Phase II of the Five Year Review of the Flathead Lake and River Fisheries Co-Management Plan Technical Synopsis and Management Recommendations Section

Presented to
The Flathead Reservation Fish and Wildlife Board

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Prepared by:

Confederated Salish and Kootenai Tribes

And

Montana Fish, Wildlife and Parks

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EXECUTIVE SUMMARY

I. BACKGROUND – FISHERIES MANAGEMENT PLAN

Flathead Lake lies both within the state of Montana and within the Flathead Indian Reservation. Therefore management responsibility is shared by the State of Montana and the Confederated Salish & Kootenai Tribes who chose to develop a "co-management" plan to guide the fishery. The Flathead fishery includes 10 native species and 11 introduced species. Together the management agencies developed the goal to manage for healthier populations of native trout. Bull trout were listed as threatened under the ESA in 1998. To many, this bull trout population symbolizes the general health of bull trout populations throughout their range. The current Co-Management Plan, adopted in 2000, was completed under considerable scrutiny from the public, professionals, agencies, and conservation groups. There was substantial skepticism about the fact that we chose angler-based approaches as our preferred method to restore some balance to the fishery. There was also opposition to applying approaches that are more aggressive than angler-based ones.

The resulting co-management plan was a consensus agreement, representing some compromise for nearly all those involved. A hotly debated component during its development was whether or not to have measurable criteria for progress. We chose not to include specific numeric targets in part because of the large and complex nature of the system and because of the insufficiency of technical data. Instead we defined the goals simply as positive or negative trends in fish populations. The only numeric goal was to maintain angler involvement of 50,000 angler days in Flathead Lake and 40,000 angler days in the Flathead River, which was the base level in 2000. Trends or direction of change in the abundance of species are suitable measures because they are based on the assumption that one key species is controlling the other. It was partly due to the lack of measurable criteria in the plan that the agencies committed to a mid-course review of the Plan to evaluate the need for changes in the strategies being employed.

This document represents Phase II of the Five Year Review of the Plan. The Phase I document was the technical portion of the review and was presented to a panel of six scientists who were selected because they are leading scientists in bull trout and lake trout biology. These experts are Bradley Shepherd of Montana Fish, Wildlife and Parks, Nigel Lester of the Ontario Canada Ministry of Natural Resources, David Beauchamp of the University of Washington, Mike Hansen of the University of Wisconsin, Lisa Eby of the University of Montana, and Bruce Rieman of USDA Forest Service Rocky Mountain Research Station. Three of these reviewers also participated in an expert panel that was convened in 1997 to address Flathead Lake management. We incorporated their reviews into our analysis and then condensed the Phase I technical report into this Phase II report that also includes our management recommendations. We plan to maintain our contacts with these experts and return to them a summary of their reviews and copies of our final scientific conclusions as well as the management decisions made by the agencies. The expert reviews will be assembled and made available following receiving all reviews and completing a summary.

The following excerpts from the Executive Summary of the Flathead Lake and River Fisheries Co-Management Plan describe the direction provided to us for implementation of the plan.

“Recreational angling will be the major tool to reduce non-native fish populations.”

“If this initial recreational angling strategy does not achieve our native trout goals, additional angling incentives will be established. These include providing direct incentives to bring lake trout to food banks and community kitchens, and encouraging or sponsoring fishing derbies to harvest large numbers of small lake trout.”

“If native trout populations do not reach secure levels using the complete set of recreational fishing strategies, more aggressive techniques may be used. These may include hook-and-line commercial fishing for lake trout, bounties for killed lake trout, and commercial netting of nonnative fish. Agency management actions could include live trapping nonnative fish, gillnetting lake trout on spawning grounds, removing rainbow trout from spawning tributaries, or installing migration barriers. In general, there is little public support for commercial fishing or for agency netting of lake trout. However these strategies may be reviewed and implemented if native trout populations drop to dangerously low levels or if they are needed to achieve native trout goals after all other techniques are exhausted.”

In this report we describe how we implemented this direction and interpret the results. We describe trends in the abundance of species and present interpretations of cause and effect. We then make management recommendations designed to bring us into better compliance with the goals of the Plan. We use Table 1, drawn from the Plan, for guidance in determining how we manage these two competing species.

Table 1. The decision matrix developed for the Flathead Lake and River Fisheries Co-Management Plan for balancing management between lake trout and bull trout.

If the Bull Trout Population…	**And the Lake Trout Population…**	**Then the Management Action Would be…**
Increases	Increases	Increase reduction of small lake trout
Increases	Stabilizes	Continue current management
Increases	Decreases	If angler use declines below current levels and other species do not replace lake trout losses, stabilize harvest of lake trout
Stabilizes	Increases	Increase reduction of small lake trout
Stabilizes	Stabilizes	Reevaluate goals and objectives
Stabilizes	Decreases	If angler use declines below current levels and other species do not replace lake trout losses, stabilize harvest of lake trout
Decreases	Increases	More rapidly reduce the number of small lake trout
Decreases	Stabilizes	Increase reduction of small lake trout
Decreases	Decreases	Identify specific causes of bull trout decline and take appropriate action; if needed, further reduce small lake trout

II. EMPIRICAL AND CIRCUMSTANTIAL EVIDENCE THAT LAKE TROUT CONTROL BULL TROUT ABUNDANCE.

The scientific foundation of the Management Plan is that lake trout in Flathead Lake reduced the abundance of bull trout. A panel of fisheries scientists that convened in 1997 drew this conclusion, however there was little direct empirical data to support it. The Montana Bull Trout Scientific Group's status review of the Flathead drainage (1995) rated non-native species as a "very high risk" to restoration. Specifically they said "Lake trout are believed to be one of the most important factors causing the recent decline of bull trout in the Flathead Lake system." We used Strategy I. *Fisheries Assessment, Monitoring, and Research* component of the Plan to test this assumption and develop parameters to measure trends in abundance. We know that the abundance of bull trout in Flathead Lake is influenced by many factors other than predation by lake trout. These factors act in the tributaries, in the main stem river, and in the lake. Examples are the degradation of tributary spawning and rearing habitat, competition and hybridization with brook trout, elevated stream temperatures, and drought. While these factors may severely depress bull trout abundance in various locations, we think it is the unprecedented shift in lake ecology due to the establishment of *Mysis* followed by the explosive increase in lake trout that has reshaped the Flathead bull trout population.

We have developed both indirect and direct evidence that lake trout influence the abundance of bull trout. First, there has been a reversal in the catch rates of lake trout and bull trout in gillnets from the pre-*Mysis* period to the post-*Mysis* period (Figure 1). Bull trout catches in spring gillnets prior to *Mysis* were much greater than catches of lake trout, and following *Mysis* lake trout catches have greatly exceeded those of bull trout.

