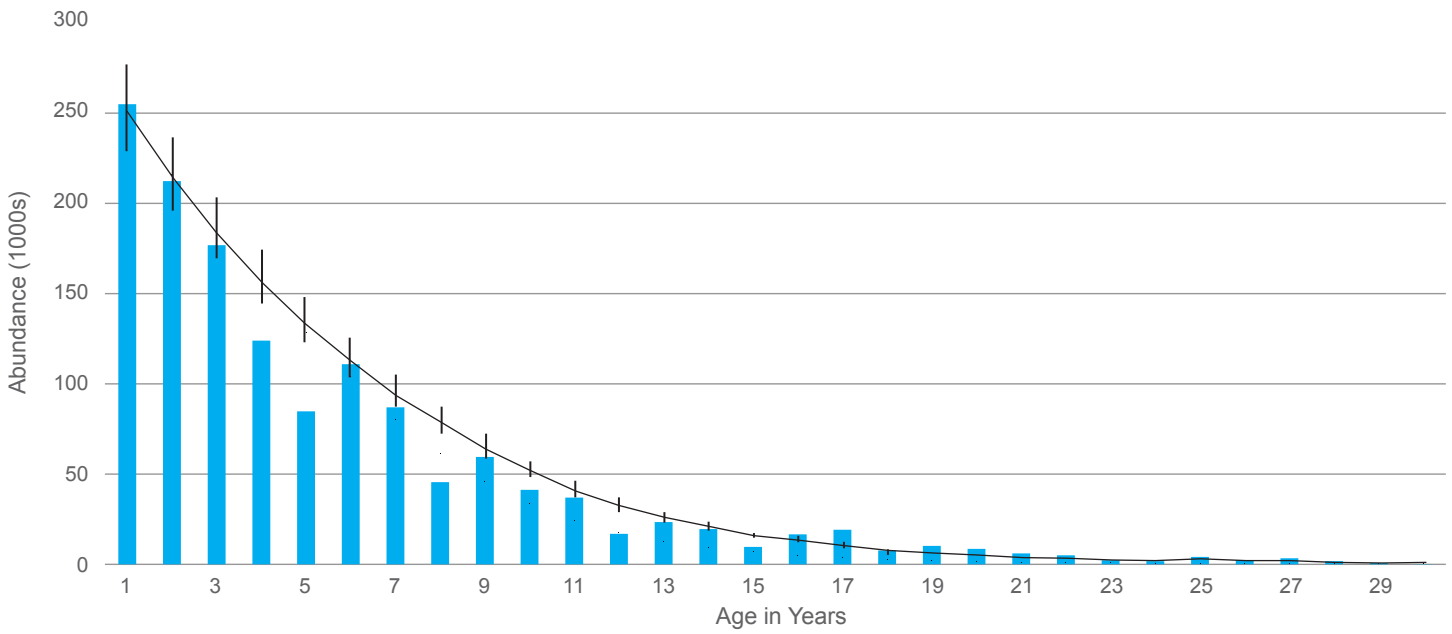

Figure 1. Current age structure (columns) and long-term simulated age structure (dashes with confidence intervals) of the lake trout population in Flathead Lake (Appendix 6) under the alternative "Do nothing except general harvest, discontinue Mack Days".

Environmental Consequences in the Project Area: Bull Trout

The lake trout population is estimated to be 5% larger under this alternative than under Alternative A, and therefore the predation on bull trout by lake trout would likely be increased. In both the short and long term the total abundance of bull trout would likely decline, but the change would be too small to measure.

Bycatch

Bycatch mortality in the general harvest is estimated to be 68 per year.

Environmental Consequences in the Project Area: Westslope Cutthroat Trout

The lake trout population is estimated to be 5% larger under this alternative than under Alternative A, and therefore the predation on westslope cutthroat trout by lake trout would likely be increased. In both the short and long term the total abundance of westslope cutthroat trout would likely decline, but the change would be too small to measure.

Bycatch

Bycatch mortality in the general harvest is estimated to be 11 per year (Table 1 and Appendix 5). This is a relatively low level of bycatch, and would not affect total westslope cutthroat trout numbers.

2. Reduce the population of adult lake trout (age 8 and older) in Flathead Lake by 90% relative to the 2010 levels

The goal of this alternative is to reduce the population of adult lake trout (age 8 and older) in Flathead Lake by 90% relative to the 2010 levels, which means an annual harvest target of 188,000 lake trout age 4 and above (the actual harvest could range between 169,000 and 207,000 fish). This alternative, like all of the action alternatives, would accomplish this goal by changing management strategies to add the option of using targeted gillnets and trapnets. Specifically, this alternative would:

- **Continue the General Harvest**
- **Change the regulations to make it legal to keep lake trout from 30 to 36 inches long.**
- **Continue Mack Days (with the slot limit removed).**
- **If we have not reached our annual harvest target of 188,000 fish with Mack Days, we would use targeted gillnets and trapnets to reach and maintain a 90% reduction in adult lake trout numbers.**
  Because trapnetting is labor intensive and expensive, we anticipate that we would, at least initially, only be able to capture a small percentage of lake trout with trapnetting. We estimate we would need to set approximately 786,700 feet of gillnet to annually reach this target (Appendix 5).
- **Potential Future Action**
  To maintain the lake trout population at the reduced size, we would need to maintain an annual harvest of 188,000 lake trout age 4 and above (Appendix 6).

Environmental Consequences in the Project Area: Lake Trout

This section describes the environmental consequences or the effects of the alternatives on lake trout in Flathead Lake and the Cumulative Effects Analysis Area (Figure 3.1).

Reduce Adult (Age 8+) Lake Trout Numbers by 90% Over the Long Term

Direct and Indirect Effects

This alternative would use Mack Days fishing contests, targeted gillnetting and trapnetting to annually harvest 188,000 (the actual harvest could range between 169,000 and 207,000) lake trout (Table 3). The slot limit, which prohibits anglers from keeping lake trout between 30 and 36 inches, and the bag limit would be removed. This harvest level is estimated to achieve a 90% reduction in total lake trout numbers over the long term, or within between 11 and 29 years, depending on variability in recruitment dynamics.

Assuming that the general and Mack Days harvests would equal 70,000 (Appendix 5), the target harvest of 188,000 lake trout would likely require that 101,000 lake trout be harvested by netting, 91,000 by gillnetting and 10,000 by trapnetting. This approach would require an estimated 720,000 feet of gillnet and 200 trap-days if 50 lake trout were caught per trap-day (Appendix 5).

Table 3. Projected annual lake trout harvest and bycatch estimates under this alternative (Appendix 6).

Harvest Method	Number	Bycatch Mortality[1]		
		Bull Trout	Cutthroat Trout	Lake Whitefish
General	25,000	52	11	0
Mack Days	45,000	95	0	0
Gillnetting and Trapnetting	73,000	304	0	182,500
Total	143,000	451	11	182,500

[1]*See Appendix 5 for estimation of bycatch.*

In the short term (<5 years), abundance of Age-4-and-older lake trout would decrease by 30%. As intra-specific competition within those age classes decreases with declining numbers, growth and condition would begin to increase and age at maturity would decrease.

This 171,000 harvest level would produce an annual mortality rate of 43% (Figure 2). The size structure of the lake trout population would change greatly relative to the status quo.

Table 4. Projected lake trout abundance and percent change from current conditions (+ 95% confidence limits) for four age groups from an age-structured stochastic simulation model under this alternative (Appendix 6). Harvest = 171,072; A = 43%.

Age Group	Projected abundance	Lower 95% limit	Upper 95% limit	% Change from Status Quo (+ 95% limits)
Short-Term (5 years)				
Ages 1–30	1,119,480	489,400	2,691,444	−16% (−63, +101%)
Ages 4–30	549,390	282,969	1,059,614	−30% (−64, +35%)
Ages 8–30	144,610	84,750	201,486	−56% (−38, −74%)
Ages 22–30	17,545	10,482	24,825	−31% (−3, −59%)
Long-Term (50-200 years)				
Ages 1–30	317,978	202,073	466,868	−79% (−68, −86%)
Ages 4–30	145,051	93,219	211,488	−82% (−74, −88%)
Ages 8–30	29,913	19,466	43,550	−90% (−86, −94%)
Ages 22–30	65	36	98	−99% (−99, −100%)

Trophy lake trout

In the short term (<5 years), numbers of trophy lake trout would decline 31% relative to the status quo (Alternative A). Over the long term (>50 years), numbers of trophy lake trout would decline 99% relative to the long-term status quo and 100% relative to the short-term status quo.

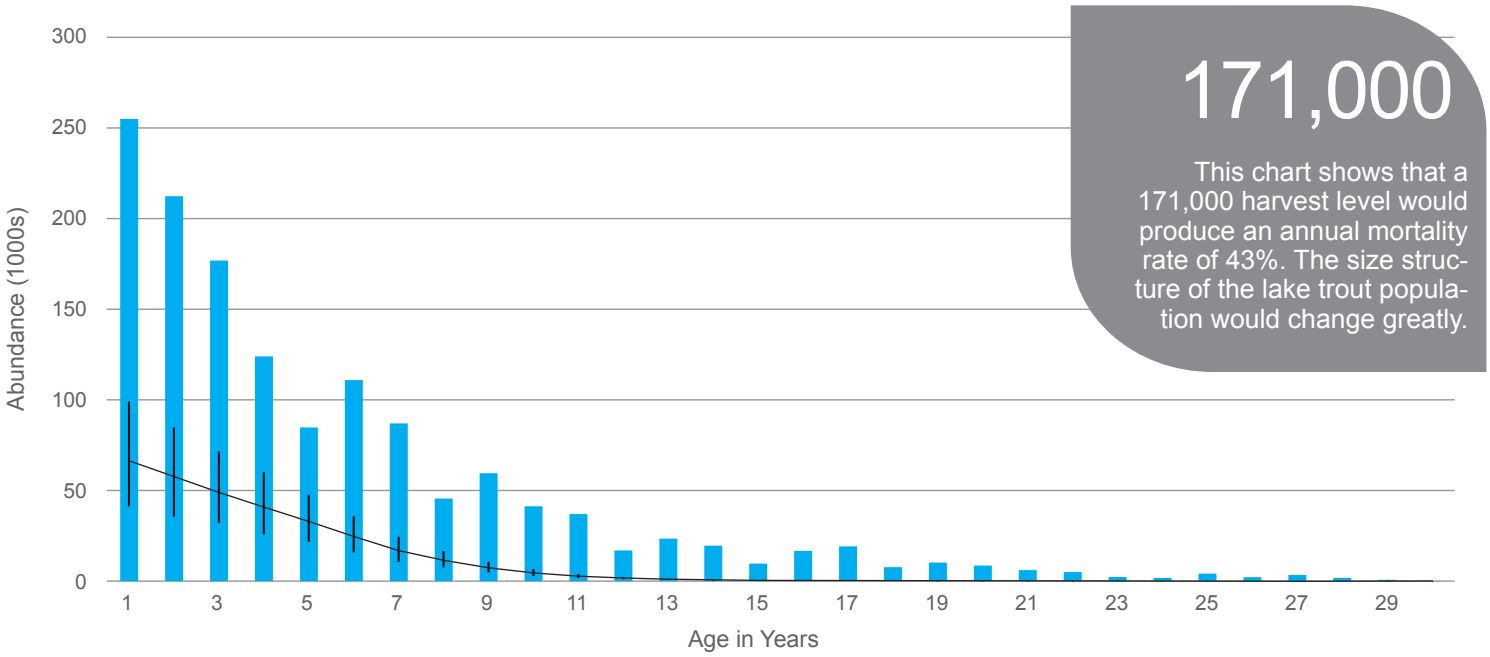

Figure 2. Current age structure (columns) and long-term simulated age structure (dashes with confidence intervals) of the lake trout population in Flathead Lake under this alternative (Appendix 6).

Environmental Consequences in the Project Area: Bull Trout

This section describes the environmental consequences or the effects of the alternatives on bull trout in Flathead Lake and the area delineated in red in Figure 3.1.

Reduce Adult (Age 8+) Lake Trout Numbers by 90% Over the Long Term

Direct and Indirect Effects

The proposed 90% reduction of lake trout numbers under this alternative would not be reached in the short term, and therefore the associated reduction in predation on bull trout would not be reached in the short term. However, some of the 90% reduction would be achieved, and therefore a decrease in predation and an increase in juvenile bull trout abundance is likely during the short term.

Bioenergetics modeling indicates that this alternative would reduce predation on bull trout by 98% (Appendix 4 and Appendix 6). This reduction in predation could result in a 98% recovery of the population lost since lake trout expanded in the 1980s, equating to 4,925 more adult bull trout in the population (Appendix 9).

Bycatch and Benefit-Risk Analysis

Annual bycatch mortality is estimated to be 52 in the general harvest, 95 in Mack Days, and 492 from gillnetting (Table 3.9 and Appendix 5). The total bycatch mortality is 655 individuals, the bulk of which would be sub-adults. This bycatch represents about 3% of the age 1+ bull trout population and 22% of the adult population.

Over the short term (<5 years) there would be an annual bycatch mortality of 655 individuals with no meaningful, off-setting reduction in predation by lake trout. Therefore, there would be about a 3% increase in the mortality rate of bull trout and minimal short–term benefits.

Over the long term (>50 years), provided that the bull trout population persists, adult bull trout are predicted to increase by 4,925 adults. Provided the assumptions underlying these predictions are correct, the potential increase in the bull trout population would exceed the bycatch mortality by 7 fold. Therefore this alternative has a positive benefit-risk ratio for bull trout, but one that is less than that of all the other alternatives.

Environmental Consequences in the Project Area: Westslope Cutthroat Trout

This section describes the environmental consequences or the effects of implementing the alternatives on westslope cutthroat trout in Flathead Lake and the area delineated in red in Figure 3.1.

Reduce Adult (Age 8+) Lake Trout Numbers by 90% Over the Long Term

Direct and Indirect Effects

The proposed 90% reduction in lake trout numbers under this alternative would not be reached in the short term, and therefore the associated reduction in predation on westslope cutthroat would not be reached in the short term. However, some of the 90% reduction would be achieved, and therefore a decrease in predation and an increase in juvenile westslope cutthroat trout abundance is likely.

Over the long term (>50 years), bioenergetics modeling predicts that a 90% reduction in adult lake trout numbers would result in a 96% reduction in predation on westslope cutthroat trout (Appendix 4). Assuming that lake trout predation accounts for a high percent of adfluvial cutthroat trout mortality, this long-term decrease in predation would likely result in a very large increase in westslope cutthroat trout abundance.

Bycatch and Benefit-Risk Analysis

Bycatch mortality in the general harvest is estimated to be 11 per year, and zero bycatch is estimated for the fishing contests and gillnetting (Table 3.9 and Appendix 5). Because the potential increase in westslope cutthroat trout is in the thousands and the bycatch is 11, the benefit-risk of Alternative is E is strongly positive for westslope cutthroat trout.

Environmental Consequences in the Project Area: Lake Whitefish

This section describes the environmental consequences or the effects of implementing the alternatives on lake whitefish in Flathead Lake and the area delineated in red in Figure 3.1.

Reduce Adult (Age 8+) Lake Trout Numbers by 90% Over the Long Term

Direct and Indirect Effects

The proposed 90% reduction of lake trout numbers under this alternative would not be reached in the short term, and therefore the associated reduction in predation on lake whitefish would not be reached in the short term. However, some of the 90% reduction would be achieved, and therefore a decrease in predation and an increase in juvenile lake whitefish abundance is likely.

Bioenergetics modeling predicts that a 90% reduction in lake trout numbers over the long term (>50 years) would result in a 97% reduction in predation on lake whitefish (Appendix 4). The lake whitefish population is currently very large and near carrying capacity at the current level of predation pressure and fishing mortality. The predicted reduction in predation rate, although large, would likely cause only a moderate increase in the abundance of lake whitefish.

Environmental Consequences in the Project Area: Invertebrates (including *Mysis*), Zooplankton, and Phytoplankton

This section describes the environmental consequences or the effects of implementing the alternatives on invertebrates, zooplankton, and phytoplankton in Flathead Lake and the area delineated in red in Figure 3.1.

Reduce Adult (Age 8+) Lake Trout Numbers by 90% Over the Long Term

Direct and Indirect Effects

Simulation modeling indicates that this alternative would decrease total lake trout abundance (Age 1+) by 1,251,549 relative to the current condition (Table 4). Bioenergetics modeling indicates that the resulting net decrease in predation would cause *Mysis* to increase from the current average density of 45/m^2 to 208/m^2 (Appendix 4). The highest density of *Mysis* that has been recorded in Flathead Lake was 126/m^2 in 1986 (Figure 3.1). Therefore we anticipate that implementation of this alternative would produce lower zooplankton densities and higher phytoplankton densities than have existed in Flathead Lake over the last 27 years.

Environmental Consequences in the Project Area: Fishing Opportunity

This section describes the environmental consequences or the effects of implementing the alternatives on fishing opportunity in Flathead Lake and the area delineated in red in Figure 3.1. Parameters chosen for analysis are changes in catch rates by species and changes in total angling effort. Species chosen for analysis are lake trout, westslope cutthroat trout, lake whitefish, and yellow perch.

Reduce Adult (Age 8+) Lake Trout Numbers by 90% Over the Long Term

Direct and Indirect Effects

Lake Trout

Nearly all lake trout caught in the recreational lake trout fishery are Age 4 (13-inch total length) and older. The abundance of Age-4-and-older lake trout would likely decrease by about 7% in the short term and by 59% in the long term relative to Alternative A. A 7% decrease in abundance would not be large enough to change catch rates and therefore catch rates within this size group would likely remain unchanged in the short term (<5 years) and decline greatly over the long term (>50 years).

The abundance of Age-8 (19-inches total length) and older lake trout would decrease by 19% over the short term (<5 years) and by 64% over the long term (>50 years) relative to Alternative A. Therefore there would likely be no change in catch rates for this size group over the short term and a very large decrease over the long term relative to Alternative A.

The abundance of Age-22 (30-inches total length) and older lake trout would decrease by 9% in the short term and by 85% in the long term relative to Alternative A. The catch rates for large lake trout would likely not change over the short term and decline to nearly zero in the long term.

All Other Fish Species

Catch rates for all other fish species would likely increase to at least the level that occurred in the 1980s, prior to the increase in the lake trout population.

Environmental Consequences in the Project Area: Fishing Economy

This section describes the environmental consequences or the effects of implementing the alternatives on the fishing economy in Flathead and Lake Counties.

REDUCE TOTAL LAKE TROUT NUMBERS BY 90% OVER THE LONG TERM

The cost of this alternative is the sum of costs to conduct the Mack Days fishing contests, deploy an estimated 720,000 feet of gillnets and deploy trapnets for 100 trap-days (Appendix 5). The total estimated annual cost of implementing this alternative is $1,118,000 (Table 5).

Table 5.Total annual costs to implement this alternative.

Harvest Method	Number	Cost
General	25,000	0
Mack Days	45,000	$310,000
Gillnetting	91,000	$728,000
Trapnetting	10,000	$80,000
Total	171,000	$1,118,000

Total angling activity in Flathead Lake would probably decline moderately in the short term (<5 years) in response to the decrease in catch rates for lake trout. Total angling activity in the Flathead River system would probably not change in the short term because we do not anticipate any changes in the fishery in the short term.

Population models predict that this alternative will lead to a 90% decrease in medium-sized lake trout, and a 100% decrease in large lake trout over the long term (>50 years). This reduction is estimated to result in a decrease of about 24% of angler trips to Flathead Lake and the upstream river sections compared to the 2007 estimated level of angler pressure (Table 6) and to the estimated long term angler pressure under the No-Action alternative, before any offsetting increases in fishing pressure for other species and to other areas are considered.

Table 6. Estimated direct changes in lake trout angler trips and expenditures resulting from implementation of this alternative over the long term (>50 years). Plus symbols represent monetary changes we could not quantify, but may largely offset the quantifiable values.

	Montana Residents	Nonresidents	Total
Baseline Angler Trips to Flathead Lake and River sections	94,378	23,122	117,500
Estimated percentage reduction in angling trips to Flathead Lake and River sections due to reduced lake trout angling (compared to No-Action alternative)	-22.3%	-24.8%	-24.0%
Increased Flathead Lake fishing for non-lake trout species	+	+	+
Increased Flathead River angler trips due to improved river fish populations	+	+	+
Increased fishing at other Montana waters to substitute for lake trout fishing trips in Flathead Lake	+	+	+
Potential off-setting increases in angling (other species and waters)	Up to 100% offset of estimated reductions		
Range of estimated reductions in angler trips and spending	No change to -22.3%	No change to -24.8%	No change to -24.0

The estimated direct angler-expenditure reductions associated with reductions in lake trout abundance would likely be substantially offset within the region by increases in angler trips and spending associated with fishing for other species and/or on other regional waters. Additionally, the reductions would occur over a period of decades.

The total economic output (sales of goods and services) of the combined Lake and Flathead County area in 2007 was $4.1 billion (Minnesota IMPLAN Group 2010). This total economic activity in the two-county area generated $2.1 billion in employee compensation, and 73,528 full and part time jobs. In the context of the entire two-county economy, the estimated decreases in direct lake trout angler spending are very small (about one-tenth of 1%). However, any change in the economic status quo impacts certain people and groups more than others.

Individuals and businesses most likely to be adversely affected by this alternative are anglers and guide businesses focusing specifically or exclusively on lake trout or trophy lake trout fishing in Flathead Lake. Those potentially benefiting from this alternative would be anglers or guides fishing the Flathead River system upstream of the lake, or anglers targeting non-lake trout species within Flathead Lake.

It is estimated that this alternative's lake trout control actions would have a negligible adverse impact on income or employment in Lake and Flathead counties. However, the actions may (over the period of several decades) have a minor adverse impact on all Flathead Lake and River anglers, and a moderate to major adverse impact on anglers and guide businesses targeting only lake trout.

Appendix 8

Monitoring and Adaptive Management

Introduction

Described in this appendix is the monitoring that would be conducted during the implementation phase of the selected alternative which will follow the completion of the Final EIS. Each alternative in the EIS sets specific harvest targets for lake trout, identifies methods to achieve those targets and predicts a range of biological and social responses. Monitoring is the means to determine if the objectives of the chosen alternative are being met and will serve as an early warning system if unforeseen problems occur. It identifies problems and triggers a process of adaptive management to correct the action and to improve the outcome. We would use two types of monitoring: (1) implementation monitoring to verify that the alternative was implemented as planned and (2) effectiveness monitoring to reconcile the predicted effects with the measured effects. A wide range of monitoring tools is described. These tools would be more clearly defined during the implementation phase if an action alternative is selected. At that time specific tools would be selected based on assessments of their predicted accuracy and cost-effectiveness.

Adaptive Management

Adaptive management would start when monitoring indicates that the measured results are inconsistent with the expected results. We have identified many potential adaptive measures, although the list is not all-inclusive because we cannot anticipate the full range of solutions before the problems have been identified (Table 1). New methods and new information will likely become available in the future and will form the basis for adaptive management. For the most difficult problems we would reconvene the Inter-

disciplinary Team and expert scientists that prepared the EIS and conduct a focused problem-solving exercise. The results of that work would be summarized in report form and the prescribed action would be implemented the following year.

Table 1. Questions likely to be raised by project implementation, and monitoring indicators and tools to answer those questions, and hypothetical adaptive solutions to deviations from desired outcomes.

Question	Monitoring Indicator	Monitoring Protocol	Benchmark Condition	Predicted Future Condition (Letter refers to altenative)	Adaptive Management Possibilities
Was the chosen alternative implemented as planned?					
Was the harvest target for lake trout achieved?	Total Lake Trout Harvested per Year	1. Creel survey (CSKT) 2. Mack Days harvest accounting (CSKT) 3. Gillnetting harvest accounting (CSKT)	70,000 lake trout harvested annually	A. 70,000 lake trout B. 88,000 lake trout C. 113,000 lake trout D. 143,000 lake trout	Adjust methods to increase or decrease harvest to more closely meet the harvest target.
2. Mack Days harvest accounting (CSKT)					
Were the implementation costs within projected limits?	Total Costs Expended (personnel, materials, etc.)	Cost Accounting (CSKT)	$350,000/ yr for 64 days of Mack Days Contests No benchmark exists for the other methods	1. Mack Days: $350,000 total, or $7/ fish 2. Bounty: unknown 3. Gillnetting: $250/1000 ft of gillnet, or $8/fish.	a. Adjust methods b. Pursue additional funding
Was the bycatch of bull trout and westslope cutthroat trout within projected amounts?	Number of native trout caught by method	Direct Accounting of Bycatch (CSKT)	16 bull trout per year in Mack Days contests O cutthroat trout per year in Mack Days contests There is no benchmark for netting	Bull trout: 12 / yr in Mack Days, 1 bull trout / 240 lake trout caught in gillnets Westslope cutthroat 1) 0 in contests 2) 0 in netting	a. Angler education b. Adjust netting methods according to depth, mesh size, etc. c. Consult with USFWS if we exceed the bycatch estimates for the alternative chosen to plan short-term and long-term changes.
Was the size range of lake trout harvested within projected limits?	Length-frequency of captured lake trout	Collect length measurements from a minimum of 1,000 random individuals for each method (CSKT)	General harvest: 19” Fall Mack Days: 20” Spring Mack Days: 13” There is no benchmark for netting	General harvest: 18” Fall Mack Days: 19” Spring Mack Days: 13” Netting: 22”	a. Change incentives in Mack Days b. Adjust mesh sizes c. Adjust net locations d. Adjust net depths

Question	Monitoring Indicator	Monitoring Protocol	Benchmark Condition	Predicted Future Condition (Letter refers to altenative)	Adaptive Management Possibilities
Did the lake trout population decrease as predicted?	1. Population abundance	1. Mark and recapture estimate (CSKT)	1. 342,000 Age 8+ by MR	1. Alternatives: A. 313,000 Age 8+ B. 232,00 Age 8+ C. 156,000 Age 8+ D. 83,000 Age 8+	a. Increase or decrease harvest b. Convene scientists to evaluate
	Relative Abundance: 2. Mortality rate	2. Standard autumn gill-netting series (CSKT)	2. 26%	2. A. 26% B. 29% C. 33% D. 38%	
	3. Mean catch per net in Spring for a) <30" and b)>30"	3. Standard spring gill-netting series (MFWP)	3. a) incomplete b) incomplete	3. a) incomplete b) incomplete	
	4. Geometric mean catch per net in Autumn a) all ages and b) Age 8+	4.Standard autumn gill-netting series (CSKT)	4. a) 3.3 / net b) 2.5 / net	4. A. a) 3.3 / net b) 2.5 / net B. a) 3.3 / net b) 1.9 / net C. a) 2.7 / net b) 1.3 / net D. a) 1.6 / net b) 0.6 / net	
	5. Relative weight	5. Standard autumn gill-netting series (CSKT)	5. 84.5	5. > 84.5	
	6. Growth rate	6. Standard autumn gill-netting series (CSKT)	6. L infinity = 999 mm K = 0.069	6. L infinity = >999 mm K = >0.069	
Did the catch rate of lake trout change as predicted?	1. Mean catch rates in general harvest	1. Creel survey (CSKT)	1. 0.59/ hr (mean of all anglers from 2005-2009)	1. A. >= 0.59 / hr B. >= 0.54 / hr C. >= 0.47/ hr D. >= 0.34/ hr	a. Evaluate possible explanations b. Evaluate change in harvest level
	2. Mean (a) total and (b) top 25 catch rates in Spring Mack Days	2. Spring Mack Days Accounting (CSKT)	2. (a) 12 / trip (b) 25 / trip in Spring Mack Days (2010-2012)	2. (a) <12 / trip (b) < 25 / trip in Spring Mack Days	
	3. Mean (a) total and (b) top 25 catch rates in Fall Mack Days	3. Fall Mack Days Accounting (CSKT)	3. (a) 13 / trip (b) 23 / trip in Fall Mack Days (2010-2012)	3. (a) <13 / trip (b) <23 / trip in Fall Mack Days	
Did the abundance of bull trout increase as predicted?	1. Annual Index count of redds	1. Redd inventories (MFWP)	1. 204 index redds (5 year mean)	1. Relative change toward reference level: A. 37%, B. 65%, C. 84% and D. 93%	a. Evaluate possible explanations b. Evaluate change in harvest level
	2. Mean catch rates in spring gillnetting series	2. Standard spring gill-netting series (MFWP)	2. 0.2 bull trout / net (2006-2010)	2. >0.2 bull trout / net	
	3. Mean catch rates in autumn gillnetting	3. Standard autumn gill-netting series (CSKT)	3. 0.11 bull trout / net	3. > 0.11 bull trout / net	
	4. Juvenile abundance estimates	4. Standard tributary sampling (MFWP)	4. Index metrics must be developed from multiple sample reaches	4. To be developed	

Question	Monitoring Indicator	Monitoring Protocol	Benchmark Condition	Predicted Future Condition (Letter refers to altenative)	Adaptive Management Possibilities
Did the abundance of westslope cutthroat trout increase as predicted?	1. Mean catch rates in spring gillnetting series 2. Mean catch rates in river sampling	1. Standard spring gillnetting series (MFWP) 2. Standard river segment population estimation (MFWP)	1. 0.2 cutthroat trout / net 2. Index metrics must be developed from multiple sample reaches	1. Maintain or increase catch rate; > 0.2 / net 2. To be developed	a. Evaluate possible explanations b. Evaluate change in harvest level
Did the angling pressure on Flathead Lake change as predicted?	Number of angling days on Flathead Lake	1. Statewide mail-in survey (MFWP). 2. Flathead Lake creel survey and aerial flights (CSKT)	1. 51,000 angler days/yr (MFWP mail-in survey 2005-2011) 2. There is no recent baseline	1. No less than 50,000 angler days / yr	Convene scientists to evaluate
Did the angling pressure on Flathead River change as predicted?	Number of angling days on Flathead River	1. Statewide mail-in survey (MFWP) 2. Flathead River	1. 46,000 angler days/ yr (MFWP mail-in survey 2011) 2. There is no recent	No less than 40,000 angler days 2. No reference	Convene scientists to evaluate
Did the *Mysis* population increase as predicted?	Number of *Mysis* per meter squared	Standardized autumn sampling by Yellow Bay Biological Station	45 / m2	A. 34 / m2 B. 51 / m2 C. 81 / m2 D. 130 / m2	Convene scientists to evaluate
Did the Zooplankton population increase as predicted?	Number of zooplankton per standard vertical tow	Standardized zooplankton sampling by Yellow Bay Biological Station	Specific zooplankton species for monitoring will be determined during the implementation phase	None identified at this time	Convene scientists to evaluate
Did the Algae population increase as predicted?	1. Average density of algae per meter squared during August 2. Water clarity	Standardized summer sampling by Yellow Bay Biological Station	1. Chlorophyll a < 1 mg/l 2. Secchi depth = 12 m	1. Chlorophyll a < 1 mg/l 2. Secchi depth = 12 m	Convene scientists to evaluate

Reporting

The CSKT, in cooperation with MFWP, will conduct the monitoring protocols each year and CSKT will prepare a summary report. The report will be disseminated to interested parties, uploaded to the Mack Days website, and presented to the Flathead Reservation Fish and Wildlife Advisory Board during their standard February public meeting. In addition to annual reporting, CSKT will report impacts to bull trout to the USFWS as part of consultation for compliance with the Endangered Species Act (this is currently done for our management actions and fishing contests).

Monitoring Protocols

Methods to Estimate Abundance of Key Species

A. Lake Trout

Direct Methods, Absolute estimates of Abundance

Mark and Recapture procedures

The absolute population estimate of abundance is generated by the mark and recapture method described in Appendix 9. Tags are placed throughout the year and Spring and Fall Mack Days events are used to re-

capture tagged lake trout, allowing for very large samples at minimal costs. In this manner two estimates are generated per year, and with one exception these estimates have varied little since 2008 (Figure 1).

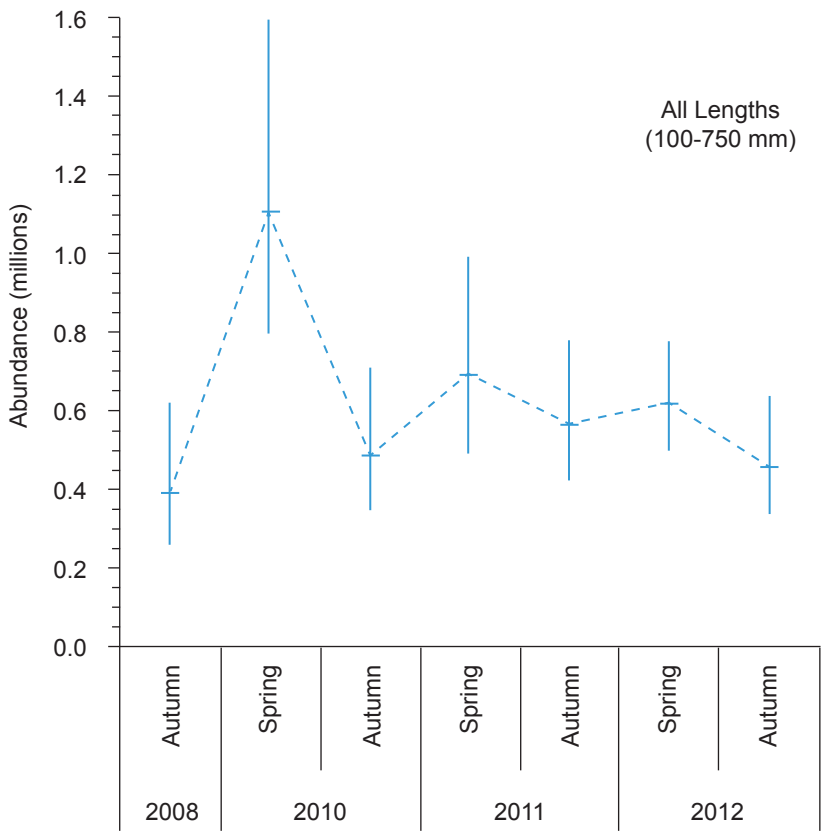

Figure 1. Abundance (+ 95% confidence limits) of lake trout estimated by mark-recapture during Fall Mack Days (2008, 2010, 2011, and 2012) and Spring Mack Days (2010, 2011, and 2012) in Flathead Lake, Montana.

This method has a 100% power to detect 25%, 50% and 75% changes of abundance of Age 8+ lake trout, which comprises the full range of proposed alternatives.

Indirect Methods: Relative Estimates of Abundance

Geometric mean catch rate in autumn stratified random location gillnetting:

A relative estimate of population abundance is generated from mean catch rates in standardized gillnetting. Stratified random gillnetting (12 panels) in autumn provides data for several measures of lake trout population dynamics, and specifically a relative measure of abundance based on mean catch rates over time (Figure 2). The catch/net in gillnets is highly variable and therefore not ideal for detecting small degrees of change. Sample sizes consisted of 48 individual nets until 2008, when the sample was expanded to 72 nets. The power to detect a change of 25% in the geometric mean catch rate using the standard sample size of 72 nets is 57% (Figure 3). Therefore we could not reliably detect the effects of Alternative B (25% reduction) with gillnetting data by using the current level of sampling intensity. The desired 80% threshold detection level would be achieved with a sample size of 122 nets (Figure 3), which would be employed during the implementation phase if Alternative B is chosen and in a particular year when the effects must be quantified.

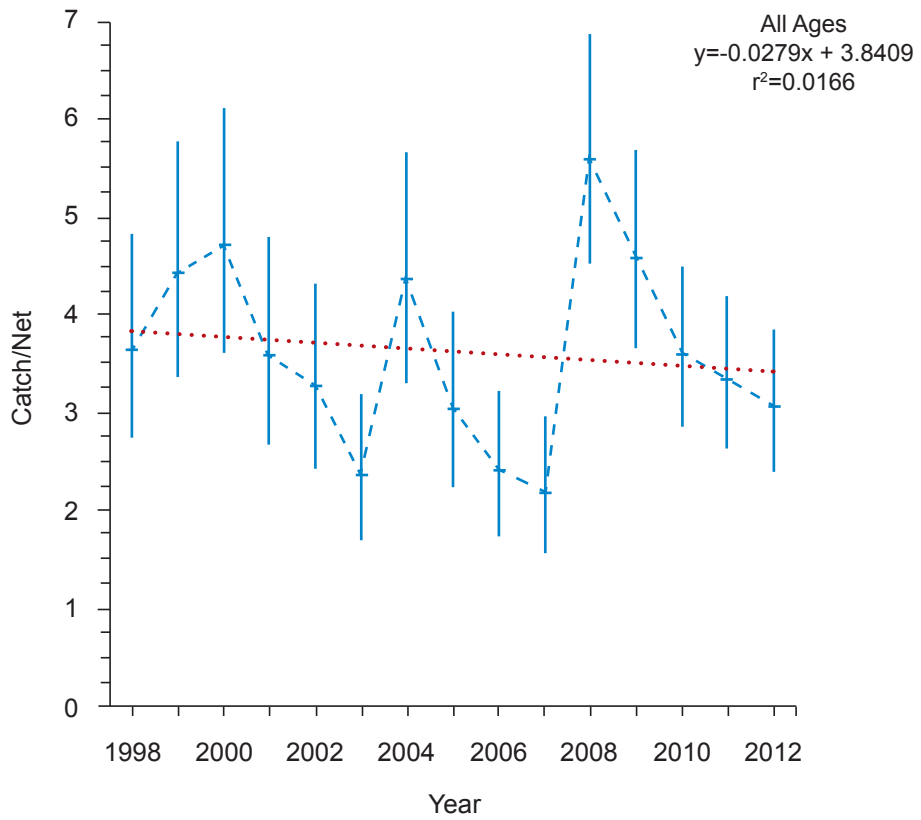

Figure 2. Catch/net of lake trout shorter than 30 inches caught in standardized gillnet surveys in autumn in Flathead Lake during 1998–2012.

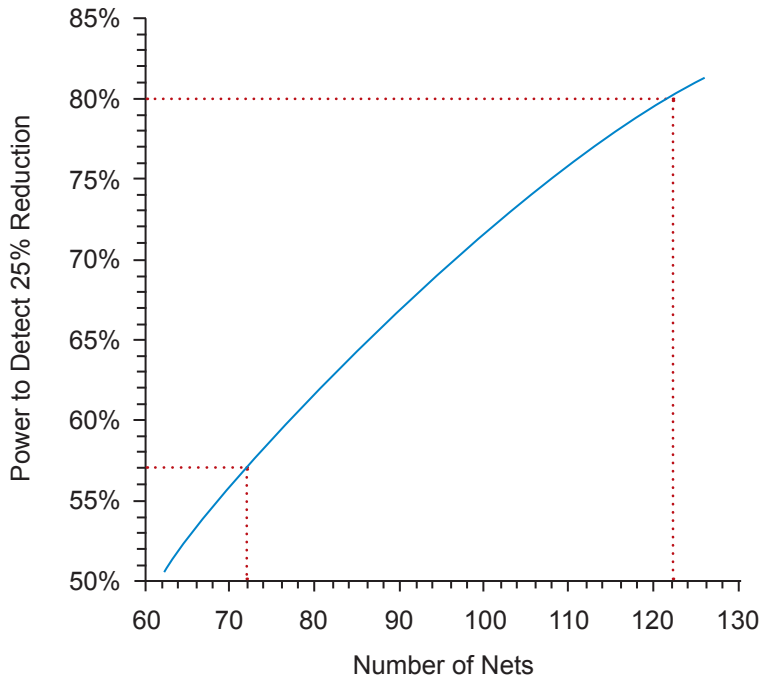

Figure 3. Power to detect a 25% reduction in geometric-mean catch/net of age-8-and-older (>460 mm) lake trout in relation to the number of nets set each year during random-stratified autumn gillnet surveys in autumn in Flathead Lake.The standard sample size of 72 nets has a power of 100% to detect a change of 50% (Alternative C) and 75% (Alternative D) in lake trout catch/net.

Mean catch rate in fixed location gillnetting in spring

This metric generates mean catch rates from standardized gillnetting procedures conducted annually in Flathead Lake. With one exception, catch rates have been consistent since 1992 (Figure 4). The power of this method to detect change has not been determined at this time, but is assumed to be low becausee of the small sample size (15 pairs of nets).

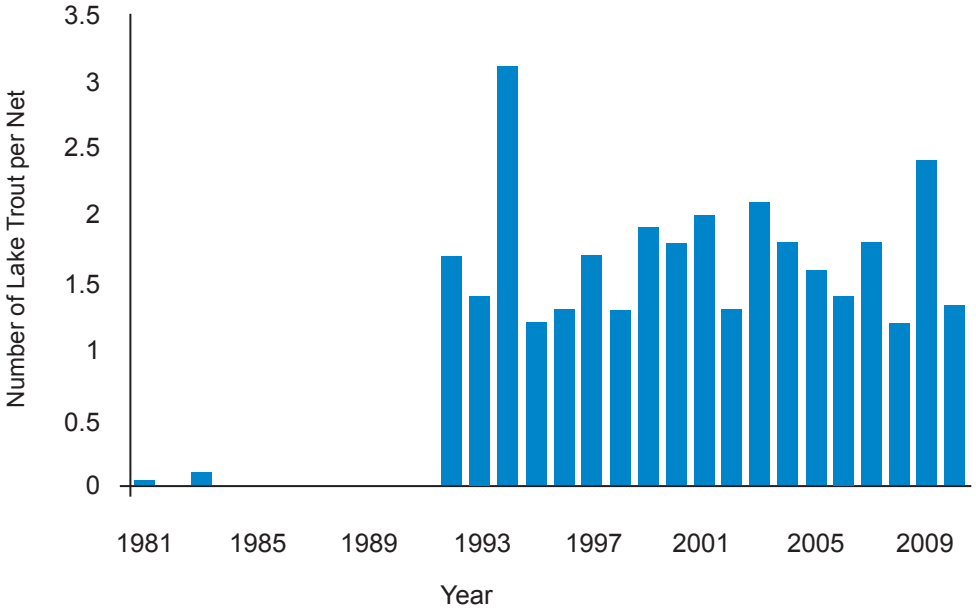

Figure 4. Mean catch rates of lake trout in gillnets set in fixed locations in spring in Flathead Lake, 1981 to 2010 (MFWP). No nets were set between 1984 and 1991.

Age-frequency of captured lake trout

This metric provides a measure of the change in size structure of the lake trout population in Flathead Lake. The length category of fish most frequently captured should decrease with suppression of lake trout. We annually generate length-frequency relationships from captures of lake trout in standardized gillnets set in autumn (Figure 5). We also generate age-frequency relationships by conversion of lengths to age based on known growth rates, although this approach is not highly accurate because of high variability in the length-at-age relationship. During implementation of one of the proposed alternatives we would age each lake trout captured during standardized sampling to monitor age frequencies without conversion error. The baseline length category with the highest frequency of capture is 500 to 525 mm.

Mortality rate from gillnet samples

Mortality rate describes the reduction in abundance of older year classes relative to younger year classes. To generate this metric lake trout are captured by standardized gillnetting in autumn and the mortality rate is calculated as the rate of decline in abundance of progressively older lake trout from age 8 to at least age 25. Mortality rates of lake trout in Flathead Lake have declined between 1998 and 2012 (Figure 6). Mortality rates would increase with increased harvest proportionally under Alternative B, C and D.