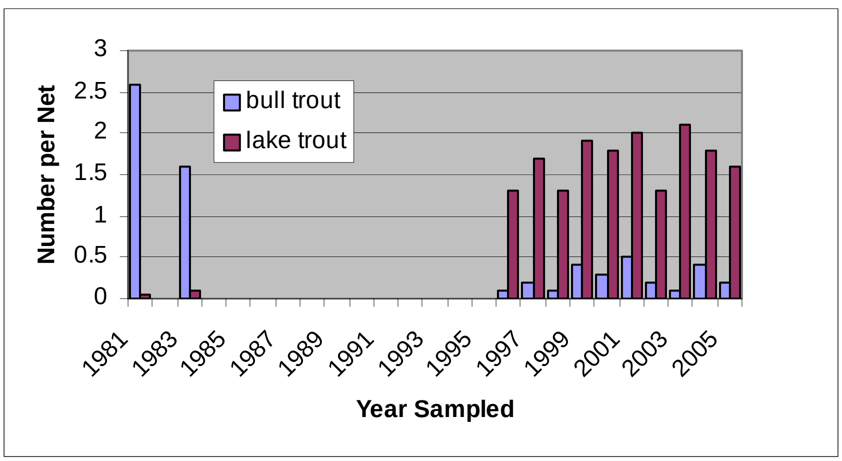

Figure 1. Catch rates in gillnets of lake trout and bull trout during spring in Flathead Lake, 1981 to 2005.

Second, Beauchamp and others (2006) used bioenergetic modeling of the Flathead Lake food web to predict the number of bull trout consumed by lake trout. Using the management agency's estimate of lake trout abundance, they estimated that lake trout annually consume over 30,000 bull trout in Flathead Lake.

Third, modeling by Staples and others (2004) indicates that bull trout population growth is highly vulnerable to mortality of subadults. The bull trout found by Beauchamp and others (2006) in the stomachs of lake trout from Flathead Lake were subadults. Staples and others (2004) report the following conclusions on this subject:
1) "Demographic model results indicated that a decrease in sub-adult survival leads to a nearly proportional decline in population growth rate (i.e. a 25% decrease in sub-adult survival results in almost a 25% decrease in population growth rate).
2) These analyses suggest that the most important pathway in the life cycle is egg number and survival to the first spawning with juvenile and sub-adult survival rates being the most influential to population growth rate".
3) Adult survival and post-spawning survival have the lowest effect on population growth rate.

Fourth, Donald and Alger (1993) found few examples of persistent sympatry between bull trout and lake trout. In addition, there are recent examples of bull trout decline following lake trout introduction, i.e.: Priest Lake, Whitefish Lake, Bowman Lake, and Kintla Lake. We are unable to determine if the declines of bull trout will continue and result in their extinction. There is little doubt that when lake trout have been introduced in a bull trout lake that bull trout have universally declined, but there is considerable debate as to whether those declines will continue to extinction or whether they will persist at much reduced levels. This uncertainty makes the management decision regarding reducing lake trout to benefit bull trout more difficult.

A task under the Co-management Plan was to conduct a bioenergetic modeling study to better understand the predatory impacts of northern pike on native trout in the upper Flathead River System. Dr. David Bennett and Dr. Kirk Steinhorst of the University of Idaho and biologists from Montana Fish, Wildlife and Parks conducted the study. The study was completed in 2006 and is available from Montana Fish, Wildlife and Parks. In the lower reach of the Flathead River and the connected river sloughs there was an estimated 1200-1300 pike. The estimated total number of fish consumed annually was nearly 260,000, primarily minnow, sucker and whitefish species. Researchers estimated consumption of 2,900 juvenile bull trout and 6,900 westslope cutthroat trout.

We have concluded that lake trout predation is presently the largest factor controlling bull trout abundance in Flathead Lake, and is also the one we are most able to modify through our management.

III. EVALUATION OF TRENDS IN ABUNDANCE OF THE KEY SPECIES

In this section we summarize and describe all relevant information available to evaluate our progress in increasing native trout and reducing lake trout during the first five years of the plan. Unfortunately we cannot directly measure total population abundance of any of the three key species. Counts of bull trout redds provide the most direct measure of adult population abundance of any measure we use. None of the indices are without flaws. They are all subject to sampling errors, and many are influenced by several factors making interpretation of their meaning difficult. We therefore rely on the uniform direction of multiple indicators that form a preponderance of evidence on which to base our conclusions.

We define the trends in abundance of the key species with terms specific to the Co-Management Plan and outlined in Table 1. In our analysis we use the term stable to define the default condition in which there were neither clear upward nor downward changes in abundance. In this context, stable is not intended to imply healthy population levels or resistance to change in the future.

A. THE TREND IN THE BULL TROUT POPULATION IS STABLE

Currently bull trout are a very small component of the Flathead Lake fish community, and therefore are a challenge to monitor. We evaluate trends in abundance with four criteria: redd counts, catches in gillnets, estimates of juvenile abundance in natal streams, and modeling.

1) Redd counts in natal streams

Redd numbers dropped 70 percent below pre-Mysis levels in the 1992 to 1997 period. Redd numbers increased in the 1998 to 2002 period, and decreased during 2003 to 2005 period. In the last six years, the number of redds counted is roughly 50 percent of pre-Mysis numbers (Figure 2). Redd surveys indicate that spawner numbers are above

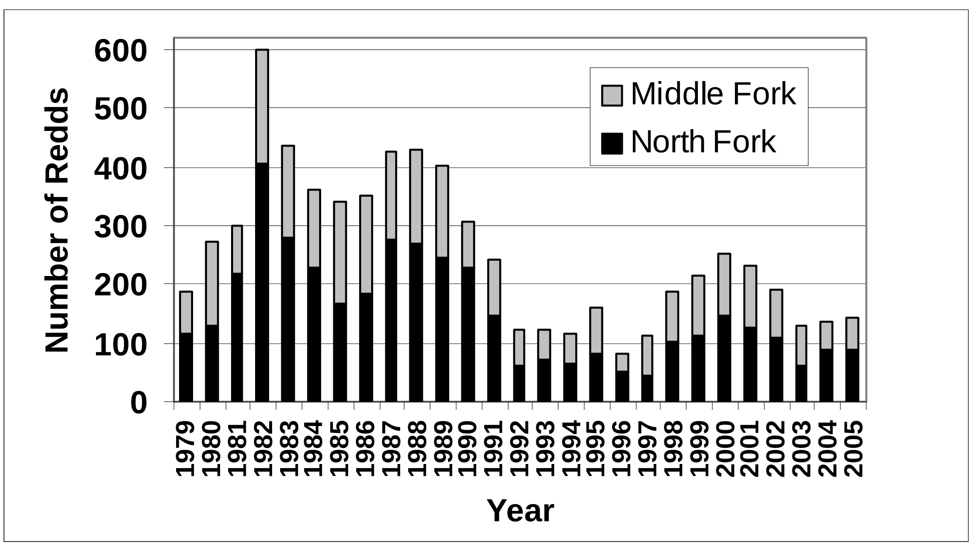

Figure 2. Index reach redd counts of adult bull trout in the North and Middle Forks of the Flathead River, 1979 to 2005. These index counts represent 45 percent of all redds in tributaries of the North and Middle Forks.

the "secure" level criteria that the agencies defined in 2002, an Objective under the Co-management Plan. However, the level is only slightly higher than the lower threshold level of secure. We consider these redd count data to indicate a stable bull trout population, because there is neither a pronounced increasing nor decreasing trend.

Secure level criteria include a stable or increasing population trend, wide geographic distribution, and at least 300 redds in the basin. Currently, redd count data do not indicate a decreasing population trend; bull trout distribution is wide with spawning in all 22 historically used spawning streams; and basin-wide redd numbers are above 300. Thus, at this time Flathead bull trout meet these criteria.

2) Fixed location gillnetting

Spring gillnetting has produced consistently low catches of bull trout, and also provides no indication of an upward or downward trend in recent years (Figure 3).