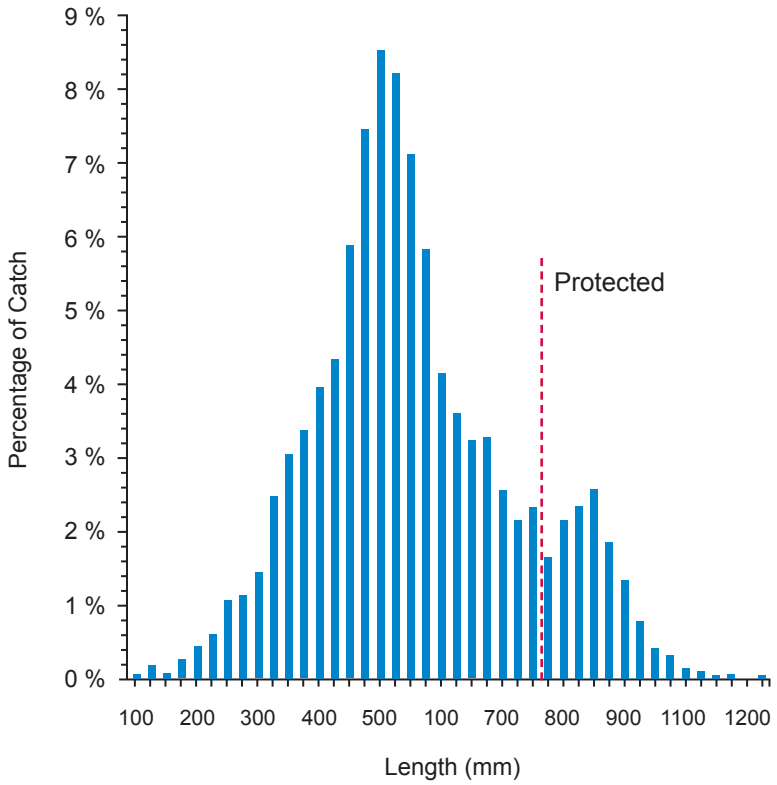

Figure 5. Length-frequency of 6,081 lake trout caught in standardized gillnet surveys in Flathead Lake, 1998–2012.

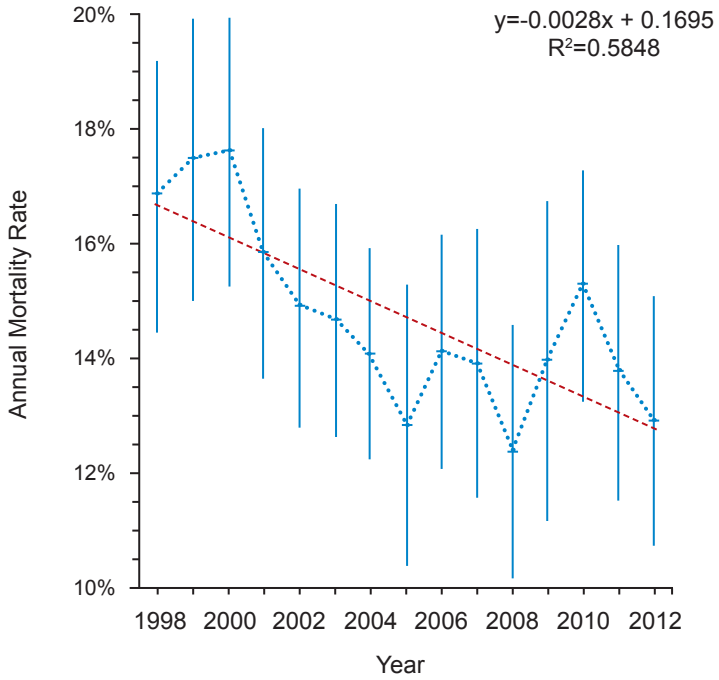

Figure 6. Mean annual mortality (+ 95% confidence limits) estimated from age frequency samples of lake trout caught in standardized-gillnet surveys in Flathead Lake, 1998–2012. The dashed line and equation depicts the linear trend through time of annual mortality during 1998–2012.

Changes in lake trout growth rate

Proposed decreases in the density of lake trout in Flathead Lake would result in decreased intra-specific competition which should facilitate faster growth rates. Mean growth rates of lake trout in Flathead Lake since 1996 have decreased (Figure 7). Growth rates are expected to increase by progressively greater degrees under Alternatives B, C and D.

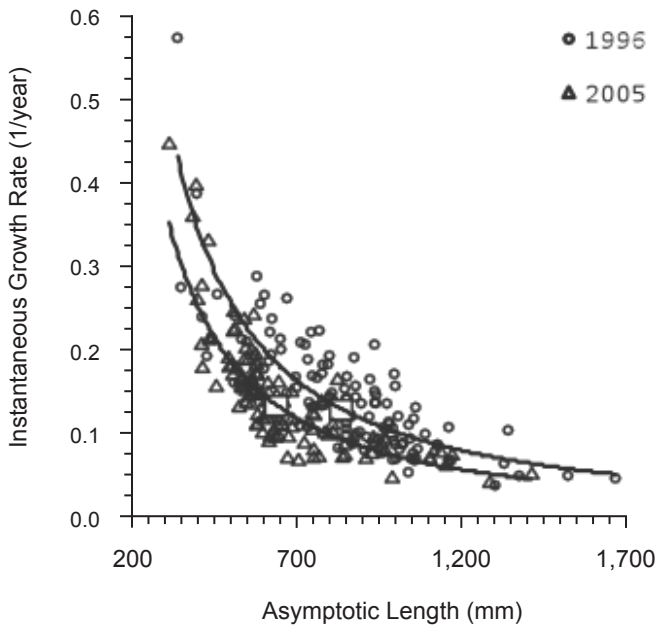

Figure 7. Instantaneous growth rate (K) and asymptotic length (L∞) for von Bertalanffy growth models of individual growth histories for lake trout in Flathead Lake, Montana in pre-1996 (open circles; n = 122) and 2005 (open triangles; n = 113). Curves depict negative power relationships between growth parameters. Open squares depict geometric mean growth parameters, which illustrates an increase in asymptotic length (L∞) with no change in instantaneous growth rate (K) that infers an increase in the annual growth rate (ω = L∞×K).

Changes in lake trout age/length at maturity

Proposed decreases in the density of lake trout in Flathead Lake would result in decreased intra-specific competition which should facilitate faster growth rates and earlier maturity at shorter lengths (Trippel 1995). The baseline length at maturity for lake trout in Flathead Lake is 491 mm for males and 547 mm for females (Figure 8). Length and age at maturity are expected to decrease by progressively greater degrees under Alternatives B, C and D.

Changes in lake trout condition

Proposed decreases in the density of lake trout in Flathead Lake would result in decreased intra-specific competition which should facilitate improved condition of individual lake trout. Relative weight, a measure of condition relative to the potential of the species across its range, has varied substantially since 1998 (Figure 9). Relative weight measurements are expected to increase by progressively greater degrees under Alternatives B, C and D.

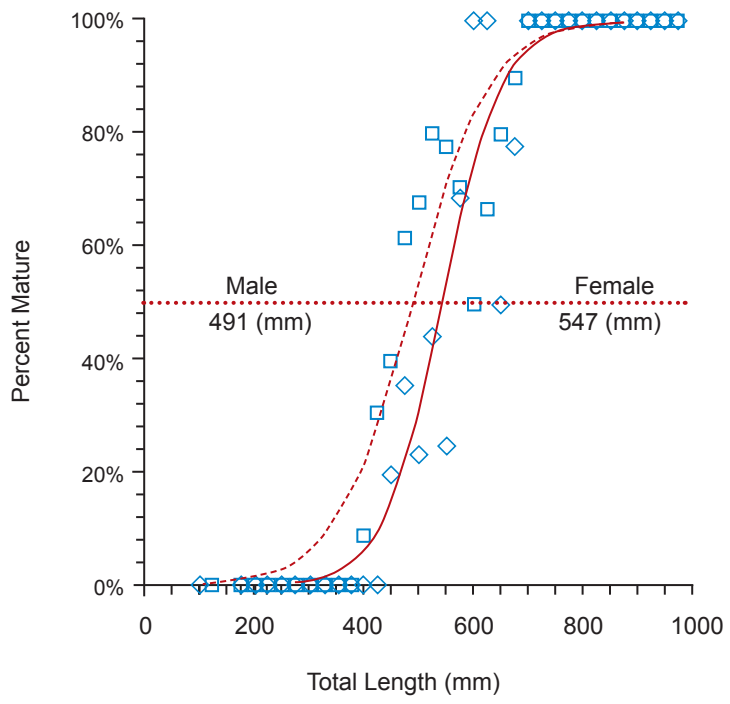

Figure 8. Percent mature as a function of total length for male (squares and dashed line) and female (diamonds and solid line) lake trout caught in standardized gillnets in Flathead Lake. The horizontal line depicts length at 50% mature for male and female lake trout.

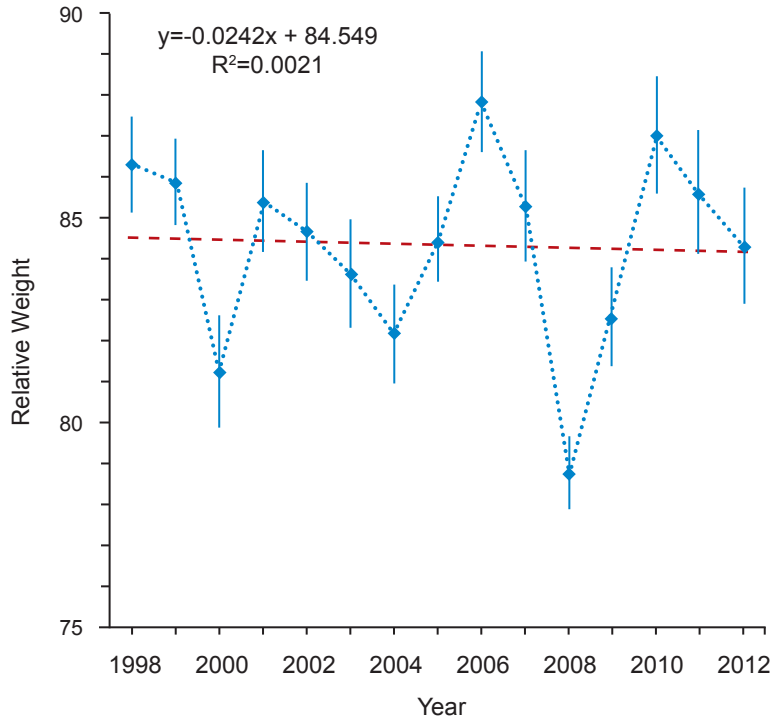

Figure 9. Mean annual relative weight (+ 95% confidence limits) of lake trout (N = 4,347; 179–437 per year) caught in standardized-gillnet surveys in Flathead Lake, 1998–2012.

B. Bull Trout

Adult abundance:

Total redds annually in index streams

Redds are enumerated by pedestrian observers in specific index reaches of known spawning streams, and provide the most accurate measures of adult bull trout abundance. Mean counts in the eight index reaches over the last five years equal 204 redds per year (Figure 10).

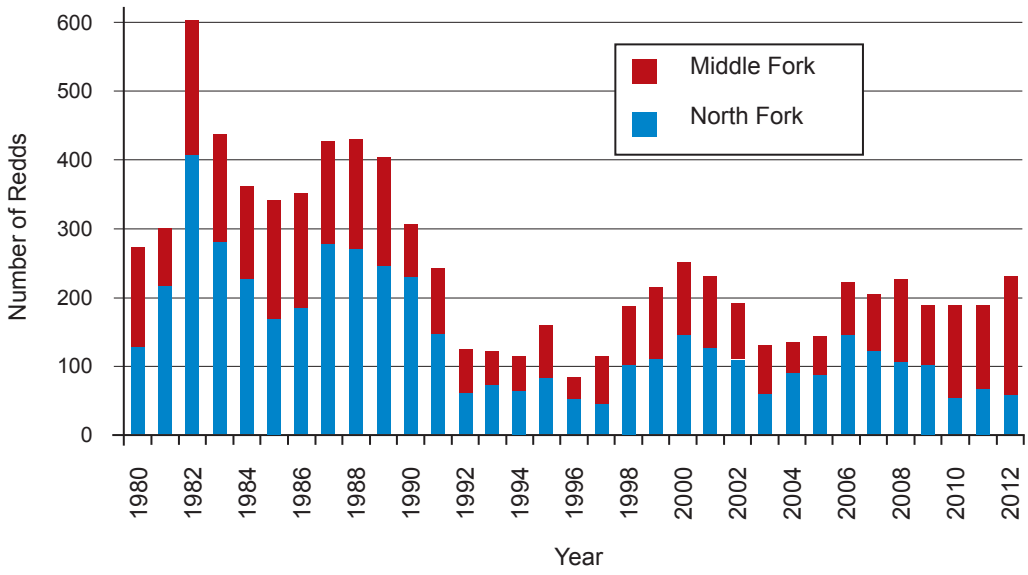

Figure 10. Total redds counted annually in eight index stream reaches of the North and Middle forks Flathead River, 1980 to 2012 (MFWP).

Mean catch per net in autumn gillnetting series

Mean catch rates are developed from standardized random gillnetting procedures conducted annually in Flathead Lake during autumn. These nets are set in a stratified random pattern throughout the lake which includes deep, offshore locations that bull trout rarely use. Therefore the resulting catch rate is not an optimal measure of trends in bull trout abundance, but is useful because it expands the suite of metrics for confirming upward or downward trends. Baseline catch rates are low (<0.1 bull trout per net) and span the period from 1998 - 2012, and therefore do not include the period prior to the large decline in bull trout abundance.

Mean catch per net in spring gillnetting series

Mean catch rates are developed from standardized gillnetting procedures conducted annually in five fixed locations during spring. This tool estimates a wider range of ages than indicated by redd counts as it includes older juveniles and subadults. The variance in mean catches has been low since 1992 (Figure 11), although the power to detect change in catch rates is also low because of the small sample size (15 pairs of nets).

Estimates of juvenile bull trout abundance in streams

Juvenile bull trout are sampled annually in selected spawning tributaries by MFWP. Fish are collected by electrofishing and abundance is estimated by the depletion method. Measures of trends in abundance are variable and are sub-population specific. Therefore this metric is useful for monitoring changes in individual streams rather than for the total population.

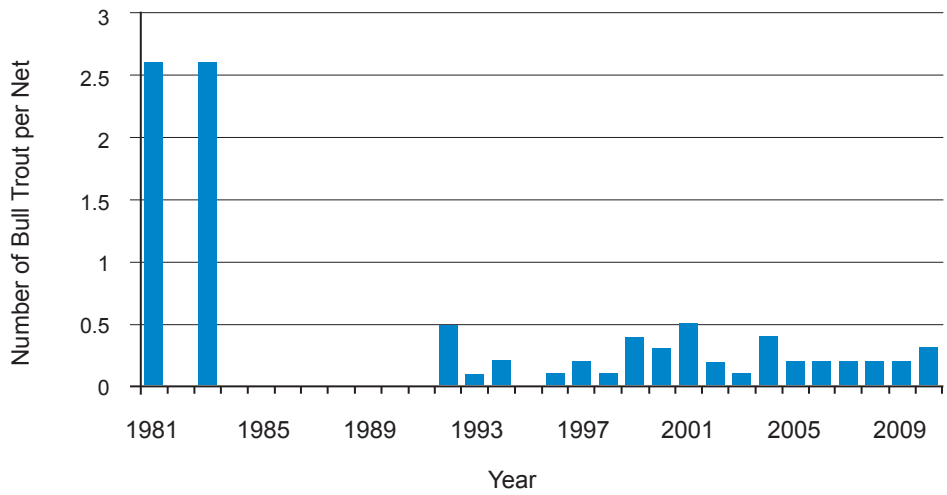

Figure 11. Mean catch per net of bull trout in gillnets set in Flathead Lake during spring, 1981- 2010. No nets were set between 1984 and 1991.

C. Westslope Cutthroat Trout

Mean catch per net of westslope cutthroat trout in spring gillnetting

Mean catch rates are developed from standardized gillnetting procedures conducted annually in five fixed locations during spring. This tool estimates a wider range of ages than indicated by redd counts as it includes subadult and older juveniles. The variance in mean catches has been moderate since 1992 (Figure 12), although the power to detect change is also low because of the small sample size (15 pairs of nets).

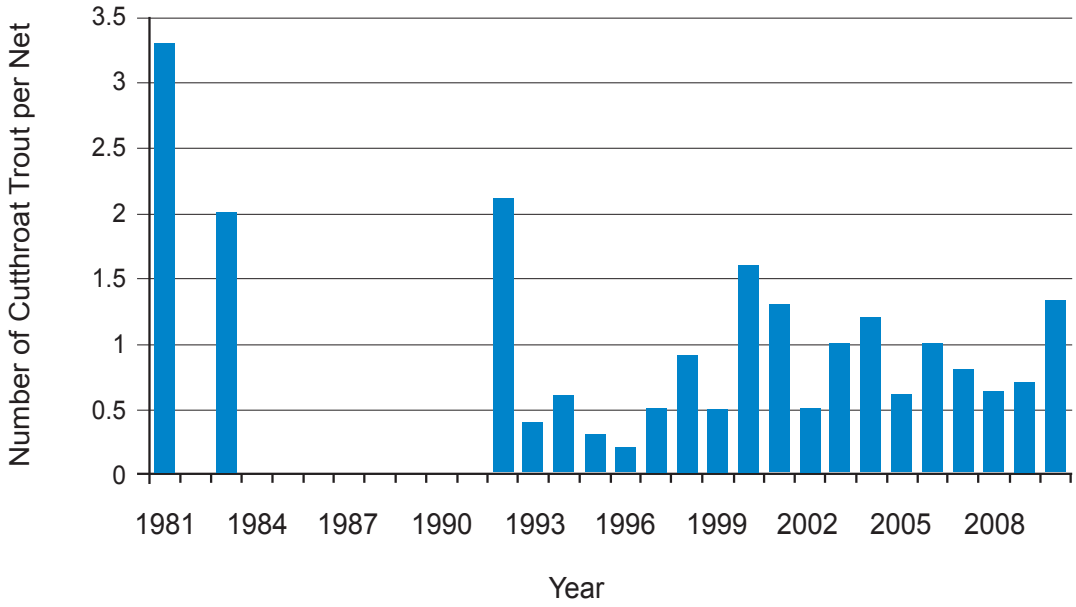

Figure 12. Mean catch per net of westslope cutthroat trout in gillnets set in Flathead Lake during spring, 1981- 2010. No nets were set between 1984 and 1991.

Mean catch rates in river sampling
Westslope cutthroat trout are sampled in the river system by MFWP by multiple techniques including electrofishing, hook and line and snorkeling. Population estimates are generated in multiple reaches of the river system. These metrics provide indications of indirect responses to lake trout suppression and would need to be further defined during implementation of an action alternative.

D. Lake Whitefish
Mean catch per net in autumn gillnetting series
Mean catch rates are developed from standardized random gillnetting procedures conducted annually in Flathead Lake. Lake whitefish are the most abundant species captured and are located in all habitats within the lake. Catch rates are high and consistent through all sample locations. The power to detect changes in abundance is 100% for all changes greater than 25%.

Mean catch per net in spring gillnetting series
Mean catch rates are developed from standardized gillnetting procedures conducted annually in five fixed locations during spring. The variance has been moderate since 1992 (Figure 12), although the power to detect change is also low because of the small sample size (15 pairs of nets).

E. *Mysis diluviana*
Mean Number of Mysis *per meter squared*
Monitoring of *Mysis* is conducted by the Flathead Lake Biological Station once per year on moonless nights in September at 40 sites. Lake trout prey heavily on *Mysis* and have the potential to be a good indicator of lake trout abundance, although recent trends in abundance of *Mysis* have been highly variable. Long-term baseline measures of *Mysis* density are 45 per meter squared.

F. Zooplankton
Mean Number of Zooplankton per standard vertical tow
Monitoring of zooplankton densities is conducted by the Flathead Lake Biological Station at specific locations by vertical net tows to a depth of 50 m. Metrics of change would be developed during implementation of an action alternative. Potential taxa for monitoring metrics are: all zooplankton, all cladocerans, or most likely, density of Daphnia sp. because they are the primary prey of *Mysis*.

G. Algae (Phytoplankton)
Mean density of algae per meter squared during August
Phytoplankton are microscopic organisms living in the water column that play the important role at the base of the food chain of photosynthesizing sunlight into biomass. Phytoplankton density is predicted to increase in each of the action alternatives. Monitoring of phytoplankton is conducted by the Flathead Lake Biological Station at specific locations within Flathead Lake using a 0-30 m tubular composite integrating sampler. An effective index of phytoplankton density is obtained by measuring the photosynthetic pigment called chlorophyll a. Baseline measures of chlorophyll a equal 0.1 micro grams per liter.

Phytoplankton in the water column reflects incident light causing water transparency to decrease as phytoplankton density increases. Secchi disks are used to measure water clarity, a surrogate measure of phytoplankton density, based on a measure of the greatest depth at which a 20 cm disk is visible. The baseline secchi depth is 12 meters, measured in August after complete dispersal of suspended sediment plume produced during the runoff period.

Methods to Estimate Total Harvest

Total lake trout harvested

General Harvest

Total harvest of lake trout would be achieved through a variety of methods, depending on the alternative selected. Determination of total lake trout harvested requires that harvest from each method be quantified. When necessary, harvest by the general public will be estimated by standard methods consisting of randomized aerial counts and access-based roving interviews of anglers throughout the year (Evarts et al. 1994). Because general harvest would be a minor component of the total harvest (<30%) in a lake trout suppression program, it would not be cost-effective to conduct an annual creel survey to estimate that small portion of the total harvest. In the absence of an empirical estimate, a default value of 25,000 lake trout harvested per year would be attributed to the general public (Appendix 5).

Targeted Suppression Harvest

Harvest during Mack Days, gillnetting, and trapnetting will be directly measured (counted) during those activities. The total harvest is the sum of each component.

Total lake whitefish harvested

General Harvest

Harvest of lake whitefish would be a product of recreational harvest and bycatch from other methods employed to suppress lake trout. If necessary, harvest by the general public will be estimated by standard methods consisting of randomized aerial counts and access-based roving interviews of anglers throughout the year (Evarts et al. 1994).

Targeted Suppression Harvest:

Harvest of lake whitefish during a suppression program by Mack Days, gillnetting, and trapnetting would be directly measured (counted) during those activities. The total harvest is the sum of each component.

Bycatch Harvest of bull trout

Bycatch of bull trout during the general harvest is estimated by the methods described in Appendix 5. Bycatch of bull trout in Mack Days, gillnetting and trapnetting would be enumerated directly (by counting).

Bycatch Harvest of westslope cutthroat trout

Bycatch of westslope cutthroat trout during the general harvest is estimated by the methods described in Appendix 5. Bycatch of westslope cutthroat trout in Mack Days, gillnetting and trapnetting is enumerated directly (by counting).

Methods to Estimate Angler Activity and Opportunity

Number of angling days on Flathead Lake

Total angler activity is monitored by MFWP using a standardized mail survey that canvasses licensed anglers. The survey is conducted in alternate years, with the last survey being conducted in 2011. Annual estimates have varied by over 100% since 2001 (Figure 13).

When necessary, total angling activity on Flathead Lake will be estimated by standard methods consisting of randomized aerial counts and access-based roving interviews of anglers (Evarts et al. 1994).

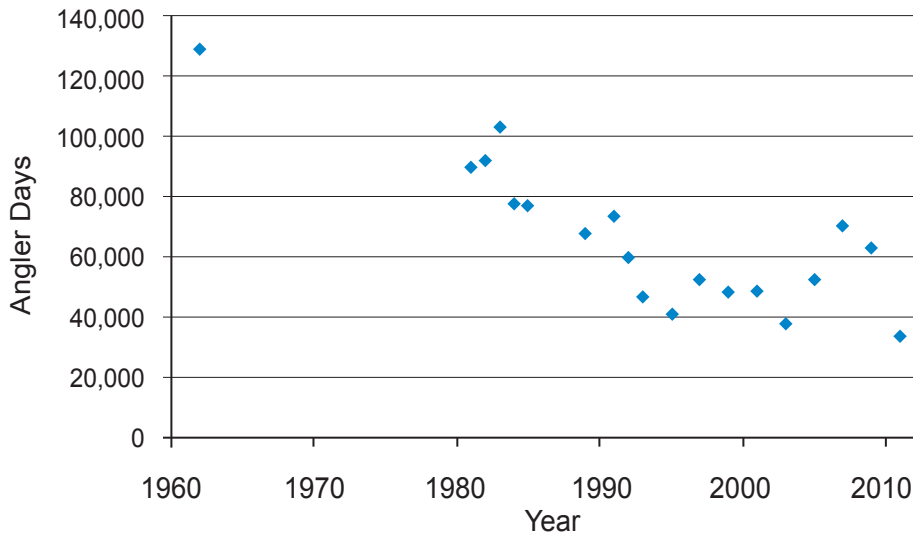

Figure 13. Total angler pressure on Flathead Lake estimated by a bi-annual mail survey (MFWP).

Number of angling days on Flathead River

Total angler activity is monitored by MFWP using a standardized mail survey that canvasses licensed anglers. The survey is conducted in alternate years, with the last survey being conducted in 2011. Annual estimates have varied by over 100% since 2001.

When necessary, number of anglers and length of fishing trips will be estimated by standard methods consisting of randomized aerial counts and access-based roving interviews of anglers (Evarts et al. 1994; Deleray 2004).

Average catch rates of lake trout

Catch rates of target fish, primarily lake trout are an indicator of fishing opportunity. When necessary, catch rates will be estimated by standard methods consisting of access-based roving interviews of anglers, either during specific periods or throughout the year (Evarts et al. 1994).

Extensive data are collected during the Mack Days contests which allows for a cost-effective and robust measure of angling success. Two measures have been developed that provide reliable and repeatable estimates of catch rates of lake trout. The first is the mean daily catch of the top 25 anglers in each of the spring and fall events (Figure 14). The baseline mean daily catch rate for the top 25 anglers during spring between 2010 and 2012 is 25 lake trout per trip, and during fall is 12 per trip. The means are developed from 35 sample days within the spring contest and 26 sample days within the fall contest. The second metric is the mean daily catch of all successful anglers in each of the spring and fall events (Figure 15). This metric incorporates the full range of angler expertise and is accordingly more variable than is the mean catch rate of the top 25 anglers. The baseline mean daily catch rate for all successful anglers during spring between 2010 and 2012 is 23 lake trout per trip, and during fall is 13 lake trout per trip. These metrics do not provide hourly catch rates, but rather daily catches that combine varying trip lengths spent by the range of anglers in the samples.

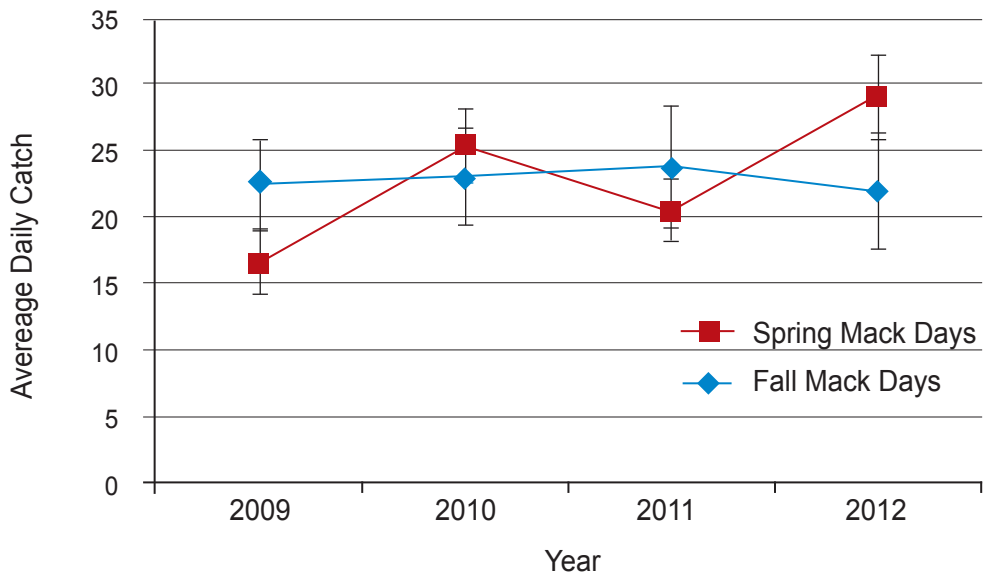

Figure 14. Average daily catch of top 25 anglers in Spring and Fall Mack Days, 2009 to 2012. The upward trend is influenced by the increase in daily bag limit restrictions from 50 to 100 over the same time period.

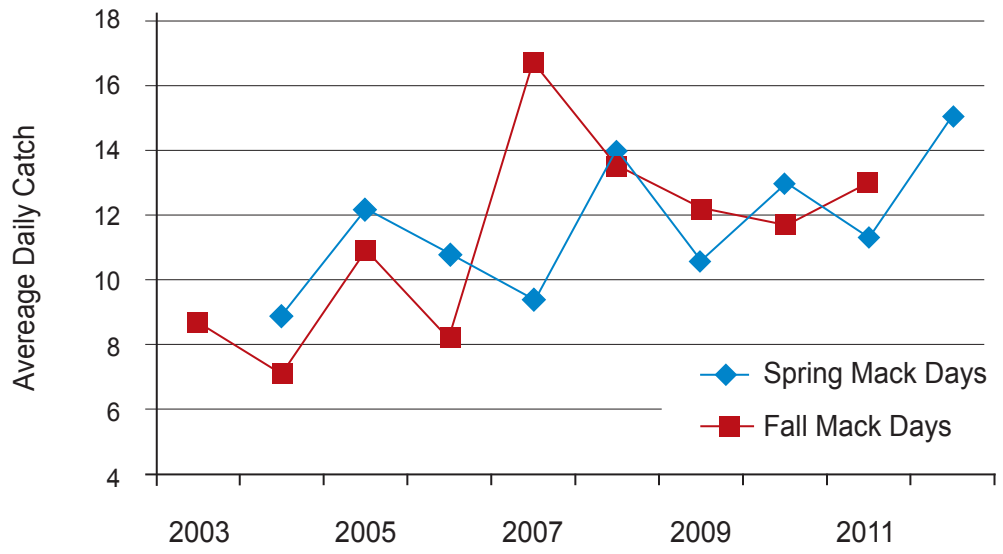

Figure 15. Average daily catch of all successful anglers in Spring Mack Days, 2004 to 2012 and Fall Mack Days, 2003 to 2011. The upward trend is influenced by the increase in daily bag limit restrictions from 20 to 100 over the same time period.

Appendix 9

ESTIMATION OF LAKE TROUT ABUNDANCE IN FLATHEAD LAKE

Introduction

To effectively manage the lake trout population, we need to know the abundance of lake trout. That knowledge allows us to set meaningful harvest targets, predict predation effects on other species, and monitor population changes through time. Much effort has been exerted to estimate lake trout abundance using mark and recapture—either the Lincoln-Peterson (single census) method based on single mark-and-recapture samples or the Schnabel (multiple census) method based on multiple mark-and-recapture samples (Ricker 1975). Both methods produce unbiased and accurate population estimates only when several assumptions are met (Ricker 1975): (1) the population is closed to additions and deletions during sampling; (2) marked and unmarked animals are equally vulnerable to capture; and (3) marked individuals do not lose their marks and are all recognized upon recapture. Violations of these assumptions lead to bias either upward or downward, depending on the specific way in which the assumption is violated.

Assumption 1: Population size does not change during sampling

Mortality and emigration must be equal for marked and unmarked individuals for the mark-recapture estimate to be unbiased. However, if handling causes marked individuals to die at a faster rate than unmarked

individuals (post-handling mortality), the resulting estimate will be biased high. We evaluated post-handling mortality in 2010 by holding 84 tagged lake trout (35 caught in gillnets and 49 caught by angling) for 24–192 hours (average = 67 hours) in an enclosure resting on the bottom of the lake at a depth of about 100 feet. Only one lake trout died while being held in the enclosure, which suggests a negligible (1.2%) rate of post-release mortality.

If recruitment or immigration occurs, the population estimate includes all animals present at the time of marking in addition to new individuals that entered the population during the period in which the estimate was conducted. In Flathead Lake, recruitment of new individuals during sampling is likely to occur as they grow into larger, vulnerable-length categories. For this reason, the population estimate refers to the number of individuals present at the time of marking, including those that were vulnerable to sampling for marking and those that grew into sizes that were vulnerable to recapture sampling. In contrast to recruitment, immigration of new lake trout into the population between the time of marking and recapture is likely trivial because the lake trout population in Flathead Lake is the largest in the region. Consequently, the effect of immigration on the mark-recapture estimate is negligible.

Assumption 2: Catchability of all fish does not change during sampling

The likelihood of capture cannot change based on differences in age, gender, social status, or territoriality. To overcome this problem, we distributed sampling effort randomly throughout the population. We also provided time from marking to recapture of individuals so that marked and unmarked individuals could mix randomly between marking and recapture sampling.

In 2009 and 2010, we identified differences in catchability between the spring and fall seasons. The spatial distribution of recapture sampling effort (that is, where people fished) differed between spring and fall angling tournaments (Figure 1). These differences led to higher captures of small lake trout during Spring Mack Days than during marking or Fall Mack Days. Young (small) lake trout likely live in deeper water than older (large) lake trout, so were more vulnerable to sampling in spring when 43% of angling effort was in deeper water, based on aerial counts of boats (Figure 1). Therefore, the estimate of lake trout abundance based on recapture samples from Spring Mack Days represented a broader segment of the total population (i.e. more small, young lake trout) than the estimate based on recapture samples from Fall Mack Days. These small (young) fish were present at the time of marking, but were not fully vulnerable to re-capture, in this case because little effort was exerted in deep water locations in which small (young) fish were present. Therefore, the mark-recapture estimate based on Spring Mack Days reflects the number of lake trout present in the population that were vulnerable to recapture sampling during Spring Mack Days, which is a larger fraction of the total population than was vulnerable during other sampling periods (Pollock et al. 1990).

Marking also must not alter the behavior of animals so that they are either more likely to be captured after marking than unmarked individuals (trap-happy response) or less likely to be captured after marking than unmarked individuals (trap-shy response). If lake trout are more likely to be recaptured, the mark-recapture estimate would be biased low. If less likely, the mark-recapture estimate would be biased high. To address this problem, we used different capture methods for marking and recapture. Typically, marking is by gillnetting and angling, whereas recapture sampling is largely by angling. Consequently, lake trout that were captured for marking by angling may have been more or less likely to be captured by angling during recapture sampling. Only one lake trout caught by angling was recaptured by angling on the same day, and many were recaptured within 10 days of capture, which suggests that trap-shy behavior was not evident.

FIGURE 1. Locations of fishing boats identified during aerial surveys conducted during Spring Mack Days (left panel; 12 March – 23 May 2010) and Fall Mack Days (right panel; 1 October – 14 November 2010) 2010 in Flathead Lake, Montana.

Assumption 3: Tags or marks are not lost between marking and recapturing periods

Tags cannot be lost, or if they are, tag loss must be quantified for the population estimate to be unbiased. To address this potential problem, we double-tag a subsample of fish to estimate tag loss so that the number of recaptures can be adjusted upward if necessary to account for lost tags. The assumption of double tagging is that an individual is exceedingly unlikely to lose both tags, so loss of one tag will almost always be observed. In 2010, we double tagged 51 lake trout and recaptured seven of them, all of which retained both tags. The sample size is too small to conclude that tag-loss does not occur, but suggests that tag-loss is probably insignificant.

In addition, all tags must be observed and identified during recapture sampling. Failure to identify tagged individuals causes the estimate of abundance to be biased high. Each captured fish is checked both by anglers (who have a financial incentive to identify marks) and by agency staff, so it is unlikely that marked fish will be missed upon recapture.

Population estimates of lake trout in Flathead Lake

One of the first efforts to estimate lake trout abundance in Flathead Lake took place between 1992 and 1996 (Weaver et al. 2006). The method used was the Schnabel-type in which anglers were recruited to mark lake trout and also to monitor their catches of marked fish over time. This effort, while not fully robust

because of possible violations of the assumptions listed above, produced an estimate of 353,732 lake trout in Flathead Lake in 1996 (Table 1).

Recent efforts by the Tribes and MFWP to estimate lake trout abundance began in 2007. Mack Days fishing contests were used to boost the number of marked fish and to more cost-effectively recapture a large sample of marked fish. This method allows the recapture sample to be increased at little additional cost. Larger samples are important because they increase the precision of the population estimate. By this method, we generated ten estimates between 2007 and 2012 (Table 1).

Table 1. Estimates of lake trout abundance in Flathead Lake, 1994 to 2012.

Estimate Number	Start Mark Period	End Mark Period	Total No. Mark	Start Recap Period	End Recap Period	Total No. Recap
1	1992	1996	1,376	1992	1996	11,572
2	10/5/07	3/10/08	856	3/14/08	4/27/08	10,108
3	9/28/09	3/9/10	1,089	3/12/10	5/23/10	34,696
4	9/28/09	3/9/10	1,089	10/1/10	11/14/10	14,351
5	9/30/10	3/10/11	897	3/11/11	5/27/11	26,262
6	1/6/11	5/22/11	853	9/23/11	11/13/11	18,475
7	9/30/10	3/10/11	897	9/23/11	11/13/11	18,475
8	9/30/10	5/22/11	1,281	9/23/11	11/13/11	18,475

Estimate Number	No. Recap Tags	Population Estimate	Upper Limit	Lower Limit	Exploitation %	Total No. Recap
1	11	353,732	786,071	215,472	0.8	11,572
2	21	393,791	618,645	261,867	2.5	10,108
3	33	1,110,106	1,591,300	797,366	3.1	34,696
4	31	488,864	708,834	347,775	2.9	14,351
5	33	693,651	1,001,173	485,510	3.7	26,262
6	34	450,813	646,126	317,390	4.0	18,475
7	26	614,497	933,008	410,656	2.9	18,475
8	42	550,842	759,694	402,330	3.3	18,475

Adjustment of the empirical population estimates based on capture vulnerability

Accuracy of a mark-recapture abundance estimate is determined by the fraction of the total population vulnerable to capture. Vulnerability to capture varies among capture methods, usually with length of fish. For most capture methods, including gillnetting and angling, smaller lake trout are less vulnerable than larger lake trout, as evidenced by the lower number of smaller fish captured, even though small fish are more abundant than large fish (Figure 3).

Vulnerability to capture is the result of variability in behavior of fish of different lengths. For example, to survive the threat of predation, smaller fish typically hide more and actively forage less than larger fish. Consequently, small fish are often less vulnerable to capture in gillnets and by anglers than larger fish. In Flathead Lake, lake trout shorter than 21 inches are not fully vulnerable to capture in gillnets, and therefore are underrepresented during gillnet sampling, whereas lake trout longer than 21 inches are fully vulnerable to the gear.

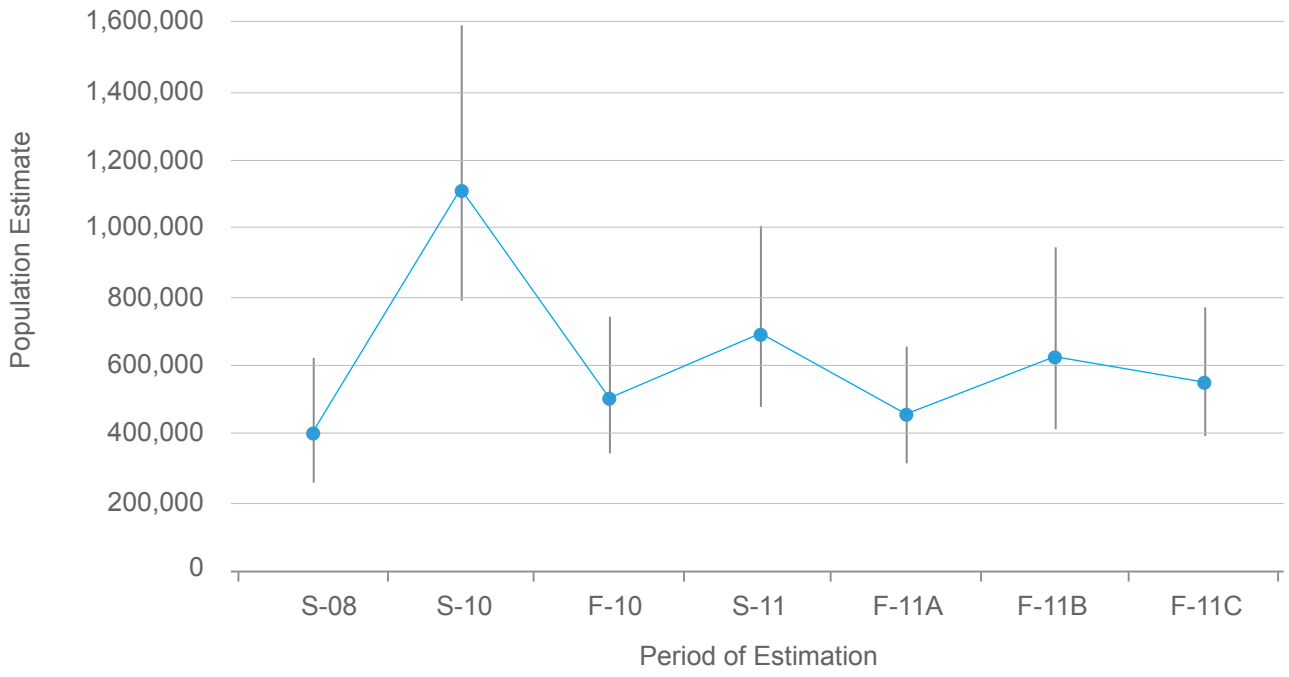

Figure 2. Mark and recapture estimates (and 95% confidence intervals) of lake trout abundance in Flathead Lake, 2008 to 2011. Note, this figure does not include expansion for capture-selectivity.

To accurately estimate abundance of each size group, size-specific capture rates are used to correct abundance of smaller sizes that were less than fully vulnerable to capture (Appendix 6). Correcting for differences in vulnerability generates the most realistic estimate of total abundance (Figure 5). The resulting modeled population consists of 1,480,280 individuals from age 1 through age 30, including 809,079 individuals from age 4 through age 30, and 312,895 individuals from age 10 through age 30 (Figure 6).

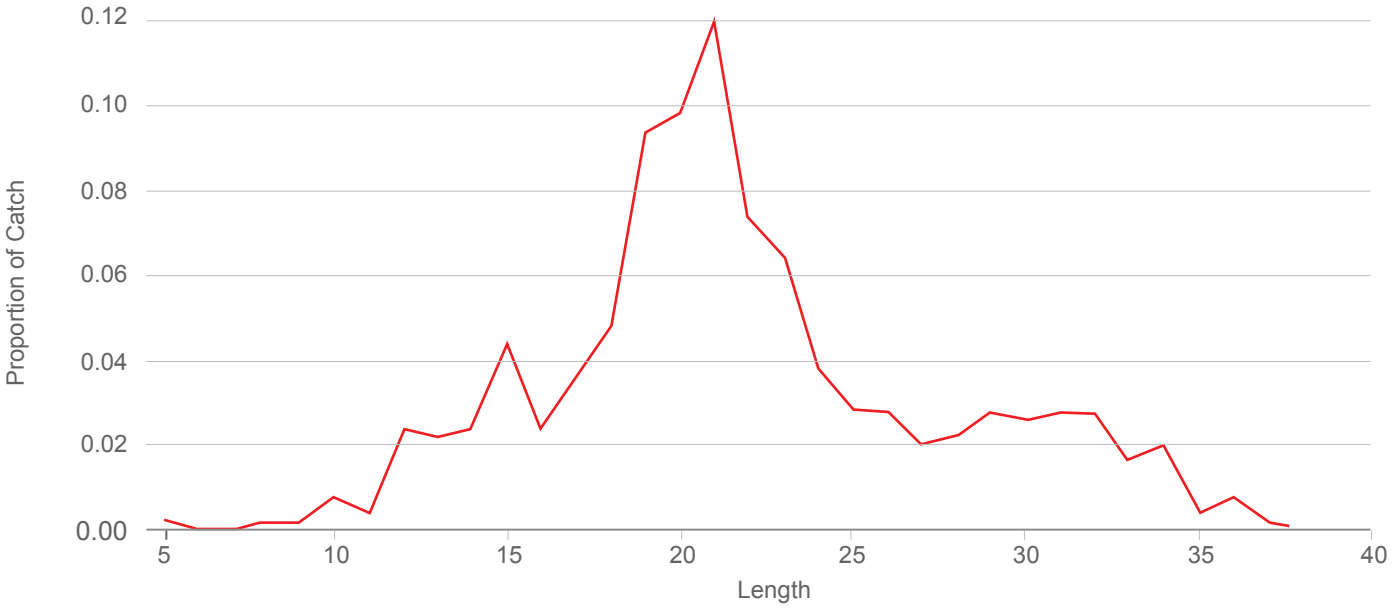

Figure 3. Length frequency of lake trout collected by gillnetting in Flathead Lake in autumn 2010.