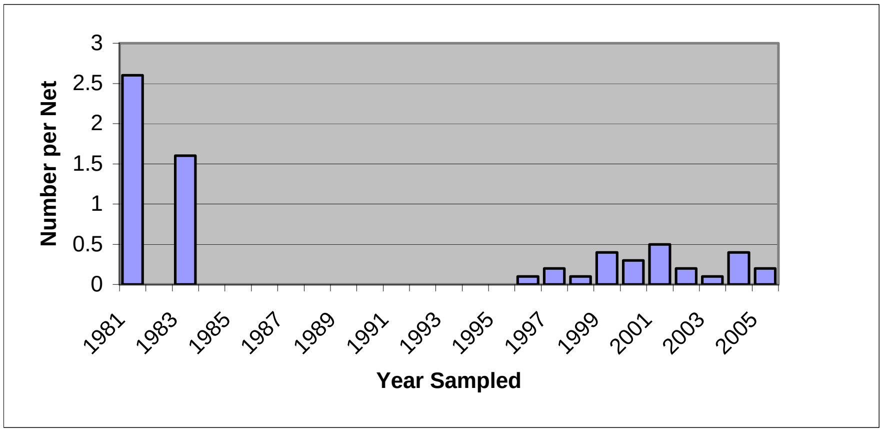

Figure 3. Average catches per net of bull trout in sinking gillnets set in spring, 1981 to 2005. The survey was not conducted in the years without catch, with the exception of 1995.

3) Juvenile bull trout abundance in natal streams

Juvenile estimates vary widely depending on stream habitat conditions and redd numbers, and also do not provide a consistent trend in abundance (Figure 4).

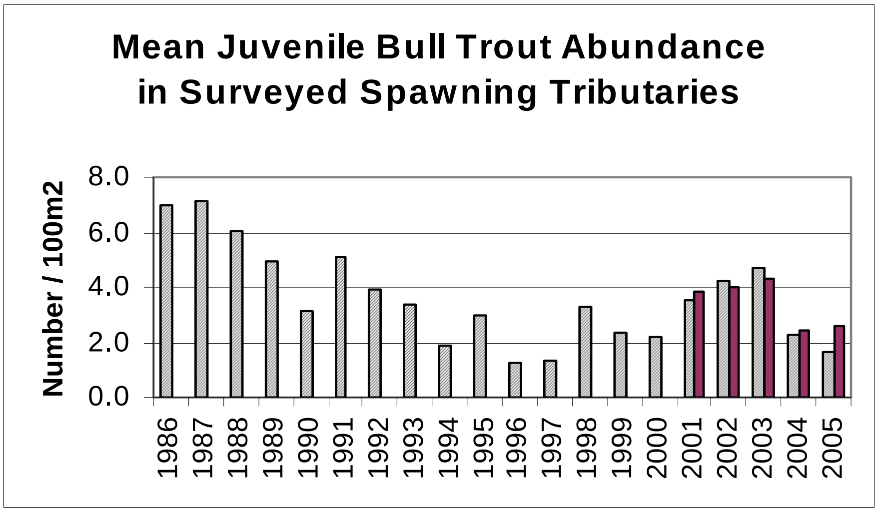

Figure 4. Annual composites of Age I and older juvenile bull trout densities calculated from electrofishing in the index sections of Flathead Lake nursery streams (n=5) from 1986 through 2005 (since 2001 n=7 shown in solid bar).

4) Modeling exercises

Staples with the help of others from the Montana State University developed a model using data from redd counts and gill-net catches through 2003 to describe the life history factors that most influence bull trout population abundance. They were unable to discern an upward or downward trend in abundance of bull trout.

The working group concludes from these indices that the bull trout population is stable, although at a level only slightly higher than the threshold we have identified as secure.

B. THE TREND IN THE WESTSLOPE CUTTHROAT TROUT POPULATION IS STABLE.

As with bull trout, westslope cutthroat trout are currently a very small component of the Flathead Lake fish community, and are an even greater challenge to monitor than bull trout because as spring spawners their redds are not very visible. We evaluate trends in abundance by using gillnetting, juvenile abundance in natal streams, and angler catches in the Flathead river and lake.

1) Fixed location gillnetting

During the 1993 to 1999 period, spring netting averaged 0.5 cutthroat trout per net, the lowest period on record (Figure 5). This was roughly 20 percent of the pre-Mysis cutthroat trout levels of 2.7 fish per net. From 2000 to 2005, catches averaged 1.0 cutthroat trout per net. Gill net catches for other species, including yellow perch and peamouth chub also increased in Flathead Lake during this period. The recent cutthroat trout catches are too variable to discern an upward or downward trend in abundance.

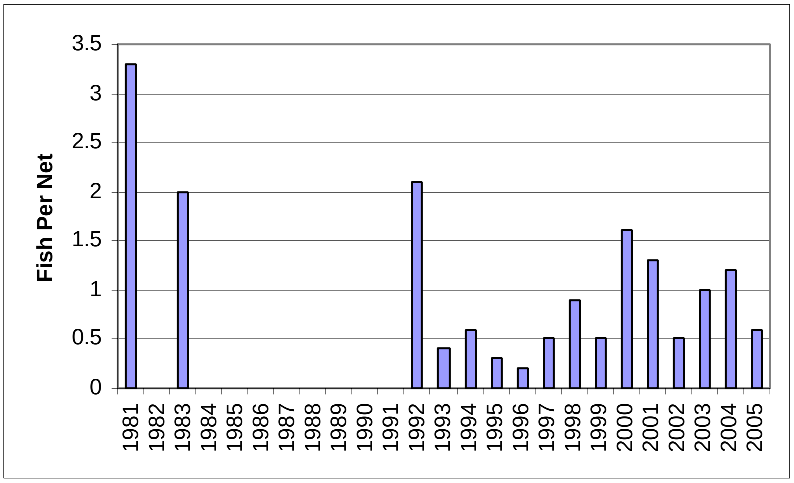

Figure 5. Average number of westslope cutthroat trout caught per floating gill net set in Flathead Lake during the annual spring survey, 1981 through 2005. The survey was not conducted in the years without catch.

2) Westslope cutthroat trout abundance in streams

Over the last 15 years, cutthroat trout population estimates in the North and Middle Forks have been relatively consistent. In addition, juvenile population estimates in a limited number of natal tributaries show no defined upward or downward trend.

None of the above indices provide a clear indication of an upward or downward trend. Therefore our summary interpretation is that westslope cutthroat trout numbers in Flathead Lake are relatively stable.

C. THE TREND IN THE LAKE TROUT POPULATION IS STABLE.

We draw our conclusions about trends in abundance of lake trout from indices generated from spring and fall gillnetting data, annual angler creel surveys, analysis of bioenergetics, and the sampling of inter-dependant species such as *Mysis*.

1) Average catches in gillnets

We conduct spring gillnetting with 15 sinking gillnets set in five fixed locations. This series has shown an enormous change in catch of lake trout since 1981 (Figure 1). The change in catch within the last ten years has been variable, but has been reduced to a range of 62% (Figure 6).

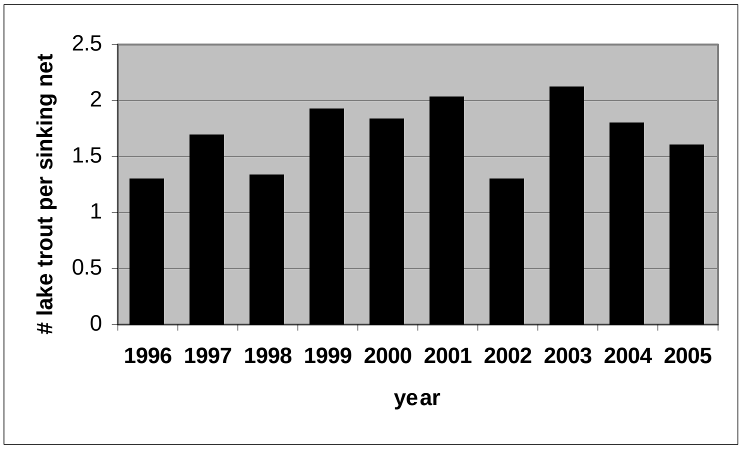

Figure 6. Average number of lake trout caught per net during spring in Flathead Lake, 1996 to 2005.

We follow a stratified random design for gillnetting in the fall, in which a total of 48 sinking gillnets are distributed across five areas and five depth strata. Each gillnet consists of 12 randomly arranged mesh sizes ranging in size from 3/8" to 3" bar measure, and each spaced one meter apart in the gang to prevent leading of fish. The average catch per net has been variable over the past eight years (Figure 7). Because this index provides no indication of an upward or downward trend, we interpret these data to indicate a stable population of lake trout.

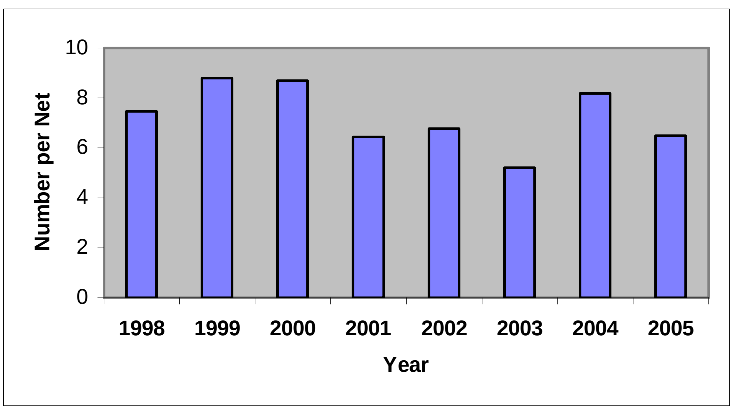

Figure 7. Average number of lake trout caught per net during fall in Flathead Lake, 1998 to 2005.

2) The lake trout mortality rate has not changed over the last five years
Mortality rate defines the decrease in abundance of fish from one year class to the next older year class (Figure 8). Over the last five years we have measured the cumulative mortality rate between the ages of seven and fifteen. An increase in the mortality rate usually indicates that the population is decreasing, while a decrease in the mortality rate usually indicates that the population is increasing.

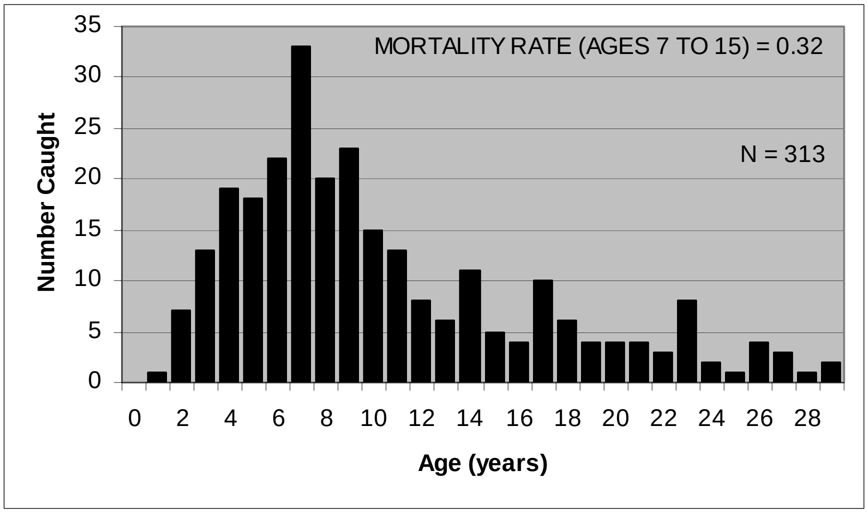

Figure 8. Age structure and mortality rate of lake trout population estimated from gillnetting samples collected in fall 2005.

The mortality rate measured from 2001 to the present has been very consistent at about 0.30 (Figure 9). The stability in this measure strongly indicates that the lake trout population has not changed in the past five years.

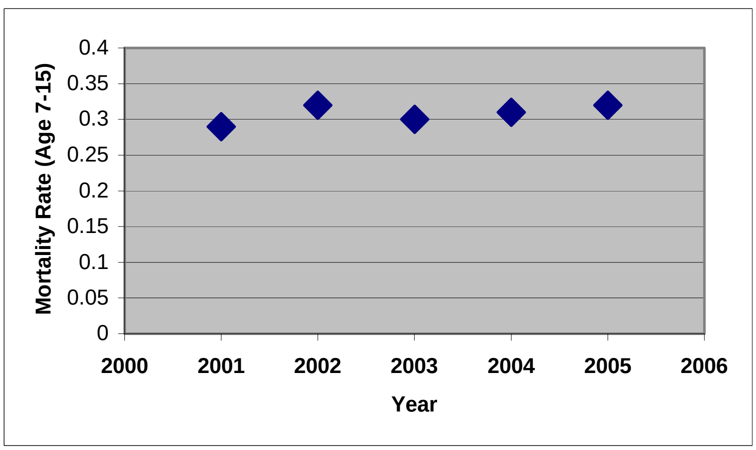

Figure 9. Mortality rates in lake trout between the ages of seven and fifteen, 2001-2005.

3) There has been a fairly constant harvest of lake trout for eight years

We have measured the annual harvest of lake trout since 1998. Our estimates of harvest have been variable, but generally around 40,000 lake trout per year (Figure 10). This eight year period of record is sufficiently long to conclude that the level of harvest is fairly stable. Because it takes lake trout about five years to recruit to the fishery, we know that we have measured three new recruiting year classes during this eight year time period. Therefore there is no indication that the annual harvest of 40,000 fish has affected recruitment, or mortality rate. These two indicators together provide strong evidence that the current harvest level is sustainable.

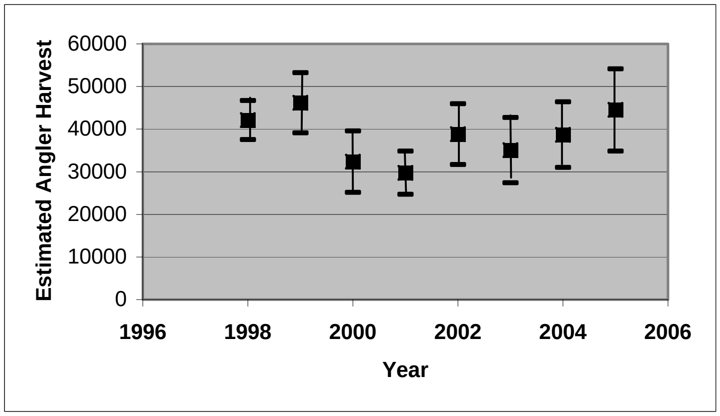

Figure 10. Estimated total harvest of lake trout in Flathead Lake, 1998-2004. Bars represent two standard deviations above and below the mean.