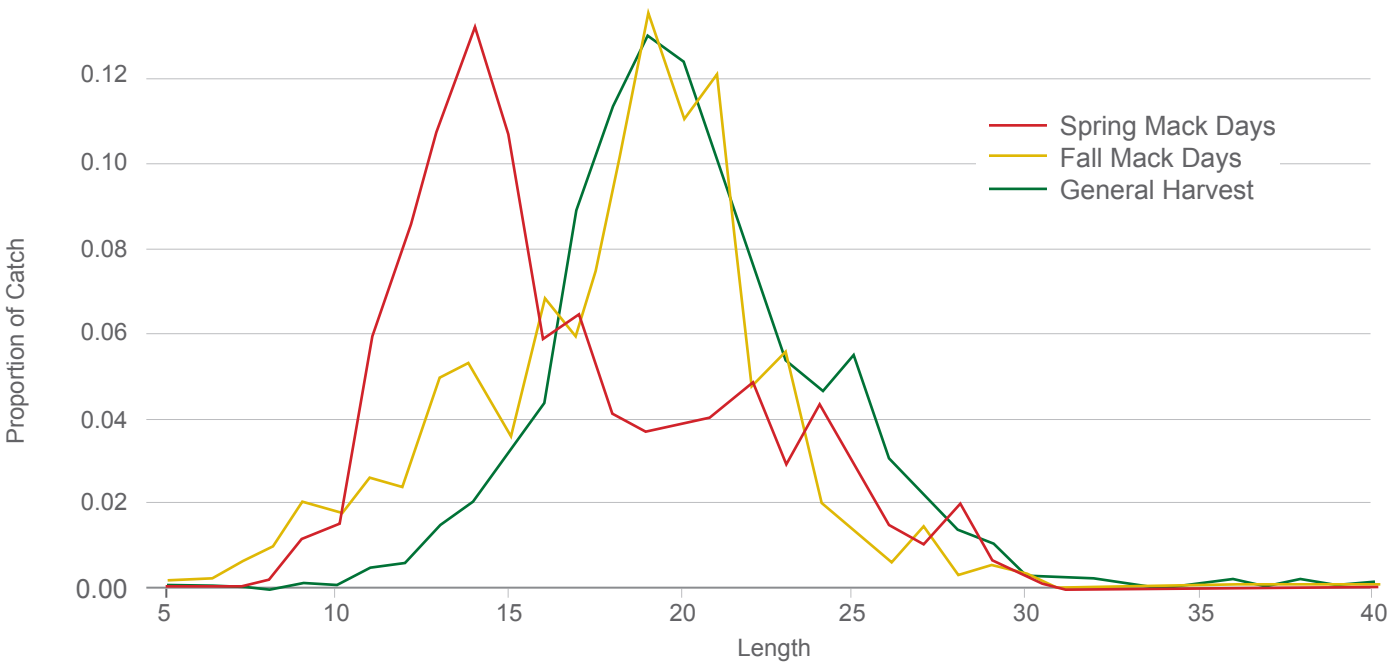

Figure 4. Length frequency of lake trout collected by angling during 2010 (CSKT files).

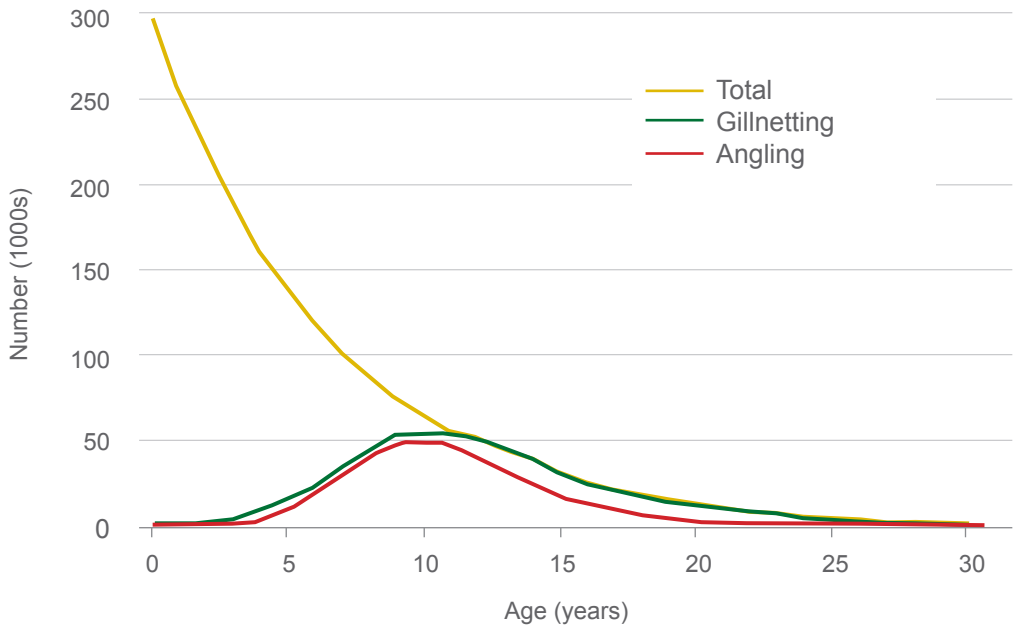

Figure 5. Graphical illustration of the process to convert gillnetting data to total population size (Hansen 2010).

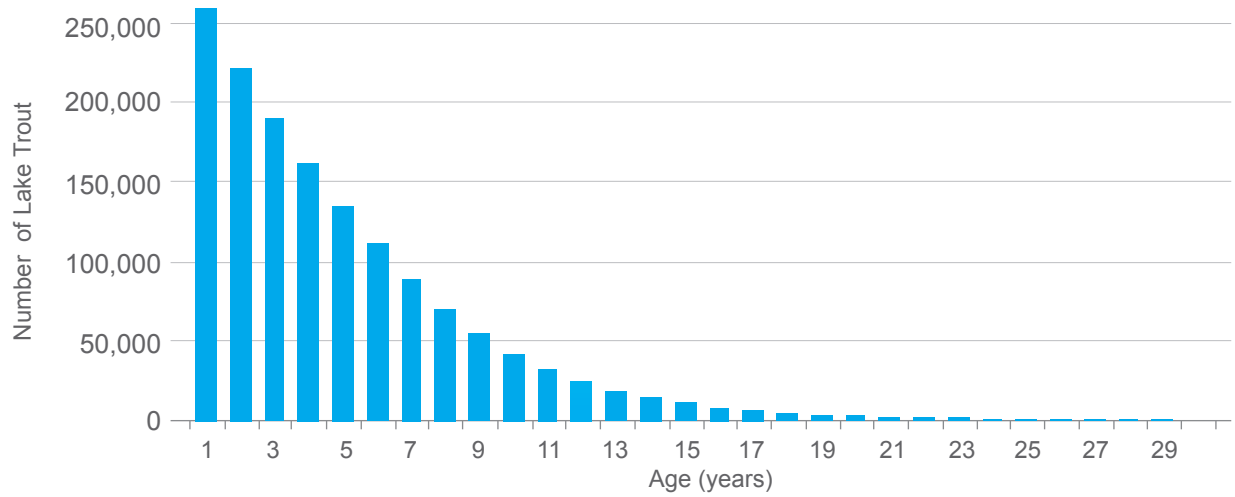

Figure 6. Modeled age structure of the Flathead Lake population of lake trout derived from samples collected by gillnetting in 2008 and adjusted by correcting for length selectivity in 2011 (Hansen 2011).

Appendix 9B. Estimation of Changes in Abundance Resulting From Reductions in Predation

As stated in the Purpose and Need for this project, reducing lake trout abundance is intended to increase native fish abundance. However, data and predictive models are not currently sufficient to accurately and precisely quantify numerical responses of prey species to decreased predation by lake trout. Despite our inability to accurately and precisely predict the effects of reduced predation on native species, the NEPA process requires that benefits and costs of alternatives be compared. High precision is not necessary to compare alternatives and to estimate benefit-risk ratios of alternatives. Accordingly, we compared alternatives based on an assumption that native species abundance will increase in proportion to the reduction in lake trout abundance when predation on that population is decreased. We used a combination of quantitative and qualitative tools to estimate responses of prey species to changes in lake trout abundance.

We first estimated lake trout abundance to establish the starting condition for a lake trout simulation model (Appendix 6). We used bioenergetics modeling to estimate predation on native species over a range of lake trout population sizes (Appendix 4). The final step, estimating potential increases in abundances of prey species in response to decreases in lake trout abundance and predation, was estimated qualitatively.

When predation is a predominant cause of mortality on fish populations, it limits abundance of prey species. Other predacious fish in Flathead Lake (in addition to lake trout) include northern pikeminnow, which is an important native predator, and northern pike, an important non-native predator, especially in the Flathead River (Muhlfeld et al. 2010). Disease, stress, and mammalian and bird predators also contribute to mortality of prey fishes in Flathead Lake. Additional mortality results from hooking during sport fishing and poaching. Despite the importance of these other sources of mortality, predation by lake trout is confirmed by diet analysis to be the largest source of mortality, and therefore, the primary limiting factor for several species in Flathead Lake (Beauchamp et al. 2006). Other mortality factors have been relatively constant or decreasing since lake trout numbers increased in the 1980s. Direct and indirect evidence indicate that past declines of native fishes were directly attributable to an increase in lake trout numbers (Beauchamp et al. 2006; CSKT and MFWP 2006). Bull trout and westslope cutthroat trout both declined 50% to 80% (depending on the indicator used) following lake trout expansion. An expert panel, convened in 1997, concluded that lake trout would need to be reduced by 70% to 90% to return the bull trout population to levels in the 1980s (McIntyre 1998). For purposes of this EIS, we used the quantity that native fish declined after lake trout expansion as the quantity available for increase in the future, should predation by lake trout be decreased.

Bull Trout

Adult bull trout abundance, based on a combination of direct and indirect estimates, has declined from 8,142 in 1982 to 1,306 in 1996 (Weaver 2010a). Currently, about 3,000 adult bull trout are present in the interconnected Flathead system (Weaver 2010a). In addition to 3,000 adult bull trout, about 20,000 juveniles are likely present in the population, based on backward projections from Age 6 to Age 1 using age-specific mortality rates (Weaver 2010b). Based on these estimates, about 5,000 fewer adult bull trout are present in the Flathead system than were present in the early 1980s (8,142 in 1982 minus about 3,000 at present). We attribute this difference to increased predation by lake trout following their population expansion. Therefore, if predation by lake trout was reduced to the level present in 1982, we assume that adult bull trout would increase to at least the level that was present in 1982.

Our expectations of bull trout increase may underestimate the full potential for population increase, but we prefer to avoid exaggerating the positive effects of management alternatives. Our estimates are conservative because bull trout numbers could increase to a higher level than was present in 1982. For example, the 1980s represent the oldest period of available records, so are often mistakenly used as a reference for full population potential. However, historic abundance of bull trout in the interconnected Flathead system prior to development likely exceeded 20,000 adults (Fredenberg, personal communication 2012). Reduced angling mortality and improved passage within spawning streams could both contribute to higher bull trout abundance than was present in the 1980s. In 1962, the annual harvest of bull trout exceeded the entire adult population size of the 1980s (Evarts 1998). We also assume that the entire historic potential of bull trout abundance is no longer possible because of irreversible changes in system production potential.

For the purpose of contrasting alternatives, we predict potential increases in bull trout abundance based on the percent reduction in predation by lake trout (Table 1).

Table 1. Predicted long-term increases in adult bull trout population in the interconnected Flathead system.

Alternative (% reduction of Age 8+ lake trout)	Percent Reduction in Predation (Appendix 6)	Numeric Increase in Adult Bull Trout (% reduction x 5,000)
A (0%)	38*	1,900
B (25%)	56	2,800
C (50%)	66	3,300
D (73%)	84	4,200
E (90%)	99	4,950

** The predicted reduction in predation is the result of fewer large lake trout greater than age 20.*

Westslope cutthroat trout

We did not attempt to predict numerical increases in westslope cutthroat trout abundance because we do not have estimates of the total number currently present. In relative terms, the 60% decline in migratory adults represents the potential increase if lake trout predation is eliminated. Therefore, for comparing alternatives, we assume that the potential increase in westslope cutthroat trout is between 0% and 60% and is directly proportional to the reduction in predation by lake trout. A 60% increase in abundance is equivalent to many thousands of individuals.

Lake whitefish

Lake whitefish abundance increased following the appearance of *Mysis*. The population size structure of lake whitefish is dominated by older fish, indicative of a lightly exploited population. Lake whitefish are the most important prey-fish of lake trout in Flathead Lake and therefore reductions of lake trout numbers would reduce predation on lake whitefish. However, the response of lake whitefish to reduced lake trout predation differs from the response of native trout because lake whitefish increased in abundance at the same time lake trout increased. Lake whitefish would likely increase in abundance following a reduction in lake trout numbers, up to the point that food-resources become limiting. Limitations in food resources would also vary among alternative because *Mysis* numbers would be larger for the alternatives having larger reductions of lake trout. A small increase in lake whitefish is expected from reducing lake trout abundance.

Yellow perch

Yellow perch have high fecundity and produce large year classes when environmental conditions are suitable. We do not have abundance measures for yellow perch, but we have observed high variability in annual recruitment. Lake trout and lake whitefish both prey heavily on yellow perch and together have probably suppressed yellow perch abundance. Decreases in predation by lake trout would be partially offset by increases in predation by lake whitefish. A small increase in yellow perch abundance is expected from reducing lake trout abundance.

Appendix 10

Economic Effects Analysis

Introduction

The four alternatives in the EIS have significantly different predicted impacts on lake trout. Additionally, because lake trout are a predatory species, changes in their abundance lead to changes in the abundance of the species they prey on, such as lake whitefish, yellow perch, westslope cutthroat trout, and bull trout. Anglers are motivated to fish specific waters based in part on the abundance of catchable fish in the waters. Studies in Montana as well as many other locations have shown changes in fish abundance and species mix is associated with changes in angler use (see, for example, Hagler Bailly Consulting, Inc. 1995). Because anglers spend money in local communities when they take fishing trips, these changes in angler trips can also lead to decreased levels of economic activity in economies surrounding affected lakes and streams (Figure 1).

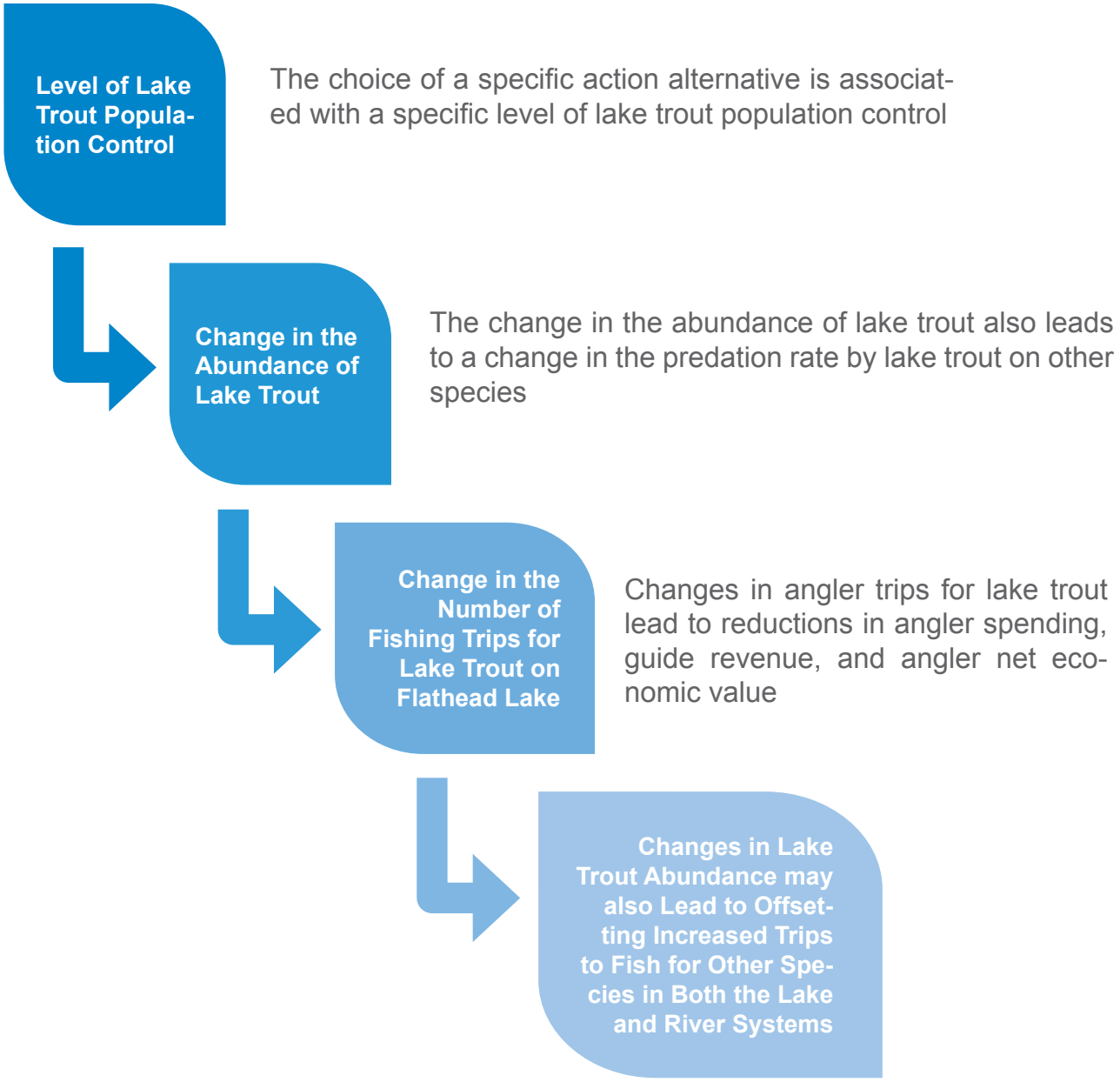

Figure 1. Relationship of changes in lake trout populations to changes in economic activity.

Table 1 shows long-term (>50 years) predicted changes in predation rates and lake trout abundance by alternative. Predicted short-term changes in abundance are much smaller. Large lake trout are most affected by all alternatives, including the Alternative A, leading to substantial declines in this lake trout size group over the long term.

Changes in abundance of prey species (lake whitefish, yellow perch, westslope cutthroat, and bull trout) are not shown as numeric percentage changes, but only as indicators of the direction of change due to uncertainty in the model predictions.

Table 1. Predicted long-term changes in lake trout predation and abundance by alternative.

Alternative	Species	Percentage Change in Predation Rate	Long-Term Percentage Change in Species Abundance (compared to current levels)
Alternative A NEPA-defined no action (maintain the status quo)	Lake trout – medium	0	0
	Lake trout – large	0	-58
	Lake whitefish	0	0
	Yellow Perch	0	0
	Westslope cutthroat	0	0
	Bull trout	0	0
Alternative B 25% reduction of adult (ages 8 and older lake trout numbers)	Lake trout – medium	NA	-13
	Lake trout - large	NA	-82
	Lake whitefish	-35	+
	Yellow Perch	-38	+
	Westslope cutthroat	-41	+
	Bull trout	-60	+
Alternative C 50% reduction of adult (ages 8 and older lake trout numbers)	Lake trout - medium	NA	-32
	Lake trout - large	NA	-94
	Lake whitefish	-60	+
	Yellow Perch	-56	+
	Westslope cutthroat	-57	++
	Bull trout	-73	++
Alternative D 73% reduction of adult (ages 8 and older lake trout numbers)	Lake trout - medium	NA	-57
	Lake trout - large	NA	-98
	Lake whitefish	-79	+
	Yellow Perch	-77	+
	Westslope cutthroat	-77	++
	Bull trout	-90	++

Classification of Estimated Impact Levels

In the following analysis, estimated impacts are presented and described in several ways. Where possible and appropriate, numerical estimates have been given in terms of lost dollars of angler spending or lost angler net economic value. Where numerical estimates are not available or possible, the estimated direction and magnitude of changes are described in qualitative terms. For each action alternative a summary categorical description of estimates of socioeconomic impacts is provided based on the classifications shown in Table 2.

Table 2. Estimated impact classification levels.

Impact Level	Impacts are described in terms of Short-Term Impacts (< 5 years) & Long-Term Impacts (> 50 years)
Negligible	The impact is at the lower levels of detection
Minor	The impact is slight, but detectable
Moderate	The impact is readily apparent and has the potential to become major
Major	The impact is severe, or if beneficial, has exceptional beneficial effects

Data and Assumptions of the Socioeconomic Environmental Consequences Analysis

Estimating the economic consequences associated with changing fish populations in a specific fishery is challenging. It is doubly challenging when two different fisheries are involved, such as is the case with the Flathead Lake and River-segment fisheries. Additionally, changes in species other than lake trout are not quantified. In this scenario, changes in lake trout populations, while reducing lake fishing pressure, may lead to partially offsetting increases in river fish populations and associated pressure. The following analysis and associated estimates of economic impacts associated with alternative lake trout control levels are based on a number of data sources and modeling assumptions (Table 3).

Table 3. Data sources and parameters used in economic analysis of environmental consequences.

Analysis Parameter or Assumption	Value	Source
Baseline fishing use levels for Flathead Lake and River segments	117,500 trips (2007 estimate) (MT residents – 94,378; Nonresidents- 23,122)	MFWP website (McFarland and Tarum 2008)
Flathead River segments impacted by changes in lake trout populations	Flathead River (Section 02) Middle Fork Flathead River North Fork Flathead River	
Distribution of Fishing Pressure by Species in Flathead Lake	Lake Trout 60% Lake Whitefish 20% Yellow Perch 20% Other - minimal	Personal Comm. Barry Hansen, CSKT
Percentage change in lake trout fishing trips associated with a 1% change in lake trout population abundance	Residents 0.66% (95% confidence interval, .32% to .99%) Nonresidents 1.22% (95% C.I. 0.85% to 1.58%)	Duffield (1995) analysis of 27 Montana River segments
Angler spending per trip	Residents $68.06 Nonresidents $591.86	USFWS (2010)
Angler Net Economic Value per Trip	Residents $38.00 Nonresidents $226.00	USFWS (2006)
Total Annual Economic Output, Employment, and Personal Income for Lake and Flathead Counties	Total Economic Output $4.1 billion; Total employee compensation $2.1 billion; Total jobs 73,528	IMPLAN Regional Economic Impact Program and Data (2008)

The parameters shown in Table 3 were used in estimating reductions in lake trout fishing trips and spending under the action alternatives. We predicted changes in angler use based on the assumption that 95% of lake trout fishing pressure targets medium-size lake trout and 5% targets large (trophy) fish (based on CSKT 2007-08 creel survey data).

The economic analysis focuses on the predicted changes in lake trout populations and associated changes in estimated angler spending and net economic value. The estimates for each alternative are presented as unadjusted estimates. This estimate does not incorporate the offsetting increase in river or lake fishing for non-lake trout species associated with decreases in lake trout. Additionally, the estimates do not incorporate any offsetting fishing activity outside or within the Flathead system associated with anglers choosing to fish elsewhere due to lower lake trout populations. Following the presentation of changes in angler use and spending under each alternative there is a discussion of mitigating factors that could lead to lower overall decreases in fishing pressure and associated angler spending. There are a number of potential mitigating factors.

Offsetting Fishing Pressure Targeting other Species

Several alternative actions are predicted to result in increases in fishable populations of several species that lake trout prey upon, including lake whitefish, yellow perch, westslope cutthroat trout, and bull trout (Table 1). Because an estimated 40% of Flathead Lake fishing trips target these other species, it follows that increases in these species will lead to increases in fishing pressure as well. The lake trout abundance model used in this analysis did not provide estimates of changes in abundance of these other species. Therefore, it is simply noted that under Alternatives C and D (and possibly B) there would be some level of off-setting angler use and associated spending in Flathead Lake.

In addition to reductions in lake trout benefiting other species in the lake, Flathead River system populations of some of these other species would also likely increase due to reduced predation by lake trout. Therefore annual angler trips (and associated spending) to the upstream sections of the Flathead River System would also likely increase, providing additional angler use and spending to off-set the losses due to reduced lake trout angling.

Angler Substitution Behavior as an Offsetting Factor

The estimates of changes in angler use and spending assume that when, due to declining fish abundance, an angler chooses not to take a trip to fish for lake trout in Flathead Lake, they do not instead choose to take a different fishing trip. This different trip could be to fish for another species in the lake or to fish in the Flathead River or even to fish in a completely different river or lake within or outside of Lake and Flathead Counties.

A 1995 study of Montana angler behavior on a set of 27 Montana river and stream sections found that approximately 89% of increases or decreases in angler trips to fish a water due to increased fish populations is offset by corresponding decreases or increases in trips to fish other Montana waters (Hagler Bailly Consulting, Inc. 1995). While this study was of river-fishing behavior and not lake-fishing, it suggests a significant share of any lost angler trips to fish for lake trout on Flathead Lake may simply be transferred to recreational use on other Montana waters.

Time as a Mitigating Factor

The timeframe of the impacts of the proposed action alternatives on lake trout abundance is extremely important in order to evaluate the socioeconomic impacts on angler trips, spending, and net economic values associated with alternative management actions. Within the world of economic impact analyses, a 50-to-200-year time horizon for the phasing in of impacts is extremely long. Furthermore, these predicted changes in lake trout abundance over time would occur within an environment of a general long-term decline in Flathead Lake fishing pressure and a general long-term increase in Flathead River fishing pressure. These trends are evident both in all angling activity (Figure 2) and in guided fishing pressure (Figure 3).

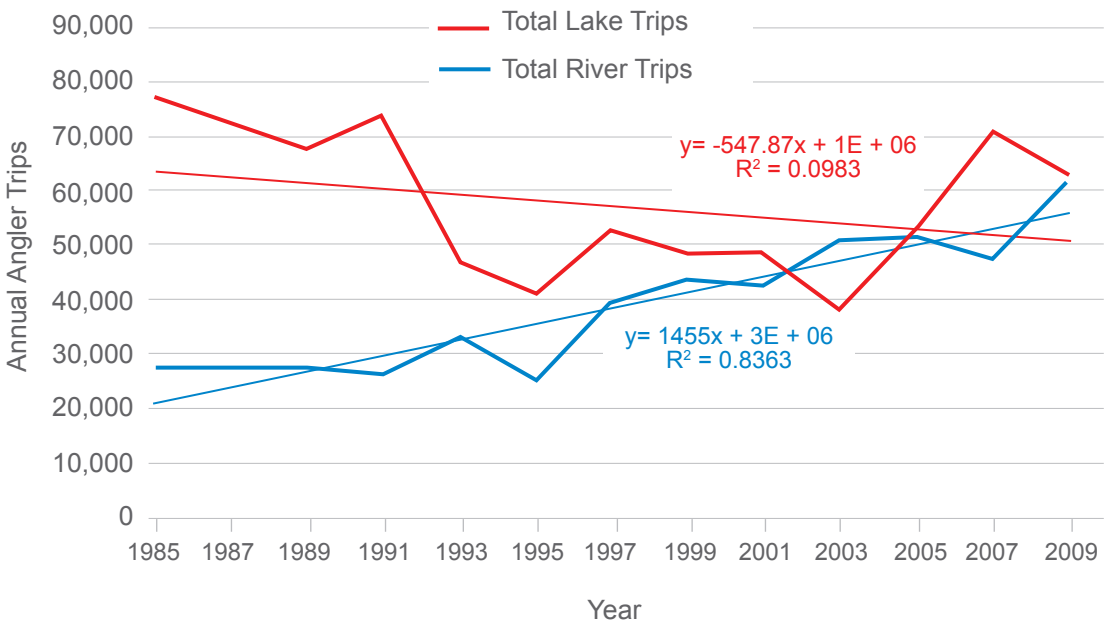

Figure 2. Annual guided fishing days, Flathead Lake and River segments, and associated linear trends over time (Source MT Dept. Fish, Wildlife & Parks).

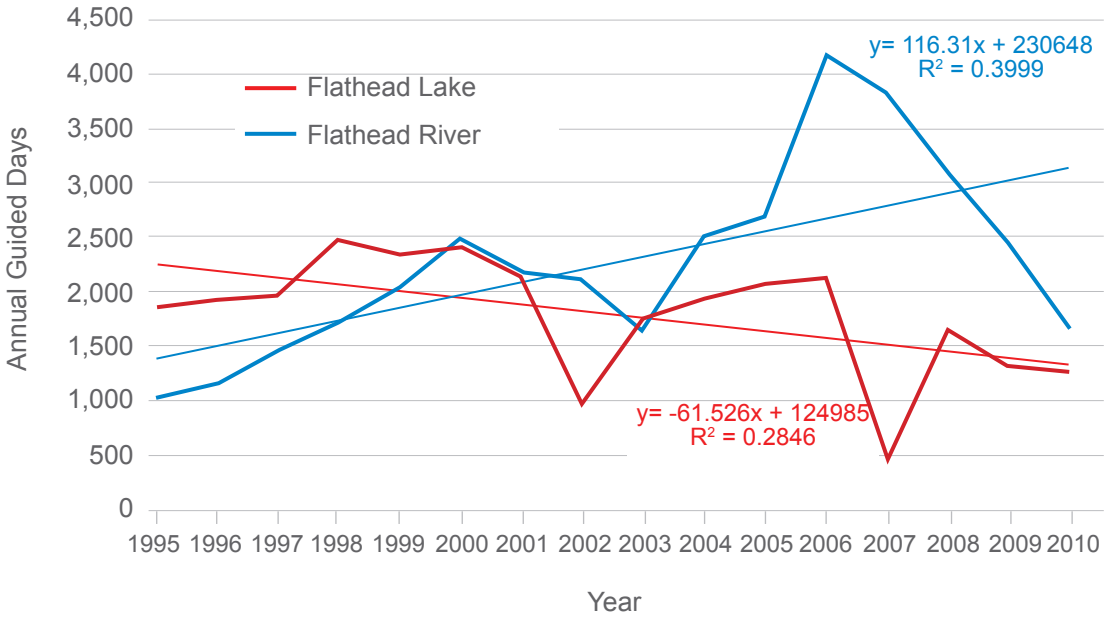

Figure 3. Trends in guided fishing use on Flathead Lake and River sections (upstream of the lake): 1995-2010 (Source MT Dept. of Commerce).

Taken together, the potential for anglers to offset some reduced lake trout fishing trips with fishing for other species in the lake, fishing in other nearby or state waters, and fishing more abundant species in the upstream Flathead River system suggests that total losses in lake trout angler pressure in the region may be significantly mitigated in the long run by these factors. Based on the estimate of compensating substitution

behavior from the 1995 Montana angler study alone, nearly 90% of estimated angler expenditure decreases may be offset by spending associated with fishing on other waters or for other species. The following impact estimates numerically present only estimated expenditure impacts associated with decreased lake trout populations. It must be emphasized, however, that the estimate of changes in angler behavior and spending would not be instantaneous, but would occur over a number of decades and within an existing environment of changing angler behavior. This long-term phase-in of impacts on lake trout abundance would provide lake trout anglers and guides on Flathead Lake ample opportunity to adjust their behavior in order to mitigate impacts.

Reductions in Lake Trout Angler Net Economic Value

Each of the action alternatives (Alternatives B, C, and D) lead to substantial reductions in lake trout populations over time. These reductions are in turn estimated to lead to reductions in angler trips targeting lake trout and associated trip expenditures. An additional category of economic loss is the loss of trip value over and above that which an angler actually spends on their fishing trip. This value is often referred to as "Net Economic Value" or "Consumer's Surplus." The U.S. Fish and Wildlife Service (2006) estimated that anglers fishing Montana waters had an average per trip Net Economic Value over and above what they spent on their trip of $38 for Montana residents and $226 for nonresident anglers. Based on the estimated losses in angler trips targeting lake trout in Flathead Lake (compared to the Alternative A, No-action alternative), associated losses in lake trout angler net economic value are estimated to range from zero, in the case of Alternative A, to -16.1% for Alternative D.

It is important to note that as in the case of estimated reduced angler expenditures, these losses in net economic value would likely be offset to a large extent by increases in net economic value associated with increased angler trips to fish for non-lake trout species or to fish different Montana waters.

Table 4. Estimated net economic value losses associated with decreased lake trout fishing trips.

Alternative	Change in Total Angler Net Economic Value
Alternative A NEPA-defined no action (maintain the status quo)	0
Alternative B 25% reduction of adult (ages 8 and older lake trout numbers)	-3.9%
Alternative C 50% reduction of adult (ages 8 and older lake trout numbers)	-9.2%
Alternative D 75% reduction of adult (ages 8 and older lake trout numbers)	-16.1%

Passive Use Values associated with Increased Bull Trout Populations

The motivation for control of lake trout in Flathead Lake is to reduce predation on westslope cutthroat trout and ESA-listed bull trout. This reduced predation of bull trout by lake trout in turn would lead to more viable bull trout populations in the Flathead System and aid recovery of the species.

Existence value reflects the utility the public derives from knowledge that a species continues to exist. A number of published studies have demonstrated that the public holds values for endangered and threatened species separate and distinct from any expected direct use of these species (i.e. willingness to pay to simply ensure that a species will continue to exist). These studies include Boyle and Bishop (1987), Elkstrand and Loomis (1998), Kotchen and Reiling (2000), and Loomis and White (1996). There is little doubt that bull trout provide intrinsic values and that these values will be enhanced by the species survival and recovery.

As a point of comparison, a study by Duffield and Patterson (1992) discusses existence value for two fish species in the Western US that appear similar to the case of the bull trout. The authors surveyed nearly 8,000 licensed fishermen in Montana to assess the passive-use value associated with the arctic grayling and cutthroat trout, two sensitive fish species found in the state's waterways. Survey participants were asked to value improved stream flows on select spawning tributaries that were recently severely dewatered. Using two different payment vehicles, including actual cash donation (where participants mail an actual contribution) and a future hypothetical donation to an organization that manages a trust fund that oversees stream flows, respondents were asked how much they would be willing to contribute (or, actually contribute) to maintain summer flows on tributaries that support the arctic grayling and cutthroat trout. The respondents that expressed a willingness to contribute indicated that they were willing to pay between $15 and $32 (in 1989 dollars) in a one-time payment.

Another perspective on the benefits associated with bull trout protection is to examine the apparent value placed on protecting and enhancing bull trout populations as revealed through public decisions. Value in this context refers to value based on all possible motivations or uses, including direct and indirect use and existence motives. One such decision was the decision by the Confederated Salish and Kootenai Tribes to implement its Wetland/Riparian Habitat and Bull Trout Restoration Plan[1].

The settlement of a natural resource damage assessment case on Silver Bow Creek and the Upper Clark Fork River provided the Confederated Salish and Kootenai Tribes with a fund to "restore, replace, or acquire equivalent" fishery and environmental services that had been damaged by a century of mining and milling in the Clark Fork basin[2]. The settlement consisted of $1.5 million specifically for bull trout recovery, $6.4 million for wetland/riparian restoration, and $10.4 million for "compensables." The latter category is compensation for foregone use and is to a large extent discretionary. The Tribes considered six different major watersheds for recovery efforts including the Flathead River Corridor Area, Little Bitterroot Watershed, Crow Watershed, Mission Watershed, Camas Watershed, and Jocko Watershed. They chose to focus the entire $18.3 million on bull trout recovery in the Jocko River basin, where wetland/riparian restoration is that fishery's biggest need[3]. This decision was made by the Tribal Council. The Jocko was selected in part because it is historically an important bull trout fishery [4] and because it shares some similarity to the damaged Silver Bow Creek (also a bull trout fishery, a similar sized watershed (about 390 square miles) with a similar rate of discharge). The Jocko watershed is also the most similar to Silver Bow Creek in its species composition and traditional cultural use. In addition, the watershed is "the most valuable bull trout tributary habitat on the Reservation" and provides "the greatest potential for wetland and riparian

1 Confederated Salish and Kootenai Tribes. 2000. Wetland/Riparian Habitat and Bull Trout Restoration Plan.
2 Personal communication, Joe Hovenkotter, tribal attorney, Confederated Salish and Kootenai Tribes, Pablo, February 3, 2003.
3 Ibid. and Les Evarts, Fisheries Biologist, Confederated Salish and Kootenai Tribes, Pablo, Jan 31, 2003.
4 Personal communication, Marcia Pablo, Cultural Preservation Officer, Confederated Salish and Kootenai Tribes, Pablo, Feb 3, 2003. See also the discussion in Section 5.2.2 on Tribal values and history related to bull trout.

area restoration"[5]. The total allocation of $18.3 million to bull trout recovery and wetland/riparian restoration is a significant commitment of resources, particularly in light of the relatively small total population of the Tribes.

INCIDENCE AND SIGNIFICANCE OF ESTIMATED ECONOMIC IMPACTS

The preceding discussion of economic impacts associated with alternative lake trout control levels is expressed in terms of reductions in angler expenditures and reductions in net economic value. These estimated impacts are qualified by noting the likely offsetting impacts of increases in angling activity, spending, and net economic value associated with compensating increased angling in other locations and for other species. Finally, it is also noted that in the context of the overall size of the Lake County and Flathead County economics, even the estimated impacts without any compensating offsets are extremely small. However, while the significance of impacts may be very small in the context of the overall economy, it is likely that some individuals and businesses would be significantly adversely impacted by some alternatives.

The businesses and individuals most likely to be adversely impacted are Flathead Lake fishing guides who specifically target lake trout in general and trophy lake trout in particular. Some of the action alternatives call for near elimination of large lake trout and substantial reductions in smaller lake trout populations. While these alternatives and their associated impacts would be phased in over a period of years, lake trout anglers and guide businesses who did not adjust their activities and business models to the changing realities of declining lake trout populations would likely see their businesses and revenues decline substantially over time.

In addition to lake trout fishing guides, any other local businesses that derive a large part of their business revenue from lake trout anglers would probably also see their revenues decrease over time, all other things being equal, as lake trout stocks were reduced in the lake.

While those businesses catering to lake trout fishing may be disproportionately negatively impacted over time, river fishing guides upstream of Flathead Lake may benefit from the lake trout reductions as the populations of other fish species increase.

As a final point of context for evaluating the estimated impacts on angler use and spending of the action alternatives, it is important to note that the estimated overall angler use changes—even when not adjusted for likely offsetting increases in fishing pressure on other waters and for other species—are quite small (less than one-half) when compared to actual observed decreases in angler use experienced from 1983 to 1995 and resulting from MFWP introduction of Mysis shrimp into Flathead Lake. This is true even though the predicted changes in angler use resulting from lake trout control would occur over 50 to 200 years, and the observed historic changes resulting from shrimp introduction occurred over only 12 years.

5 Confederated Salish and Kootenai Tribes. 2000. Wetland/Riparian Habitat and Bull Trout Restoration Plan. At p. 38.

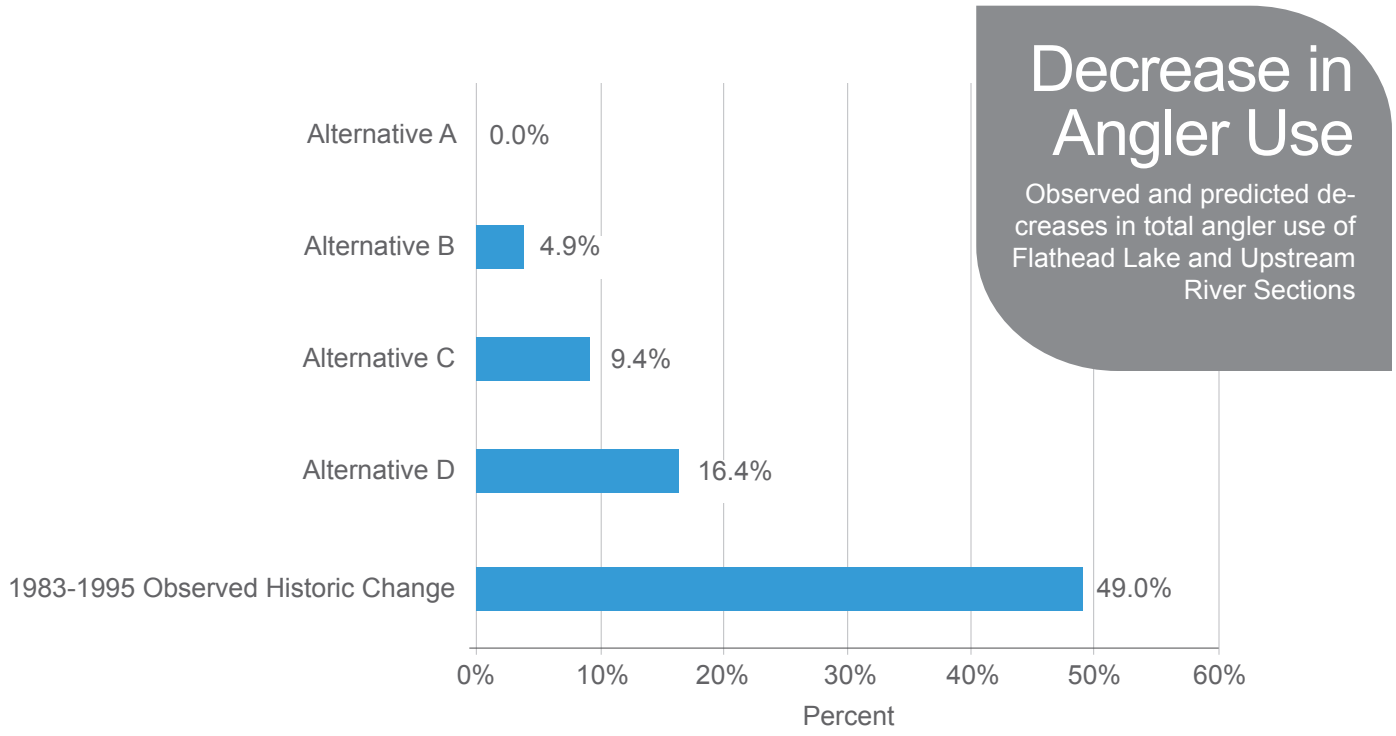

Figure 4. Comparison of the total estimated impacts of action alternatives on Flathead system angler use with observed historic impacts of Mysis *shrimp introduction in Flathead Lake.*

Appendix 11

Restoration Plan for Bull Trout Clark Fork River Basin and Kootenai River Basin, MT

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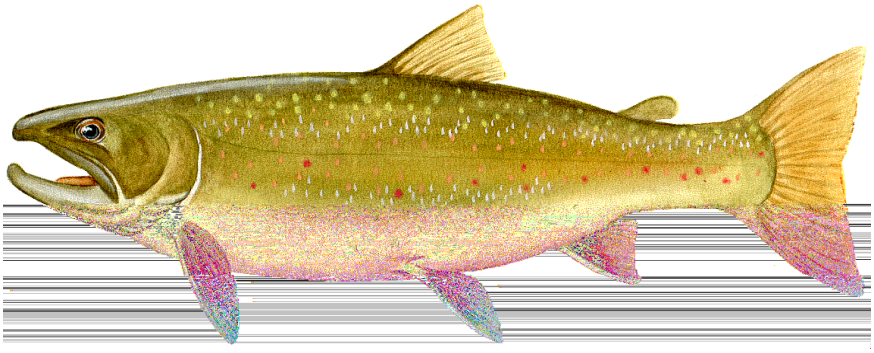
RESTORATION PLAN
FOR
BULL TROUT
IN THE
CLARK FORK RIVER BASIN
AND
KOOTENAI RIVER BASIN
MONTANA



Prepared by:

MONTANA BULL TROUT RESTORATION TEAM

FOR GOVERNOR MARC RACICOT

c/o Montana Department of Fish,Wildlife and Parks
1420 East Sixth Avenue
Helena, Montana 59601

JUNE 2000

RESTORATION PLAN FOR BULL TROUT IN THE CLARK FORK RIVER BASIN AND KOOTENAI RIVER BASIN, MONTANA

This restoration plan for bull trout in Montana was developed collaboratively by, and is supported by, the Montana Bull Trout Restoration Team, appointed by Governor Marc Racicot. Restoration Team members represented the organizations listed below. All parties to this restoration plan recognize that they each have specific statutory responsibilities that cannot be abdicated, particularly with respect to the management and conservation of fish and wildlife, their habitat, and the management, development and allocation of land and water resources. Nothing in this plan is intended to abrogate any of the parties' respective responsibilities. Each party has final approval authority for any activities undertaken as a result of this agreement on the lands owned or administered by them.

The Restoration Plan was developed by the Montana Bull Trout Restoration Team, represented by the following organizations and agencies (arranged in alphabetical order by agency/organization):

American Fisheries Society

Bonneville Power Administration

Confederated Salish and Kootenai Tribes

Montana Department of Fish, Wildlife and Parks

Montana Department of Natural Resources and Conservation

National Wildlife Federation

Plum Creek Timber Company, L.P.

U.S. Fish and Wildlife Service

U.S. Forest Service

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EXECUTIVE SUMMARY

Purpose of the Bull Trout Restoration Plan

The purpose of this restoration plan is to provide the framework for a strategy to reverse or halt the decline of bull trout populations in western Montana, and restore populations in areas where they have declined. The plan provides general guidance for conservation and protection of those populations that are stable or increasing, as well as recommendations to restore populations that have declined. Its approach is to conserve the best remaining populations and restore diminished populations. This document is intended to guide state restoration efforts, and complement federal conservation and recovery processes. It is intended to be used by management agencies, watershed groups, and private landowners as a reference to conserve and recover bull trout throughout western Montana. The plan complements existing mandates and management objectives, such as forest plans, and should be adopted and incorporated into them.

Bull Trout Life History

Bull trout are native to the streams and rivers within the Columbia River basin in western Montana. They are found in all major river drainages including the Blackfoot, Clark Fork, Swan, Flathead, and Kootenai Rivers. Bull trout are generally migratory, spawning and rearing in smaller, higher order streams, and then later rearing and overwintering in larger rivers or lakes. They have very strict habitat requirements that are generally referred to as the four C=s - clear, cold, complex, and connected. This includes clean, cold water; high levels of shade, undercut banks, and woody debris in streams; high levels of gravel in riffles and low levels of fine sediments; stable, complex stream channels; and connectivity among and between drainages. Connectedness between populations allows periodic genetic exchange, as well as founding of new populations and recolonization of extirpated populations by migrants. This variety of life history strategies and resulting habitat requirements is important to the stability and persistence of populations, but also complicates restoration and conservation because a diversity of high quality habitats are needed. When individual habitat components are altered, by human or natural events, bull trout populations may be negatively impacted.

Montana=s Bull Trout Restoration Team

Bull trout populations have been harmed by (in no particular order) competition, hybridization, and predation by legally and illegally introduced fish; land management activities; fishing harvest; and loss of habitat connectivity. Since settlement of Montana by Europeans, the distribution of bull trout in Montana has declined, prompting the need for a formalized conservation strategy to protect and conserve the species. In response to the decline of the species, Governor Marc Racicot appointed an interdisciplinary Bull Trout Restoration Team in 1993 to Awork in a cooperative fashion to produce a plan that maintains, protects, and increases bull trout populations@ independent of the federal listing process. The restoration team

consists of nine members that represent state, federal, and tribal management agencies, industry, and conservation organizations. The team was chartered to produce a restoration plan that would:
1) include a process and timetable for recovery, 2) set specific restoration goals, resource management criteria, and methods to monitor results; and 3) identify the biological and habitat needs of bull trout.

Restoration/Conservation Areas for Bull Trout

The Restoration Team appointed a group of scientists to provide the technical expertise necessary for the restoration planning effort. The Scientific Group recognized 12 different restoration/conservation areas (RCAs) in four major drainages based on the current pattern of distribution and fragmentation of bull trout populations in Montana:

Major river drainages and respective restoration/conservation areas:

Clark Fork Basin
- Clark Fork River drainage
  - Lower Clark Fork River (downstream from Thompson Falls Dam)
  - Middle Clark Fork River (Thompson Falls Dam to Milltown Dam)
  - Upper Clark Fork River (upstream from Milltown Dam)
  - Rock Creek (tributary to upper Clark Fork River)
  - Bitterroot River
  - Blackfoot River

- Flathead River drainage upstream from Kerr Dam
  - Flathead River (North and Middle Fork Flathead River, Flathead Lake)
  - South Fork Flathead River (upstream from Hungry Horse Dam)

- Swan River (upstream from Big Fork Dam)

Kootenai River Basin
- Kootenai River drainage
  - Lower Kootenai River (downstream from Kootenai Falls)
  - Middle Kootenai River (between Kootenai Falls and Libby Dam)
  - Upper Kootenai River (upstream from Libby Dam).

These restoration/conservation areas largely represent fragmentation of the historic range of bull trout in Montana into isolated groups of populations mainly due to human alteration of the environment. Restoration of bull trout will require restoration of historical connectivity

within and among these areas. Connectivity is achieved when fish can move between areas and interbreed. The more connectivity that can be restored within and among these areas, the greater the likelihood of long-term survival. With this structure, a local population may go extinct, but through occasional straying of migrants from other populations, may be recolonized.

Status reports for each of the restoration conservation areas were prepared by the Scientific Group. Included in the status reports are a description of the status of bull trout in each of the areas, identification of threats to restoration, identification of core areas containing the best remaining spawning and early rearing habitat where recovery efforts should be focused, and a recovery or conservation goal for the watershed. The restoration plan is founded on these status reports, as well as technical reports on the role of stocking in bull trout recovery, the relationship between land management activities and habitat requirements of bull trout, and an assessment of methods for removal or suppression of introduced fish to aid in bull trout recovery.

Within each restoration/conservation area, core areas have been identified for bull trout (Appendix C, Figs. 5-16). Core areas are watersheds, including tributary drainages and adjoining uplands, used by migratory bull trout for spawning and early rearing, and by resident bull trout for all life history requirements. Core areas typically support the strongest remaining populations of spawning and early rearing bull trout in a restoration/conservation area, and are usually in relatively undisturbed habitat. Nodal habitats are those used by sub-adult and adult bull trout as migratory corridors, rearing areas, overwintering areas, and for other critical life history requirements.

The emphasis of restoration will be focused on protecting and restoring core areas that contain the best remaining spawning and early rearing habitat for bull trout in each restoration/conservation area, maintaining the genetic diversity represented by the remaining local populations, and reestablishing and maintaining historical connectivity within and between areas where and when possible. Because of the importance of core areas to conservation and restoration of bull trout in Montana, overall restoration will be based on protection of them. Since multiple populations are less likely to go extinct at the same time due to natural events, viability of bull trout will be greatly enhanced by maintaining multiple populations in multiple restoration/conservation areas. These considerations were used in development of the goal, objectives, and restoration criteria for restoration of bull trout in Montana.

This restoration plan is a voluntary effort on behalf of the State of Montana to restore bull trout populations to a sufficient level of abundance and distribution to allow for recreational utilization. Recreational utilization will be allowed for individual populations that meet specific criteria similar to that developed for Hungry Horse Reservoir and described on page 29. The restoration criteria contained herein may exceed those that are necessary to consider bull trout Arecovered@ under the ESA, and should not be construed as Arecovery criteria@ for the purposes of ESA delisting of bull trout. ESA recovery/delisting criteria will be developed independent of, but complementary to this plan as part of the federal recovery planning process.

Restoration Goal/Objectives

Goal: The goal of the Montana Bull Trout Restoration Plan is to ensure the long-term persistence of complex (all life histories represented), interacting groups of bull trout distributed across the species= range and manage for sufficient abundance within restored RCAs to allow for recreational utilization. To meet this goal, cooperative management, monitoring, and restoration among local, state, tribal and federal resource management agencies, as well as private citizens, conservation organizations, and industry will be necessary. Without such cooperation, it will not be possible to meet the goal and objectives of this plan.

Goal Objective 1 - Protect existing populations within all core areas and maintain the genetic diversity represented by those remaining local populations

Bull trout populations, including disconnected local populations, have substantial genetic divergence among them (Leary et al. 1993; Kanda et al. 1997, unpublished information). Therefore, each breeding population, roughly the equivalent to each core area, should be conserved. Each of the populations represented in the 115 core areas distributed throughout the 12 RCAs (Appendix C) must be protected, and if necessary, enhanced (expanded) in order to conserve the unique genetic diversity contained in those populations. Protection of populations within core areas also requires that nodal habitat be managed appropriately in order to maintain the complete life history of each unique population.

Goal Objective 2 - Maintain and restore connectivity among historically connected core areas

The effective population size of core area populations, and therefore the long-term persistence of bull trout within its native range in Montana will be enhanced by reconnecting historically connected core areas within RCAs to provide opportunity for genetic exchange between populations and refounding of new populations. Any measures to facilitate passage between populations must carefully consider how to best prevent the spread of whirling or other diseases or organisms throughout the watershed that may adversely affect bull trout or other species of native fish, such as westslope cutthroat trout.

Goal Objective 3 - Restore and maintain connectivity between historically connected Restoration/Conservation Areas (RCAs)

Fragmentation among populations is a serious threat at different geographic scales, from larger scale RCAs to smaller scale core areas (see number 2 above). Human-caused fragmentation

of populations at the RCA level disrupts the migratory corridors historically used by bull trout. Fragmented bull trout populations have an increased risk of extinction (Gilpin 1997), because the effects of risk factors such as interactions with nonnative fish, mining, grazing, and forestry are locally exacerbated. Connectivity between RCAs is desirable when and where feasible to maintain/restore full migratory capacity and to help maintain viable populations, as long as doing so does not put a healthy population at risk. Potential risks versus benefits must be carefully considered on a site-by-site basis when considering restoring connectivity.

Goal Objective 4 - Develop and implement a statistically valid population monitoring program.

An effective population monitoring program is necessary to assess the status of bull trout in core areas in all RCAs to determine progress towards meeting interim and overall restoration criteria of this plan.

Achievement of these objectives will be dependent upon the availability of resources to fully implement the plan. Ideally, 100% attainment of the objectives should occur. However, where resources are scarce, restoration efforts will be prioritized to achieve the greatest results based on available resources.

Although the goals and objectives are based on the best current scientific thought, the Bull Trout Restoration Team acknowledges that there remain sources of uncertainty about the habitat requirements and population dynamics of bull trout. This uncertainty may necessitate the goal or objectives being modified over time to reflect changes in current knowledge about bull trout.

If met, the above objectives will result in the protection of existing populations represented by core areas, expansion and connectivity of some of those populations to enhance long-term persistence, connectivity of several RCAs to enable full migratory capacity, and a monitoring program to assess success. To meet these objectives and achieve the overall restoration goal, it will be necessary to achieve specific restoration criteria. Meeting these criteria in a timely manner will require planning and prioritizing actions and locations. It is anticipated that the best way to do this will be to develop RCA management/restoration plans that identify specific threats, actions to address threats, and prioritize those actions. These plans could be expanded versions of existing status reports that include more site-specific descriptions of restoration opportunities.

Restoration Criteria:

The criteria below represent a desired future condition for bull trout by the State of Montana to ensure sufficient abundance and distribution to allow recreational utilization.

Achievement of these criteria will require cooperation and resources of all entities involved in bull trout conservation. No single agency or individual can, or should accomplish them alone.

For purposes of this restoration plan, bull trout will be considered restored in the Kootenai and Clark Fork River basins when the following criteria are met.

1. Stable to increasing populations, as defined in the monitoring protocol developed per Objective 4, are documented in at least 67% of all core areas (pending completion of the monitoring plan) by not later than 2014 in each of the RCAs according to established monitoring criteria. The required percentage of populations with stable to increasing populations and the target date will be finalized as part of the monitoring plan that will be developed per Criteria 3 below, and may change based on that analysis. The technical rationale for the percentage and target date will be included in the monitoring plan. If a monitoring plan is not developed, the default will remain 67%. The monitoring period could be reduced if modeling and statistical analysis completed per Criteria 3 indicate doing so would be appropriate, or if other monitoring indices are used in accordance with monitoring guidelines that will be established. Such indices could include juvenile abundance estimates, age/size class structure, or some other statistically valid index or combination of indices. Once a core area or RCA reaches its restoration goal, carefully monitored fishing should be allowed in that RCA.

2. Potential opportunities for fish passage (including fish ladders, trap and haul, etc.) need to be evaluated and pursued at Milltown, Thompson Falls, Cabinet Gorge, Noxon, and other dams as warranted. Evaluation of such passage opportunities is to be completed within 10 years after this plan is finalized. If determined feasible, passage should be incorporated into normal management and dam operation procedures. If not feasible, the rationale and analysis showing why such passage is not feasible must be documented.

3. A population monitoring plan is to be developed by not later than the end of 2002 outlining the types of monitoring that is to be done in each RCA to meet the above objectives, assess the status of bull trout within each, and to measure success towards achieving restoration criteria described above. Unless recommended differently by the population monitoring plan, interim population monitoring should be implemented at least according to the following schedule, if not sooner, to measure success towards meeting Criteria 1 above:

   # Population index monitoring should be occurring in at least 40% of the core areas of each RCA by not later than 2002.

   # Population index monitoring should be occurring in at least 50% of the core areas of each RCA by not later than 2004.

- Population index monitoring should be occurring in at least 67% of the core areas of each RCA by not later than 2006.

Proposed Actions to Restore Bull Trout

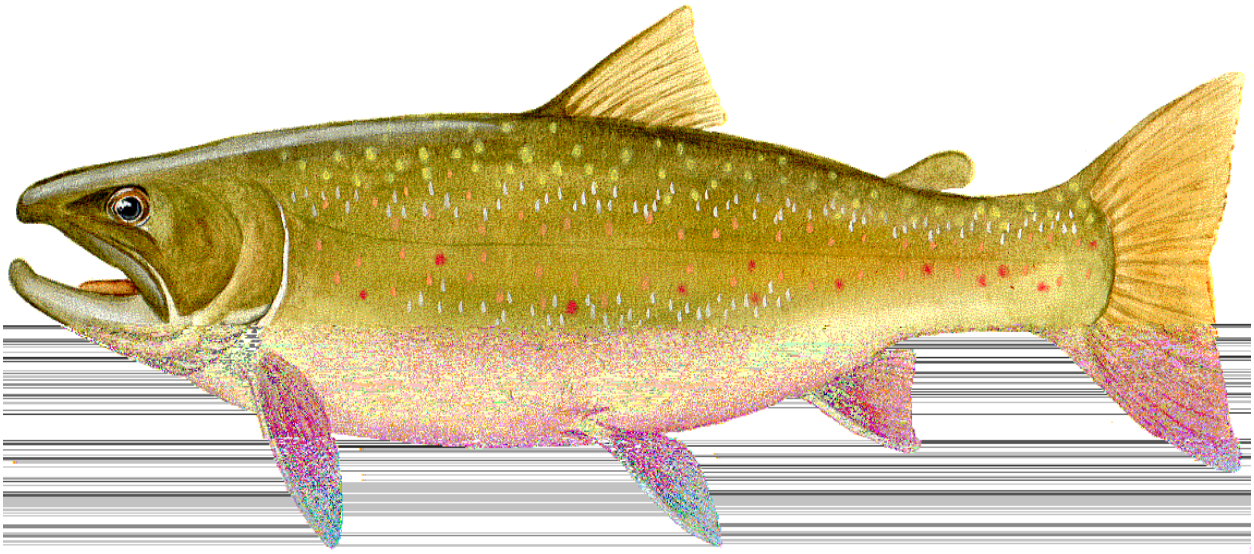
The Restoration Plan recommends nearly 100 possible actions to conserve and restore bull trout populations in Montana (Appendix E). Possible actions to achieve these restoration goals/objectives are grouped into four general categories: 1) fisheries management, 2) habitat management, 3) genetics/population management, and 4) education and administration. Restoration efforts within individual watersheds must therefore address specific causes of decline in each of these categories (fisheries, habitat, population management, and education) that apply to the watershed, particularly as they pertain to core and nodal areas. Recommendations to address threats to bull trout populations and achieve restoration have been developed as part of this plan. Following these recommendations, where applicable, should remove many of the threats affecting bull trout, and should meet restoration goals/objectives for bull trout throughout Montana.

Restoration of bull trout in Montana requires addressing a variety of very complex, intertwined issues - some of which are policy-type issues and some of which are identifiable, measurable, on-the-ground issues; some of which must be addressed at a statewide level, and others that should be addressed at a local level or watershed level. Therefore, implementation of this plan must occur simultaneously at all levels - local, state, and federal, depending on their interest, agreements, mandates, and missions. Watershed groups (groups of citizens and agency representatives who work together to help bull trout in specific drainages) and management agencies working in conjunction with watershed groups will implement restoration actions outlined in this restoration plan. Where watershed groups do not form or do not adequately implement conservation strategies, management agencies shall fulfill their legal and regulatory responsibilities.

The restoration plan anticipates a variety of actions occurring throughout the range of bull trout in Montana, depending on available resources, local interest, and agency mandates. In many locations, resources are available for restoration activities for only that specific location, such as hydro dam mitigation in the Lower Clark Fork, Hungry Horse and Libby Dam mitigation, Kerr Dam mitigation, and the natural resource damage settlement in the Upper Clark Fork. In the instances where there are no earmarked resources, this plan relies on a strategy that will place priority on those restoration/conservation actions and areas that are currently in the most recoverable condition and which offer the greatest chance for success. In this way, the strongest populations will be preserved, and efforts will then build on that success to recover additional populations. Implementation of this plan should result in restoration of bull trout in Montana, as well as enhancement of other species of native fish, and the aquatic habitat upon which they depend. It is nonbinding, and relies on voluntary implementation by landowners, land managers, and local watershed groups.

How To Use This Plan

This plan is comprised of four main components: 1) background information on bull trout and the development of this plan, 2) a restoration goal, restoration objectives, and restoration criteria, 3) possible recommendations to achieve restoration, and 4) an implementation section. Additional technical information is contained in appendices. Readers should first thoroughly read this restoration plan to become familiar with it and its overall objective and purpose. Individuals or agencies contemplating land use, planning, or management activities within the range of bull trout should then review Appendix E - the narrative outline of possible actions to restore bull trout to ensure those activities are compatible with restoration of bull trout. Much of the specific information referenced in this plan and the narrative outline is contained in technical reports prepared by the Scientific Team and referenced in the appendices. A tear-out order form for those reports is contained on the last page of this document.



RESTORATION PLAN FOR BULL TROUT
in the
CLARK FORK RIVER BASIN and KOOTENAI RIVER BASIN, MONTANA

PURPOSE

The purpose of this document is to provide a strategy to reverse or halt the decline of bull trout populations in western Montana, as well as to provide general guidance for conservation and protection of those populations that are stable or increasing. Its approach is to conserve the best remaining populations, and restore degraded or extirpated populations. This document is intended to guide State restoration efforts and complement federal conservation and recovery processes. It is intended to be used by management agencies, watershed groups, and private landowners as a reference to conserve and recover bull trout throughout western Montana. Where not already covered by existing processes, it is intended that conservation objectives and strategies contained in this plan be adopted and incorporated into other ongoing planning and conservation processes occurring throughout the range of bull trout in Montana, such as the Interior Columbia Basin Ecosystem Management Plan and forest planning processes. It is also intended that this plan be consistent with the overall federal recovery plan for bull trout.

The foundation of this strategy is a series of documents prepared by the Montana Bull Trout Scientific Group. These documents include status reports for 12 bull trout restoration/conservation areas (RCAs) in Montana (Rock Creek is included in the Upper Clark Fork RCA Status Report). Additionally, the Scientific Group has prepared reports on three of the most significant issues in bull trout restoration: the relationship between land management activities and habitat requirements of bull trout (MBTSG 1998); removal or suppression of introduced species (MBTSG 1996g); and the use of fish stocking in bull trout restoration (MBTSG 1996h). An additional status report for the one bull trout population in Montana east of the Continental Divide, the Oldman River RCA, was prepared by the Saint Mary, Belly,

Waterton International Resource Team. This restoration plan covers those populations in western Montana within the Columbia River basin, and therefore does not contain specific provisions for the Oldman River RCA. However, many of the conservation actions put fourth in this plan also apply to the Oldman River Restoration/Conservation Area.

INTRODUCTION

Bull trout (*Salvelinus confluentus*) are native to the upper Columbia River basin in northwest Montana. These fish have very specific habitat requirements generally described as the four C═s - clean, cold, complex, and connected. These include clean, cold water; in-stream and overhead cover; gravelly stream bottoms with low sediment levels; and complex stream channels. Due to numerous factors, including disruptive land management practices, expansion of introduced fish (Shafland and Lewis 1984), non-sustainable harvest, and loss of habitat connectivity, bull trout have declined, and are now widely considered an imperiled species (Howell and Buchanan 1992; Thomas 1992; Rieman and McIntyre 1993; Lee et al. 1997; Rieman et al. 1997). Lee et al. (1997) suggest that bull trout populations in the upper Columbia River basin have declined by more than 50%. Bull trout are considered a Species of Special Concern by the Montana Department of Fish, Wildlife and Parks (FWP) and the Montana Chapter of the American Fisheries Society, and have been listed as threatened under the Endangered Species Act by the U.S. Fish and Wildlife Service (USFWS 1998; USFWS 1999).

Slobodkin (1986) reported that the likelihood of extinction is minimal for populations that are numerically large, with species that have a long breeding season, if the adults complete many breeding cycles, if the migratory rate between populations is relatively high, and if the species is not impacted by interspecific competition. Bull trout have a relatively short breeding season; now have numerous barriers to migration; the migratory rate between populations appears to be low (Kanda et al. 1997); and they are subject to hybridization with brook trout (Leary et al. 1983; 1993) and interspecific competition from brook trout, lake trout, and brown trout. Thus,

they are more prone to extinction without implementation of immediate and long-term conservation and restoration measures.

In response to increasing concern about declining bull trout populations, the State of Montana initiated this bull trout restoration planning effort. Where resources are not already specifically allocated towards bull trout conservation, this restoration plan relies on a strategy that places priority on those areas that are in the most recoverable condition, and that offer the greatest chance for success. In this way, the strongest populations will be preserved, and efforts will then build on that success to recover additional populations. Implementation of this plan should result in restoration of bull trout in Montana, as well as enhancement of other species of native fish, and the aquatic habitat upon which they depend. Other plant and animal species that depend upon a healthy aquatic and riparian ecosystem should also benefit from successful implementation of this plan.

COLLABORATIVE ARRANGEMENTS

Restoration Team

In 1993, following a facilitated roundtable discussion convened by Governor Marc Racicot to discuss the need for creating and implementing a bull trout restoration plan in Montana, an interdisciplinary Montana Bull Trout Restoration Team was appointed. The team was composed of individuals representing the U.S. Fish and Wildlife Service (USFWS), Montana Department of Fish, Wildlife and Parks (FWP), U.S. Forest Service (USFS), Confederated Salish & Kootenai Tribes (CSKT), Plum Creek Timber Company, L.P. (Plum Creek), Montana Department of State Lands (now Montana Department of Natural Resources and Conservation, DNRC), Montana Chapter American Fisheries Society (MCAFS), Bonneville Power Administration (BPA), and the National Wildlife Federation (NWF). This team was chartered by the State of Montana to develop a process to restore bull trout independent of (but possibly complementary to) the Endangered Species Act listing process. The charter for this group deemed it essential that bull trout conservation efforts employ a public participation process that

would work closely with various public segments impacted by, and interested in, bull trout restoration (Appendix A).

Scientific Group

One of the Restoration Team═s first acts was to appoint a Scientific Group to provide the technical expertise necessary for this restoration planning effort. Members of the group are from universities, natural resource management agencies, and private industry, but were not chosen to serve as representing any organization or particular constituency.

Early in the restoration planning process, the Scientific Group recommended, for management purposes, that bull trout range in Montana be divided into 11 separate restoration/conservation areas (RCAs) based on patterns of distribution and fragmentation. The Scientific Group then developed status reports for each of the RCAs that describe distribution, risks and a restoration goal (MBTSG 1995a-e, 1996a-f). Rock Creek was later classified as a separate RCA, although its status is described in the Upper Clark Fork RCA status report (MBTSG 1995e). In addition to providing the Restoration Team with status reports for bull trout restoration/conservation areas in Montana, the Scientific Group also prepared three technical reports - *The Role of Stocking in Bull Trout Recovery*, *Assessment of Methods for Removal or Suppression of Introduced Fish to Aid in Bull Trout Recovery*, and *The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout*. The Scientific Group also provides scientific review and recommendations on items that need to be addressed by the Restoration Team or other appropriate entities, and members serve as interim members of the Technical Advisory Committees for review of fish stocking projects and removal or suppression of non-native fish projects which may affect bull trout restoration.

Although members of the Scientific Group may change and the disciplines represented might be broadened, this group will continue to provide technical expertise and oversight to the Restoration Team, its successor Steering Committee, and watershed groups.

Local Watershed Groups

The Restoration Team recommends a watershed group approach utilizing local watershed groups where they exist and where practical to help implement restoration efforts and improve bull trout populations. Each watershed group should address specific problems affecting bull trout in their watershed. They will accomplish this by using this restoration plan, drainage-specific status reports, and the three technical reports (MBTSG 1996g-h, 1998) as the framework for their efforts. Resource management agencies will work with watershed groups, and will maintain their responsibilities to restore bull trout. This approach will continue to be modified and adapted for each basin.

Because most bull trout habitat in the South Fork of the Flathead River drainage is within the boundaries of land administered by the USFS, and much of it is designated as wilderness, the South Fork Flathead Conservation Agreement Working Group was established. In 1996, the group developed a South Fork of the Flathead Conservation Agreement. The agreement was signed in May 1997 by representatives from the U.S. Fish and Wildlife Service, Bonneville Power Administration, Bureau of Reclamation, U.S. Forest Service, Confederated Salish and Kootenai Tribes, and Montana Department of Fish, Wildlife and Parks. The objectives of the Agreement are to 1) ensure proactive involvement of concerned agencies/entities in addressing factors affecting bull trout, 2) facilitate interagency communication and coordination for the identification, evaluation and resolution of factors affecting bull trout, and 3) provide a fishable population of bull trout in the South Fork drainage. As monitoring of the South Fork bull trout population continues, criteria developed by the South Fork Conservation Agreement Working Group will be used to determine the conditions under which a fishing season for bull trout can be reestablished.

In most RCAs, watershed or working groups will help develop local conservation strategies, as well as help implement conservation activities associated with restoring bull trout. The role of these groups is further described in the Implementation section of this plan. Where watershed groups do not form or do not adequately implement conservation strategies, management agencies shall fulfill their legal and regulatory responsibilities.

NATURAL HISTORY

Taxonomic Classification

Bull trout are members of the family Salmonidae. Although the char native to Montana were historically referred to as Dolly Varden or bull trout, they were formally described as bull trout in 1978, a species distinct from Dolly Varden, *S. malma* (Cavender 1978). Further investigations using morphological characteristics (Haas and McPhail 1991; Baxter et al. 1997), chromosomal comparisons (Cavender 1984; Phillips and Ihssen 1990), and biochemical genetics (Pleyte et al. 1992; Crane et al. 1994; Phillips et al. 1994; Baxter et al. 1997; Leary and Allendorf 1997) have supported the species status of the bull trout. Bull trout are mainly an inland species, but may be anadromous when they exist in coastal streams. In contrast, Dolly Varden are mainly a coastal species and often are anadromous. The two species coexist with little hybridization (Baxter et al. 1997; Leary and Allendorf 1997) in drainages in British Columbia and at least as far south as the Puget Sound area of Washington.

Analysis of mitochondrial DNA allowed separation of bull trout into three evolutionary groups: Klamath River, lower Columbia River, and upper Columbia River (Williams et al. 1997). Within the Upper Columbia River, a high level of genetic diversity has been observed, indicating that bull trout populations in this region represent a substantial portion of the remaining genetic variation in the species (Williams et al. 1997). Further analysis indicated that within upper Columbia River drainages there is little genetic variation, but among different drainages within the upper Columbia River basin there is substantial genetic divergence (Kanda et al. 1997). Preservation of the high degree of genetic diversity among populations therefore requires the continued existence of many populations distributed throughout the upper Columbia River region (Kanda et al. 1997). In other words, each drainage seems to harbor its own unique Astrain@ of bull trout, whose preservation is important to the species as a whole.

Distribution

Bull trout are recognized as occurring in five population segments (Fig. 1) distributed in the states of Washington, Oregon, Nevada, Idaho and Montana, as well as the Canadian provinces of British Columbia and Alberta (Cavender 1978; Haas and McPhail 1991). They are most likely to occur in colder, higher elevation, low to mid-order watersheds with lower road densities (Rieman et al. 1997). Cavender (1978) suggests bull trout originated in the Columbia River system, and their dispersal has followed the deglaciation and climatic changes since the Pleistocene. During this period, migration to streams and rivers could have been facilitated by headwater transfers resulting from ice dams and post-glacial flooding, use of main streams to gain access to upper reaches, and entry into salt water allowing access to coastal streams (Goetz 1989; Bond 1992; Brown 1992).

Fig. 1. Overall distribution of bull trout throughout its range.

Bull trout are a fish adapted to cold waters, and their distribution reflects this requirement. Their southern distribution is restricted and limited to headwaters, glacial-fed waters and spring-fed sections of streams (Bond 1992). Over the past 25 years, bull trout have become extirpated in the McCloud River in California and the upper Deschutes, the north Santiam and the Middle Fork of the Willamette River in Oregon (Goetz 1989; Rode 1990; Brown 1992; Ratliffe and Howell 1992).

In western Montana, bull trout are found within two major subbasins of the Columbia River basin, the Kootenai and the Clark Fork drainages (Fig. 2), as well as in the Saskatchewan River drainage east of the Continental Divide. Within these subbasins, they are found in several major river drainages including the Blackfoot, Clark Fork, Swan, Flathead, and Kootenai Rivers. Both the Clark Fork and the Kootenai River populations comprise discrete population segments. The Clark Fork population has been physically separated from the rest of the Columbia River population by Albeni Falls for at least 10,000 years. There were no historical barriers to fish movement upstream of Albeni Falls, thus bull trout in the Pend Oreille/Clark Fork drainage likely formed a large metapopulation. The Kootenai River population has been separated from the Columbia River population for a similar period by Bonnington Falls downstream of Kootenay Lake in British Columbia. Evidence of the separation of these populations includes lack of anadromous salmonids upstream of these falls.

The Clark Fork River population, which includes Lake Pend Oreille and the entire Clark Fork River drainage upstream, was once perhaps the largest metapopulation in the historic range of bull trout. This metapopulation used several major drainages, including the Bitterroot, Blackfoot, Flathead, upper Clark Fork and Rock Creek (Everman 1892). Bull trout from Lake Pend Oreille are known to have migrated upstream past Missoula to spawn, and likely also migrated up the Flathead, Bitterroot and Blackfoot drainages as well.

The Kootenai River population inhabits the Kootenai River and its tributaries, as well as Kootenay Lake and Lake Koocanusa. This population comprises a significant portion of the bull trout known within the upper Columbia River basin. Recent work indicates that the Lake Koocanusa population may be one of the healthier extant populations with over 800 redds

counted in 1999 in the Wigwam River, a key spawning tributary that arises in Montana and flows north through British Columbia before entering the river/reservoir.

Fig. 2. Map showing major river basins (Clark Fork, Kootenai, Flathead, Swan) in Montana.

Life History and Habitat Requirements

Bull trout are native to streams, rivers, and lakes in northwestern Montana. They are long-lived fish that do not reach breeding age until at least five years of age. Sub-adult and adult bull trout feed primarily on other fish, resulting in their being dubbed the Acannibal of Montana=s streams@ (Anonymous 1929). Bull trout spawn in the fall, and their eggs remain up to six inches deep in spawning gravels until spring, when the fry emerge. Young bull trout remain in the stream for one to four years, huddled among bottom rocks and other cover. Bull trout grow up to lengths of 37 inches and weights as heavy as 20+ pounds. Sub-adult and adult fluvial bull trout reside in larger streams and rivers and spawn in smaller tributary streams, whereas adfluvial bull trout reside in lakes and spawn in tributaries.

Bull trout may have either a resident or migratory life history. Resident fish usually spend their entire lives in smaller tributaries and headwater streams. Migratory fish spawn and their progeny rear for one to several years in tributary streams before migrating downstream to larger rivers or lakes where they mature and spend most of their adult life. Adults migrate back to their natal tributaries to spawn, apparently with a high degree of fidelity (Swanberg 1996, Kanda et al. 1997; unpublished data). Bull trout also may migrate during the summer to seek colder water and during the winter to seek relatively ice free habitats (Jakober 1995). Resident and migratory bull trout can live together and one life history form can probably give rise to the other.

This variety of life history strategies is important to the stability and persistence of populations, but also complicates restoration and conservation because a diversity of high quality habitats are needed. When individual habitat components are altered, by human or natural events, bull trout populations may be negatively impacted.

The following summary accounts of life history and bull trout habitat requirements were derived from the report *The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout* prepared by the Montana Bull Trout Scientific Group (MBTSG 1998 - Appendix F). More specific details and references are contained in that report.

Spawning

The majority of migratory bull trout spawning in Montana occurs in a small percentage of the total stream habitat available. Spawning takes place between late August and early November, principally in third and fourth order streams. Spawning adults use low gradient areas (less than 2%) with gravel/cobble substrate and water depths between 0.1 and 0.6 meters (4 to 24 inches; avg. = 0.3 m (12 inches)) and velocities from 0.09 to 0.61 m/sec (0.3 to 2.0 ft./sec; avg. = 0.31 m/sec (1.0 ft./sec)). Proximity of cover for adult fish before and during spawning is an important habitat component. Spawning tends to be concentrated in reaches influenced by groundwater, where temperature and flow conditions may be more stable. The relationship between groundwater exchange and migratory bull trout spawning, and the spawning habitat requirements of resident bull trout requires further investigation.

Incubation

Existing studies suggest that successful incubation of bull trout embryos requires cold water temperatures below 8° C ($46\ ^{o}$ F), gravel/cobble substrate with high permeability to allow water to flow over incubating eggs, and low levels of fine sediment (sediment particles smaller than 6.35 mm (0.25 inches) in diameter) that smother eggs and fry. Eggs are deposited as deep as 25 cm (10 inches) below the streambed surface, and fry do not emerge until 7 to 8 months later, depending upon water temperature. Spawning adults alter streambed characteristics during redd construction to improve survival of embryos, but conditions in redds often degrade during the incubation period. Mortality of eggs or fry can be caused by scouring during high flows, freezing during low flows, superimposition of redds, or deposition of fine sediments or organic materials that smother the eggs or fry. A significant inverse relationship exists between the percentage of fine sediment in the incubation environment and bull trout survival to emergence. Entombment appeared to be the largest mortality factor in incubation studies in the Flathead drainage. Groundwater influence plays a large role in embryo development and survival by mitigating mortality factors.

Juvenile Rearing in Tributary Streams

Basic rearing habitat requirements for juvenile bull trout include cold summer water temperatures (< 15° C) with sufficient surface and groundwater flows. Warmer temperatures are associated with lower bull trout densities, and can increase the risk of invasion by other species that could displace, compete with, or prey on juvenile bull trout. Juvenile bull trout are generally bottom foragers and rarely stray from cover. They prefer complex forms of cover that include deep pools, large woody debris, rocky stream beds, and undercut banks. High sediment levels and embeddedness can result in decreased rearing densities. Unembedded cobble/rubble substrate is preferred for cover and feeding, and also provides invertebrate production. Highly variable streamflow, reduction in large woody debris, bedload movement, and other forms of channel instability can limit the distribution and abundance of juvenile bull trout.

Subadults and Adults in Tributary Streams

Habitat characteristics that are important for juvenile bull trout of migratory populations (low water temperatures, clean cobble-boulder substrates, and abundant cover) are also important for stream-resident subadults and adults. However, stream resident adults are more strongly associated with deep pool habitats than are migratory juveniles.

Movement and Migration in Tributary Streams

Both migratory and stream-resident bull trout move in response to developmental and seasonal habitat requirements. Migratory individuals can move great distances (up to 156 miles [250 km]) among lakes, rivers, and tributary streams in response to spawning, rearing, and adult habitat needs (Swanberg 1996). Stream-resident bull trout migrate within tributary stream networks for spawning purposes, as well as in response to changes in seasonal habitat requirements and conditions. Open migratory corridors, both within and among tributary streams, larger rivers and lake systems are critical for maintaining bull trout populations.

Subadults and Adults in Large Rivers

Most migratory bull trout remain in tributaries for one year or more before moving into large rivers downstream. After they reach large river habitats, bull trout can remain there for brief periods, or for as long as several years, before either moving into lakes or returning to tributary streams to spawn. During their river residency, bull trout commonly make long-distance annual or seasonal movements among various riverine habitats, apparently in search of foraging opportunities and refuge from warm, low-water conditions in mid-summer and ice in winter. Little is known about these movement patterns among basins, but it is likely that river residency and migratory behavior in each bull trout stock largely reflects local adaptation to the specific array of suitable habitats historically available in the basin. The degree of genetic control of migratory behavior in bull trout is unknown.

Subadults and Adults in Lakes

Lakes and reservoirs are critically important to adfluvial bull trout populations. In six of the 12 bull trout restoration/conservation areas (Flathead, Swan, South Fork Flathead, Upper Kootenai, Lower Kootenai, and Lower Clark Fork), large bodies of standing water form the primary habitat for rearing of subadult migratory bull trout and provide food and cover for fish to achieve rapid growth and maturation. Growth rates of juvenile bull trout increase substantially as they enter large river and lake environments and shift their diet from insects to fish. Despite the importance of lakes and reservoirs, very limited information is available range-wide on habitat use by bull trout in these waters. In general, bull trout appear to be bottom oriented in lakes, but use relatively shallow zones (less than 40 m; 130 ft), provided water temperatures there are less than 15° C (59° F). During summer, bull trout appear to primarily occupy the upper hypolimnion of deep lakes, but forage opportunistically in shallower waters. River/lake transition zones appear to be particularly important habitats. Introduced species, especially lake trout (*S. namaycush*)

and Mysis shrimp (*Mysis relicta)* in combination, have been implicated in drastically altering the food web where they occur, which has led to declines or extinction of bull trout in many lakes (McIntyre 1998). Although poorly understood at this time, habitat conditions in lakes and reservoirs are potentially critical to persistence of migratory bull trout populations and require additional investigation.

Status and Trends

Bull trout are still widely distributed, although declines in abundance, the loss of important life history forms, local extinctions, fragmentation, and isolation of high-quality habitats are apparent throughout the Columbia River basin (Lee et al. 1997, Rieman et al. 1997). Although still widespread, strong or protected populations are less common (Rieman et al. 1997). According to the assessment of aquatic species and resources prepared for the Interior Columbia River Basin Ecosystem Management Plan, areas supporting strong populations of bull trout occur in only six percent of available watersheds (Lee et al. 1997). Many formerly complex, diverse and connected river systems have been transformed into a patchwork of fragmented habitats with isolated populations. This isolation may place the remaining populations at a risk of extinction (Rieman and McIntyre 1993; Lee et al. 1997). Continued loss of habitat associated with detrimental land use practices further threatens remaining bull trout populations (Rieman et al. 1997).

In Montana, bull trout are still widely distributed throughout their historic range, although numbers and distribution have declined during the past century (Everman 1892; Thomas 1992; MBTSG 1995a-e; MBTSG 1996a-f; Peters 1990; Weaver 1997). The Swan River, South Fork Flathead, and upper Kootenai River populations appear to be stable or increasing. Migratory bull trout populations in the Clark Fork, Blackfoot, Flathead, and Bitterroot rivers have suffered large declines in abundance and distribution since European settlement, although intensive restoration efforts in the Blackfoot River drainage appear to have at least stabilized that population.

RESTORATION/CONSERVATION AREAS

Historically, in western Montana bull trout constituted two discrete population segments, the Kootenai and Clark Fork River metapopulations, and a number of isolated or disjunct populations in four major river drainages within these discrete population segments (Table 1).

Humans have modified habitat and disrupted stream flows, thermal regimes, and migration routes throughout the bull trout's range in these drainages. This has eliminated connectivity within these major drainages, resulting in smaller fragments between which migration and straying is unlikely or can occur only downstream. Small, isolated populations are much more susceptible to environmental and human-caused threats, and thus have a greatly decreased probability of long-term persistence (Wilcox and Murphy 1985; Slobodkin 1986; Gilpin 1997). Loss of interconnectivity has resulted from migration barriers or habitat changes such as altered thermal regimes or dewatering.

Based on this existing pattern of distribution and fragmentation, and for organizational purposes, the Montana Bull Trout Scientific Group recognized 12 restoration/conservation areas (RCAs) for bull trout in western Montana within the two historic metapopulations (Table 1, Fig. 3). A metapopulation is a collection of geographically distinct populations interconnected by migration and straying. RCAs have been delineated largely due to fragmentation of historically connected systems. Because of fragmetation and loss of interconnectivity, RCAs now essentially function as smaller, individual metapopulations. Within each RCA, there are numerous local populations, each containing numerous individuals. The more connectivity that can be restored within and between these areas, the greater the likelihood of long-term persistence (Gilpin 1997) (Fig. 4).

2

have been divided into

12 SMALLER RCAs

consisting of

NUMEROUS POPULATIONS AND CORE AREAS

Table 1. Major river drainages and respective restoration/conservation areas:

Clark Fork Basin

Clark Fork River drainage
- Lower Clark Fork River (downstream from Thompson Falls Dam)
- Middle Clark Fork River (Thompson Falls Dam to Milltown Dam)
- Upper Clark Fork River (upstream from Milltown Dam)
- Rock Creek (tributary to upper Clark Fork River)
- Bitterroot River
- Blackfoot River

Flathead River drainage upstream from Kerr Dam
- Flathead River (North and Middle Fork Flathead River, Flathead Lake)
- South Fork Flathead River (upstream from Hungry Horse Dam)

Swan River drainage
- Swan River (upstream from Big Fork Dam)

Kootenai River Basin

Kootenai River drainage
- Lower Kootenai River (downstream from Kootenai Falls)
- Middle Kootenai River (between Kootenai Falls and Libby Dam)
- Upper Kootenai River (upstream from Libby Dam)

Fig.3. Map showing location of Restoration/Conservation Areas in Montana.

Fig. 4. Hypothetical example of a metapopulation (A). Each drainage represents a collection of localized populations that are geographically distinct, yet are genetically interconnected through movement of individuals among populations. Areas with higher habitat quality and strong populations (dark shading) provide surplus production and dispersing individual bull trout. Lighter shading represents lower quality habitat that still supports bull trout, but with little or no dispersal. If passage is blocked between populations (B), then dispersal and genetic exchange between most populations are stopped. Similarly, if the number of populations become greatly reduced (C), exchange between populations becomes less likely, and all populations become more susceptible to extirpation (adapted from Rieman and McIntyre 1993).

Separate status reports for each of the RCAs west of the Continental Divide have been prepared, except Rock Creek, which is included in the Upper Clark Fork report (MBTSG 1995a-e; MBTSG 1996a-f). Each status report describes historic distribution, current distribution, risks to bull trout in each watershed, and a restoration or conservation goal for each RCA. Status reports are the collaborative effort of biologists, hydrologists, and other scientists, and have drawn on information and research from a variety of sources in each management area. They include both quantitative and qualitative assessments based on the best available information, as well as professional judgement.