4) Angling pressure in Flathead Lake is moderate

Angling pressure in Flathead Lake has averaged 2.73 angler-hours/ha/yr over the last eight years. We have examples from lakes much smaller than Flathead that support pressure up to 8 angler-hours/ha/yr for lake trout, and examples from many large lakes in Ontario that support up to 4 angler-hours/ha/yr. While the Ontario lakes have much more restrictive harvest regulations than we have on Flathead Lake, Flathead anglers keep a much lower percent of their catch than do Ontario anglers. Because angling pressure on Flathead Lake is below the average of most lakes with lake trout, we think it is unlikely that the current level of pressure is sufficient to cause the lake trout population to decline.

5) Current yield of lake trout in Flathead Lake is moderate

The current harvest of lake trout in Flathead Lake equates to about 0.7 kg/ha/yr. This yield is roughly comparable to the sustainable yields of lake trout from numerous other lakes of widely varying sizes (Figure 11). We conclude that the current yield of lake trout in Flathead Lake is moderate, and therefore provides no indication that lake trout are in decline.

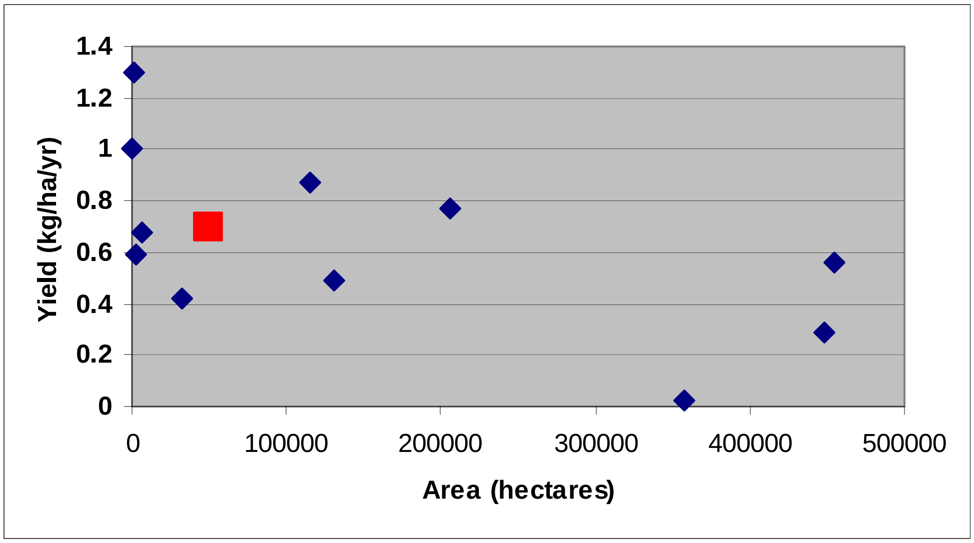

Figure 11. Average annual yields of lake trout in lakes of varying size. The box represents Flathead Lake.

6) Changing length at age of lake trout

Growth of fish is often used as a measure of population change because it often changes with the abundance of the population. If the biomass of forage species is constant while predator levels are increasing, then there is less forage for each predator causing reduced growth. We have measured growth rates by otolith analysis over three different time periods. In 1995 we determined ages of a sample of lake trout of widely varying lengths and collected over the course of several years. We separated this sample of fish into those born before 1973, and those born after 1983 when the *Mysis* population expansion occurred, in hopes of separating the influence of *Mysis*. In 2006 we determined the age of 153 lake trout collected in fall of 2005. On average, the largest fish at age, at least for fish ten years and older, occurred in the period prior to *Mysis* and while kokanee were still present in the lake (Figure 12). Fish from the sample representing the immediate post-*Mysis* period had intermediate lengths at age, although this sample was necessarily restricted to fish 13 years and younger. The fish collected in 2005 on average were the shortest at age. We attribute the changes from pre- to post-*Mysis* periods to be largely due to the loss of kokanee, a high caloric-value prey. The changes from the immediate post-*Mysis* period to 2005 cannot be attributed to the absence of kokanee, may reflect changes in density of lake trout. These changes may be the result of an increasing lake trout population, although this conclusion must be qualified because the small sample of fish from the immediate post-Mysis period leaves substantial room for error. We conclude, that there is no indication from these data that the lake trout population is declining.

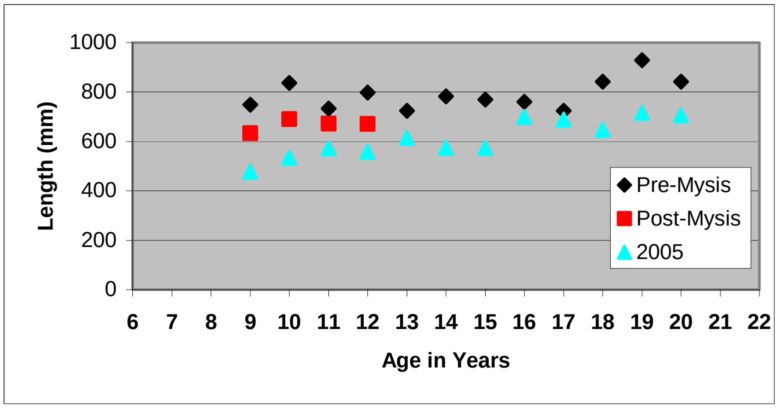

Figure 12. Length at age of lake trout in Flathead Lake for three time periods: prior to Mysis (yellow), immediately following Mysis (purple), and more than 10 years following Mysis (blue).

7) The condition of lake trout in Flathead Lake is poor

Lake trout populations can be compared based on a standardized measure of weight at length, called relative weight. A value of 100 represents the average condition of lake trout across their range. Lake trout greater than 400 mm in Flathead Lake have relative weights in the 5th percentile of lake trout range-wide (Figure 13). There are many factors that drive condition. As with growth rate, condition is closely related to the forage availability relative to density of predators. The poor condition of lake trout in Flathead Lake is an indication that the population is large relative to its prey base.

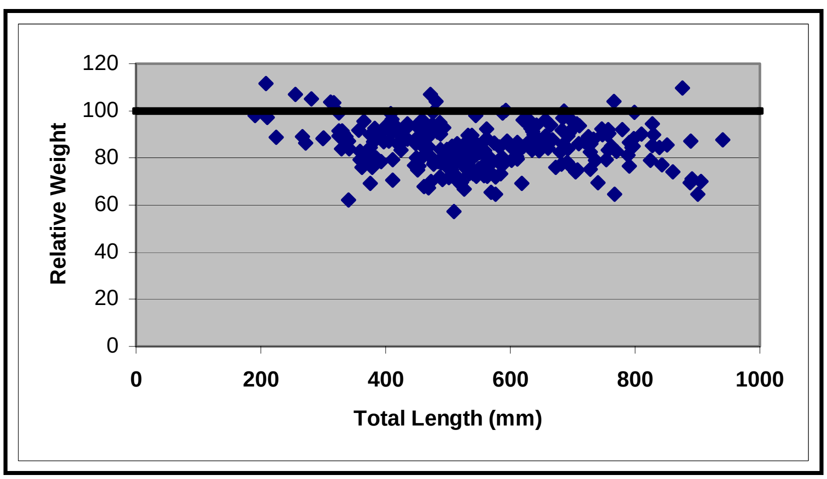

Figure 13. The relative weights of female lake trout in Flathead Lake, 2005.