The Montana Bull Trout Scientific Group conducted a subjective process to identify risk factors to restoration in each RCA. Twenty-four different risk factors to restoration of bull trout in Montana were identified by the Scientific Group in the RCAs (MBTSG 1995a-e; MBTSG 1996a-f), and are summarized in Appendix B. These include threats from habitat alteration, fisheries management, barriers, introduced species, environmental instability, and demographic variables such as abundance, trend, and life forms. The primary threats to restoration of bull trout identified in the status reports for individual RCAs can be classified into two general areas: 1) effects of land management activities and 2) effects of fisheries management (legal and illegal) activities, including introduction and management of nonnative species and species management priorities (Appendix B). A weighted sum rank of the risks identified forestry practices as the greatest risk to restoration of bull trout, ranking as a very high risk threat in all RCAs. Legal fish introductions (historic and potential future) ranked closely behind, followed by illegal fish introductions, illegal harvest, dams, and agriculture/dewatering (Appendix B). Specific potential effects of land management activities on bull trout are described in detail in MBTSG (1998), as well as in USFWS (1997b). Specific potential effects of introduced species on bull trout are summarized in Appendix G and USFWS (1997b). Status reports will be updated with the most current information at least every five years to reflect current conditions and restoration progress.

Core Areas

Within each RCA, core and nodal habitats have been identified for bull trout (Appendix C). Core areas are watersheds, including tributary drainages and adjoining uplands, used by migratory bull trout for spawning and early rearing, and by resident bull trout for all life history requirements (Figs. 5-16). Core areas typically support the strongest remaining populations of spawning and early rearing bull trout in an RCA, and are usually in relatively undisturbed habitat. Nodal habitats are those used by sub-adult and adult bull trout as migratory corridors, rearing areas, overwintering areas, and for other critical life history requirements.

Restoration or conservation goals have been developed by the Scientific Group for each of the RCAs through a subjective process based on the best available scientific information and professional judgement. Emphasis of the individual RCA goals is to maintain the population genetic structure throughout the watershed, establish or maintain self-reproducing migratory populations of bull trout in all identified core area streams, establish or maintain connectivity within and among core areas and RCAs, and establish a goal of a minimum number of redds and individuals distributed throughout each watershed (Appendix D). These goals are considered a minimum for maintenance of long-term persistence of bull trout and genetic variation in each individual RCA, except in the Flathead RCA, where an extensive long-term data set exists, and the goal is set at a higher standard than what is thought to be required for long-term persistence. The individual goal for the Flathead RCA is based on the known potential of that watershed, determined through extensive monitoring, and is therefore at a higher standard than the other RCA goals. Fulfilling all of the individual RCA restoration goals is not required to consider the population restored.

Fig. 5. Map of the Upper Clark Fork Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 6. Map of the Rock Creek Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 7. Map of the Blackfoot Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 8. Map of the Middle Clark Fork Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 9. Maps of the Bitterroot Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 10. Map of the Lower Clark Fork Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 11. Map of the Flathead Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 12. Map of the South Fork Flathead Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 13. Map of the Swan Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 14. Map of the Upper Kootenai Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 15. Maps of the Middle Kootenai Restoration/Conservation Area depicting core areas and nodal habitat.

Fig. 16. Map of the Lower Kootenai Restoration/Conservation Area depicting core areas and nodal habitat.

CONSERVATION STRATEGY FOR RESTORATION AND RECOVERY

Restoration of bull trout in Montana will require maintenance of complex habitats and networks of those habitats along a continuum of scales, from a broad, basin-wide scale to a mid, watershed-level scale to a fine, stream-specific scale. Therefore, this restoration plan employs a multi-tier strategy, as described by Lee et al. (1997), that addresses restoration at several levels of scale. The basic approach of this recovery strategy, at all scales, is to protect the best remaining populations and habitats, usually core areas, and restore degraded or extirpated populations such that the long-term viability of bull trout in Montana is assured. Where resources are not already dedicated to restoration of bull trout, this strategy will place priority on those restoration/conservation actions and areas that are currently in the most recoverable condition and that offer the greatest chance for success. In this way, the strongest populations will be preserved, and efforts will then build on that success to recover weaker populations.

At the broad scale level, this plan calls for establishing a network of well connected restoration/conservation areas that contain all of the necessary life history and dispersal requirements of bull trout, as well as the genetic diversity necessary for long-term persistence and adaptation to a variable environment. Restoration must emphasize connectivity between historically connected RCAs where appropriate, and overall health of the aquatic ecosystem of western Montana.

The emphasis of restoration at the watershed-level scale is to maintain complex habitats and conserve bull trout populations within RCAs by protecting remaining stronghold drainages and addressing and fixing existing threats while minimizing or preventing additional new threats. This involves identifying and protecting existing high quality streams, conserving and rehabilitating important degraded streams, and managing watersheds to maintain natural structure, function, and processes. Initial efforts should emphasize protection and restoration of important core and nodal areas so that life history requirements of all age and size classes are met. Core areas need to have the most stringent levels of protection, as they currently meet the bull

trout═s specific spawning and early rearing habitat requirements, and will provide the stock for recolonization of other areas within a watershed as restoration efforts proceed. The conservation approach for core areas should be to maintain the factors and all habitat elements that contribute to success of those populations. Restoration at the watershed-level scale will provide the size and diversity of habitats within the watershed to support viable metapopulations, as well as positively influence conditions in important mainstem habitats downstream.

Restoration at the fine, stream-specific scale involves addressing specific actions and threats in specific streams that are important to, or influence, bull trout habitat. It is expected that restoration efforts by watershed groups will occur primarily at the stream-specific and watershed-level scales.

RESTORATION and CONSERVATION GOAL

Background

The specific habitat requirements of bull trout, the diversity of life history strategies, and their use of relatively long migratory corridors complicates restoration and conservation efforts, and illustrates the need for connectedness between populations. Connectedness within and between populations allows periodic genetic exchange, as well as founding of new populations and recolonization of extirpated populations by migrants. With this structure, a local population may go extinct, but through straying of migrants from other populations, may be recolonized. Since multiple populations are less likely to go extinct at the same time due to natural phenomenon (see Fig. 4), viability of bull trout will be greatly enhanced by maintaining connected populations.

The rate of straying is an important aspect of metapopulation dynamics because it influences the likelihood of recolonization (Rieman and McIntyre 1993). For bull trout, the rate of straying is generally low (Kanda et al. 1997; unpublished data), so recolonization may take a long time. Because of the importance of core areas to conservation and recovery of bull trout in

Montana, recovery will be based on protection of core areas and reestablishment of connectivity between associated core areas.

This restoration plan is a voluntary effort on behalf of the State of Montana to restore bull trout populations to a sufficient level of abundance and distribution to allow for recreational utilization. The restoration criteria contained herein may exceed those that are necessary to consider bull trout Arecovered@ under the ESA, and should not be construed as Arecovery criteria@ for the purposes of ESA delisting of bull trout. ESA recovery/delisting criteria will be developed independent of, but complimentary to this plan as part of the federal recovery planning process.

Restoration Goal/Objectives

Goal: The goal of the Montana Bull Trout Restoration Plan is to ensure the long-term persistence of complex (all life histories represented), interacting groups of bull trout distributed across the species= range and manage for sufficient abundance within restored RCAs to allow for recreational utilization. To meet this goal, cooperative management, monitoring, and restoration among local, state, tribal and federal resource management agencies, as well as private citizens, conservation organizations, and industry will be necessary. Bull trout will be considered restored in the Kootenai and Clark Fork River basins when the following objectives are met:

Goal Objective 1 - Protect existing populations within all core areas and maintain the genetic diversity represented by those remaining local populations

Bull trout populations, including disconnected local populations, have substantial genetic divergence among them (Leary et al. 1993; Kanda et al. 1997, unpublished information). Therefore, each core area population should be conserved. Each of the populations represented in the 115 core areas distributed throughout the 12 RCAs (Appendix C) must be protected, and if necessary, enhanced (expanded) in order to conserve the genetic diversity contained in those

populations. Protection of populations within core areas also requires that nodal habitat be appropriately managed in order to maintain the complete life history of each population.

Criteria for Adding or Deleting Core Areas

Core areas are a central feature of the conservation strategy represented by this plan. A list of core areas is contained in Appendix C. Because scientific understanding of the distribution and specific importance of certain populations of bull trout is changing, the plan provides for additions or deletions to the list of core areas identified for conservation.

Adding Core Areas: For a watershed to be added as a core area under the Montana Bull Trout Restoration Plan, it must meet all of the following criteria:

- There is documented bull trout spawning and rearing use according to monitoring protocols accepted by Montana Fish Wildlife and Parks.
- It is a third or fourth order watershed.
- The scientific judgment of the Montana Bull Trout Scientific Group or Montana Fish Wildlife and Parks determines that the core area contains among the strongest remaining populations of bull trout in an RCA, usually in a relatively undisturbed area.

Deleting Core Areas: For a watershed to be deleted as a core area, it must have any one of the following criteria:

- The population of bull trout has been extirpated.
- The scientific judgment of the Montana Bull Trout Scientific Group or Montana Fish Wildlife and Parks determines that the core area is no longer a stronghold in the RCA that warrants the prioritization afforded a core area.

Secondary Core Watersheds

Secondary core watersheds are third or fourth order watersheds identified by the Montana Bull Trout Scientific Group or Montana Fish Wildlife and Parks that are not core areas but support some use of bull trout and could become important in the future. These secondary streams do not support as much spawning or as dense of populations as the core areas, but warrant broad screen observation under the population monitoring protocol as potential core area additions or other reasons important to bull trout restoration. A list of secondary core watersheds is located at the end of Appendix C.

Goal Objective 2 - Maintain and restore connectivity among historically connected core areas

The effective population size of core area populations, and therefore the long-term persistence of bull trout within its native range in Montana will be enhanced by reconnecting historically connected core areas within RCAs to provide opportunity for genetic exchange between populations and refounding of new populations. Any measures to facilitate passage between populations must carefully consider how to best prevent the spread of whirling disease, other fish diseases, or undesirable aquatic organisms throughout the watershed that may adversely affect bull trout or other species of native fish, such as westslope cutthroat trout.

Goal Objective 3 - Restore and maintain connectivity between historically connected Restoration/Conservation Areas (RCAs)

Fragmentation among populations is a serious threat at different geographic scales, from larger scale RCAs to smaller scale core areas (see number 2 above). Human-caused fragmentation of populations at the RCA level disrupts the migratory corridors historically used by migratory bull trout. Because they are smaller and isolated, fragmented bull trout populations are at higher

risk of extinction (Gilpin 1997). The effects of other risk factors to small, isolated populations, such as interactions with nonnative fish, mining, grazing, and forestry, may be locally exacerbated. Connectivity between RCAs is desirable when and where feasible to maintain/restore full migratory capacity and to help maintain viable populations, as long as doing so does not put a healthy population at risk. Potential risks versus benefits must be carefully considered on a site by site basis when considering restoring connectivity.

Goal Objective 4 - Develop and implement a statistically valid population monitoring program

An effective population monitoring program is necessary to assess the status of bull trout in core areas in all RCAs to determine progress towards meeting interim and overall restoration criteria of this plan.

It is important that these objectives be read together and are not considered independent of one another. Achievement of these objectives will be dependent upon the availability of resources to fully implement the plan. Ideally, 100% attainment of the objectives should occur. However, where resources are scarce, restoration efforts will be prioritized to achieve the greatest results based on available resources.

Although the goals and objectives are based on the best current scientific thought, the Bull Trout Restoration Team acknowledges that there remain sources of uncertainty about the habitat requirements and population dynamics of bull trout. This uncertainty may necessitate the goal or objectives being modified over time to reflect changes in current knowledge about bull trout.

If met, the above objectives will result in the protection of existing populations represented by core areas, expansion and connectivity of some of those populations to enhance long-term persistence, connectivity of several RCAs to enable full migratory capacity, and a monitoring program to assess success. To meet these objectives and achieve the overall restoration goal, it will be necessary to achieve specific restoration criteria. Meeting these criteria in a timely manner will require planning and prioritizing actions and locations. It is anticipated that the best way to do this will be to develop RCA management/restoration plans that identify specific threats, actions to address threats, and prioritization of those actions. These plans could be expanded versions of existing status reports that include more site-specific descriptions of restoration opportunities.

Restoration Criteria:

The criteria below represent a desired future condition for bull trout by the State of Montana to ensure sufficient abundance and distribution to allow recreational utilization. Achievement of these criteria will require cooperation and resources of all entities involved in bull trout conservation. No single agency or individual can, or should have to accomplish them alone.

For purposes of this restoration plan, bull trout will be considered restored in the Kootenai and Clark Fork River basins when the following criteria are met.

1. Stable to increasing populations, as defined in the monitoring protocol developed per Objective 4, are documented in at least 67% of all core areas (pending completion of the monitoring plan) by not later than 2014 in each of the RCAs according to established monitoring criteria. The required percentage of populations with stable to increasing populations and the target date will be finalized as part of the monitoring plan that will be developed per Criteria 3 below, and may change based on that analysis. The technical rationale for the percentage and target date will be included in the monitoring plan. If a monitoring plan is not developed, the default monitoring requirement will remain 67% of

all core areas. The monitoring period could be reduced if modeling and statistical analysis completed per Criteria 3 indicate doing so would be appropriate, or if other monitoring indices are used in accordance with monitoring guidelines that will be established. Such indices could include juvenile abundance estimates, age/size class structure, or some other statistically valid index or combination of indices.

Where monitoring demonstrates that bull trout are sufficiently recovered in a waterbody or drainage, and meet criteria developed by FWP for that waterbody to allow angling for bull trout, opening of that waterbody to bull trout angling will be considered. Before a waterbody is opened to angling for bull trout, the proposed regulation will be subject to normal regulation setting procedures, will undergo MEPA analysis, and will require FWP Commission approval. Criteria for opening and for future closures of waterbodies for angling may be similar to that developed by the South Fork (Flathead) Conservation Agreement group for Hungry Horse Reservoir:

> The proposed regulation for a daily and possession limit of one bull trout from Hungry Horse Reservoir shall remain in effect as long as the bull trout catch per net in fall gill nets and the annual bull trout redd counts in the Hungry Horse Reservoir annually monitored tributaries remain above 70% of the long-term averages. The fishery will be closed if the values fall below 70% of the long-term averages for two consecutive years. If the fishery is closed because it fails to meet these criteria, it will not be re-opened until the bull trout catch per net in fall gill nets and the annual bull trout redd counts in the Hungry Horse Reservoir annually monitored tributaries reach or exceed the long-term average values for two successive years. If illegally introduced species appear in the Hungry Horse Reservoir fish assemblage, or if the reservoir fails to refill to elevation 3559 msl for two successive years, the harvest regulation will be reviewed.

2. Potential opportunities for fish passage (including fish ladders, trap and haul, etc.) need to be evaluated and pursued at Milltown, Thompson Falls, Cabinet Gorge, Noxon, and other dams as warranted. Evaluation of such passage opportunities is to be completed within 10 years after this plan is finalized. If determined feasible, passage should be

incorporated into normal management and dam operation procedures. If not feasible, the rationale and analysis showing why such passage in not feasible must be documented.

3. A population monitoring plan is to be developed by not later than the end of 2003 outlining the types of monitoring that is to be done in each RCA to meet the above objectives, assess the status of bull trout within each, and to measure success towards achieving restoration criteria described above. Unless recommended differently by the population monitoring plan, interim population monitoring should be implemented at least according to the following schedule, if not sooner, to measure success towards meeting Criteria 1 above:

- Population index monitoring should be occurring in at least 40% of the core areas of each RCA by not later than 2002.
- Population index monitoring should be occurring in at least 50% of the core areas of each RCA by not later than 2004.
- Population index monitoring should be occurring in at least 67% of the core areas of each RCA by not later than 2006.

It should be noted that individual restoration goals have been developed for each RCA (Appendix D). Fulfilling all aspects of the individual RCA restoration goals is not required to consider bull trout in Montana restored, since the overall goal above supersedes the individual goals. However, to maintain the long-term persistence of bull trout in all RCA═s, resource managers should strive to also meet those individual RCA restoration goals.

ACTIONS TO ACHIEVE RESTORATION GOALS

There has been considerable debate about the cause of bull trout decline. Causes of decline are many and varied, and often act in a synergistic manner to magnify smaller causes.

Because of the complex interaction of causes of decline, and in order to achieve restoration, these causes and threats must be identified and corrected. Addressing individual symptoms will be insufficient for long-term persistence of local populations. For example, installing instream habitat structures to temporarily provide for a variety of degraded hydrologic functions may not be as beneficial as implementing restoration measures on the land (Frissell and Nawa 1992; Chapman 1996) that would provide a long-term solution to the cause of such problems.

Threats to bull trout, and thus restoration and recovery of bull trout, can be grouped into three general categories: fisheries management, habitat management, and genetics/population management (Fig 17). Some or all may apply in each watershed.

Components of these three categories can be further classified into the five factors considered by the U.S. Fish and Wildlife Service when evaluating the status of threatened or endangered species. Those five factors are:

(A) the present or threatened destruction, modification, or curtailment of its habitat or range;
(B) overutilization for commercial, recreational, scientific, or educational purposes;
(C) disease or predation;
(D) the inadequacy of existing regulatory mechanisms;
(E) other natural or manmade factors affecting its continued existence.

Restoration efforts within individual watersheds must therefore address specific causes of decline in each of the three general categories (habitat, fisheries, and population management) that apply to a watershed, particularly as they pertain to core and nodal areas. Examples of the type of actions that should be reviewed and addressed in each watershed, by category, include:

Habitat Management

* Protect core and nodal habitats from additional degradation
* Restore degraded bull trout habitat to meet the requirements of bull trout
* Adopt land management guidelines and practices that maintain or improve important bull trout habitat processes
* Maintain/restore physical integrity of habitat

* Reduce point and nonpoint pollution
* Determine effectiveness of existing habitat protection regulations and BMPs
* Restore and maintain natural hydrologic conditions (flow, timing, duration)
* Operate dams to minimize impacts

Fisheries Management

* Implement angling regulations to prevent overharvest and minimize incidental catch of bull trout
* Educate anglers about fishing regulations and proper identification of bull trout
* Develop/implement fish stocking policies
* Develop/implement fish management goals that emphasize bull trout in core areas
* Where feasible, suppress or eradicate introduced species that compete with, hybridize with, or prey on bull trout
* Limit scientific collection of bull trout
* Regulate collection methods
* Regulate private ponds/preclude stocking of fish that compete with, prey on, or hybridize with bull trout in bull trout watersheds
* Monitor and prevent spread of fish diseases
* Prevent illegal introductions of nonnative aquatic flora and fauna

Population/Genetics Management

* Maintain sufficient population size in watersheds
* Prevent hybridization with brook trout
* Maintain/restore connectivity between populations - prevent fragmentation
* Determine genetic baselines in each watershed
* Maintain locally adapted, genetically pure populations
* Manage populations (numbers and life forms) for long-term viability
* Develop fish stocking and reintroduction policy for bull trout

Fig. 17. Factors influencing bull trout restoration.

RECOMMENDATIONS TO ADDRESS THREATS/ACHIEVE RESTORATION

The actions described above are further detailed in a narrative outline (Appendix E) which may be used as a tool in the development of specific conservation implementation plans to identify specific threats to bull trout restoration in each watershed, and to develop strategies to address those threats. Not all apply to each watershed. Other recommendations for addressing threats to bull trout populations and achieve restoration have been prepared by the Bull Trout Scientific Group and include: *The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout* (Appendix F), *Assessment of Methods for Removal or Suppression of Introduced Fish to Aid in Bull Trout Recovery* (Appendix G), and *The Role of Fish Stocking in Bull Trout Recovery* (Appendix H). These recommendations are meant to complement other existing resources and approaches, not replace them. For example, the monitoring based strategy in the technical report *The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout* (Appendix F) is not meant to replace other existing approaches for protecting and conserving bull trout. The report, and its monitoring-based strategy, represent an important body of science that should be incorporated into public and private resource management processes. The selected approach should balance cost effectiveness and biological benefits to bull trout.

IMPLEMENTATION

Many actions are already underway to conserve and restore bull trout in Montana (Appendix I). Implementing this plan will simply be a continuation of already existing actions in many areas. It is expected that implementation will occur in a variety manners and levels by the different involved/affected interests, depending on their interest, agreements, mandates, and missions. The primary avenue for implementation of habitat restoration will be land and fisheries management agencies working in conjunction with local watershed groups under the umbrella of this restoration plan. Restoration and conservation goals and actions are conceived as occurring

at several scales, from landscape-wide to site-specific. It is through a series of conservation actions by both public and private landowners that a regional or watershed conservation plan will be effective in restoring bull trout in a naturally functioning landscape.

As evident from prior sections, restoration of bull trout in Montana requires addressing a variety of very complex, intertwined policy-type issues and identifiable, measurable, on-the-ground issues; some of which must be addressed at a statewide level, and others that should be addressed at a local or watershed level. Therefore, implementation of this plan must occur simultaneously at local, state, and federal levels. Adoption of more specific conservation implementation plans by private landowners and state and federal management agencies is necessary to complement on-the-ground restoration activities being undertaken by local watershed groups. Relevant elements of this plan should also be incorporated into pertinent policies and regulations (e.g., fish stocking, management guidelines) affecting all watersheds.

Implementation needs to be science-based, include a monitoring component, and coordinate agency and private efforts to change current practices in order to restore bull trout. Implementation must also be adaptive to use new information and processes. An example of such an approach is the monitoring based strategy presented in the technical report *The Relationship Between Land Management Practices and Habitat Requirements of Bull Trout* (MBTSG 1998). That report advocates monitoring baseline habitat conditions prior to initiating land management activities in the caution zones of core and nodal areas, designing the activities to minimize risks to bull trout, monitoring habitat components during and after the activity to determine if impacts occurred, and adapting future projects based on information learned from the monitoring of previous projects. Another example is the Adaptive Management Commitment proposed by Plum Creek Timber Company in their Native Fish Habitat Conservation Plan (USFWS 1999).

It is anticipated that implementation will follow the model presented in the Upper Klamath Basin Conservation Strategy (Light et al. 1996):

Gather existing and new information on population, habitat, and watershed conditions

Identify specific factors that threaten bull trout viability

Develop and implement actions to address and eliminate threats to bull trout viability

- Secure Existing Populations
- Expand Populations to Former Range
- Connect Populations

Monitor results and evaluate effectiveness of specific actions

- Population Response
- Habitat Response
- Watershed Processes

Steering Committee

An interdisciplinary Steering Committee comprised of representatives of state, federal, and tribal management agencies with management authority for bull trout or bull trout habitat, as well as conservation organizations and industry representatives will oversee and monitor implementation of this plan, and evaluate overall effectiveness of restoration efforts, as summarized in annual monitoring reports compiled by the Bull Trout Coordinator. The team will meet at lest annually to review progress reports, discuss issues, prioritize statewide issues and actions, evaluate effectiveness of the plan towards achieving restoration, and serve as an umbrella to coordinate local watershed groups. In essence, this committee will function as a state recovery implementation committee.

Scientific Group

A Montana Bull Trout Scientific Group, appointed by the Steering Committee, will remain in place to provide scientific input and review for the Steering Committee. The Scientific Group needs to remain interdisciplinary, and should continue to be comprised of individuals from a diversity of agencies and institutions. Participation on the Scientific Group should be a part of that individual═s job responsibilities rather than an addition to them, and should be funded and given high priority accordingly. The Scientific Group will review annual monitoring reports, provide technical input to the Steering Committee and other entities regarding issues affecting bull trout restoration, and will evaluate overall effectiveness of restoration efforts.

Technical Advisory Committees

The Scientific Group technical papers addressing introduced species and fish stocking recommended the formation of a technical advisory committee (TAC) to review projects involving hatchery or transplanted bull trout and suppression and removal of introduced fish that might affect bull trout restoration. Such a committee will function on an ad hoc basis as needed.

They will be using the checklist and criteria provided in the reports for screening proposed stocking and suppression projects.

Watershed Groups

Watershed groups were identified early in Restoration Team meetings as being a cornerstone of the Montana bull trout restoration/conservation strategy. Watershed groups are broader in scope and seek a more diverse, less structured membership than the Technical Advisory Committees.

The role of watershed groups is to use the information provided in this plan, together with their knowledge of the watershed and input from technical experts, to determine ways to reduce risks to bull trout, to restore degraded habitat, to evaluate proposed activities in the drainage, and to work together to put these ideas into action. While watershed groups may make recommendations regarding state or private land activities, implementation of these recommendations is voluntary. However, in some instances activities may ultimately be legally guided under the Endangered Species Act through Habitat Conservation Plans or other conservation plans and agreements. Many activities affecting bull trout in Montana occur on National Forest Service lands, and these actions are legally guided by Forest Plans, all of which have adopted INFISH (U.S. Forest Service 1995) standards, guidelines and procedures, which should be replaced by the adopted Record of Decision for the Interior Columbia Basin Ecosystem Management Project when that document is finalized.

Objectives of watershed groups will include:

1) Provide a process for interagency coordination and participation by interested groups and individuals in bull trout restoration; this might include developing a local drainage conservation strategy and prioritizing actions for restoration.

2) Facilitate the exchange of information on bull trout distribution, population trends, and factors precluding or limiting productivity.

3) Develop action-oriented management plans for watersheds, outlining current status of bull trout in the watershed, specific threats, and actions to address threats.

4) Improve public awareness of bull trout value and importance of protection and restoration efforts.

5) Incorporate westslope cutthroat trout and other native fish management into their restoration and conservation activities.

Where possible, bull trout watershed groups can be coordinated with, or included in other efforts to develop watershed restoration processes that involve both agency personnel and citizen participation. House Bill 546, passed by the 1997 Legislature, strengthened the state═s authority to develop Total Maximum Daily Loads (TMDLs) (water quality improvement strategies). The Department of Environmental Quality (DEQ) has been directed to lead the process with guidance from a statewide advisory group, local conservation districts, watershed groups and other interested parties. In several drainages, DEQ will be setting up watershed advisory groups to address impaired waterbodies. Bull trout conservation could be addressed through these groups or sub-committees of them.

While implementation and monitoring of different restoration techniques will need to continue, it may be most productive and prudent to combine these techniques with improved land and water stewardship within the watershed. Local watershed-based groups typically favor resource stewardship, and can offer the combination of local residents, fish biologists and other resource professionals, and interested individuals working to improve land management practices. These watershed groups also provide an opportunity to develop participatory, cooperative monitoring programs.

Drainage Specific Restoration and Conservation Strategies

To effectively and efficiently implement restoration strategies for bull trout in each watershed, drainage-specific restoration strategies outlining specific threats and specific actions to address those threats must be developed for each RCA. These strategies should follow the format of the status reviews, but contain more site-specific information so that specific threats can be prioritized and corrected. These restoration strategies must be science-based, and tied to the concepts and principles outlined in this restoration plan. Technical specialists appointed by

MFWP will serve as the lead entity in drafting these. Other State, federal, or Tribal management agency, nongovernmental organization, watershed group, or other appropriate entities may assist FWP in completing these plans. Development of such strategies should incorporate as much local expertise as possible and should be developed in conjunction with watershed groups to ensure the necessary information is included. Strategies will include, but not be limited to, an update of the current status in each watershed, identification of key waters in each watershed, identification of specific threats in each key water and watershed, an assessment of methods and cost estimates to address specific threats, prioritization of restoration actions, and implementation of watershed management/restoration plans and restoration actions. These plans will serve to prioritize and guide restoration efforts, and will be the foundation upon which annual work planning and reporting will be based. They will serve as a reference, but will not be binding.

Coordination

It is expected that the Bull Trout Coordinator position currently housed in the Montana Department of Fish, Wildlife and Parks will remain on a half-time basis to serve as staff to the Steering Committee and as liaison between the Steering Committee, Scientific Group, and watershed groups. The Coordinator will compile annual status and monitoring reports for review by the Steering Committee, and also will ensure all of these groups, as well as any other interested parties, are provided the most current and available information regarding bull trout restoration efforts. It is expected that funding and staffing for coordination of watershed groups and implementation of restoration efforts will be shared by agency and corporate interests involved in activities in the different drainages.

Monitoring

A key component of this restoration plan is to monitor implementation, compliance with, and effectiveness of conservation measures contained in the plan. This will be enabled through

continued population and habitat monitoring. A summary of monitoring results and evaluation documents for each RCA will be prepared annually by the Bull Trout Coordinator, and will be provided to the Scientific Group and Steering Committee. The summary will include a summary of the most recent population and habitat monitoring results, as well as an overall assessment of the status of bull trout and bull trout habitat in each RCA. Monitoring will enable adaptive feedback to agencies and watershed groups to ensure restoration actions are effective and consistent with this Restoration Plan.

Because of the scale and complexity of monitoring required, a cooperative monitoring effort will be required. No single agency or entity can complete the required monitoring individually.

Coordination with other plans, strategies, mandates, and missions

Bull trout habitat occurs over a wide range of ownerships and jurisdictions, each of which operate under different laws, regulations, policies, and mandates, some of which supersede others. For federal lands, laws and implementing regulations that direct management include the Clean Water Act, National Environmental Policy Act, Endangered Species Act, National Forest Management Act, and Power Planning Act; state lands are administered under legislation and policies such as the Montana Environmental Policy Act, School Trust Lands Administration, and FWP and DNRC enabling legislation. Laws that govern administration of private lands are more flexible, with management primarily at the discretion of the landowner. In addition to existing mandates and policies, various other conservation strategies, including species and habitat conservation plans, federal recovery plans for ESA listed species, land allocation decisions in Forest Service Land and Resource Management Plans, management guidelines, and interagency Memorandums Of Understanding (MOUs) direct management of habitat containing bull trout.

It is the intent of the Restoration Team that this plan not supersede existing laws, regulations, mandates, and agreements, but rather the results of this effort be adopted and incorporated into them. As previously stated, the restoration plan is intended to be used by local watershed groups and land managers as a guideline for developing and implementing more specific, local conservation strategies for bull trout in local watersheds. For example, where not already addressed by Forest Land and Resources Management Plans, as amended by INFISH (U.S. Forest Service 1995) or the Interior Columbia River Basin preferred alternative (ICBEMP EIS Team 1997), the conservation objectives and standards and guidelines outlined in this plan should be amended to Forest Service Regional Guides and U.S. Forest Service Forest Land and Resource Management Plans. Similarly, the conservation objectives and measures outlined in this plan should provide sideboards for ESA consultation and when developing fisheries management and waterbody (e.g., lake, river or stream) management plans.

FUNDS POTENTIALLY AVAILABLE FOR IMPLEMENTATION

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Table 2. Funds potentially available for bull trout restoration

FUTURE FISHERIES IMPROVEMENT PROGRAM (FWP)

< ANNUAL FUNDING: APPROXIMATELY $750,000 FOR PROJECTS THAT RESTORE OR ENHANCE HABITAT FOR WILD FISH. PREFERENCE IS GIVEN FOR PROJECTS THAT RESTORE HABITAT FOR NATIVE FISH

HB 647 - BULL TROUT AND CUTTHROAT TROUT ENHANCEMENT PROGRAM (FWP)

ANNUAL FUNDING: $750,000 DURING 2000-2001 BIENNIEUM; $500,000/YEAR THEREAFTER FROM RIT FUND

FUNDING WILL BE INCORPORATED INTO AND ADMINISTERED BY THE FUTURE FISHERIES PROGRAM, BUT MAY ONLY BE USED FOR PROJECTS THAT BENEFIT BULL TROUT AND/OR CUTTHROAT TROUT

FUNDS MAY BE USED FOR HABITAT ENHANCEMENT AND FOR REDUCTIONS IN SPECIES COMPETITION

PARTNERS FOR FISH AND WILDLIFE PROGRAM (U.S. FISH & WILDLIFE SERVICE)

< ANNUAL FUNDING APPROXIMATELY $175,000 FOR BULL TROUT HABITAT RESTORATION: FUNDS ARE USED IN CONJUNCTION WITH OTHER FUNDING SOURCES FOR PROJECTS THAT ENHANCE OR RESTORE HABITAT FOR NATIVE FISH

NATURAL RESOURCE DAMAGE SETTLEMENT WITH ARCO

< REQUIRES THAT AT LEAST $500,000 OF NRD CONSENT DECREE BE SPENT ON BULL TROUT RECOVERY PROJECTS OVER THE NEXT 10 YEARS

< APPROXIMATELY $10 MILLION AVAILABLE ANNUALLY (THROUGH A COMPETITIVE GRANT BASIS) TO RESTORE, REPLACE, REHABILITATE, OR ACQUIRE THE EQUIVALENT OF NATURAL RESOURCES THAT WERE INJURED AS A RESULT OF MINING AND SMELTING IN THE UPPER CLARK FORK BASIN.

< IN ADDITION, 5% OF CLARK FORK RIVER SETTLEMENT (CURRENTLY IN NEGOTIATION) THAT EXCEEDS $10 MILLION (UP TO MAXIMUM OF $5 MILLION) MUST BE SPENT ON BULL TROUT RESTORATION

MILLTOWN DAM MITIGATION (MONTANA POWER COMPANY)

< $60,000/YEAR AVAILABLE FOR HABITAT RESTORATION

AVISTA (WASHINGTON WATER POWER) RELICENSING AGREEMENT

< NATIVE SALMONID (BULL TROUT AND WESTSLOPE CUTTHROAT TROUT) RESTORATION PLAN

$1.3 MILLION AVAILABLE 1999

$500,000 ANNUALLY OVER THE NEXT 40 YEARS

< TRIBUTARY ENHANCEMENT FUND FOR LOWER CLARK FORK RIVER AND THOMPSON RIVERS

$487,500 AVAILABLE FOR BULL TROUT HABITAT RESTORATION IN 1999

$237,500 AVAILABLE FOR BULL TROUT HABITAT RESTORATION ANNUALLY THEREAFTER FOR 4O YEARS

< FISH PASSAGE FUNDING

$400,000/YEAR DEPOSITED INTO FISH PASSAGE FACILITIES FUND AT CABINET GORGE AND/OR NOXON DAM. SHOULD FACILITIES NOT BE CONSTRUCTED, FUNDS BECOME AVAILABLE FOR ADDITIONAL HABITAT RESTORATION.

NORTHWEST POWER PLANNING COUNCIL=S FISH AND WILDLIFE PROGRAM

< APPROXIMATELY $600,000/YEAR (based on an annual selection process) APPLIED DIRECTLY TO BULL TROUT HABITAT RESTORATION AND MONITORING

< HIGHEST PRIORITY GIVEN TO REBUILDING NATIVE FISH STOCKS (BULL TROUT AND WESTSLOPE CUTTHROAT)

<

- **KERR DAM MITIGATION** (Payments to the Confederated Salish and Kootenai Tribes)

  - $17 MILLION FOR FISH AND WILDLIFE HABITAT ACQUISITION ON THE FLATHEAD RESERVATION

  - $10.75 MILLION FOR FISH AND WILDLIFE HABITAT RESTORATION ON THE FLATHEAD RESERVATION

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GLOSSARY

adfluvial:	fish that spawn in tributary streams where the young rear from 1-4 years before migrating to a lake, where they grow to maturity
aggrade:	raise the grade or level of a river valley or streambed by depositing streambed material or material or debris
connected:	populations between which both upstream and downstream movements of all life stages of individuals is possible and can occur
core area:	core areas are watersheds, including tributary drainages and adjoining uplands, used by migratory bull trout for spawning and early rearing, and by resident bull trout for all life history requirements
cover:	anything that provides visual isolation or physical protection for a fish, including vegetation that overhangs the water, undercut banks, rocks, logs and other woody debris, turbulent water surfaces, and deep water
disjunct population:	a population found in a headwater lake, that is self-reproducing, but is functionally isolated from the rest of the system due to barriers, thermal conditions, etc.
drainage:	an area (basin) mostly bounded upstream by ridges or other topographic features, encompassing part or all of a watershed
entrainment:	displacement of fish from a reservoir through an outlet from a dam or from a river into an irrigation ditch
escapement:	adult fish which return to spawn
fluvial:	fish that spawn in tributary streams where the young rear from 1-4 years before migrating to a river system, where they grow to maturity
fragmentation:	the breaking up of a larger population of fish into smaller disconnected subpopulations
fry:	first-year fish
local population:	a population occurring in a specific portion of a drainage, usually a tributary, that is adapted to that specific location, and that is usually separated from other populations within a drainage.
metapopulation:	a collection of localized populations that are geographically distinct, yet are genetically interconnected through movement of individuals among populations
migratory:	describes the life history pattern in which fish spawn and spend their early rearing years in specific tributaries, but migrate to larger rivers, lakes or reservoirs as adults during their non-spawning time
nodal habitat:	waters which provide migratory corridors, overwintering areas, or other critical life history requirements
population:	an interbreeding group of fish that spawn in a particular river system (or part of it)
redd:	a disturbed area in the gravel, or a nest, constructed by spawning fish in order to bury the fertilized eggs

resident: fish that spend their entire life cycle usually in tributary or small headwater streams in which they were hatched

restoration: the process by which the decline of a species is stopped or reversed, and threats to its survival are removed or decreased, so that its long-term survival in nature can be ensured

Restoration/Conservation Areas (RCAs): portions of major drainages between which migration and straying is unlikely or can occur only downstream. It is within or between these restoration/conservation areas that bull trout will need to function as metapopulations.

Restoration Team: a policy-level group with representatives from State, Tribal, and federal agencies, conservation organizations and private industry; appointed by Governor Racicot to establish a Bull Trout Restoration Plan for Montana

riparian area: lands adjacent to water such as creeks, streams and rivers and, where vegetation is strongly influenced by the presence of water

risk: a factor which has contributed to the past or current decline of the species

Scientific Group: composed of agency, private and university scientists appointed by the Restoration Team to conduct technical analysis

strategy: planning, directing, and implementation of projects for achieving specific objectives

threat: a factor which jeopardizes the future conservation of the species

watershed: a drainage basin which contributes water, organic matter, dissolved nutrients, and sediments to a river, stream or lake

Watershed Group: a group of agency representatives, landowners and recreational and commercial users of a watershed, plus a liaison from the Scientific Group; created by the Restoration Team and charged with developing restoration actions to help restore bull trout

ACRONYMS

AFS	**American Fisheries Society**
BPA	**Bonneville Power Administration**
CSKT	**Consolidated Salish and Kootenai Tribes**
DNRC	**Montana Department of Natural Resources and Conservation**
ESA	**Endangered Species Act**
FERC	**Federal Energy Regulatory Commission**
FWP	**Montana Department of Fish, Wildlife and Parks**
ICBEMP	**Interior Columbia Basin Ecosystem Management Project**
RCA	**Restoration/Conservation Area**
RT	**Montana Bull Trout Restoration Team**
SG	**Montana Bull Trout Scientific Group**
TMDL	**Total Mean Daily Load**
US EPA	**United States Environmental Protection Agency**
USGS	**United States Geological Survey**
USFWS	**United States Fish and Wildlife Service**

APPENDICES

Appendix A. Restoration Team Charter

Appendix B. Risk factors to bull trout in Montana Restoration/Conservation Areas (RCAs), and the threat the risk factor poses to future restoration of the bull trout.

Appendix C. Summary of core areas identified in Montana RCA status reports

Appendix D. Summary of restoration goals for Bull Trout RCAs in Montana

Appendix E. Narrative outline of possible recovery actions to restore bull trout

Appendix F. Executive Summary - The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout

Appendix G. Executive Summary - Assessment of Methods for Removal or Suppression of Introduced Fish to Aid in Bull Trout Recovery

Appendix H. Executive Summary - The Role of Stocking in Bull Trout Recovery

Appendix I. Description of current conservation measures.

Appendix B. Risk factors to bull trout in Montana Restoration/Conservation Areas (RCAs), and the threat the risk factor poses to future restoration of the bull trout. The description of threats and risks to the fish are the best scientific judgment of the Scientific Group and local resource experts/professionals. Those risks which are of greatest concern are noted with a double asterisk.

RISK	BITTER ROOT	BLACK FOOT	L.CLK FORK	M.CLK FORK	U.CLK FORK	FLAT HEAD	S. FK FLAT HEAD	SWAN	LOW KOOT	MID KOOT	UPP KOOT	SUM RANK
Environmental Instability												
Drought	*				*				*	*		4
Landslide/Geology	*		*							*		3
Flood/Rain on Snow	*		*						*	*		4
Fire	*				*					*		3
Introduced Species												
Private Ponds											*	1
Legal Introductions	**	**	**	**	**	**		**	*	**	*	18
Illegal Introductions	*	*	*	*	*		**	**	*	*	**	13
Fisheries Management	*	*	*	*		**						6
Barriers												
Culverts												0
Diversions	**	**			*						*	6
Thermal	*	*		*?	**					*		6
Dams		**	**	*	**					**		9

RISK	BITTER ROOT	BLACK FOOT	L.CLK FORK	M.CLK FORK	U.CLK FORK	FLAT HEAD	S. FK FLAT HEAD	SWAN	LOW KOOT	MID KOOT	UPP KOOT	SUM RANK
Habitat												
Grazing	**	**			**							6
Agriculture and Dewatering	**	*		**(Flat head)	**						*	8
Dam Operations				*(Flat head)			**		*	**	*	7
Forestry Practices	**	**	**	**	**	**	**	**	*	**	**	21
Recreational Develop.												0
Transportation				* (St Regis)					*	*		3
Population												
Population Trend	*	*	*	*	*	*						6
Distribution/Fragment.	*		**	*	*							5
Abundance	*		*	*	*	*			*	*		7
Biological Sampling												0
Angling		*		*				*		*		4
Illegal Harvest		*	**	**	*		*	*	*		*	10
TOTAL	22	20	18	19	21	9	7	9	10	18	11	

Appendix C. Summary of core areas and ownership, identified in Montana RCA status reports.

Core Area	Ownership	Area (ac)	Percent
BITTERROOT DRAINAGE (Total)	National Forest Lands	519498.2	88.2%
	Private Lands	65554.3	11.1%
	State Lands	3841.1	0.6%
	National Wildlife Ref.	211.8	<0.1%
Upper East Fork Bitterroot River	National Forest Lands	97364.9	99.1%
	Private Lands	853.2	0.9%
Warm Springs Creek Drainage	National Forest Lands	28191.1	98.9%
	Private Lands	313.7	1.1%
Sleeping Child Creek Drainage	National Forest Lands	49124.4	84.3%
	Private Lands	8656.4	14.9%
	State Lands	499.9	0.9%
Shalkaho Creek Drainage	National Forest Lands	64702.4	83.8%
	Private Lands	11977.7	15.5%
	State Lands	489.6	0.6%
Fred Burr Creek Drainage	National Forest Lands	29569.0	72.4%
	Private Lands	11263.5	27.6%
W. Fork Bitterroot above Painted Rocks Res.	National Forest Lands	187073.3	98.0%
	Private Lands	3615.2	1.9%
	State Lands	281.4	0.1%
Upper Burnt Fork Creek Drainage	National Forest Lands	41844.9	61.0%
	Private Lands	24586.9	35.8%
	State Lands	1965.4	2.9%
	National Wildlife Ref.	211.8	0.3%
Blodgett Creek	National Forest Lands	17436.4	78.1%
	Private Lands	4286.6	19.2%
	State Lands	604.8	2.7%
Little Boulder Creek	National Forest Lands	4191.8	100.0%
	Private Lands	1.1	<1.0%
BLACKFOOT (Total)	National Forest Lands	399255.5	66.8%
	Private Lands	175423.8	29.3%
	State Lands	21418.7	3.6%
	National Wildlife Ref.	204.9	<0.1%
	BLM	1409.9	0.2%
N. Fork Blackfoot River	National Forest Lands	157794.4	79.2%
	Private Lands	33399.3	16.8%
	State Lands	6547.9	3.3%
	National Wildlife Ref.	204.9	0.1%
	Bureau Land Manage.	1174.0	0.6%
Monture Creek Drainage	National Forest Lands	73472.1	75.7%
	Private Lands	17917.4	18.5%

Core Area	Ownership	Area (ac)	Percent
	State Lands	5603.7	5.8%
Copper Creek Drainage - Tributary of Landers Fork	National Forest Lands Private Lands State Lands	25501.3 1468.4 232.3	93.7% 5.4% 0.9%
Cottonwood Creek Drainage	National Forest Lands Private Lands State Lands Bureau Land Manage.	17753.6 21655.9 4306.4 74.7	40.5% 49.5% 9.8% 0.2%
Clearwater River above Rainy Lake (Includes E. Fork Stillwater River)	National Forest Lands Private Lands	10918.0 50.8	99.5% 0.5%
Deer Creek Drainage	National Forest Lands Private Lands	2424.2 10859.2	18.2% 81.8%
Placid Creek Drainage	National Forest Lands Private Lands State Lands	15155.5 16949.8 1724.6	44.8% 50.1% 5.1%
Belmont/Gold Creek Drainage	National Forest Lands Private Lands State Lands	15184.2 43314.5 1100.8	25.5% 72.7% 1.8%
Landers Fork Drainage	National Forest Lands Private Lands State Lands	44135.1 6866.9 834.2	85.1% 13.2% 1.6%
W. Fork Clearwater Drainage	National Forest Lands Private Lands	9230.0 12384.1	42.7% 57.3%
Morrell Creek Drainage	National Forest Lands Private Lands State Lands BLM Lands	27687.1 10557.3 1068.7 161.2	70.1% 26.7% 2.7% 0.4%
LOWER CLARK FORK DRAINAGE (Total)	National Forest Lands Private Lands State Lands	285526.7 24078.2 633.6	92.0% 7.8% 0.2%
Prospect Creek Drainage	National Forest Lands Private Lands State Lands	108403.8 6726.7 624.3	93.6% 5.8% 0.5%
Rock Creek Drainage	National Forest Lands Private Lands State Lands	19287.7 1310.3 9.3	93.6% 6.4% <0.1%
Vermillion River Drainage	National Forest Lands Private Lands	58062.0 9872.3	85.5% 14.5%
	National Forest Lands	82786.9	94.2%

Core Area	Ownership	Area (ac)	Percent
Bull River Drainage	Private Lands	5068.4	5.8%
Graves Creek	National Forest Lands Private Lands	16986.2 1100.6	93.9% 6.1%
MIDDLE CLARK FORK DRAINAGE (Total)	National Forest Lands Private Lands State Lands Indian Lands or Res. National Wildlife Ref.	594975.9 137957.4 23229.8 203758.6 6441.1	61.6% 14.3% 2.4% 21.1% 0.7%
Fish Creek Drainage	National Forest Lands Private Lands State Lands	127884.5 27758.4 6571.3	78.8% 17.1% 4.1%
St. Regis River Drainage	National Forest Lands Private Lands State Lands	203586.0 15196.3 3140.9	91.7% 6.8% 1.4%
Trout Creek Drainage	National Forest Lands Private Lands	44784.9 641.0	98.6% 1.4%
Cedar Creek Drainage	National Forest Lands Private Lands	42895.6 2038.1	95.5% 4.5%
Petty Creek Drainage	National Forest Lands Private Lands State Lands	35717.9 16509.0 604.5	67.6% 31.2% 1.1%
Rattlesnake Creek Drainage	National Forest Lands Private Lands State Lands	44028.5 5151.0 259.5	89.1% 10.4% 0.5%
W. Fork Thompson River Drainage/Fishtrap Creek	National Forest Lands Private Lands State Lands	96078.4 27384.2 4410.8	75.1% 21.4% 3.4%
Jocko River Drainage	Indian Lands or Res. Private Lands State Lands National Wildlife Ref.	182184.2 43196.9 8242.7 6441.1	75.9% 18.0% 3.4% 2.7%
Mission Creek above Mission Dam	Indian Lands or Res. Private Lands	8838.8 82.5	99.1% 0.9%
Post Creek above McDonald Dam	Indian Lands or Res.	12735.6	100%
UPPER CLARK FORK DRAINAGE (Total)	National Forest Lands Private Lands State Lands BLM Lands	180715.1 217302.2 18369.6 4182.1	43.0% 51.6% 4.4% 1.0%

Core Area	Ownership	Area (ac)	Percent
Boulder Creek Drainage	National Forest Lands	42875.9	94.4%
	Private Lands	2379.4	5.2%
	State Lands	18.4	0.3%
	BLM Lands	144.1	<0.1%
Warm Springs Creek Drainage	National Forest Lands	47906.5	42.0%
	Private Lands	63807.1	56.0%
	State Lands	2233.2	2.0%
Harvey Creek Drainage	National Forest Lands	19506.2	77.7%
	Private Lands	5275.2	21.0%
	State Lands	244.4	1.0%
	BLM Lands	89.1	0.4%
Racetrack Creek Drainage	National Forest Lands	26285.5	69.4%
	Private Lands	10692.1	28.2%
	State Lands	901.1	2.4%
Little Blackfoot River Drainage	National Forest Lands	44141.0	80.9%
	Private Lands	135148.4	18.7%
	State Lands	14972.5	0.3%
	BLM Lands	3948.9	0.1%
ROCK CREEK DRAINAGE (Total)	National Forest Lands	311558.7	88.6%
	Private Lands	37447.7	10.6%
	State Lands	1764.8	0.5%
	BLM Lands	1000.2	0.3%
East Fork Rock Creek above E. Fk. Reservoir Dam	National Forest Lands	37566.3	72.9%
	Private Lands	12900.4	25.0%
	State Lands	1035.6	2.0%
Middle Fork Rock Creek	National Forest Lands	70108.8	89.9%
	Private Lands	7642.6	9.8%
	State Lands	77.3	0.1%
	BLM Lands	133.8	0.2%
Stony Creek	National Forest Lands	18727.2	98.8%
	Private Lands	235.0	1.2%
Wyman Creek	National Forest Lands	10392.4	100%
Hogback Creek	National Forest Lands	10148.7	99.9%
	Private Lands	6.8	0.1%
Alder Creek	National Forest Lands	8848.2	100.0%
	Private Lands	0.5	<0.1%
Welcome Creek	National Forest Lands	12732.2	99.9%
	Private Lands	6.6	0.1%
Ranch Creek	National Forest Lands	27680.9	99.1%
	Private Lands	240.3	0.9%

Core Area	Ownership	Area (ac)	Percent
Gilbert Creek	National Forest Lands Private Lands State Lands	10422.0 3997.7 4.5	72.3% 27.7% <0.1%
Walquist Creek			
FLATHEAD RIVER DRAINAGE (Total)	National Forest Lands Private Lands State Lands National Park Lands	499382.2 37348.5 79922.7 346738.7	51.8% 3.9% 8.3% 36.0%
Big Creek Drainage	National Forest Lands Private Lands State Lands	51352.0 1321.4 489.1	96.6% 2.5% 0.9%
Coal Creek Drainage	National Forest Lands Private Lands State Lands	35162.5 590.6 9141.3	78.3% 1.3% 20.4%
Whale Creek Drainage	National Forest Lands Private Lands State Lands	40456.4 233.5 519.7	98.2% 0.6% 1.3%
Trail Creek Drainage	National Forest Lands Private Lands State Lands	42201.0 2038.4 183.9	95.0% 4.6% 0.4%
Red Meadow Creek Drainage	National Forest Lands Private Lands	17611.5 687.4	96.2% 3.8%
Howell Creek Drainage (Canada)			
Cabin Creek Drainage (Canada)			
Nyack Creek Drainage	National Park Lands Private Lands	52045.3 2142.9	96.0% 4.0%
Park Creek Drainage	National Park Lands Private Lands	18458.7 4.2	100% <0.1%
Ole Creek Drainage	National Park Lands	29868.7	100%
Bear Creek Drainage	National Forest Lands Private Lands National Park Lands	24185.5 817.0 11185.3	66.8% 2.3% 30.9%
Long Creek Drainage	National Forest Lands Private Lands	13922.6 3.0	100.0% <0.1%
Granite Creek Drainage	National Forest Lands	18764.3	100.0%
Morrison Creek Drainage	National Forest Lands	30935.4	100.0%
Schafer Creek Drainage	National Forest Lands	32734.0	100.0%

Core Area	Ownership	Area (ac)	Percent
Clack Creek Drainage	National Forest Lands	8562.1	100.0%
Strawberry Creek Drainage	National Forest Lands	31984.3	100.0%
Bowl Creek Drainage	National Forest Lands	19116.7	100.0%
Akolala Creek (Disjunct)	National Park Lands	3454.9	100.0%
Bowman Creek (Disjunct)	National Park Lands	26496.8	100.0%
Camas Creek (Disjunct)	National Park Lands Private Lands	10251.6 0.9	100.0% <0.1%
Cyclone Creek (Disjunct)	National Forest Lands State Lands	3807.0 2462.9	60.7% 39.3%
Harrison Creek (Disjunct)	National Park Lands	14301.1	100.0%
Kintla Creek (Disjunct)	National Park Lands	28192.2	100.0%
Lincoln Creek (Disjunct)	National Park Lands	7889.0	100.0%
Logan Creek (Disjunct)	National Forest Lands Private Lands State Lands	97865.2 12944.8 1330.3	87.3% 11.5% 1.2%
Logging Creek (Disjunct	National Park Lands	19811.4	100.0%
McDonald Creek (Disjunct)	National Park Lands Private Lands	101572.5 735.0	99.3% 0.7%
Quartz Creek (Disjunct)	National Park Lands	16645.3	100.0%
Swift Creek (Disjunct)	National Forest Lands Private Lands State Lands	11302.2 14150.1 36823.2	18.1% 22.7% 59.1%
Upper Park Creek (Disjunct)	National Park Lands	6565.2	100.0%
Upper Stillwater River (Disjunct)	National Forest Lands Private Lands State Lands	17250.0 1679.2 28972.5	36.0% 3.5% 60.5%
Frozen Lake + inlet and outlet (Disjunct)	National Forest Lands	2169.6	100.0%
SOUTH FORK FLATHEAD DRAINAGE (Total)	National Forest	605616.7	100.0%
Wounded Buck Creek Drainage	National Forest	10909.1	100.0%
Wheeler Creek Drainage	National Forest	13564.2	100.0%
Sullivan Creek Drainage	National Forest	48995.0	100.0%
Spotted Bear River Drainage	National Forest	118633.6	100.0%

Core Area	Ownership	Area (ac)	Percent
Bunker Creek Drainage	National Forest	66143.1	100.0%
Little Salmon Creek Drainage	National Forest	36255.9	100.0%
White River Drainage	National Forest	55154.2	100.0%
South Fork upstream from Gordon Creek	National Forest	202754.7	100.0%
Big Salmon Creek (Disjunct)	National Forest	49196.4	100.0%
Doctor Lake (Disjunct)	National Forest	4010.3	100.0%
SWAN RIVER DRAINAGE (Total)	National Forest Lands Private Lands State Lands	118978.7 36094.2 23316.3	66.7% 20.2% 13.1%
Elk Creek Drainage	National Forest Lands Private Lands	13832.4 3375.6	80.4% 19.6%
Goat Creek Drainage	National Forest Lands Private Lands State Lands	14314.7 4644.5 3210.4	64.6% 20.9% 14.5%
Lion Creek Drainage	National Forest Lands Private Lands	16946.3 3425.8	83.2% 16.8%
Piper Creek Drainage	National Forest Lands Private Lands	6328.5 1631.2	79.5% 20.5%
Jim Creek Drainage	National Forest Lands Private Lands	7240.9 4795.5	60.2% 39.8%
Lost Creek Drainage	National Forest Lands State Lands	15517.8 4358.6	78.1% 21.9%
Woodward Creek Drainage	National Forest Lands Private Lands State Lands	3439.1 6084.7 6447.7	21.5% 38.1% 40.4%
Cold Creek Drainage	National Forest Lands Private Lands	12490.3 7947.5	61.1% 38.9%
Lindbergh Lake (Disjunct)	National Forest Lands Private Lands	21388.0 3627.1	85.5% 14.5%
Holland Lake (Disjunct)	National Forest Lands	4883.3	100.0%
Soup Creek	National Forest Lands Private Lands State Lands	2597.4 562.2 9299.6	20.8% 4.5% 74.6%

Core Area	Ownership	Area (ac)	Percent
LOWER KOOTENAI DRAINAGE (Total)	National Forest Lands Private Lands State Lands	56512.2 4859.2 651.2	91.1% 7.8% 1.0%
O═Brien Creek Drainage	National Forest Lands Private Lands State Lands	26106.6 4042.8 330.3	85.7% 13.3% 1.1%
Keeler Creek (disjunct)	National Forest Lands Private Lands State Lands	30405.7 816.4 320.9	96.4% 2.6% 1.0%
Long Creek, Idaho			
Fisher/Parker Creeks, Idaho			
Stanley Creek (disjunct)			
MIDDLE KOOTENAI DRAINAGE (Total)	National Forest Lands Private Lands State Lands	201418.4 37753.6 4295.2	82.7% 15.5% 1.8%
Quartz Creek Drainage	National Forest Lands Private Lands	22663.0 855.7	96.4% 3.6%
Pipe Creek Drainage	National Forest Lands Private Lands State Lands	55012.9 12347.0 627.9	80.9% 18.2% 0.9%
Libby Creek Drainage	National Forest Lands Private Lands State Lands	123742.5 24551.0 3667.4	81.4% 16.2% 2.4%
UPPER KOOTENAI RIVER DRAINAGE	National Forest Lands Private Lands State Lands	59598.4 7436.9 438.6	88.3% 11.0% 0.6%
Grave Creek Drainage	National Forest Lands Private Lands State Lands	43820.8 4191.3 123.7	91.0% 8.7% 0.3%
Wig Wam River (Montana Portion)	National Forest Lands Private Lands	15575.6 30.9	99.8% 0.2%
Phillips Creek (disjunct)	National Forest Lands Private Lands State Lands	202.1 3214.7 314.8	5.4% 86.1% 8.4%
Total of ALL Core Areas in All RCAs in Montana	National Forest Lands	3833037.7	71.6%

Core Area	Ownership	Area (ac)	Percent
	Private Lands	781255.9	14.6%
	National Park Lands	346738.7	6.5%
	Indian Reservation	203758.6	3.8%
	State Lands	177881.6	3.3%
	BLM Lands	6592.2	0.1%
	National Wildlife Ref.	6857.8	0.1%
	TOTAL	5,356,121.5	100%

SECONDARY CORE STREAMS			
Bitterroot	Little Boulder Creek		
	Blodgett Creek		
Blackfoot	Alice Creek		
	Hogum Creek		
	Arastra Creek		
	Poorman Creek		
	Beaver Creek		
Lower Clark Fork	Swamp Creek		
	Martin Creek		
Rock Creek	West Fork Rock Creek		
	Cinnamon Bear Creek		
South Fork Flathead	Felix Creek		
Lower Kootenai	Callahan Creek		
Middle Kootenai	West Fisher		
	Fisher River		
Upper Kootenai	Canadian tribs. to the Wigwam River and Kootenay River		

Appendix D. Summary of restoration goals for Bull Trout RCAs in Montana, as listed in individual status reports (MBTSG 1995 a-e, 1996a-f)

BITTERROOT

- Maintain self-sustaining bull trout populations in all the watersheds where they presently exist
- Maintain the population genetic structure throughout the watershed
- Reestablish connectivity between the Bitterroot River and its tributaries
- Establish a self-reproducing migratory population in the Bitterroot River which spawns in all identified core area tributary streams
- Maintain a count of at least 100 redds or 2,000 total individuals in the migratory population over a period of 15 years (3 generations), with spawning distributed among all identified core watersheds

BLACKFOOT

- Maintain the self-reproducing migratory life form in the Blackfoot River which have access to tributary streams and spawn in all core watersheds
- Maintain the population genetic structure throughout the watershed
- Maintain and increase the connectivity between the Blackfoot River and its tributaries
- Establish a baseline of redd counts in all drainages that presently support spawning migratory bull trout
- Maintain a count of at least 100 redds or 2,000 individuals in the Blackfoot drainage, with an increasing trend thereafter

LOWER CLARK FORK

- Maintain self-sustaining bull trout populations in all watersheds where they presently exist
- Maintain the population genetic structure throughout the watershed
- Reestablish the historic bull trout migratory corridor in the Clark Fork River-Lake Pend Oreille system
- Establish baseline redd surveys in all drainages that presently support spawning migratory bull trout
- Maintain a count of at least 100 redds or 2,000 total individuals in the migratory population sustained over a period of 15 years (3 generations), with spawning well distributed within identified core areas
- Assess the feasibility of providing fish passage

MIDDLE CLARK FORK

- Maintain self-sustaining bull trout populations in all the core areas where they presently exist
- Maintain the population genetic structure throughout the watershed
- Reestablish connectivity within the Clark Fork River and between the Clark Fork and Flathead rivers and their tributaries.

- In the Clark Fork River above the St. Regis River: Maintain a count of at least 100 redds or 2,000 total individuals in the migratory populations over a period of 15 years (or at least three generations), with spawning distributed among all identified core areas
- In the Clark Fork River from Thompson Falls Dam up to, and including, the St. Regis River: maintain a count of at least 100 redds or 2,000 total individuals in the migratory population over a period of 15 years (or at least three generations), with spawning distributed among all identified core areas
- In the Flathead River portion of the drainage: maintain a count of at least 100 redds or 2,000 total individuals in the migratory populations over a period of 15 years (or at least three generations), with spawning distributed among all identified core areas

UPPER CLARK FORK
- Maintain self-sustaining bull trout populations in all the watersheds where they presently exist
- Maintain the population genetic structure throughout the watershed
- Reestablish a migratory corridor through Milltown Dam between the upper Clark Fork and middle Clark Fork
- Restore the connectivity within the Clark Fork River
- Establish a self-reproducing migratory population in the Clark Fork River which is connected to, and spawns in, tributary streams
- Maintain a count of at least 100 redds or 2,000 total individuals in the migratory population over a period of 15 years (at least three generations), with spawning distributed among all identified core areas

ROCK CREEK
- Maintain self-sustaining bull trout populations in all the watersheds where they presently exist
- Maintain the population genetic structure throughout the watershed
- Maintain a count of at least 100 redds or 2,000 total individuals over a period of 15 years (3 generations) in the Rock Creek Watershed

FLATHEAD
- Maintain or restore self-sustaining populations in the core areas
- Protect the integrity of the population genetic structure
- Enhance the migratory component of the population
- Increase bull trout spawners to attain the average redd count level of the 1980's, and maintain this level for 15 years (3 generations) in the North Fork and Middle Fork monitoring areas. The average 1980's redd counts in index streams were 240 in the North Fork (Whale, Trail, Coal and Big creeks) and 151 in the Middle Fork (Morrison, Granite, Lodgepole, and Ole creeks)
- Provide a long-term stable or increasing trend in overall population.
- Provide for spawning in all core areas

SOUTH FORK FLATHEAD

- Maintain the population's genetic structure and do not allow loss of the existing diversity
- Protect and maintain the existing native species complex through natural reproduction
- Determine the age structure of the spawning population and ensure it remains healthy
- Establish a baseline population index and develop population goals that will maintain or improve those baseline levels

SWAN

- Maintain the population genetic structure both within and between tributaries in the Swan River drainage (the genetic effects of an expanding Swan bull trout population on Flathead Lake populations is unknown)
- Maintain a self-sustaining bull trout population dominated by the migratory life form
- Maintain stable population levels within the current bull trout distribution, especially in all core areas
- Maintain the age structure of the spawning population
- Maintain the existing high degree of connectivity within the Swan River drainage
- Quantify and maintain the existing pattern of inter-annual variation in spawner escapement between streams (currently, some go up while others go down - if these patterns begin to occur in synchrony, the likelihood of extinction is increased)
- Minimize the opportunity for movement of introduced species into the drainage above Bigfork Dam, but explore options for upstream migration of native species from Flathead Lake [Currently there is no upstream passage at Bigfork Dam, and lake trout and lake whitefish are present below the dam. If lake trout are established in the Swan drainage, the bull trout population will be negatively impacted. However, this lack of connectivity with the Flathead drainage may be detrimental to bull trout and cutthroat trout in both the Flathead and the Swan drainages. Selective passage of bull trout and westslope cutthroat trout at Bigfork Dam may be desirable at some point in the future but there is great concern that human error or equipment failure could result in inadvertent transport of lake trout upstream. Many do not believe the risk is worth taking.]

LOWER KOOTENAI

- Maintain existing self-sustaining populations with stable age structure and distribution
- Protect the integrity of the population genetic structure
- Improve current habitat conditions in O'Brien Creek
- Establish a protocol for information exchange with Idaho and British Columbia
- Establish a baseline of redd counts in all drainages that presently support spawning migratory fish (O═Brien Creek, possibly Callahan Creek, and the Yaak river below Yaak Falls)
- Maintain a count of at least 100 redds or 2,000 individuals over a period of 15 years (or at least three generations), with spawning distributed among all identified core areas, and an increasing trend thereafter

- For the disjunct Bull Lake population: maintain the population genetic structure, improve habitat conditions in the core areas (Stanley and Keeler Creeks), and maintain the migratory component of the population. Establish a baseline of redd counts in all drainages that presently support spawning migratory fish. At least 100 redds or 2,000 individuals over a period of 15 years (or at least three generations), with spawning distributed among all identified core areas, and an increasing trend thereafter.

MIDDLE KOOTENAI

- Maintain the population genetic structure by ensuring that all existing populations will remain stable or increase from current numbers in the future
- Maintain the self-reproducing migratory life form in the Kootenai River which has access to tributary streams and spawns in core areas
- Maintain and increase the connectivity between the Middle Kootenai River and its tributaries
- Increase the number of quality spawning tributaries
- Establish a baseline of redd counts in all drainages that presently support spawning migratory bull trout
- Maintain a count of at least 100 redds or 2,000 individuals in the middle Kootenai drainage over a period of 15 years (or at least three generations), with spawning distributed among all identified core areas
- Maintain and improve habitat conditions in Quartz Creek
- Increase spawning in the Fisher River and Libby Creek

UPPER KOOTENAI

Due to the existing uncertainties and data needs, the following restoration goal should be considered interim pending further study and better coordination with British Columbia:.

- Maintain a self-sustaining population dominated by the migratory life form
- Maintain the population genetic structure
- Maintain a stable or increasing trend in spawning escapement (redd counts) for three generations (15 years)
- Stabilize and improve habitat in core areas. Initial efforts should focus on documenting current distribution and abundance so core areas can be reevaluated
- Coordinate actions with British Columbia to accomplish restoration goals

Appendix E. Outline Narrative of possible processes and actions that could aid in the restoration of bull trout in Montana. This section borrows from several works of Rieman and McIntyre (1993, 1995, 1996), Frissell and Nawa (1992), Frissell (1993), and Utah Department of Natural Resources (1997) (**Note**: Not all items apply to all watersheds).

A. Habitat Management

1.0. Characterize physical processes that affect suitable habitat

Physical processes such as geomorphology, groundwater influence, and gradient significantly affect bull trout distribution and abundance across their range, and the effects vary by site (Watson and Hillman 1997). A thorough understanding of the interaction of these physical processes is necessary to fully understand the factors affecting bull trout distribution and abundance, particularly when developing land management protection and enhancement programs.

1.1. Geomorphology
1.2. Ground water influence
1.3. Gradient

2.0. Delineate suitable habitat within each watershed

Bull trout habitat that is occupied during parts or all of the year should be delineated within each watershed. Potential and previously occupied suitable habitat similarly should be delineated, with emphasis on areas where connectivity is lacking.

2.1. Delineate additional habitat as survey, inventory, and restoration efforts justify

Additional suitable habitat should be delineated as survey and inventory efforts increase the known distribution of bull trout, and as restoration efforts lead to expansion of currently occupied range.

3.0. Categorize and prioritize drainages suitable for bull trout in each watershed

Delineated bull trout habitat should be categorized into different management categories, and within each category, those drainages should be ranked and prioritized in order of importance to restoration of bull trout.

3.1. Define different habitat types/categories

Within each watershed, bull trout habitat will be categorized into each of the following habitat types:

3.1.1. Core habitat

Because of their importance to individual populations, the statewide population, and RCA and statewide restoration goals, identification of important core areas is essential. Core areas in each RCA will be identified, and should be identified strictly on their biological capacity to function as core areas, independent of existing or planned land uses.

3.1.2. Nodal habitat

Nodal habitat includes waters that provide migratory corridors, overwintering areas, or other critical life history requirements for sub-adult and adult overwintering and migrating bull trout. Identification and protection of nodal habitat is important for maintaining proper metapopulation function.

3.1.3. Other occupied habitat

3.1.4. Important potential habitat

3.2. Develop criteria to prioritize drainages for protection and/or restoration within each habitat type

Criteria to prioritize drainages for protection and/or restoration within each habitat type should be developed for each watershed. Criteria emphasis will be on those habitats that contain the strongest populations, and those that would contribute most to restoration of the species in the watershed and overall.

3.3. Prioritize habitats in order of importance for protection and/or restoration

Within each watershed, delineated habitat types will be prioritized based on criteria developed for the watershed, as well as the importance of the habitat to restoration of bull trout in the watershed and overall.

4.0. Maintain existing high priority habitat types

Quality bull trout habitat and habitat processes must be maintained to ensure long-term viability of bull trout populations. Successful conservation of bull trout depends on maintaining existing locally adapted and diverse bull trout populations through protection of those habitats in the best condition with the strongest populations. Management actions in these areas should minimize risks that might result in the alteration of the quality, complexity or ecological and hydrological processes in these areas (Rieman and McIntyre 1993). Management recommendations for the different habitat types delineated in each watershed are described below.

4.1. Core Areas

Core areas are watersheds, including tributary drainages and adjoining uplands, used by migratory bull trout for spawning and early rearing, and by resident bull trout for all life history requirements. Core areas typically support the strongest remaining populations of spawning and early rearing bull trout in an RCA, and are usually in relatively undisturbed habitat.

4.1.1. Ensure core areas remain intact, and management actions do not significantly alter the quality, complexity, or ecological or hydrological processes in core areas.

Core areas typically contain the strongest remaining spawning and early rearing populations of bull trout, and are usually in relatively undisturbed habitat.

These areas need to have the most stringent levels of protection as they currently meet the specific habitat requirements of spawning and early rearing bull trout, and will potentially provide the stock for recolonization of adjacent drainages. It is essential to identify and protect these habitats to facilitate population expansion and restoration. Management activities should be carefully planned and implemented in core areas. Conservation strategies developed by land management entities for these areas should recognize the importance of maintaining the integrity of essential habitat components:

a. Water temperature - Water temperature requirements for bull trout vary for different life stages. Management actions should maintain or enhance water temperature requirements for bull trout in sensitive reaches of bull trout core areas.

b. Substrate and sediment regime - Bull trout embryo survival, fry emergence, and overwinter survival, as well as habitat productivity, are very sensitive to increases in fine sediments in the substrate. The sediment regime in which the aquatic system evolved should be maintained or restored to reduce input of fines. Actions that alter the natural timing, volume, input, rate, storage, and transport of sediments in important bull trout habitat should be avoided.

c. Habitat complexity - including cover, sinuosity, gradient, and substrate is required for proper functioning of bull trout habitat. Complexity should be maintained in all important bull trout habitat, and restored where appropriate.

d. Streamflow (maintain natural hydrologic conditions such as flow quantity, timing, duration to maintain natural channel and floodplain features) - Important hydrologic conditions should be maintained or mimicked through maintenance of instream flows, reservoir operations, timing and duration of diversions, and management of runoff to ensure necessary hydrologic conditions meet the requirements of different life stages of bull trout at required times and locations of those life stages.

e. Channel stability - The stability and physical integrity of the aquatic habitat used by bull trout, including stream banks, shorelines, and bottom configuration, should be maintained or restored to ensure proper function and optimal conditions for bull trout.

f. Connectivity - Connectedness within and among metapopulations is necessary for long-term viability of bull trout populations. Where possible and appropriate, physical barriers such as dams, diversions, and culverts should be removed or modified to allow passage. Fish passage structures should be built where barriers cannot be removed. Sources and causes of other types of barriers such as dewatered portions of stream, chemical barriers resulting from runoff, and thermal barriers should be identified, evaluated, and corrected to restore connectivity.

g. Stable, vegetated banks

h. Chemical water quality - Bull trout require clean, cool water. Point and nonpoint sources of runoff have been identified as threats to bull trout habitat is several watersheds. Sewage effluent from Butte, Missoula, and Deer Lodge contributes to poor water quality and algal growth in the

Clark Fork River. Excessive agricultural runoff similarly leads to poor water quality and algal growth in some areas. Contaminated mine runoff has immediate and chronic toxic effects that negatively impact bull trout. Actions that negatively affect water quality parameters such as temperature, pH, dissolved oxygen, nutrient input, and chemical composition should be avoided, and factors already negatively impacting water quality should be remediated.

i. In-stream cover such as boulders, woody debris, and undercut banks are necessary and should be maintained. Sources of instream cover must also be maintained, including recruitment of large woody debris. Coarse woody debris in streams has been correlated with bull trout distribution and abundance. Woody debris should be left in stream channels, and the riparian corridor and associated uplands should be managed to allow continual recruitment of woody debris in habitats where woody debris comprise the primary type of cover.

4.1.2. Designate additional core areas as additional inventory and monitoring data justify

Additional areas meeting requirements of a core area should emerge as restoration efforts become implemented, habitat conditions improve, and survey and inventory data accumulate. Important bull trout habitat should be evaluated periodically to determine if it meets the requirements of a core area. If so, it should be considered as, and managed as already delineated core areas.

4.2. Nodal Areas

ANodal@ habitats are critical for maintaining existing populations, life histories, and metapopulation function. Migratory corridors and overwintering areas should be managed to retain natural physical and biological conditions that enable migration and gene flow. Additional nodal habitat should be identified as survey and inventory data increase and restoration efforts are completed.

4.2.1. Ensure important habitat processes in nodal habitats meet the requirements of sub-adult and adult overwintering, rearing, and migrating bull trout

Migratory corridors between core areas, spawning sites, and overwintering areas are critical for maintaining viable metapopulation function. Because of their importance to the population and restoration efforts, important nodal areas should receive a high level of protection from detrimental impacts. Management activities must be carefully planned and implemented in important nodal habitat to maintain its ability to meet the life history needs of bull trout. Activities that could result in impacts to habitat criteria important in nodal areas should be rigorously scrutinized to ensure nodal habitat is not degraded. All habitat functioning as a migratory corridor to connect sites important to different life stages must be identified and managed to meet the requirements of bull trout. Rivers and water bodies that function as overwintering habitat for adult bull trout should be identified, and managed to ensure important biological processes are maintained such that they continue to function as overwintering habitat. Conservation strategies developed by land management entities for these areas should recognize the importance of maintaining the integrity of essential habitat components:

a. Water temperature
b. Habitat complexity
c. Streamflow (maintain natural hydrologic conditions to maintain natural channel and floodplain features)
d. Connectivity
e. Stable, vegetated banks
f. Chemical water quality
g. Instream cover

4.2.2. Designate additional nodal area habitat as additional inventory and monitoring data justify

As restoration efforts become effective, management practices change, and inventory and monitoring data accumulate, new areas should be designated and managed appropriately as nodal habitat. As additional core areas are identified, additional nodal habitat connecting core areas must also be identified and designated.

4.3. Potential habitat

Habitat that has potential to support bull trout, especially that which connects existing occupied, fragmented habitat, is important to the eventual restoration of viable bull trout populations. High priority potential habitat should be protected from further degradation, and where necessary, restored to make it suitable for bull trout. Survey and inventory of potential bull trout habitat should continue where the presence/absence and status of bull trout is unknown. All bull trout distribution and population data collection should be standardized, and located in a centralized database repository available to authorized scientists, researchers, and managers.

5.0. Restore high priority core area habitat, nodal area habitat, and potential habitat such that it meets the requirements of bull trout, as described in Appendix F (*The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout)*

Restoration of degraded high priority habitat to proper functioning conditions, and elimination of factors limiting recovery of bull trout in each watershed, will enable restoration of viable populations of bull trout. Restoration includes restoring hydrologic function, removing barriers, correcting existing limiting factors, and reducing or eliminating threats.

5.1. Evaluate past and present conditions in each habitat type by watershed

Past and present conditions should be compared where possible to identify Ahistorical@ conditions and specific degradation factors, and to plan restoration efforts. Aerial photography, old management records and plans, and other historical data should be compared against current conditions to assess factors resulting in current conditions.

5.2. Identify existing specific threats in each habitat type and watershed that may be limiting bull trout

Many habitats are being limited by one or more impacts such as barriers, degraded habitat, or introduced fishes. Site specific and rangewide threats that are limiting restoration and the long-term viability of populations should be identified by waterbody, watershed, and/or recovery basin.

5.3. Implement restoration efforts to enhance suitability of habitat for bull trout

Once factors limiting an area═s suitability as bull trout habitat are identified, and where possible, restoration efforts should be planned and implemented to alleviate the limiting factor(s) and restore suitability of the habitat for bull trout, and to improve ecological function and value of the area. Site specific restoration processes might include:

a. Redcue management induced sediment delivery
b. Control industrial, agricultural, and sewage effluent runoff
c. Screen water diversions and irrigation ditches
d. Secure instream flows/water rights from willing sellers
e. Install appropriate fish passage structures where needed
f. Riparian fencing
g. Bank stabilization
h. Runoff control structures
I. Remove barriers where appropriate
j. Stream channel restoration
k. Provide instream-structure
l. Restore recruitment of large woody debris to the stream channel
m. Restore connectedness and opportunities for migration where possible and desirable
n. Other specific items as identified in each watershed

6.0. Continue to implement existing habitat protection standards and regulations, encourage voluntary conservation standards, and determine their effectiveness towards conservation of bull trout

Several regulatory practices are in place that address some of the issues that have been identified as threats to bull trout in Montana, particularly habitat management, land use practices, and streamside protection regulations. Existing regulations, such as SMZ regulations, should be thoroughly reviewed to ensure they are achieving the desired results. Other regulatory stipulations such as the Stream Protection Act and the Natural Streambed Protection Act should also be reviewed to determine effectiveness at protecting important bull trout habitat. Additional necessary regulations should be considered when and where necessary.

6.1. Implement and enforce existing regulatory requirements

Existing state and federal regulatory requirements including the Montana Stream Protection Act, Streamside Management Zone Law, and Montana Natural Streambed and Land Preservation Act, Federal Cleanwater Act, etc. serve to various degrees to protect stream bed, banks, adjoining riparian habitat, and water quality. These regulatory mechanisms should continue to be implemented and enforced throughout bull trout habitat to ensure projects they permit minimize impacts to important bull trout habitat requirements.

6.1.1. Montana Stream Protection Act
6.1.2. Streamside Management Zone Law
6.1.3. Montana Natural Streamside and Land Preservation Act
6.1.4. INFISH and other appropriate guidelines

Forest management policies and guidelines, including INFISH, Forest Management Plans, Resource Management Plans, and other appropriate guiding policies should be fully implemented and adhered to on federal lands containing bull trout habitat. If these guidelines are insufficient to protect bull trout habitat, modifications should be enacted to address the insufficiencies.

6.2. Review implementation compliance and effectiveness of existing regulatory laws towards maintaining bull trout habitat components (as described in Appendix F - *The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout*) necessary for bull trout restoration and conservation, and make recommendations to minimize impacts to bull trout as part of the permitting process

To determine the effectiveness of existing regulatory laws towards maintaining necessary bull trout habitat components, audits of compliance and effectiveness should be conducted. Audits should include long-term habitat monitoring to determine the effectiveness of existing regulations towards meeting and maintaining habitat criteria necessary for bull trout.

6.2.1. Review applications for regulatory permits and make recommendations to minimize impacts to bull trout habitat

Applications for permits to alter stream channels, stream banks, or associated riparian habitat regulated by the Montana Stream Protection Act, Streamside Management Zone Law, and Montana Natural Streambed and Land Preservation Act should be thoroughly reviewed by personnel from the Department of Environmental Quality, Department of Natural Resources and Conservation, and/or Department of Fish, Wildlife & Parks. Recommendations specific to bull trout conservation for the activity will be made as part of the permit application and review process.

6.2.2. Monitor compliance with regulations and permit stipulations

Compliance with existing habitat protection regulations and effectiveness towards meeting and maintaining desired habitat conditions for bull trout should be evaluated, and weaknesses elucidated.

6.2.3. Determine deficiencies of existing regulations towards maintaining habitat processes necessary for bull trout restoration and conservation

In addition to audits of compliance, long-term monitoring should be conducted to determine if existing regulations are effective towards maintaining necessary habitat conditions for bull trout. Recommendations to address deficiencies and improve such regulations to benefit bull trout should be developed and enacted. Examples of habitat components that should be monitored are described in

Appendix F (*The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout*).

6.2.4. Implement additional local, state, and federal regulatory practices as necessary and applicable to maintain habitat processes necessary for bull trout restoration

Modification of existing requirements, as well as implementation of additional regulatory requirements, should be enacted and implemented as necessary to protect important bull trout habitat from specific identified threats and degradation. Examples of such laws might be stricter SMZ requirements if it is determined current requirements are insufficient.

6.3. Develop and evaluate BMPs for a variety of activities and encourage land management entities to develop conservation strategies that are consistent with the needs of bull trout and with this restoration plan

6.3.1. Continue to conduct and evaluate forestry BMP audits; tie to fish monitoring to determine effectiveness

Forestry best management practices (BMPs) should continue to be implemented for timber sales and related activities. Compliance audits should be completed at a selected number of randomly picked sites where timber sales have occurred to determine compliance. Repeat audits and long-term monitoring should be established to determine long-term effectiveness of BMP practices towards conservation of bull trout, and modifications to BMPs should be made as data supports.

6.3.2. Conduct and evaluate grazing BMP audits; tie to fish monitoring to determine effectiveness

Grazing best management practices (BMPs) should be implemented at a selected number of representative allotments in bull trout habitat. Compliance audits should be completed to determine compliance. Repeat audits and long-term monitoring should be established to determine long-term effectiveness of BMPs, and modifications to recommended BMPs should be made as data supports.

6.3.3. Encourage stricter zoning/building requirements for developments near stream banks to reduce cumulative impacts from housing developments

Commercial and recreational developments along streams may impact bull trout by modification of stream channels, increased sedimentation, loss of riparian cover, and nonpoint pollution runoff. Zoning guidelines to reduce impacts of development would help to reduce impacts.

6.3.4. Prevent sediment delivery to streams

BMP standards that currently are applied to logging roads to reduce sediment delivery to streams should also be applied where roads are constructed for other purposes in bull trout core and nodal habitat.

7.0. Operate reservoirs to minimize impacts on bull trout

Resident bull trout occur in some reservoirs, and migratory bull trout use reservoirs as important nodal and overwintering habitat. In some areas, reservoirs and reservoir operations may be the most significant factor limiting the restoration and long-term viability of bull trout. Dams serve as passage barriers to bull trout, and dam operations may severely impact critical life stages of bull trout in an entire watershed. Storage of water and reservoir operations affect floodplain dynamics, sediment regimes, habitat complexity, water temperatures, and bull trout migration. However, dams may also have beneficial impacts by restricting movement of introduced species such as brook trout that may compete with, hybridize with, or prey on bull trout, or carry disease that may infect bull trout. Reservoirs should be operated to protect and maintain conditions for bull trout and other native species.

Dams considered major barriers to fish movement include:

Dam	Separates	From
Kerr	Lower Flathead/Clark Fork	Flathead Lake
Milltown	Middle Clark Fork	Upper Clark Fork
Thompson Falls	Lower Clark Fork	Lake Pend Oreille
Noxon	Lower Clark Fork	Lake Pend Oreille
Cabinet Gorge	Lower Clark Fork	Lake Pend Oreille
Bigfork	Flathead Lake	Swan River
Libby	Upper Kootenai River	Lower Kootenai River

7.1. Develop operational rules that protect and maintain conditions for bull trout, with consideration that they must also serve the multi-use purposes of dams and adhere to specific operational requirements

Management of reservoirs is complex due to multiple ownerships with multiple operation considerations and requirements, including power generation, flood control, water delivery, and flow regulation. Some operational parameters that may be contradictory to this plan are mandated, such as federal flood control requirements and other endangered species requirements. However, whenever and wherever possible, operational rules that protect and maintain conditions for bull trout should be followed so such operations minimally impact bull trout.

7.1.1. Implement integrated rule curves (IRCs)

Integrated rule curves developed for Libby and Hungry Horse reservoirs should be implemented to ensure flow timing, quantity, and duration are sufficient to meet the needs of bull trout and other species, and maintain a healthy, functional aquatic ecosystem.

7.1.1.a. Implement Integrated Rule Curves for operation of Libby Dam, and adhere to the 90-110' recommended drawdown limit until this

occurs, allowing for variances needed for flood control requirements.

7.1.1.b. Implement Integrated Rule Curves for operation of Hungry Horse Dam, and adhere to the 85' recommended drawdown limit until this occurs, allowing for variances needed for flood control requirements.

7.2. Review reservoir operations in bull trout RCAs

Overall operation of reservoirs should be reviewed to evaluate specific positive and negative impacts to all life stages of bull trout affected by the reservoir.

7.2.1. Provide recommendations through FERC relicensing process

Several dams are currently undergoing, or soon will be undergoing federal relicensing by FERC. Recommendations for operational rules that protect and maintain conditions for bull trout, passage issues, and other operational issues should be developed and mandated through this process.

7.2.1.a. Recommendations to reduce negative impacts of reservoir operations on bull trout will be made during FERC relicensing of hydroelectric dams.

7.2.1.b. Recommendations resulting from FERC relicensing of hydroelectric dams should be implemented.

7.3. Avoid excessive drawdown

As part of the evaluation of reservoir operations, recommendations for maximum allowable drawdown should be developed and followed, along with the conditions under which those recommendations could be exceeded, such as for federal flood control requirements. Reservoir operators should avoid exceeding the recommended drawdown limit in order to minimize potential impacts to bull trout, habitat, and proper ecosystem functioning.

7.4. Maintain necessary flows below reservoirs during critical life stages of bull trout

Different life stages of bull trout have different flow requirements during different times of the year. It is essential that proper flow quantity, timing, and duration occur below reservoirs to accommodate the different needs. For example, staging adults may need higher flows for upstream movements at certain locations during late summer than they would in early spring or at other locations. Reservoir operations should attempt to mimic the natural hydrograph during critical life history stages.

7.5. Stabilize flow regimes at Aload-following@ facilities

Load following facilities are those where releases occur in response to electricity demands. This often results in dramatically changing flows from hour to hour and day to day, depending on electricity demands, and leads to an unstable aquatic ecosystem below the reservoir. Flows at these facilities should be evaluated, and where supported

by specific evaluations, flow regimes should be modified to reduce impacts associated with currently fluctuating flow regimes.

7.6. Allow peak flows that simulate natural peak flows to prevent delta formation at the mouths of tributaries

In some areas, such as below Libby Dam, lack of flushing action as a result of constant, regulated flows has led to accumulation of sediments at tributary mouths, and formation of deltas. High releases to simulate natural peak flows should occur periodically from reservoirs to flush sediments and mimic and restore natural conditions below the reservoirs.

7.7. Allow for fish passage where necessary and feasible

Fish passage has been identified as an important factor limiting proper metapopulation function in some RCAs. Methods to allow passage should be developed on a site-by-site basis where feasible and appropriate. Potential for upstream migration of introduced species and disease must be considered when evaluating specific dams for fish passage.

7.7.1. At Lower Clark Fork Dams (Cabinet Gorge, Noxon Rapids, Thompson Falls):

a. Determine genetic baseline of bull trout blocked by Cabinet Gorge Dam
b. Determine genetic baseline of bull trout collected from tributaries upstream of Cabinet Gorge, Noxon Rapids, Thompson Falls, and Milltown Dams
c. Compare genetic baselines of blocked fish with tributary fish to determine proportion of blocked fish that originated in each tributary (spawning) stream
d. Conduct telemetry studies in conjunction with genetic baseline studies to determine spawning locations of blocked fish
e. Implement methods to allow passage of blocked fish to historical spawning tributaries

8.0. Protect habitat through purchase, conservation easements, management plans, etc.

Important habitat and habitat processes should be protected for long-term benefit through purchase of habitat, purchase of conservation easements, and adherence to management plans for
that habitat. These types of measures should be considered on a site-by-site basis, and implemented where necessary to ensure the long-term protection of important bull trout habitat.