8) Increasing angler catch rates of lake trout

Angler catch rates can be an indicator of population abundance provided certain conditions are met. We have conducted a continuous angler creel survey on Flathead Lake since 1998. Over this time period the average catch rate for lake trout has increased incrementally nearly every year (Figure 14). Catch rates can be effective indicators of abundance provided that several factors such as the skill of the anglers remains constant. If angler skill improves it can falsely indicate an increase in abundance. We have observed the angling public learn to effectively catch lake trout since the collapse of kokanee. We think it is reasonable to assume that continual improvement in the skill of anglers is causing most of the increase in catch rates. However, the increase is so large that we also think it is reasonable that this index we cannot completely rule out the possibility that the increased catch rate is attributable to an increase in lake trout abundance.

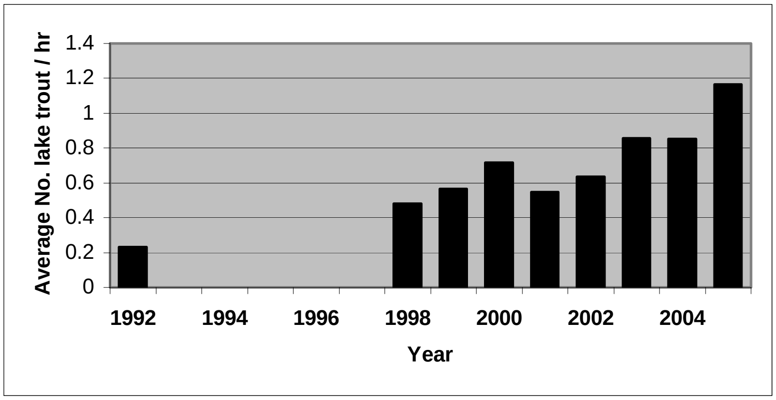

Figure 14. Average number of lake trout caught per hour by anglers targeting lake trout from boats in Flathead Lake, 1992-2005.

9) Gillnet catches indicate the presence of many year classes of lake trout and a low mortality rate. In fall we sample the entire lake with gillnets to estimate the size structure of the lake trout population. After determining the age of the sampled fish we estimate the age structure and determine the mortality rate.   The Flathead population has about 20 well represented year classes, and nine very abundant year classes. Such a wide range of year classes makes this a population that is resilient to over-harvest. The mortality rate between ages 7 and 15 is 0.32 (Figure 15). Populations increase or decrease based on whether or not the mortality rate is greater than the rate of recruitment into the population. Many researchers have found that lake trout populations are able to withstand harvest that results in a mortality rate of about 0.45 to 0.50. Assuming an average rate of recruitment, the low mortality rate of 0.32 in the Flathead population indicates that current exploitation is moderate and sustainable.

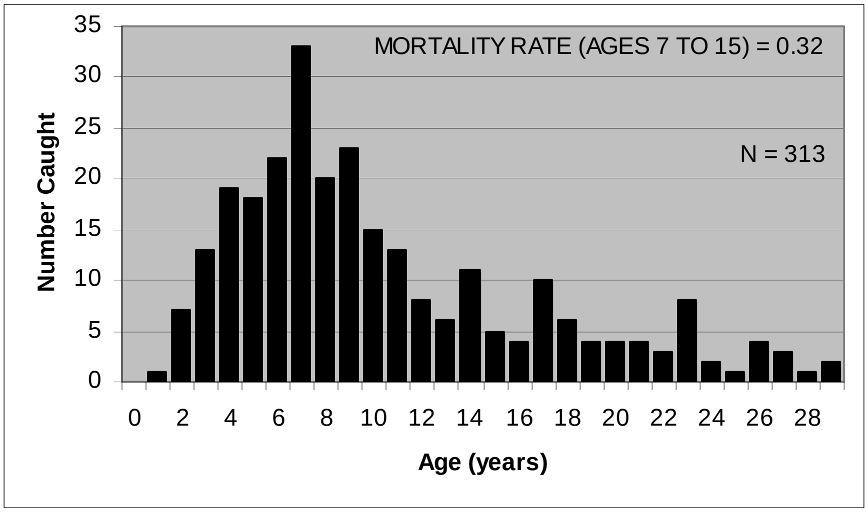

Figure 15. Age structure and mortality rate of the lake trout population estimated from gillnetting samples collected in fall 2005.

10) The abundance of *Mysis relicta* is not increasing.

Dan Wicklum, while working for the Flathead Lake Biological Station, determined that *Mysis* abundance was not limited by its zooplankton prey base. He predicted that the available zooplankton biomass could support up to a five-fold increase in abundance of *Mysis*. His work gave us the first indication that Mysis numbers were controlled by predation rather than by their own prey base. Dave Beauchamp later used the bioenergetics model to corroborate Wicklum's findings and he quantified a very high rate of predation by lake trout on *Mysis* (Figure 16).

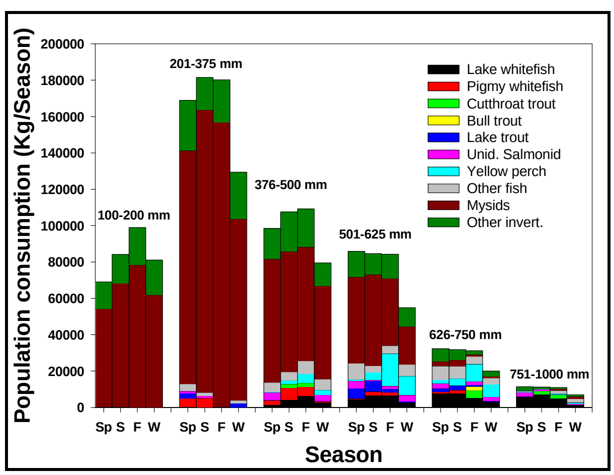

Figure 16. Components of lake trout diet in Flathead Lake, 1998-2001.

The bioenergetics model predicts that the removal of 1000 lake trout from the population would result in an increase in mysid biomass of 659 kg, or an increase of 0.13 mysids/m^2. These research results identified the linkage between *Mysis* numbers and those of lake trout, their main predator. Therefore because Mysis numbers have not increased over the last decade (Figure 17), we conclude that it is very unlikely that lake trout have markedly decreased over the same time period.

None of the indices we have developed indicate that the lake trout population is declining. We conclude that the lake trout population is relatively unchanged because mortality rates have been very consistent over the last five years. This conclusion is supported by the fact that our harvest estimates for lake trout that have not increased substantially over the same time period. The yield and angler pressure in Flathead Lake are below the sustainable averages for other lake trout lakes. In addition, the lake trout growth rate and poor condition indicate a population that is large relative to its prey base. Further evidence that lake trout are not declining is found in the fact that their growth rate is declining, their condition is poor, and angler catch rates are uniformly increasing. Finally, we conclude that the lake trout population is resilient to declines because it currently exhibits a low mortality rate and consists of over twenty well-populated year classes.