9.0. Monitor baseline habitat conditions and habitat restoration progress, and implement an adaptive management feedback loop

In order to determine the effectiveness of habitat protection and restoration techniques and efforts, a monitoring program exhibiting appropriate statistical rigor should be implemented. Baseline habitat conditions should be described quantitatively and qualitatively in bull trout watersheds to monitor effects of land management practices, effects of specific restoration efforts, and results of overall habitat restoration efforts. A rigorous sampling of habitat parameters that capture spatial and temporal variation should be completed in conjunction

with ongoing restoration efforts. An example of baseline parameters that might be measured are identified in Appendix F (*The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout)*.

9.1. Establish index reaches in streams in each 4th code HUC watershed

Index reaches in different habitat types should be established to enable long term monitoring of habitat conditions and criteria in each watershed.

9.2. Determine specific baseline habitat conditions in index reaches in each 4th code HUC watershed

Specific baseline habitat criteria should be monitored in index reaches of streams in different habitat types in each watershed to determine long-term trends.

9.2.1. Water temperature

9.2.2. Substrate

a. Substrate scores provide an overall assessment of streambed particle size and quality. Higher substrate scores reflect a situation in which large particles are not covered by finer material and therefore provide more spaces between the rocks which are favored by juvenile bull trout. This is important because juvenile bull trout are extremely substrate oriented, and changes in substrate can affect the number of bull trout in the stream. Substrate scoring involves visually assessing the dominant and subdominant streambed substrate particles, along with embeddedness in a series of cells across transects.

b. Hollow core sampling measures the size range of materials in the streambed. Research has shown an inverse relationship between incubation success and fine sediment in redds (Chapman 1988). A similar negative correlation has been found for emergence success (Weaver and Fraley 1991, 1993). Monitoring both streambed substrate score and streambed composition in spawning areas provides information pertinent to land management decisions that might affect bull trout.

9.2.3. Habitat Complexity
9.2.4. Stream flow, timing, and duration
9.2.5. Channel stability and condition
9.2.6. Chemical water quality

9.3 Monitor effects of habitat restoration efforts and techniques on bull trout habitat integrity

The effectiveness of habitat restoration and conservation efforts and techniques on bull trout habitat components should be monitored. Monitoring should include both establishing baseline conditions and determining the effectiveness of proposed conservation measures and techniques to ensure they maintain or enhance bull trout habitat.

9.4. Incorporate an adaptive management feedback mechanism to integrate knowledge learned from monitoring into implementation of conservation measures to minimize risks to bull trout

Knowledge gained through monitoring should be incorporated through an adaptive management process to increase knowledge on the effects of various conservation measures. Conservation measures that are not effective will then be modified using information gained in monitoring to achieve intended effectiveness.

10.0. Identify habitat management research needs

Many questions remain to be answered regarding different aspects of the life history, ecological associations, and habitat needs of bull trout in Montana. Research is needed to improve knowledge to develop, improve, and implement specific management practices to ensure the long-term viability of bull trout in Montana.

10.1. Determine life history requirements of resident and migratory bull trout through study of hydrologic, hydraulic, biologic, and watershed features

10.2. Determine effectiveness of different habitat restoration techniques (e.g., instream structures)

10.3. Determine temperature regimes in bull trout drainages, and suitability of temperature regimes for restoration

10.4. Evaluate effects of hydropower operations and methods to optimize reservoir operations to benefit bull trout

10.5. Determine range of temperature tolerance for bull trout life stages in different habitats

11.0. Evaluate implementation of, and compliance with, habitat protection and restoration strategies outlined in restoration plan

B. FISHERIES MANAGEMENT

1.0. Prevent overharvest and incidental mortality of bull trout

Sport fishing for bull trout and other species in bull trout habitat has been identified as potentially negatively impacting bull trout in Montana. Management should be thoroughly reviewed, and modified or implemented where necessary, to conserve bull trout. Fishing regulations should include an angler education component, and must be enforced. Sport fishery management goals directed at recreational fishing should be evaluated. In waters where sport fish management goals are in conflict with bull trout restoration goals, sport fish goals should be modified to emphasize protection and restoration of bull trout. Scientific collection permits and collection methods should be closely scrutinized to prevent overcollection, or collection in sensitive areas.

1.1. Implement sport angling regulations that prevent overharvest of bull trout; modify as necessary

Sport fishing regulations should prevent direct mortality of bull trout in unrestored populations. Regulations should be continually evaluated to determine their effectiveness at conserving bull trout populations, and compliance by the public. They should be modified as necessary to address specific threats associated with sport fishing for bull trout or other species.

1.1.1. Strictly manage or eliminate harvest of bull trout

Angling regulations should be instituted and continually evaluated to prevent direct mortality of bull trout in unrestored areas. If populations become recovered according to specified criteria, angling should be allowed, but closely monitored.

1.1.2. Close important spawning and staging to all fishing during critical periods

Angling should be restricted in important staging and spawning areas during the time of year bull trout are vulnerable in these areas to reduce impacts such as unintentional capture by anglers fishing for other species.

1.1.3. Regulate bag limits and slot limits on potential competitors and predators

In core areas and other important waters, angling regulations should be instituted to manage introduced species to the benefit of bull trout. Such regulations may include liberalizing seasons and bag limits on species that compete with, prey on, or hybridize with bull trout; modifying or eliminating slot limits that benefit such species; and allowing techniques that improve harvest of such species.

1.2. Reduce angler pressure in areas where incidental catch mortality may be detrimental

In certain locations, angler pressure for other fish species may result in unacceptable incidental mortality to bull trout. In such cases, methods to reduce overall angling pressure, and thus incidental mortality, should be explored and implemented.

1.2.1. Seasonal or permanent road closures

In important bull trout habitat where easy access promotes heavy fishing pressure, seasonal or year-round road closures could be evaluated as a method to reduce angler access and pressure.

1.2.2. Conservative bag limits for other species

Reduction in the bag limits of target species responsible for heavy angling pressure could be considered in areas where incidental catch of bull trout is unacceptable.

1.3. Educate anglers to identify bull trout and about bull trout regulations

Misidentification and subsequent possession of bull trout by anglers may be a source of significant mortality of bull trout in certain areas. Efforts to educate anglers about bull trout and other trout identification is necessary and should be ongoing. Education materials for anglers on bull trout identification and information about fishing regulations and closures should be developed and made readily available.

1.4. Discourage recreational anglers and commercial guides from targeting bull trout in waters closed to bull trout fishing

Because of their large trophy size, relative scarcity, and ease of capture, bull trout may be targeted by commercial guides and recreational anglers. Education and enforcement efforts should be directed at these anglers to prevent unacceptable injury and mortality to bull trout.

1.5. Limit scientific collection and regulate collection methods (techniques, intensity, timing, duration)

Scientific collection, location and timing of collection, and approved collection techniques should be closely regulated and controlled. Collection of bull trout should require strong justification, and should be permitted for valid research purposes only. Impacts of collection will be minimized by restrictions on the locations of collection and time of year. Collection techniques also will be closely scrutinized and regulated.

1.6. Implement guidelines and techniques to minimize risks of electrofishing in waters containing bull trout

Electrofishing guidelines will be required to be followed by management agencies and researchers as part of standard management practices, and as a stipulation on collection permits to minimize risks to bull trout. Guidelines will dictate timing, location, and intensity of electrofishing practices, and will be strictly followed.

2.0. Prevent introduction of nonnative fishes that compete with, prey on, or hybridize with bull trout in bull trout habitat

Brook trout, lake trout, northern pike, and other introduced fishes have been identified as a potential serious threat to bull trout in many important bull trout waters. Policies and enforcement actions must be implemented to prevent intentional or unintentional release of introduced fishes that may compete with, prey on, or hybridize with bull trout.

2.1. Develop and implement fish stocking policies to reduce threats of stocking introduced fishes that compete with, prey on, or hybridize with bull trout

Policies to reduce threats of stocking introduced fishes in important bull trout habitat should be adopted and implemented. Examples include not stocking brook trout (which hybridize with bull trout) in waters containing bull trout, not stocking piscivorous fishes in waters where bull trout would be susceptible to predation, and not stocking other introduced species that compete with bull trout for food, shelter, or space.

2.2. Develop and implement policies and procedures for responding to illegal introductions of live fish and other aquatic flora and fauna

2.3. Review all pond permit applications; preclude stocking of introduced species that compete with, prey on, or hybridize with bull trout in bull trout habitat

Applications for private pond permits should be thoroughly reviewed for potential threats to bull trout. Stocking of introduced species that may be detrimental to bull trout should not be allowed in bull trout habitat. Applicants will be encouraged to stock private ponds with native species such as westslope cutthroat trout. In some instances, introduced species will be removed and native fishes stocked in existing ponds.

3.0. Suppress or remove introduced fishes that compete with, prey on, or hybridize with bull trout where appropriate

Nonnative fishes are a limiting factor to certain bull trout populations, and contribute to the factors limiting bull trout in other populations. Suppression or removal of introduced species should be evaluated and implemented on a case by case basis according to recommendations in Appendix G (*Assessment of Methods for Removal or Suppression of Introduced Fish to Aid in Bull Trout Recovery)*.

3.1. Evaluate presence/absence of introduced fishes in bull trout habitat

Legal and illegal introductions of introduced aquatic predators into bull trout habitat have led to species such as brook trout, northern pike, and lake trout becoming established in many bull trout waters. Illegal introductions continue to occur. Monitoring for the presence/absence of lake trout, northern pike, and other introduced fishes in likely locations should occur to allow a quick response to reduce or eradicate those fish before they become firmly established. Determination of population trend and abundance of introduced fishes and their prey should continue, as well, to better understand the factors impacting bull trout populations.

3.2. Determine site-specific impacts of introduced fishes where such species are suspected to be causing negative impacts to bull trout, and review methods to reduce or eliminate impacts of those fishes

Introduced fishes may significantly impact a local bull trout population or an entire watershed. Impacts from introduced fishes in bull trout habitat must be evaluated, and where significant, those impacts must be reduced or eliminated. If not possible to reduce or eliminate impacts, then such impacts should be accounted for in overall management and restoration progress of bull trout in the basin in which the impacts are occurring. An evaluation should include a cost/benefit analysis, probability of success, and overall benefit to the bull trout population.

3.2.1. Flathead Lake, a key portion of the Flathead River Drainage RCA, has become dominated by lake trout, to the point where they have become the top predator in that system, and may be contributing to the decline of bull trout. Impacts to bull trout by lake trout in Flathead Lake and possible methods to reduce impacts should be reviewed and incorporated into a management plan for the lake.

3.2.1.a. Evaluate biological, economical, and sociological impacts of suppressing lake trout to enhance bull trout.

3.2.1.b. Implement management recommendations to reduce impacts of lake trout on bull trout in Flathead Lake.

3.3. Suppress or remove introduced fishes in areas where appropriate, according to guidelines in Appendix G (*Assessment of Methods for Removal or Suppression of Introduced Fish to Aid in Bull Trout Recovery)*

In waters where it is feasible, introduced fishes should be suppressed or eliminated to remove that threat to bull trout, particularly where a recent illegal introduction has been detected. In some waters, it may not be feasible, or the management goal for that water may be such that it is not appropriate to remove introduced aquatic predators. In

such cases, the presence and threat posed by such introduced fishes will be accounted for in overall management of the stream, RCA, and basin.

3.3.1. Suppress or eradicate
3.3.2. Liberalize harvest regulations
3.3.3. Establish barriers to upstream movement

4.0. Establish fish species goals and fisheries management goals in waters within the range of bull trout, and ensure bull trout populations are not adversely impacted by fisheries management activities

In some waters, fisheries management goals are not consistent with, or are in conflict with bull trout management needs and goals and may favor introduced fishes over bull trout. Management goals in all bull trout waters should be evaluated on a site-by-site basis, and modified if necessary if it is determined the management goal conflicts with, or is detrimental to, bull trout restoration goals.

5.0. Ensure compliance with regulations and policies

5.1. Enforce angling regulations; target problem areas

Enforcement of angling regulations should occur throughout bull trout habitat. Additional enforcement efforts should occur in problem areas and in response to specific complaints.

5.2. Strictly enforce state laws preventing illegal transport and introduction of live fish

Illegal introduction of live fish is one of the greatest and most difficult problems associated with management of native fish. Enforcement of State laws governing the transport and introduction of live fish should be prosecuted to the fullest extent possible.

5.3. Enforce pond permit regulations

Rules governing private ponds should be treated and enforced as strictly as other rules related to illegal stocking of introduced fish.

5.4. Comply with management guidelines and policies

Policies and guidelines governing the collection and management of bull trout and other fishes should be followed, and modified as necessary to appropriately conserve bull trout.

6.0. Evaluate and assess impacts of disease and parasites on bull trout populations

Disease and parasites have the potential to have a catastrophic impact on bull trout populations. Efforts to minimize exposure to, and transmission of, disease to bull trout must be implemented. Effects of disease and minimization of those effects must be understood.

6.1. Determine effects of whirling disease on bull trout

Whirling disease has recently become established in Montana waters. Impacts of whirling disease on bull trout must be determined, and management efforts undertaken to limit spread of whirling disease into important bull trout spawning and juvenile rearing habitats.

6.2. Monitor for presence of whirling disease in important bull trout spawning and rearing areas

The extent of the distribution and expansion of whirling disease should be continually studied and monitored to understand potential implications of its presence in important spawning and rearing habitat.

6.3. Implement methods and practices to reduce factors that increase risk of disease transmission

Practices to reduce factors that increase risk of disease transmission should be instituted. This includes adoption of a fish transfer policy, installation of barriers to prevent upstream movement of diseased fishes, and eradication of diseased fishes in areas where such action is feasible.

6.4. Maintain fish health screening and transplant protocols to reduce risk of disease transmission

Fish health screening procedures and transplant protocols will be implemented to ensure only disease-free fish are stocked in bull trout habitat.

6.5. Use knowledge gained from whirling disease monitoring to prevent, control, and/or eradicate other diseases that may impact bull trout

7.0. Identify fish management research needs

7.1. Continue to evaluate impact of whirling disease on bull trout growth and survival

7.2. Determine level and impacts of competition and hybridization with introduced salmonids

7.2.1. Lake Trout
7.2.2. Kamloops Rainbow Trout (Kootenai)
7.2.3. Brook Trout

7.3. Determine impacts of predation on different life stages of bull trout in different watersheds

7.4. Determine movements, habitat use, and season of use of adult and sub-adult migratory bull trout in different drainages

7.5. Evaluate food web interactions in different drainages affected by introduced fishes, *Mysis*, reservoir operations, etc.

7.6. Determine whether integrated rule curves (IRCs) may be favoring other fish species over bull trout

8.0. Evaluate implementation of, and compliance with, fisheries management strategies outlined in this restoration plan

The effects of different fisheries management goals and techniques on bull trout populations, including restoration techniques and goals, sport fish goals, fisheries management techniques, and water body goals should be continually monitored to ensure they are compatible with conservation and restoration of bull trout.

C. GENETICS/POPULATION MANAGEMENT

1.0. Maintain locally adapted and diverse bull trout populations

Maintenance of locally adapted genetic strains of bull trout in individual drainages is necessary for long-term conservation of the species. Locally adapted strains have genotypic and phenotypic traits that are ecologically and evolutionarily important to the long-term persistence of the species in that drainage, and that result in populations that are behaviorally, physiologically, and morphologically adapted to the local environment. Maintenance of genetic integrity of bull trout in individual drainages also results in increased genetic diversity among connected metapopulations, resulting in increased probability of persistence of the species across its range. Unique local bull trout populations should be managed at least to the extent that genetic diversity is maintained and preserved.

1.1. Determine purity and uniqueness of bull trout populations and extent of hybridization with brook trout

Genetic testing utilizing the most current genetic analysis techniques should be conducted in areas where bull trout overlap with brook trout. Genetic analysis should determine the genetic purity of bull trout populations and the amount and extent of hybridization with brook trout. Genetic testing should also be done in other areas to determine the uniqueness of local bull trout populations. This information will be used to assess feasibility of transplanting fish to extirpated areas and in establishment of hatchery broodstock if it is necessary.

1.2. Establish genetic baselines in each RCA

Genetic baselines should be developed in each RCA to enable determination of loss of genetic diversity, and to maximize conservation integrity of transplanted bull trout if such action is deemed necessary in an RCA or portion thereof.

1.3. Monitor genetic status of existing populations

The genetic status of existing populations where baseline information has been collected should be monitored to ensure genetic integrity and diversity is being maintained.

1.4. Manage localized populations (numbers and life forms) and habitat to maintain long-term viability

Local populations of bull trout should be managed such that sufficient numbers of individuals are maintained throughout a dispersed geographical area to ensure long-term persistence and viability. Management should include ensuring factors limiting to different life forms and life stages are addressed and eliminated.

2.0. Maintain genetic integrity of populations and proper metapopulation function

Maintenance of genetic integrity and proper metapopulation function is necessary for restoration and long-term viability of the species. Maintenance of genetic integrity involves reducing the amount of hybridization with other species, relying on natural reproduction and population expansion, and maintaining connectivity between populations. A metapopulation is a collection of geographically distinct populations that are genetically interconnected through movement of individuals among populations. The collection of smaller, geographically distinct but interconnected populations essentially forms a single, larger population. Therefore, proper metapopulation function includes interconnectedness between local populations to maintain genetic exchange between populations over time (Hanski and Gilpin 1991). Properly functioning metapopulations stabilize local population dynamics by allowing genetic exchange between populations, increasing heterozygosity, reducing vulnerability to losses incurred through environmental and demographic stochasticity (Wilcox and Murphy 1985), stabilizing demographic variables such as birth and death rates, and allowing recolonization of locally extirpated populations. The key to maintaining proper metapopulation function is to maintain high quality habitat and geographically distinct populations, as well as connectivity between those locally distinct populations.

2.1. Establish introduction and transplant protocols that maximize genetic variability and viability of bull trout populations

Introduction and transplant protocols should be developed and followed utilizing the best available genetic information regarding the purity and uniqueness of local populations, and following the recommended guidelines contained in Appendix H (*The Role of Fish Stocking in Bull Trout Recovery*).

2.2. Expand existing populations where feasible and appropriate

Many existing populations are small and isolated, and therefore face a higher probability of extinction. In order to increase the viability and reduce the probability of extinction, existing population numbers and range should be increased wherever possible.

2.2.1. Habitat restoration

2.2.2. Suppression or removal of introduced species

2.2.3. Restoration of connectivity between local populations

Barriers resulting in loss of connectivity and genetic exchange between populations should be eliminated. Existing connectivity should be maintained to allow genetic exchange and proper metapopulation function.

2.2.4. Prevent further fragmentation of existing populations

Further fragmentation of habitat and loss of connectivity should be avoided by implementation of appropriate land management practices, regulatory stipulations, zoning practices, and elimination of threats that result in fragmentation of habitat.

3.0. Continue to improve knowledge of status and distribution of bull trout populations in Montana

In many areas, the status and distribution of bull trout is not completely known. As restoration efforts continue and are completed, it is expected that the distribution of bull trout will expand from present levels. Therefore, survey and inventory efforts should continue throughout the range of bull trout in Montana.

3.1. Review databases for bull trout distribution records

State, federal, and tribal management agency databases should be searched for records indicating the presence of bull trout. This baseline information will provide a foundation of knowledge about known distribution and recent historical occupancy by bull trout in different waters. It will also be useful for prioritizing locations of future survey and inventory efforts.

Data on the distribution and status of bull trout in the Kootenai River basin and Lower Clark Fork River basin will be obtained from Idaho and British Columbia for the portion of those basins within their respective jurisdictions.

3.2. Identify potential habitat

Rather than only identifying locations where bull trout currently exist, it is important to identify potential habitat where they once likely occurred. Potential habitat should be identified and surveyed for suitability for bull trout. It is restoration and management of these areas that will allow expansion of current populations, restore connectivity, and help enable restoration goals to be met.

3.3. Conduct surveys in potential habitat where bull trout status is unknown

Once potential habitat has been identified, survey and inventory efforts should be initiated to determine occupancy by bull trout.

3.4. Develop regular schedule for follow-up surveys in potential habitat to determine recolonization

Follow-up surveys should be scheduled in potential habitat to monitor recolonization by recovering bull trout populations.

4.0. Implement standardized monitoring program in all RCAs to assess bull trout population status

Standardized monitoring of population numbers and trends is necessary, and should occur to evaluate effectiveness of restoration efforts and progress towards meeting restoration objectives.

4.1. Design a standardized, statistically sound bull trout population monitoring program for all RCAs

A statistically sound, standardized survey and monitoring program should be designed to allow collection of compatible data, comparison of results from different areas, and to ensure a sufficient sample size to assess population status and restoration progress in RCAs and rangewide. The monitoring procedures should be adopted and used by all entities collecting population and habitat data.

4.2. Implement standardized monitoring program in all RCAs

A monitoring program should be implemented in all RCAs to monitor population trends and habitat conditions. Monitoring results should be used to assess progress towards meeting restoration goals in RCAs and restoration basins.

4.2.1. Redd surveys will be the primary method used to acquire information on trends in adult bull trout abundance. The number of spawning sites (redds) should be monitored annually in index stream sections. These counts provide information on the number of adult fish spawning in upper basin tributaries.

4.2.2. Juvenile abundance estimates are a valuable tool for monitoring changes in population due to changes in substrate quality or water quality during incubation, emergence and early rearing. These estimates will be made annually either by snorkeling and counting fish by species and age class or by electrofishing and using two-catch or mark-recapture estimators.

4.2.3. Gill netting surveys of lakes and reservoirs, done as part of overall fisheries population monitoring, provides information about the status and overall condition of adult bull trout inhabiting reservoirs, as well as other species of interest such as lake trout, brook trout, and northern pike.

4.2.4. River monitoring, done as part of overall fisheries population monitoring, provides information about the status and overall condition of adult bull trout inhabiting mainstem rivers, as well as other species of interest.

5.0. Identify population and genetic research needs

Many questions need to be answered about specific population and genetics questions regarding bull trout. Research should be conducted to answer questions that will lead to a better understanding of bull trout life history and habitat requirements, and also lead to better management of bull trout.

5.1. Determine if resident bull trout can refound a migratory life form in areas that have been isolated
5.2. Determine mechanism by which migratory life forms undergo transition to resident forms, and how long this might take.
5.3. Determine consequences of genetic fragmentation/isolation due to human-made barriers

6.0. Evaluate implementation of, and compliance with, population and genetics management strategies outlined in this restoration plan

D. ADMINISTRATION, EVALUATION, AND INFORMATION MANAGEMENT

1.0. Promote collaborative efforts to garner support at a local level

Because bull trout occur over a large geographical range in a myriad of land ownerships, a collaborative approach to implement this restoration plan should be used to ensure it has local acceptance and support. Cooperative management, restoration, and monitoring of bull trout is necessary at all levels. Cooperative management must include land owners, land users, management agencies, and other interested publics. Partnerships, formal and informal agreements, and cooperative development of management plans will lead to greater acceptance and support of restoration efforts, and increase the efficiency and probability of restoration.

1.1. Encourage establishment of local watershed groups in each recovery area and assist them to implement restoration actions

Restoration and maintenance of bull trout should occur at a watershed level, using input from local landowners, managers, and other interested publics. Such watershed groups, comprised of landowners, management agency personnel, university faculty, conservation group members, representatives from private industry, local government officials, and other interested publics, need to work in a collaborative manner to implement and achieve restoration. Collaborative efforts should include using local watershed groups to jointly develop and implement specific restoration actions for local watersheds. Restoration should include enhancement of degraded habitat to support well distributed populations of bull trout, as well as populations of other native flora and fauna associated with high quality bull trout habitat. Watershed groups may be established in conjunction with other watershed groups such as DEQ TMDL watershed groups.

1.2. Develop outline of implementation plan for each watershed

In order to effectively and efficiently implement restoration strategies for bull trout in each watershed, implementation plans outlining specific threats and specific actions to address those threats should be developed. Specific watershed implementation plans should utilize local knowledge and expertise to implement restoration, and should utilize this restoration plan as a guide to develop such management plans. Watershed restoration/implementation plans must also consider other existing recovery and

management plans so that restoration occurs at an ecosystem approach. This will likely occur as part of the federal recovery planning process.

1.2.1. Identify key waters in each watershed
1.2.2. Identify specific threats in each key water and watershed
1.2.3. Develop methods and cost estimates to address specific threats
1.2.4. Prioritize actions
1.2.5. Implement watershed management/restoration plans and restoration actions

1.3. Enter into cooperative management agreements with landowners and management agencies to protect and enhance habitat and ensure restoration strategies are implemented

Because bull trout habitat crosses numerous landowner and jurisdictional boundaries, it is most effective to protect, manage, and restore habitat in a cooperative manner with all affected parties. Site specific, drainage specific, and basin-wide management plans and agreements should be developed, entered into, and implemented to ensure habitat is restored, maintained, and properly managed, and other restoration strategies are implemented. Local watershed groups will play a key role developing management plans, prioritizing and implementing restoration actions, and ensuring restoration occurs at the local level.

1.4. Work cooperatively with British Columbia and Idaho in watersheds that include these areas

Portions of the Kootenai and Clark Fork Rivers flow into or through Idaho and British Columbia. Coordinated management, data collection, monitoring, and conservation efforts should occur to ensure management of bull trout and bull trout habitat in these areas and to increase efficiency and cooperation.

1.5. Where watershed groups do not form or do not adequately implement conservation strategies, management agencies shall fulfill their legal and regulatory responsibilities

2.0. Implement restoration plan

Implementation of this restoration plan at a local and statewide level by private landowners and state and federal management agencies should lead to eventual restoration of bull trout in Montana. Because of the complexity and size of the issues regarding bull trout restoration, the collaborative watershed-based restoration approach must include sufficient technical assistance and regulatory assistance to ensure success.

2.1. Provide technical assistance to watershed groups

Technical assistance and expertise regarding habitat restoration, monitoring, and data sharing must occur, and must be a priority among agencies with such expertise.

2.2. Assist private landowners with development of acceptable Habitat Conservation Plans or other conservation plans

To encourage private landowners to do good things for bull trout and help provide assurances that those actions will not result in further regulatory restrictions,

management agencies must assist private landowners with development of individual conservation plans that will provide those necessary assurances.

3.0. Ensure restoration strategies are included as part of, and coordinated with, other recovery efforts, management plans, and cooperative agreements

Numerous other recovery plans, management plans, and conservation agreements have been, or are being, developed for other species occurring in the same range as bull trout. These include the Kootenai White Sturgeon Recovery Plan, Swan Valley Grizzly Bear Conservation Agreement, and Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout in Montana (FWP 1999b). Restoration goals and conservation efforts for all of these and other species should be coordinated to ensure one is not undermining others, to increase efficiency of restoration efforts, and to implement restoration actions for all species at an ecosystem level. Components of this restoration plan should be included in other planning efforts such as land management plans, forest plans, Upper Columbia River Basin Environmental Impact Statement, and other management planning efforts.

4.0. Develop and implement education actions to garner support for bull trout restoration

Education actions to garner and maintain support of bull trout restoration efforts are needed at several levels. School education programs are needed to educate youth about the importance of bull trout, native species, and aquatic ecosystems. Media support is critical for reaching a large segment of the public. Collaborative efforts with landowners, user groups, conservation clubs, and local governments are necessary to ensure support for bull trout restoration and management is achieved. Education actions to garner support for bull trout and bull trout restoration should be a cooperative effort between local, state, federal, private, and non-profit organizations, and will occur at local, regional, and nationwide levels.

4.1. Develop school education programs and materials

Education programs about bull trout and their value as a component of Montana═s native fauna will be presented to schools as part of the Project Wild curriculum and through other aquatic education programs. Materials about natural history, conservation efforts, and the restoration program should be provided to schools through such presentations.

4.2. Effectively utilize written and electronic media

Electronic and written media sources should be provided regular updates about bull trout restoration efforts and conservation issues, and will be provided necessary background materials to accurately report about bull trout restoration and conservation efforts. Media organizations will be added to mailing lists to receive new and pertinent information as it becomes available.

4.3. Create and make available education materials

Education materials about bull trout and bull trout restoration efforts, such as videotapes, posters, leaflets, signs, and handouts, will be developed and distributed to appropriate audiences. Materials will include information for anglers on bull trout

identification; information about fishing regulations and closures; materials for schools about the importance of bull trout, native fishes, and aquatic ecosystems; information for the public about status of restoration efforts; increased personal contact by law enforcement personnel; and materials for watershed groups and management agencies regarding the latest information about bull trout management.

4.4. Make public presentations to civic groups, conservation organizations, and other interested publics

Presentations about bull trout and bull trout restoration efforts should be made to local civic groups and organizations on a regular basis to directly educate those potentially impacted by bull trout restoration efforts, to alleviate fears and misconceptions about restoration efforts, and to garner support for restoration efforts from those groups and individuals.

4.5. Implement internal education program among management agencies

Because management agencies are comprised of numerous individuals that have a variety of responsibilities and values, it is important to develop an internal education program within agencies to ensure the agency message and motives are consistent, and so all portions of an agency═s operations are consistent with restoration efforts.

5.0. Secure funding and cooperation to implement restoration strategies

Funding and commitment to implement restoration actions in each of the watersheds, and cooperation among and between affected private and governmental entities is imperative. Actions that combine funding opportunities with landowner cooperation should be emphasized since actions that involve cooperative funding opportunities and support of landowners stand the greatest chance of producing measurable improvements. Such cooperation and funding will be sought for all phases of restoration.

5.1. Garner financial and personnel support from management agencies

Federal, state, and tribal land and wildlife management agencies will have primary lead for implementing bull trout restoration efforts. A commitment of funds and personnel to implement restoration strategies should be sought from these management agencies to restore bull trout.

5.2. Seek state and federal legislative appropriations to implement restoration strategies

Appropriations from state and federal legislatures will be sought to provide funding for immediate implementation of restoration strategies.

5.3. Pursue cooperative funding, partnerships, challenge cost share opportunities, and other private and governmental grants

Agency funding and legislative appropriations will be used to match funding available through cooperative funding opportunities and partnerships. Examples include funding opportunities through the National Fish and Wildlife Foundation, Partners for Wildlife, Future Fisheries Program, and other private and government funding sources. Applications for grants to fund specific restoration efforts will be submitted when possible and appropriate.

5.4. Use mitigation funds as available

In some watersheds, mitigation funds for past and future land use activities that have resulted in degradation of bull trout habitat have been allocated. Mitigation funds should be used to implement restoration strategies that are consistent with the intent of the mitigation funds, and to match other possible private and government funding sources.

6.0. Develop and maintain a centralized database repository for all bull trout distribution and monitoring data

Collection of bull trout population and habitat data is being conducted by state, federal, and tribal agencies, as well as by private industry and consulting firms. Certain data parameters should be collected and reported in a standardized format to allow compilation and analysis at a variety of different levels.

6.1. Develop and use standardized data collection reporting forms and develop procedures for reporting data from all sources

Use of standardized data reporting forms will facilitate standardized collection of important data parameters, and will allow reporting and entry of common data variables that will lead to increased efficiency in entering, summarizing, and analyzing bull trout data. Procedures for reporting data and submitting data collection forms should be developed to facilitate data entry and storage.

6.2. Maintain a centralized data repository for bull trout distribution and monitoring data, and develop procedures for accessing and utilizing the database

A centralized data repository, maintained by the State, has been established (MRIS). Bull trout distribution and monitoring data should be entered into the database annually, and data will be made available to authorized individuals for analysis. Procedures and requirements for accessing the database and certain data fields will be developed.

7.0. Evaluate implementation of, and compliance with, restoration strategies

Implementation of restoration strategies, particularly those ranked as high priority, should be monitored and evaluated annually, and recommendations regarding restoration progress should be provided in a progress report at least once every five years

7.1. Prepare status report every five years

A status report of bull trout distribution, population trends, and restoration efforts should be prepared at least every five years utilizing the information contained in the database.

The Scientific Group report AThe Relationship Between Land Management Activities and Habitat Requirements of Bull Trout@ provides a summary review of scientific information about habitat requirements of bull trout, and the relationship between effects of land management activities and bull trout habitat. It also provides a framework for a criteria-based strategy to maintain quality bull trout habitats in Montana through reducing impacts from land management activities. To accomplish the latter, a set of criteria-based standards for maintaining and improving bull trout habitat is proposed.

The strategy incorporates establishing a baseline of existing conditions and monitoring to ensure those conditions are improved or maintained. Proposed activities which will further jeopardize the viability of bull trout can be screened and subsequently modified or deferred. In addition, the process will provide some impetus for improvements in areas which are currently contributing to a reduction in bull trout viability. This proposed strategy is not meant to replace existing mechanisms for protecting stream systems. Rather, it will compliment existing mechanisms by increasing our understanding of the effects of land management activities on stream systems and bull trout populations.

The proposed strategy is not based upon setting specific numeric targets or thresholds. Instead, narrative criteria are used to describe an objective for several of the most important physical parameters required by bull trout. In place of strict numeric thresholds or restrictions on specific activities, this approach attempts to foster an environment of responsibility. In the event that this fails, a more restrictive approach may be promulgated by regulatory agencies to ensure bull trout persistence.

Introduced brook, brown and lake trout have contributed to the decline of bull trout in Montana. Removal or suppression of these introduced species may play a role in recovery of bull trout in some circumstances. This paper discusses the removal or suppression of introduced fish as one aspect of the recovery process for bull trout in Montana.

The protection of habitats supporting bull trout will be the most effective means of maintaining a competitive advantage for bull trout over introduced species. Habitat protection in core areas and nodal habitats should be a primary emphasis of any bull trout restoration program. While this does not assure the exclusion of introduced species, it is a logical first step in bull trout restoration. Before removal or suppression of introduced species should be undertaken, further introductions of these species should be discontinued.

Goals of the removal or suppression projects should be well developed and should include a determination of whether the effort will attempt to totally remove or just suppress the target species. A panel should be established to review all proposed suppression and removal projects.

A review of the use of toxicants, trapping and netting, electrofishing, and angling as removal agents indicates that they may help in site-specific situations such as small streams and lakes. But none, even in combination, will be practical on a large scale for bull trout recovery under most circumstances. Complete removal of introduced fishes will be possible in only a few site specific instances. Even if total removal of introduced species is achieved, it may not result in bull trout recovery.

Habitat manipulation to favor bull trout is probably not possible when introduced species are present and habitat restoration probably would aid in bull trout recovery.

Five situations are identified where removal and suppression should be considered. They are not listed in order of priority:

1. Where recent invasions of introduced species have occurred or when the target species is restricted to a small area or is not well established but has a high potential for spreading.

2. Where it is necessary to protect core areas and nodal habitats.

3. Where a bull trout population is in immediate danger of extinction.

4. Where preservation of native species is a priority.

5. Where innovative experimental projects will further the knowledge of how this tool might be most effective. While all removal projects are experimental in nature, this refers to innovative projects that attempt to learn more about techniques and population effects of projects. New and innovative ideas and methods will have to be developed before introduced species control will be successful, particularly in large, complex lakes and streams.

The potential for negative impacts on non-target fauna is discussed and a checklist is included that should be reviewed before any suppression or removal project is undertaken.

This issue paper addresses the role of bull trout stocking, whether from hatcheries and/or fish transplants, in Montana's bull trout recovery effort. The appropriate use of hatcheries in fisheries management, including native species recovery, is currently under debate. In consideration of this ongoing controversy, we believe it important to discuss the distinction between traditional fish stocking and the hatchery uses discussed here. Introductory and background information is presented to define key terms and familiarize the reader with the subject matter, including historical information on bull trout culture, the Endangered Species Act (ESA) perspective, and the changing role of hatcheries. We described and evaluated potential strategies involving the use of hatcheries or transplants in bull trout recovery. We accepted or rejected each strategy based on screening criteria.

The Scientific Group views stocking as one of many potential tools in the recovery of bull trout. We approved a strategy to create genetic reserves for seriously declining populations. We approved restoration stocking as a recovery strategy **only if** the actual cause of extirpation is identified and corrected first. We conditionally approved research strategies. These do not meet the criteria for restoration, but information gained through experiments may benefit restoration efforts. The Scientific Group rejected strategies using supplementation, new introductions outside the native range of bull trout, and put, grow and take as recovery efforts.

Approved strategies focus on protecting unique stocks and restoration stocking, with the primary objective of establishing viable, self-sustaining bull trout populations. We recognize that these measures will not substitute for correction of the factors causing or contributing to present declines. Secondarily, we identified areas of research that might be useful in the recovery process.

It is our opinion that the approved strategies should be considered among several potential tools available for bull trout recovery in Montana. While we differ in our individual opinions on implementation, we all agree that any projects involving stocking must be appropriate in scope, judiciously applied, rigorously designed, and thoroughly monitored. To ensure that this occurs, we recommend the Restoration Team appoint a technical advisory committee (TAC) to screen all projects involving the use of hatchery or transplanted bull trout. Ultimately, our goal is full recovery of naturally-reproducing, wild bull trout populations.

Appendix I. Description of Current Conservation Measures

There are many conservation measures that have already been undertaken or are underway to address causes of decline and methods for restoration of bull trout in Montana, including expanded population, distribution and habitat surveys; research projects; improved land management; habitat restoration; implementation of management guidelines; and development of regulatory mechanisms. These actions have included efforts by federal, state and tribal governments as well as private entities and individuals, and are expected to continue and expand.

Population and Habitat Survey and Inventory

Different types of survey and inventory efforts have been, or are being, conducted in all bull trout RCAs, with the most extensive bull trout survey efforts being in the Swan and Flathead River basins. Survey and inventory efforts include creel census along Rock Creek, Blackfoot River, Clark Fork River, and Swan Lake; spawning site inventories (redd surveys) along numerous streams and rivers throughout the range of bull trout in western Montana; electrofishing and gill net surveys throughout Montana in association with other fish management activities; and presence/absence surveys for juvenile bull trout in numerous smaller tributary streams. These efforts are expected to continue.

Habitat Restoration

Numerous habitat restoration projects have been undertaken throughout the range of bull trout in Montana, including the removal of artificial barriers, streambank stabilization, stream channel restoration, riparian fencing and enhancement, sediment source reduction projects, and installation of irrigation diversion screens (ALCON Ecological Consulting 1994; FWP 1996, 1999; Montana Bull Trout Restoration Team 1997; Pierce et al.1997). These types of projects are cooperative efforts between local, state, and federal management agencies, private industry, conservation groups, and individual landowners, and are expected to continue.

Connectivity

Lack of connectivity has been identified as a major threat to restoration in several watersheds in Montana. Connectivity in and among these watersheds is broken by a variety of factors including dams, diversions, culverts, barriers, dewatering, and stretches of unsuitable or inhospitable habitat. In some instances, barriers to connectivity may actually benefit bull trout by preventing the upstream migration of introduced species (e.g., Hungry Horse Dam) and prevent the upstream spread of disease such as whirling disease. Therefore, barriers to connectivity are being evaluated on a case by case basis. Positive and negative aspects of restoring passage of bull trout and

other fish species (native and introduced) are being evaluated at Milltown, Thompson Falls, Noxon, Cabinet Gorge, and Rattlesnake dams. A study conducted to evaluate movement of bull trout transported above Milltown dam indicates the benefits derived from restoring passage for adult bull trout is potentially great (Swanberg 1997). Additional studies are being conducted or are planned for Thompson Falls, Noxon, Cabinet Gorge, and Milltown Dams.

Barriers such as water diversion structures and impassable culverts are being evaluated on a case by case basis, and recommendations to address such barriers are being developed. In several instances, fish ladders have been installed at irrigation diversions, and impassable culverts have been replaced, allowing passage of fish over the diversion.

Management

Habitat

Management activities include actions by federal, state and tribal governments, as well as private landowner initiatives. Within the upper Columbia River basin, 93% of the remaining bull trout watersheds with known or predicted strong populations are on Forest Service and Bureau of Land Management (BLM) administered lands. In Montana, 80.5% of the area within core area watersheds is federally administered, 3% are state-owned, and 12.6% are private (Appendix C). Consideration of bull trout is now mandated for Forest Service and BLM actions through land use management plans and site-specific activity plans, as well as ESA Section 7 requirements.

In 1995, the Inland Native Fish Strategy (INFISH) was adopted by the Forest Service and used to amend Regional Guides and Forest Plans to include interim direction in the form of riparian management objectives, standards and guidelines, and monitoring requirements (U.S. Forest Service 1995). INFISH standards can only be modified following a watershed analysis or site specific evaluation. While an important component of INFISH is flexibility, compliance with INFISH has varied both among Forests and among Ranger Districts, and there is no implementation monitoring built into the plan. INFISH is an interim measure until the Interior Columbia Basin Ecosystem Management Plan is finalized (ICBEMP EIS Team 1997).

Montana adopted a Streamside Management Zone (SMZ) law in 1991 to address water quality issues related to forest practices. A SMZ is a buffer strip that serves as a natural filter that helps to keep sediment out of the stream. SMZ rules were adopted in 1993 to help define and clarify the SMZ law.

In 1994, the Montana Department of Natural Resources and Conservation (DNRC) agreed to go beyond SMZ rules and adopted additional practices to protect riparian areas along streams containing bull trout. DNRC defers all timber harvest within SMZs in these streams, unless a fisheries biologist agrees that some trees for a specific sale can be harvested without impact. DNRC also

inspects the condition of the SMZ at the time of grazing lease renewals and takes necessary steps to exclude cattle from the SMZs unless informed by a FWP fisheries biologist that cattle will not have a detrimental impact. Plum Creek Timber Company requires its grazing lessee_s to implement specific Best Management Practices (BMPs) as well as complete an approved Range Management Plan. Leaseholders are also required to complete an end of year report summarizing how compliance performance standards were complied with and whether the range management plan was effective, and changes that should be made the following year.

Forestry Best Management Practices (BMPs) have been developed to reduce impacts from forest management activities and to prevent sedimentation of streams (Logan and Clinch 1991). An audit process is used to evaluate whether BMPs are being applied and if they are effectively limiting non-point source pollution. Audit cycles have been completed in 1992, 1994, 1996, and 1998, with over 90% compliance ratings (MT DSL 1994; Mathieus 1996, Fortunate 1998). The Restoration Team has recommended an evaluation of forestry BMP compliance, as well as initiation of long-term monitoring at selected audit sites to determine long-term effectiveness. Such monitoring efforts begain in 1999.

It has also been recommended that recently developed grazing BMPs (MDNRC 1999) be implemented and audited.

Fisheries

Fish population management activities also have been undertaken to benefit bull trout. FWP has initiated a policy requiring an environmental assessment on all brook trout stocking, and confining these plants to waters currently harboring brook trout, but not bull trout. Experimental brook trout removal projects have been conducted and are ongoing. Electrofishing is prohibited where bull trout are spawning, and FWP electrofishing guidelines to minimize injury to fish must be followed as a condition of collection permits.

Collection permits for bull trout and other species in bull trout habitat are carefully scrutinized to ensure minimal impacts on bull trout populations through restrictions on locations, timing, and methods that are approved. Private pond permits are also carefully reviewed for impacts to bull trout. In some situations, native cutthroat are substituted for other introduced species previously stocked in private ponds.

Fishing for bull trout is prohibited in all Montana waters except Swan Lake. In order to reduce impacts from targeting bull trout for catch-and-release, there is no *intentional* fishing allowed for bull trout except in Swan Lake. To further protect spawning bull trout, several important spawning streams have been closed to all fishing, and the mouths of several tributaries where bull trout stage have been closed to all fishing from June 1 through August 30 to eliminate hook and release mortality to bull trout in these staging areas.

In 1995 the Montana State Legislature increased the penalty for possession of bull trout greater than 18 inches up to $500 per fish; two fish comprise a penalty of up to $1,000 and can be prosecuted as a felony. Smaller bull trout were not targeted because they are easily confused with brook trout. Enforcement of, and education about, bull trout regulations has been increased, particularly in problem areas, to ensure compliance (Long 1997). Enforcement of bull trout fishing regulations has been made a high priority for FWP wardens (Long and Kelly 1998).