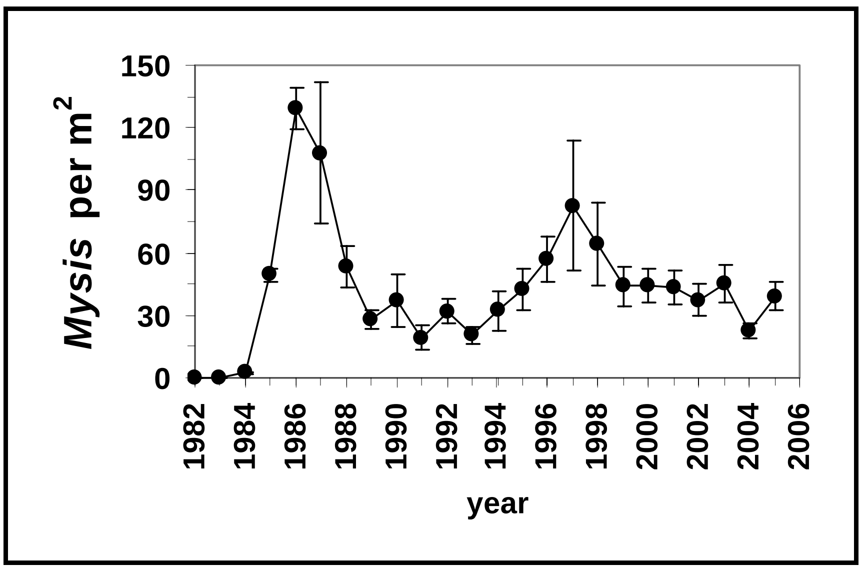

Figure 17. Mean density (number per m^2 of lake surface area) of *Mysis relicta* in annual collections obtained in vertical net hauls (1m diameter). Brackets show 95% confidence interval. Data from B. K. Ellis and J. A. Stanford, unpublished, Flathead Lake Biological Station.

D. TRENDS IN ANGLER PRESSURE IN FLATHEAD LAKE

Both the annual angler creel survey and the biannual mail-in creel survey indicate relatively stable levels of angler use over the last ten years (Figure 18). The annual creel averages roughly 32,000 angler days per year. The mail-in creel survey estimates roughly 48,000 angler days per year over the same period. The Plan calls for a reevaluation of our management strategies if fishing pressure declines (based on a three-year average). The stability in pressure over the six years of the Plan indicates that there is no trigger at this time to reevaluate our management strategies.

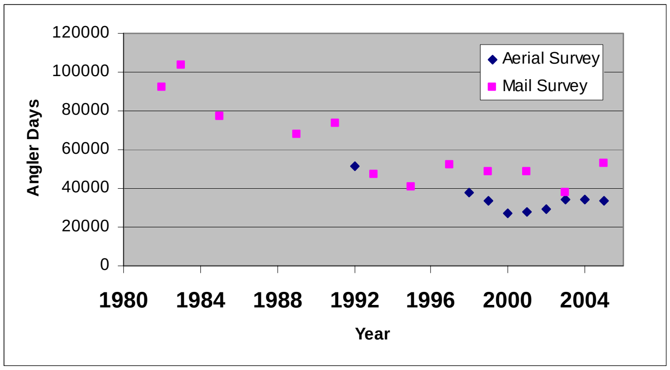

Figure 18. Estimates of angler pressure on Flathead Lake by two methods: aerial surveys and mail surveys, 1981 to 2005.

IV. EVALUATION OF EFFORTS AND METHODS TO REDUCE THE LAKE TROUT POPULATION

In this section we evaluate our past efforts to reduce the lake trout population under Strategy 5 of the Co-management Plan as well as measure population responses to our actions. As demonstrated in the above section, we have been unsuccessful in the first five years of the plan in achieving the desired population trends. However, we think that were it not for our efforts the lake trout population would likely be increasing.

A. REDUCTION IN POPULATION WILL VERY LIKELY CAUSE COMPENSATORY RESPONSES IN THE LAKE TROUT POPULATION

We expect that the lake trout population will respond to reductions in density by compensating both in increased growth rate and in a younger age at maturity. The age at which female lake trout reach full maturity has changed from age 6 to age 11 between 1997 and 2005 (Figure 19). This degree of change toward later maturity indicates a large reserve for compensation. For example, there is a potential for a five year reduction in age at maturity.

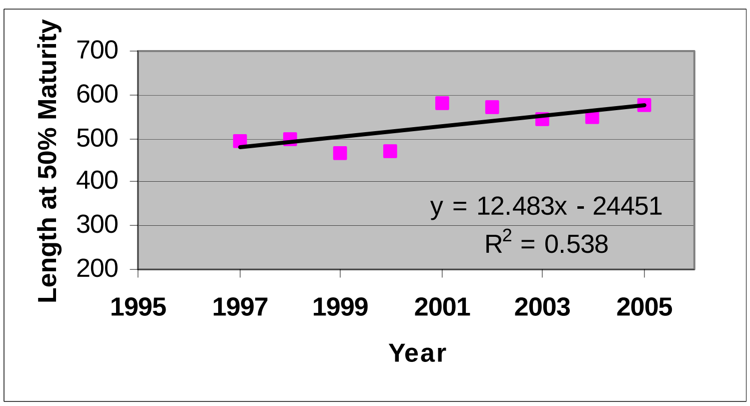

Figure 19. Length at which 50% of female lake trout were mature, 1996 to 2005.

For example, if a 25% reduction in the population causes a three year reduction in age at maturity, that smaller population could actually produce more eggs. In this case we project the smaller population would produce about five million more eggs, from about 215 million to 220 million eggs per year.

In addition, a reduction in the lake trout population would also reduce the rate of cannibalism. The bioenergetics model predicts that the present lake trout population consumes over 400,000 lake trout annually. If cannibalism occurs at a rate proportional to the population size, a 25% reduction in the lake trout population could result in about 100,000 fewer lake trout consumed.

These examples are hypothetical because we do not know if compensation will occur or if it does then to what degree. Because we think a reduction in lake trout will cause a compensatory reaction, we assume that recruitment will at least remain constant, or not decline as the population is decreased.

B. RECENT EFFORTS TO INCREASE LAKE TROUT HARVEST HAVE NOT BEEN LARGE ENOUGH TO REDUCE THE LAKE TROUT POPULATION

During the first five years of the Flathead Lake Co-Management Plan we implemented several measures under Strategy 5A intended to reduce lake trout. For example, we increased the bag limit from 15 to 20 lake trout, we changed regulations to allow 2 lines per angler, and CSKT issued a new lake-specific fishing license for $10 to attract more anglers. Also during this time we constructed three fishing piers and improved four boat ramps. While these steps have likely contributed to increased harvest, they have minimal potential because there is a low ceiling on the number of lake trout that anglers will harvest. The Montana Bull Trout Scientific Group in 1995 labeled "Fisheries Management" as a "very high risk" to restoration. They specifically addressed the use of regulations to alter fish populations and stated they "are unlikely to have major impacts on bull trout recovery".

We conclude that sponsored fishing contests in conjunction with fishing regulations can effectively increase harvest. We initiated fishing contests, because they require all participants to harvest their catch. We have facilitated nine events since 2002. Each event, since the first in 2002, has generated incrementally larger harvests (Figures 20 and 21). However, to date, our creel harvest estimates indicate that the total annual harvest has not increased as much as have the increases in harvest associated with the events.