Regulatory

Several state and federal land-use regulations exist that, if properly applied, may benefit bull trout. State regulations include: the Montana Stream Protection Act that requires a permit be obtained for any project that may affect the natural and existing shape and form of any stream or its banks or tributaries; the Streamside Management Zone Law that permits only selective logging within at least 50 feet of any lake, stream, or other body of water, but prohibits other activities such as clearcutting and heavy equipment operation; the Montana Natural Streambed and Land Preservation Act (310 permit) that requires private, nongovernmental entities to obtain a permit for any activity that physically alters or modifies the bed or banks of a perennially-flowing stream; and the Montana Pollutant Discharge Elimination System that applies to all discharges to surface water or groundwater, including those related to construction, dewatering, suction dredges, and placer mining. Before permits allowing activities covered under these regulations are issued, applications are regularly reviewed by personnel from FWP, Montana Department of Natural Resources and Conservation, and the Montana Department of Environmental Quality. Recommendations to limit impacts to bull trout are mandated through the permitting process.

Federal regulations that work to conserve bull trout habitat include the Clean Water Act (including 401 and 404 permits) that regulates discharge or placement of dredged or fill material into waters of the United States; Federal Land Management Protection Act (FLPMA); and internal agency management guidelines and policies such as Forest Management Plans. Activities that may impact bull trout on federal lands, or covered under federal regulation, will continue to undergo a review process under the National Environmental Protection Act (NEPA), at which time alternatives to minimize impacts are considered.

In June, 1998, bull trout in the Columbia basin were listed as threatened under the Endangered Species Act. As such, they are afforded the regulatory protections of the ESA (USFWS 1998). This includes a consultation requirement for federal actions, as well as protection from "take" as defined in the ESA. In the final rule listing bull trout as threatened, the U.S. Fish and Wildlife Service identified several items that would be considered "take" - any action that might result in take is

required to be permitted by the U.S. Fish and Wildlife Service. Items identified as take include (USFWS 1998):

1. Take of bull trout without a permit, which includes harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting, or attempting any of these actions, except in accordance with applicable State fish and wildlife conservation laws and regulations within the Columbia River bull trout population segment;

2. To possess, sell, deliver, carry, transport, or ship illegally taken bull trout;

3. Unauthorized interstate and foreign commerce (commerce across State and international boundaries) and import/export of bull trout (as discussed in the prohibition discussion earlier in this section);

4. Introduction of non-native fish species that compete or hybridize with, or prey on bull trout;

5. Destruction or alteration of bull trout habitat by dredging, channelization, diversion, in-stream vehicle operation or rock removal, or other activities that result in the destruction or significant degradation of cover, channel stability, substrate composition, temperature, and migratory corridors used by the species for foraging, cover, migration, and spawning;

6. Discharges or dumping of toxic chemicals, silt, or other pollutants into waters supporting bull trout that result in death or injury of the species; and

7. Destruction or alteration of riparian or lakeshore habitat and adjoining uplands of waters supporting bull trout by timber harvest, grazing, mining, hydropower development, or other developmental activities that result in destruction or significant degradation of cover, channel stability, substrate composition, temperature, and migratory corridors used by the species for foraging, cover, migration, and spawning.

   Other activities not identified above will be reviewed on a case-by-case basis to determine if a violation of section 9 of the Act may be likely to result from such activity. The Service does not consider these lists to be exhaustive and provides them as information to the public.

Reservoir Operations

Reservoir operations affecting bull trout consist primarily of the timing, duration, and volume of water releases from reservoirs; downstream flows and water temperatures; and remaining pool depths and associated limnological characteristics of the reservoirs themselves. Recommendations for operation of reservoirs to maintain and protect conditions for bull trout, and minimize negative impacts to bull trout and other native fishes will be developed through the relicensing processes, biological opinions, and other processes. The settlement agreement for Noxon Rapids and Cabinet Gorge Dams includes a commitment and funding to evaluate, and if feasible, implement passage for bull trout and other native salmonids. The agreement also includes funding for a native salmonid restoration plan (see Table 2).

FWP has developed integrated rule curves (IRCs) for the operation of Hungry Horse and Libby Dams that integrate operations for resident fish, anadromous fish, power generation, and flood control (Chilsom et al. 1989; Marotz et al. 1988; May et al. 1988; Skaar et al. 1996). These rule curves have been developed based on ten years of empirical data collection and analysis and sophisticated modeling techniques. The IRCs were adopted by the NWPCC and incorporated into their Fish and Wildlife Program in 1994. However, they have not been implemented, as the reservoirs are being operated in accordance with a National Marine Fisheries Service Biological Opinion for endangered Snake River salmon. The flood control provisions of the IRCs (Variable Flow or VAR-Q approach) have not been adopted by the U.S. Army Corps of Engineers, and also limit the full implementation of the IRCs. Implementation of Integrated Rule Curves for Libby and Hungry Horse reservoirs is essential to restoration, and will continue to be pursued through various forums in the Pacific Northwest.

Genetic Integrity

Maintenance of genetic integrity has been identified as a top priority in each of the RCAs. Towards that end, the Montana Department of Fish, Wildlife and Parks implemented a policy in 1996 to not stock brook trout, which hybridize with bull trout, into waters containing bull trout without first conducting a thorough environmental analysis. Investigations to determine the genetic diversity of bull trout populations have been conducted in some drainages in Montana, especially in the Flathead River drainage (Kanda et al. 1997), and are expected to continue in additional drainages in the Clark Fork drainage. A strategy to create genetic reserves for seriously declining populations has been developed by the Scientific Group, but stocking as a restoration strategy will be approved **only if** the actual cause of
extirpation is first identified and corrected. Any projects involving stocking must be appropriate in scope, judiciously applied, rigorously designed, and thoroughly monitored. To ensure this occurs, a technical advisory committee (TAC) appointed by the Director of MFWP will first screen all projects involving the use of hatchery or transplanted bull trout. Strategies that will not be allowed for restoration include using supplementation, new introductions outside the native range of bull trout, and put, grow and take.

Monitoring

The purpose of monitoring is two-fold: 1) to acquire tools for management of bull trout and their habitat; and 2) to evaluate the effectiveness of this strategy in making progress towards achievement of the state-wide restoration goal. The requirements of monitoring are also two-fold: 1) variables must be measurable, and 2) it must be repeatable. Three types of monitoring are

identified for this restoration and conservation strategy: 1) population status and evaluation of trends in population abundance; 2) baseline habitat condition and evaluation of habitat response to land management activities in bull trout core and nodal areas; and 3) evaluation of implementation and compliance with strategies developed in this Plan. Existing ongoing monitoring includes population and habitat monitoring:

1. Population status and evaluation of trends in population abundance.

A monitoring program should result in determination of bull trout presence/absence, relative abundance, and changes in population size in each of the bull trout RCAs. Methods being used to monitor population status and trends include conducting redd surveys, juvenile abundance estimates, and trapping of upstream migrating adults or downstream migrating juveniles. Specific methodology follows that described by Shepard and Graham (1983) and Weaver (1997) that has been conducted, with few modifications, for 18 years in the upper Flathead basin.

Population and habitat monitoring, as described above, are being conducted throughout the range of the bull trout in western Montana (see Montana Bull Trout Restoration Team 1997). In many areas, index reaches have been established for repeated, annual monitoring. In addition to redd surveys and juvenile abundance surveys, long-term river monitoring electrofishing surveys, lake/reservoir gill net surveys, and creel census surveys are being conducted to determine the status and trend of bull trout populations.

2. Describe baseline habitat condition and evaluate habitat response to land management activities in bull trout core and nodal areas. To determine the effectiveness of restoration and conservation efforts, it is necessary to establish baseline habitat data. Except in the Flathead Basin, there currently is no standardized rangewide monitoring program to assess overall baseline habitat conditions. There are extensive site-specific habitat monitoring programs being implemented associated with ongoing and planned restoration and mitigation projects. Sediment source surveys and water temperature monitoring have been or are being conducted in several RCAs. Baseline stream habitat inventories have been completed in several National Forest streams, as well as streams owned by Plum Creek Timber Company. McNeil core samples and substrate scores are also being conducted at certain areas throughout the range. Continued baseline habitat monitoring, as well as effectiveness monitoring of land management and restoration techniques must continue, in conjunction with adaptive management feedback.

Data Management

Management of bull trout abundance and distribution data has been centralized at the Kalispell office of the Montana Department of Fish, Wildlife and Parks Information Services Unit since 1993.

Bull trout data are stored as part of the fish species database in the Montana Rivers Information System (MRIS). These data are stored by the EPA River Reach Numbering System and include the following fields: stream use, relative abundance, genetic status, habitat value, survey date, population status, and a data quality rating. The tabular data can be geographically displayed in a Geographic Information System (GIS) using an event table that includes a _to_ and a _from_ field which more accurately describes the upper and lower extent of bull trout presence in a river reach. Data are updated annually through a process that includes all FWP and federal fisheries biologists. Biologists are sent a tabular printout of all data for each bull trout record in the database as well as a GIS plot displaying bull trout abundance. One packet is sent to the lead FWP fisheries biologist for an area, who in turn sends it to the other state and/or federal biologists with management responsibilities for the area to review. These changes are incorporated into the MRIS fish species database.

Education

FWP information/education officers have developed a coordinated education effort to increase public awareness and concern for the plight of the bull trout (MBTRT 1997). Education efforts include public outreach through Project WILD, Project WET and other school programs; coordination with local and national media to develop press releases, radio talk shows, television spots, and news stories about bull trout and bull trout issues; public meetings to advise local citizens of management strategies for bull trout; development and distribution of identification cards to assist anglers to identify bull trout; development and posting of signs informing anglers of bull trout fishing regulations and how to identify bull trout; development of a video _All About Bull Trout_ targeted at fourth graders to be distributed to schools throughout Montana; development and presentation of a major fair display that is exhibited at county and regional fairs in Montana; and presentations to civic groups about bull trout and native fish management. Other state and federal management agencies, conservation organizations, and private industry, including the Montana Wood Products Association, also have implemented aggressive educational campaigns to promote bull trout conservation. It is expected that this level of effort will continue.

Research

Research needed to increase knowledge about bull trout, as well as to evaluate current management and regulatory practices, has been identified in status reports for each RCA, and is summarized in the stepdown outline (Appendix E). Many phases of identified research topics have already been initiated, and it is expected that research will be ongoing. Completion of this research will greatly enhance understanding, management, and conservation of bull trout within and among individual RCAs.

Coordination

A great deal of coordination has been, and will continue to be, required to develop and implement restoration actions. The interdisciplinary Restoration Team has been actively developing this restoration plan and overseeing restoration efforts since 1994. A coordinator has been hired to serve as staff to the Restoration Team, act as liaison between the Restoration Team and Scientific Group, coordinate with local watershed groups, and ensure all of these groups, as well as any other interested parties, are provided the most current and available information regarding bull trout. Interdisciplinary watershed groups comprised of landowners, agency personnel, industry representatives, and concerned citizens have been developing restoration projects, securing funding through partnerships, and implementing on-the-ground habitat restoration. Management agencies have been working cooperatively through watershed groups, partnerships, and policy-level meetings to implement restoration actions. This type of coordination, as well as establishment of technical advisory groups to oversee stocking proposals, screen land management activities, and evaluate effectiveness of restoration efforts, is expected to continue to occur at local, regional, and statewide levels.

TECHNICAL REPORT ORDER FORM

Send to: Bull Trout Coordinator
Montana Department of Fish, Wildlife and Parks
P.O. Box 200701
Helena, MT 59620

	Title (Place an X next to those titles you are requesting)	
	The Relationship between Land Management Activities and Habitat Requirements of Bull Trout (1998)	
	The Role of Stocking in Bull Trout Recovery (1996)	
	Assessment of Methods for Removal or Suppression of Introduced Fish to Aid in Bull Trout Recovery (1996)	
	Bull Trout Status Report - Bitterroot River Drainage (1995)	
	Bull Trout Status Report - Blackfoot River Drainage (1995)	
	Bull Trout Status Report - Swan River Drainage (1996)	
	Bull Trout Status Report - S. Fork Flathead River Drainage (1995)	
	Bull Trout Status Report - Flathead River Drainage (1995)	
	Bull Trout Status Report - Lower Clark Fork River Drainage (1996)	

	Bull Trout Status Report - Middle Clark Fork River Drainage (1996)	
	Bull Trout Status Report - Upper Clark Fork River Drainage (1995)	
	Bull Trout Status Report - Lower Kootenai River Drainage (1996)	
	Bull Trout Status Report - Middle Kootenai River Drainage (1996)	
	Bull Trout Status Report - Upper Kootenai River Drainage (1996)	
	Bull Trout Restoration Plan (2000)	

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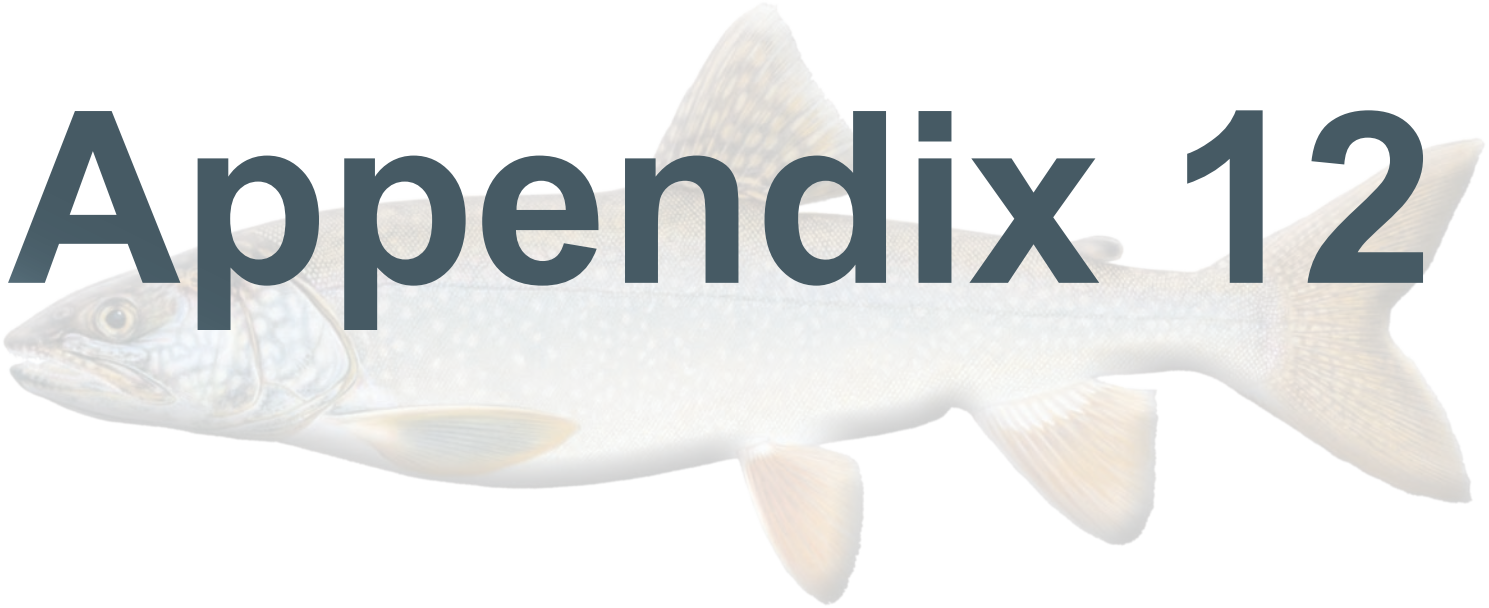


Appendix 12

Glossary

A

A: a term to describe mortality, expressed as a percentage of the lake trout population lost from death over one year.

adfluvial: a life-history strategy that includes spawning in tributary streams where the young rear from 1 to 4 years before migrating to a lake, where they grow to maturity, reaching maximum size in the more productive lake environment.

AFS: American Fisheries Society

age-structured stochastic model: a computer simulation of changes in the age structure of the lake trout population by estimating the changes in mortality and recruitment while incorporating random events.

allele: constituent component of a gene. Most genes are comprised of two alleles, one from each parent, which control the same inherited characteristic.

B

BIA: Bureau of Indian Affairs

bioaccumulation: the accumulation of toxic chemicals through the consumption of water or food. The chemicals concentrate in the tissues of living organisms.

BPA: Bonneville Power Administration, which oversees the operation of federal dams in the Columbia River basin, such as Hungry Horse Dam.

bycatch: unintentional catch of non-target species while attempting to remove target species.

bounty: a monetary value paid for specific sizes or species of fish determined to be overly abundant.

C

catch per unit effort (CPUE): a measure of relative abundance used in fisheries management. Catch is a count of fish, while effort is a standardized measure of time expended to catch fish.

connected: open access between both upstream and downstream habitats used by different life stages.

core area: core areas are watersheds, including tributary drainages and adjoining uplands, used by migratory bull trout for spawning and early rearing, and by resident bull trout for all life history requirements.

cover: anything that provides visual isolation or physical protection for a fish, including vegetation that overhangs the water, undercut banks, rocks, logs and other woody debris, turbulent water surfaces, and deep water.

cumulative effects: Cumulative effects result from the incremental effects that result from the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency, group, or person undertakes them.

CSKT: Confederated Salish and Kootenai Tribes, fisheries co-manager of Flathead Lake with Montana Fish, Wildlife and Parks.

D

DNRC: Montana Department of Natural Resources and Conservation, owns and manages lands within the Flathead River watershed.

direct effects: Direct effects occur in the project area—which is defined as where the proposal would occur. Direct effects are caused by the action, and occur at the same time and place as the action.

disjunct population: a population found in a headwater lake that is self-reproducing but functionally isolated from the rest of the system due to barriers, thermal conditions, etc.

drainage: an area (basin) mostly bounded upstream by ridges or other topographic features, encompassing part or all of a watershed.

E

EA: Environmental Assessment, used to determine environmental impacts of a proposed action.

entrainment: displacement of fish from a reservoir through an outlet from a dam or from a river into an irrigation ditch.

effects required by NEPA: See 40 CFR § 1508.7 and 1508.8. We discuss direct, indirect, and cumulative effects. Each is defined separately in this glossary.

EIS: Environmental Impact Statement. A document used to determine environmental impacts of a proposed action, and employed when there may be significant environmental effects.

ESA: Endangered Species Act.

escapement: adult fish that return to spawn.

Exploitation: refers to the rate or amount of removal of fish from a population.

F

fishing contest: an organized competitive fishing event.

fishing mortality: number of fish in a population that die over a given time period solely due to fishing pressure.

fluvial: a life-history strategy in which fish spawn in tributary streams where the young rear from 1 to 4 years before migrating to a river system, rather than a lake, where they grow to maturity.

FONSI: Finding of no Significant Impact, the final step in an Environmental Assessment.

fragmentation: the breaking up of a larger population of fish into smaller disconnected subpopulations.

fry: young-of-the-year fish.

G

gametes: the cells of sexually reproducing organisms that fuse together during fertilization to form an embryo. Fish gametes are commonly known as eggs and sperm or milt.

general harvest: recreational harvest of fish by individuals of the public who possess a general fishing license.

I

IDT: Interdisciplinary Team, specialists that prepare EAs and EISs.

indirect effects: occur in the project area, which is defined as where the proposal would occur. Indirect effects are caused by the action and occur later in time or farther removed in distance, but are still reasonably foreseeable.

introgression (introgressive hybridization): movement of genes from one species into the gene pool of another species resulting in a complex mixture of parental genes.

L

life-history form: adfluvial, fluvial, resident strategies that fit the environmental circumstances to maximize survival

littoral zone: the part of a lake close to shore.

local population: a population occurring in a specific portion of a drainage, usually a tributary, that is adapted to that specific location and that is usually separated from other populations within a drainage.

M

Mack Days: A fishing contest administered and funded by the CSKT to encourage the removal of lake trout in Flathead Lake by angling to benefit native fish species. Prizes are awarded—up to $150,000 per contest. Contests generally occur twice a year, during spring and fall. See the website www.mackdays.com.

Mack Attack: a fishing derby unrelated to Mack Days, put on by a local businesses on Flathead Lake.

metapopulation: a collection of localized populations (of the same species) that are geographically distinct, yet are genetically interconnected through movement of individuals among populations.

migratory: describes a life history pattern in which fish spawn and spend their early rearing years in specific tributaries, but move to larger rivers, lakes, or reservoirs as adults during their non-spawning period.

mortality rate: a measure of the number of deaths in a population, scaled to the size of that population, per unit time.

N

NEPA: National Environmental Policy Act

nodal habitat: waters that provide migratory corridors, overwintering areas, or other critical life-history requirements.

P

piscivore: carnivorous fish that eats fish.

population: an interbreeding group of fish

R

redd: a disturbed area in the gravel, or nest, constructed by spawning fish in order to bury their fertilized eggs. The female uses her tail to dig a slight depression in the gravel and then deposits her eggs. Biologists walk streams and locate and count redds during the fall (low water).

reduce a population: in the context of this proposal, reducing a population means removing enough individuals to exceed recruitment in order to achieve a target future population number.

resident: fish that spend their entire life cycle usually in tributary or small headwater streams in which they were hatched.

restoration: the process by which the decline of a species is stopped or reversed, and threats to its survival are removed or decreased so that its long-term survival in nature can be ensured.

Restoration/Conservation Areas (RCAs): portions of major drainages between which migration and straying is unlikely or can occur only downstream. It is within or between these restoration/conservation areas that bull trout will need to function as metapopulations.

Restoration Team (for bull trout): a policy-level group with representatives from State, Tribal, and federal agencies, conservation organizations, and private industry appointed by Governor Racicot to establish a Bull Trout Restoration Plan for Montana.

riparian area: lands adjacent to water such as creeks, streams, and rivers where vegetation is strongly influenced by the presence of standing or flowing water.

risk: a factor that has contributed to the past or current decline of the species.

S

scoping: the process of soliciting public and agency involvement to help define the issues associated with a proposed action.

slot limit: In the current Flathead Lake fishing regulations, no lake trout may be kept that are between 30 and 36 inches long. This regulation is described as the “slot limit”. Fish in this size group must be returned to the lake. The purpose of returning large-sized fish is to ensure there is a trophy-sized component (fish over 30 inches long) to the lake trout fishery in Flathead Lake now and in the future.

stable: as used in the Co-Management Plan stable refers to a population with no apparent increasing or decreasing trend.

strategy: planning, directing, and implementing projects to achieve specific objectives.

T

threat: a factor that jeopardizes the future conservation of a species.

trophy (lake trout): In the context of this EIS, a trophy lake trout in Flathead Lake is one that is 30 inches long or longer.

U

US EPA: United States Environmental Protection Agency

USGS: United States Geological Survey

USFWS: United States Fish and Wildlife Service

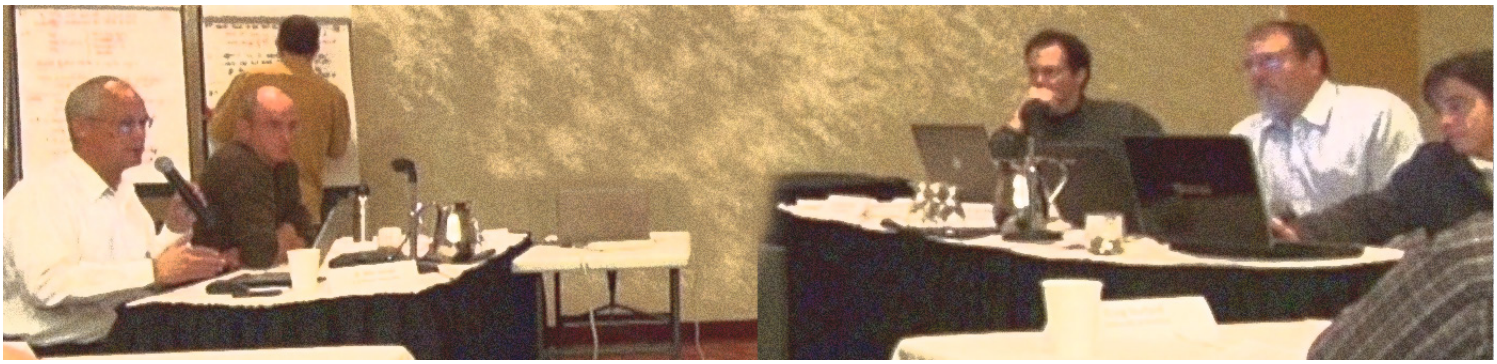
W

watershed: a drainage basin that contributes water, organic matter, dissolved nutrients, and sediments to a river, stream or lake.

Watershed Group: a group of agency representatives, landowners and recreational and commercial users of a watershed, plus a liaison from the Scientific Group created by the Restoration Team and charged with developing restoration actions to help restore bull trout.

Appendix 13

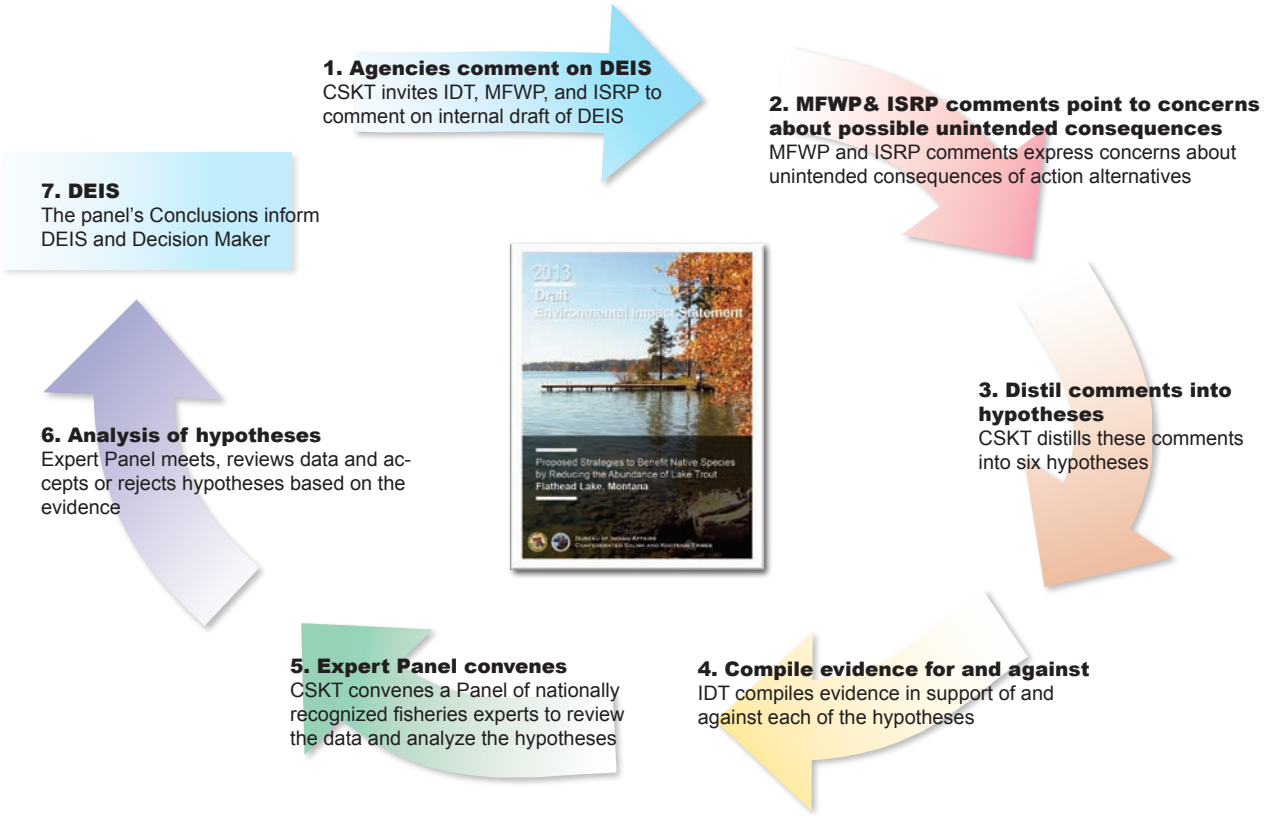
Expert Panel Assessment of NEPA Comments for the DEIS



Introduction

In 2012, during an agency review of the Draft Environmental Impact Statement (DEIS), the Confederated Salish and Kootenai Tribes (CSKT) received comments from Montana Fish, Wildlife & Parks (MFWP) and the Independent Scientific Review Panel (ISRP) that suggested action alternatives in the DEIS may have unintended consequences. The Tribes hold native species in the highest regard and wish to avoid bringing unintentional harm to them. Therefore, we convened a panel of fisheries experts (Expert Panel) to review these potential issues in a two-day workshop that was open to the public. To facilitate the Panel's work, the Tribes distilled comments into six hypotheses (questions) based on the premise that suppression would harm rather than benefit native fish species, particularly bull trout and

westslope cutthroat trout. The Interdisciplinary Team (IDT) then compiled evidence for and against each hypothesis, including recent and historic data, modeling, and anecdotal information and distributed it to the panelists. The compilation focused on the Flathead Basin, but included information from comparative systems based on species or lake ecology. The Expert Panel then convened in a workshop to review and discuss the validity of six hypotheses in light of evidence for and against them. Their goal was to address the potential for unintended consequences of suppressing lake trout in Flathead Lake.



EXPERT PANEL

Dr. Dave Beauchamp
Professor of Aquatic and Fisheries Sciences, Washington Cooperative Fish and Wildlife Research Unit, University of Washington

Dr. Lisa Eby
Associate Professor of Aquatic Vertebrate Ecology, University of Montana

Dr. Chris Guy
Assistant Leader USGS Montana Cooperative Fishery Research Unit, Montana State University

Dr. Mike Hansen
Professor of Fisheries and Water Resources, University of Wisconsin-Stevens Point

Dr. Brad Shepard
Senior Aquatic Scientist, Wildlife Conservation Society

Expert Panel Workshop

Attendees

Roughly 40 people attended public portions of the Expert Panel Workshop each day. Attendees included two members of the ISRP and all members of the ID Team: Jim Bower, MT Department of Natural Resources and Conservation; Chris Downs, National Park Service; Bonnie Ellis, University of Montana; Wade Fredenberg, US Fish and Wildlife Service; Barry Hansen, CSKT; Craig Kendall, US Forest Service; Clint Muhlfeld, US Geological Survey; Craig Stafford, University of Montana; and Pat Van Eimeren, US Forest Service. Mark Deleray, Jim Vashro and Lee Nelson of MFWP attended as observers.

Process

The workshop included three steps:

1. Discovery

In public forum, Expert Panel members reviewed each hypothesis in relation to evidence supplied by the ID Team. The Panel also questioned the ID Team about data sources and analyses. Both the ID Team and the public were encouraged to provide input. Discussion of each hypothesis ended when the Panel decided they were ready to deliberate.

2. Deliberation

Panel members met for 8 hours in closed session to debate merits of the hypotheses based on the best available information, with a charge to provide their best, unbiased, scientific assessment of the validity of each hypothesis, but without a requirement to reach consensus. The Panel was also asked to consider and suggest analysis of existing data that might illuminate the best selection of EIS alternatives. The Panel was asked to avoid incorporating political or management considerations, such as methods of implementation, into their deliberations or decisions.

3. Decision and Documentation

The Panel presented their findings in a public forum (2 hours) to the assembled IDT and public, followed by open discussion of their findings. All present were encouraged to question or comment on the Panel's findings. That presentation and inclusion of the Panel's findings in this appendix of the DEIS document this process.

The Hypotheses

Hypothesis 1

Suppression of lake trout would recreate the same conditions that caused the decline of bull trout in the 1990s, including a lake trout population that was up to 50% larger than is present today and was comprised of more than 90% juveniles less than 8 years old.

Hypothesis 1 is based on the following assumptions:

- Reports of lake trout catch rates during 1988–1990 were thought to be higher than those from creel surveys in 1992 and beyond.
- Catch rates of lake trout in Flathead Lake are assumed to be directly proportional to abundance, so indicated higher abundance during 1988–1990 than at present.
- Suppression would cause a compensatory increase in recruitment to produce a population dominated by lake trout younger than age 8, similar to the late 1980s, and more abundant than today's population.

The Expert Panel unanimously rejected Hypothesis 1 for the following reasons:

- Anglers may have experienced higher catch rates during 1985–1991 than at present by focusing their effort in areas where the relatively few lake trout were concentrated (see Hypothesis 5), and catchability may have increased after the sudden loss of kokanee, their primary prey, neither of which necessarily indicate a larger population size before 1992.
- Lake trout have a relatively low reproductive potential that limits the rate of population growth due to: their late age of maturity, large egg size in relation to body size (relatively few eggs), broadcast spawning behavior (no parental care to increase egg survival), and a six month incubation period. Therefore the lake trout species is not capable of a population growth rate (a super-exponential rate would have been required) that would lead to 50% higher abundance in the six year span from 1985–1991 than at present (see Appendix 6).
- For example, after harvest and sea lamprey were controlled in Lake Superior, the lake trout population required over 20 years to reach peak abundance from very low abundance (Figure 1).
- The Panel agreed that the lake trout population could have been comprised of 90% immature individuals during the period of population growth (1985–1991), but more importantly, also concluded (based on M. Hansen's modeling results) that abundance of immature lake trout (and total lake trout) is much higher presently than anytime during 1985–1991 (Figure 2). Therefore, the lake trout population can presently exert much higher mortality on juvenile bull trout than any time during the period in question, and the same is true for the suppression scenarios (see Appendix 6).

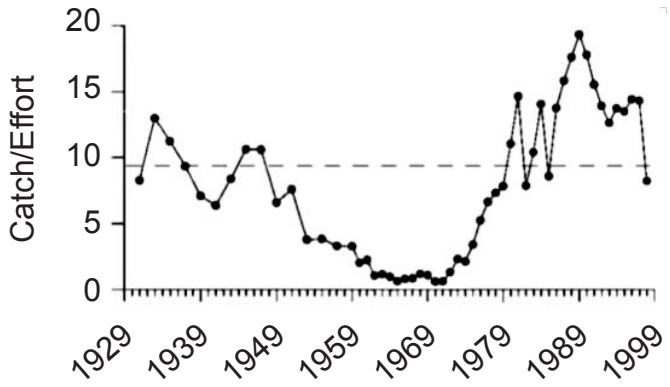


Figure 1. Geometric-mean catch per effort (CPE; number per kilometer of gill net set for 1 night) of wild lean lake trout in all Michigan waters of Lake Superior during 1929–1998. The dashed line shows the average geometric-mean CPE during 1929–1943 (Wilberg et al. 2003).

> *"During the period of expansion of* Mysis *and lake trout, the whole system was in a state of flux—you had an increase of* Mysis*, lake trout take off, you have the extirpation of kokanee (a primary prey of bull trout)—the entire lake community was adjusting to an influx of novel predators, competitors, and prey. Those adjustments have been made. If a suppression effort is undertaken, we are not going to be backing ourselves through that same gauntlet.*
>
> — Dr. Dave Beauchamp

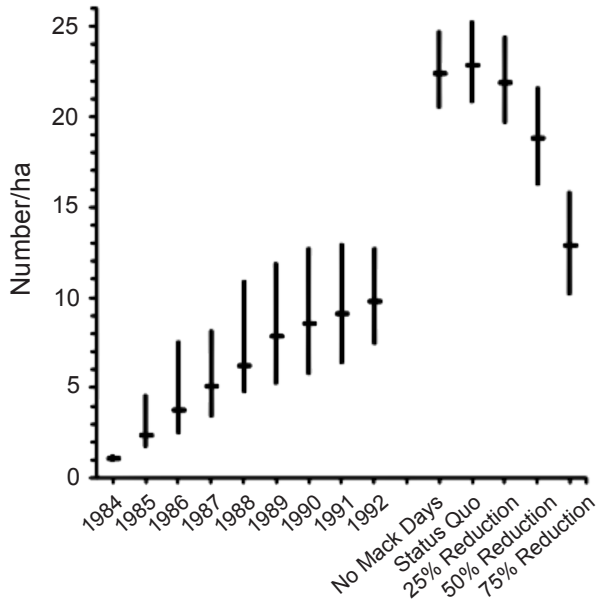


Figure 2. Modeled abundance of immature lake trout Ages 1-7 (columns equal 95% confidence intervals) from 1984 to 1992 and for five potential levels of suppression (see Appendix 6).

- Conditions that caused the decline of bull trout are more complicated than just presence of juvenile lake trout, such as large and irreversible food-web changes and elimination of kokanee.
- Understanding the cause of bull trout decline in the 1990s is not necessary to justify lake trout suppression in the future, because the ecosystem has changed so dramatically since the 1990s that factors controlling bull trout abundance then are not likely acting now.

Hypothesis 2

Very high abundance of juvenile lake trout (not adult lake trout) was the strongest factor in the decline of bull trout in the Flathead system.

Hypothesis 2 is based on the following assumptions:

- During the period in which lake trout were actively replacing bull trout (1985–1992), the lake trout population was largely composed of increasing numbers of juveniles aged 1–7.
- Competition from juvenile lake trout, although difficult to document and rarely results in mortality, may have an equal or greater effect on bull trout than predation by lake trout (Ferguson et al. 2012).
- The absence of bull trout in diets of small lake trout does not eliminate the possibility of a predatory effect of juvenile lake trout on bull trout.

The Expert Panel unanimously rejected Hypothesis 2 (specifically that juveniles were the strongest factor) for the following reasons:

- The abundance of juvenile lake trout was not very high in the 1990s relative to the abundance of juvenile lake trout today (Figure 2), so juvenile lake trout are now a more significant competitor or predator with bull trout than before 1992.
- The Panel concluded juvenile lake trout contributed to the decline of bull trout, but given the lack of information during that time period, could not differentiate among competitive effects on bull trout caused by Mysis, kokanee, or lake trout that all changed during the 1980s.
- Proposed suppression alternatives would reduce juvenile lake trout numbers, thereby reducing bull trout competitors lower than present, because juvenile lake trout are currently more abundant and would remain more numerous than in the 1990s.
- The factors currently regulating bull trout abundance (and keeping it from rebounding in the face of substantial habitat restoration in the spawning tributaries) is likely different than what caused the initial decline.

> *"I doubt we will ever be able to determine if competition or predation is the mechanism. We don't have the data…So we are not going to get to that answer without a lot of speculation. But I don't think we need that information to move forward.*
>
> — Dr. Chris Guy

Hypothesis 3

Food limits juvenile bull trout abundance in Flathead Lake today and limited bull trout abundance prior to the establishment of Mysis.

Hypothesis 3 is based on the following assumptions:

- For competition to regulate survival of bull trout, food or another resource must be limiting to both bull trout and one or more other competitor species.
- In Flathead Lake, bull trout declined as Mysis increased during 1988–1992, and subsequently, zooplankton and some prey fishes declined or disappeared (kokanee).

The Expert Panel unanimously rejected Hypothesis 3 for the following reasons:

- The Panel does not agree that food has ever limited bull trout abundance in Flathead Lake, and found no data to support the food-limiting hypothesis.
- Evidence is lacking that bull trout growth and condition have changed over the period from before to after Mysis increased, and would likely be evident if food was limiting.
- Intra-specific competition does not likely regulate bull trout survival at present-day low levels of abundance.
- Mysis have expanded the prey base of juvenile bull trout (Mysis represent about 50% of their diets by weight, CSKT unpublished data).

> *"The Panel's big concern is that the bull trout population is so small that at least some sub-populations may be on the brink of extinction, so that all situations carry great risk.*
>
> — Findings of Expert Panel

Hypothesis 4

The current annual harvest of 70,000 lake trout will benefit native fish.

Hypothesis 4 is based on the following assumptions:

- Removal of any lake trout that is large enough (>650 mm) to eat juvenile or sub-adult bull trout potentially reduces overall competition and predation risk for bull trout in Flathead Lake.
- Predicting effects of lake trout suppression on bull trout survival to adulthood is subject to high prediction uncertainty and low detection power.

The Expert Panel agreed with Hypothesis 4 with qualifications for the following reasons:

- Sustained annual harvest of 70,000 lake trout (with Mack Days) is modeled to cause a 37% decrease in predation on bull trout, relative to a harvest of 33,000 (without Mack Days). This assumes a random encounter rate in which bull trout predation risk is proportional to lake trout abundance. Potential benefits to bull trout would require 5-8 years to be measured.

- A reduction in predatory lake trout would likely increase survival of juvenile and sub-adult bull trout to maturity.

- Although the current annual harvest of 70,000 lake trout would likely decrease predation on bull trout, any potential increase in bull trout resulting from decreased predation would be too small to measure. In addition, mortality from bycatch would partially offset the gains. Thus, removal of 70,000 lake trout annually is likely insufficient to drive an increase in bull trout numbers.

Hypothesis 5

Lake trout catch rates would likely change directly with changes in abundance.

Hypothesis 5 is based on the following assumptions:

- Catch rates in some fisheries change directly (proportionately) with density of the target species, and lake trout fisheries may exemplify such a relationship.

- If catch rates are proportional to abundance in Flathead Lake, a 25% reduction in abundance would cause a 25% reduction in catch rate (similarly for 50% and 75% reductions).

The Expert Panel unanimously rejected Hypothesis 5 for the following reasons:

- Lake trout populations commonly demonstrate a negative relationship between vulnerability and abundance because lake trout concentrate in high-quality habitat that is not randomly distributed where anglers focus their effort (Shuter et al. 1998) (Appendix 6)

- A 25% reduction in lake trout density would not likely be noticeable to anglers, because overall angler harvest rate would only decline by 8%, although rates specifically for large fish would decline by greater amounts (Appendix 6).

- Reductions in lake trout density of 50% and 75% would likely be noticeable to anglers, because angler harvest rate would decline by 21% and 42%, respectively (Appendix 6).

> *"The lake trout in Flathead Lake concentrate in high quality habitats. On the fishermen's side, most angling is similarly nonrandom. Fishermen tend to go where fish concentrate, and this is actually a fairly well-developed theory in fisheries science.*
>
> — Dr. Mike Hansen

- During Mack Days in Flathead Lake, catch rates in “hot spots” decline from Friday to Sunday, only to recover the following Friday, presumably because lake trout repopulate these areas from Monday through Thursday when the event is not conducted.

Hypothesis 6

A suppression program that includes dwarf lake trout would have no effect on the level of predation on native fish.

Hypothesis 6 is based on the following assumptions:

- Dwarf lake trout would be included in any harvest strategy focused in deep waters.
- Suppressing dwarfs would not reduce lake trout predation on native species because dwarf lake trout do not prey on native species.
- Suppressing dwarfs would improve conditions for leans by reducing intra-specific competition, and thereby increasing predation on native species.

The Expert Panel unanimously rejected Hypothesis 6 for the following reasons:

- Dwarfs are intermingled with leans in deep waters, so it is not feasible for a fishery to capture only dwarfs, as leans would always be included in the catch.
- Removing dwarfs would have a positive effect on a suppression program because dwarfs should likely replace leans as abundance of leans declines.
- While there are no known unintended consequences from removing dwarfs, a suppression program intended to reduce predation on bull trout should target the entire lake trout population in Flathead Lake, not just the deep-water component of the population.

> *“One way to look at this is to ask “What is the likelihood that suppression would only target dwarfs?” The answer is that deep nets are going to catch both dwarfs and leans because the populations overlap in time and space… it would not be possible to target just dwarfs.*
>
> — Dr. Lisa Eby

Conclusion

The Expert Panel deliberated over concerns that suppression activities proposed in the DEIS could result in unintended consequences: namely that suppression could harm rather than benefit native fish species, particularly bull trout and westslope cutthroat trout.

The Panel concluded the following:

1. The suppression actions proposed in the DEIS would not have the unintended consequences proposed by commenters.

2. For suppression to be effective, it must be aggressive and long term. Suppression actions must be large enough to have a detectable and measurable impact on lake trout and native fish populations.

3. It is not only very unlikely that a suppression program would re-create the conditions that caused the steepest decline in native fish numbers, but it is unlikely the mechanism originally responsible for the decline is acting the same way it did back in the early 1990s.

4. Suppression presents a perfect opportunity for a robust adaptive management program. A number of key parameters would need to be regularly monitored to measure the effectiveness of the program at accomplishing the goal set forth in the EIS — to reduce the lake trout population to a level that benefits native fish populations. If goal is not met, management would need to change and adapt to new information to ensure the long-term viability of native fish populations in the Flathead system.

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