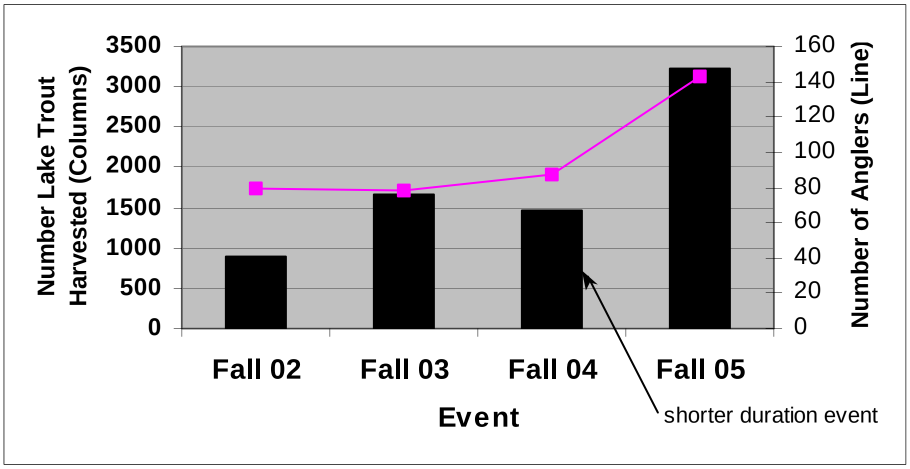

Figure 20. Total lake trout harvested and number of anglers participating during fall fishing events, 2002 to 2005.

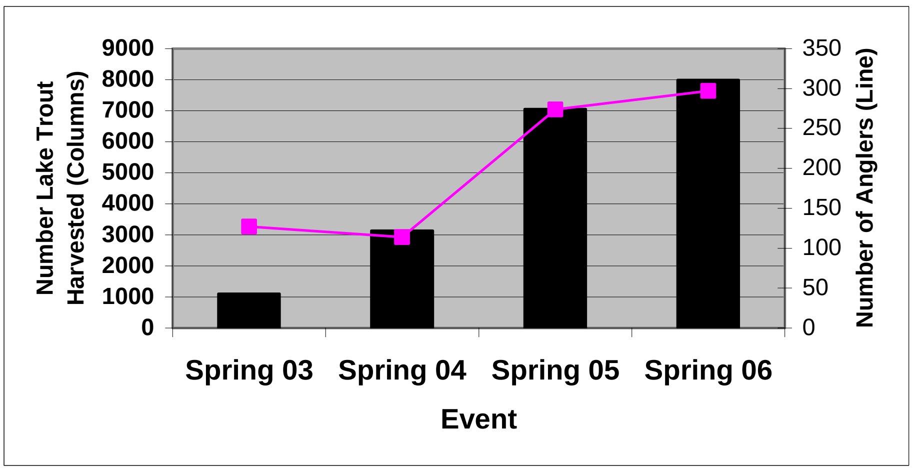

Figure 21. Total lake trout harvested and number of anglers participating during spring fishing events, 2003 to 2006.

C. UNCERTAINTIES ABOUT NATIVE SPECIES RESPONSE TO A REDUCTION IN LAKE TROUT

An “expert panel” indirectly addressed this issue in 1998. They stated that restoration of bull trout to 1980’s levels would require that lake trout also be returned to 1980’s levels. Rather than evaluate such radical shifts, we now need to take a more focused look at the functional relationship between the numbers of each species. For example, would small decreases in lake trout allow for at least small increases in bull trout?

One large unknown in this relationship is the exact nature of lake trout predation on native trout. The degree to which lake trout reductions will facilitate the increase in native trout is related to whether predation occurs as a random encounter, or by the targeting of seasonal concentrations of native trout. Results of the bioenergetics model favor the theory that predation is occurring as a random event based on the wide range of locations and depths at which lake trout were captured that contained bull trout in their stomachs (Figure 22).

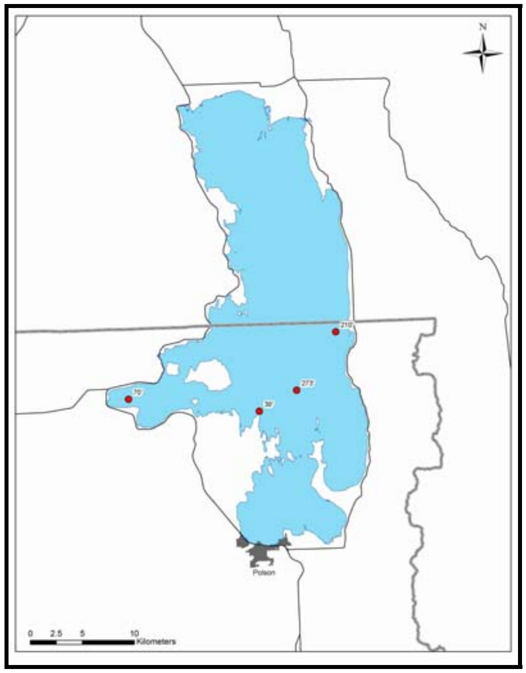

Figure 22. Locations and depths of captured of lake trout containing bull trout in their stomachs 1998-2001.

V. CONCLUSIONS

Our monitoring efforts during the first five years of the Plan indicate stable populations of both native trout and lake trout. Table 1 on page 7 directs us in this situation to re-evaluate our goals. We have also concluded that current angler exploitation of lake trout is moderate and sustainable, and that we have not significantly increased lake trout harvest or angler pressure during the first five years of the Plan. Therefore we have not been able to test the premise of the Plan that increasing lake trout harvest would lead to increased native trout numbers. Our actions to date have not caused any measurable change in the fish community in the last five years.

Although our conclusions are based on a preponderance of evidence available today, we acknowledge that uncertainties remain in the interpretation of these data. If we obtain information in future investigations that contradicts these conclusions, we will incorporate that information, redraft our conclusions, and adjust our management strategies. The risk to the lake trout fishery from drawing an incorrect conclusion about the trend in abundance is small, because the population is so robust.

VI. MANAGEMENT RECOMMENDATIONS

A. BACKGROUND

Over the last five years we have implemented many new management actions. By monitoring those actions we have generated much new information on the fisheries ecology of Flathead Lake. We are dealing with the later stages of a dynamic process that has occurred over the last twenty years and resulted in tremendous shifts in the fish community. Unfortunately, many of these ecological changes were unexpected and opposite to the conventional wisdom of the time. For example, when the Mysis population exploded, it was assumed that they would out-compete kokanee for the zooplankton prey base. Instead we learned that Mysis also caused the lake trout population to explode resulting in overwhelming predation on kokanee driving them to extinction. We then assumed that the Mysis population declined from its peak because it outpaced its prey base. Instead we later learned that predation by lake trout and lake whitefish was controlling their numbers, and that the zooplankton biomass actually greatly exceeded the energetic demand of Mysis.

When we completed the Plan in 2000, we assumed that lake trout in Flathead Lake would be as vulnerable to over-harvest as they are in other lakes across their range. We knew that lake trout are more sensitive to over-harvest than most species because:

1) They are long lived. Many fish in Flathead Lake are over 30 years old, and therefore subject to fishing pressure for many years
2) They mature late, in some cases, not until 10 years of age. Therefore when harvested before maturity the population loses its reproductive strength.
3) They have low fecundity, averaging about 5000 eggs per female. Bass and perch for example may produce up to 50,000 eggs per female.
4) They are often caught and released by anglers, but not without incidental hooking mortality.
5) They are slow growing, taking up to 10 years to reach twenty inches long. Pike for example can reach 20” in three years.

Furthermore, on Flathead we have very liberal regulations. We have open seasons during spawning and winter, periods closed to fishing in many lake trout lakes. We also have a liberal bag limit and allow two lines. These facts laid the groundwork for the thinking that with some directed effort we could easily reduce the lake trout population and achieve the goals of the Plan.

During these past five years of monitoring, we have learned that the lake trout population in Flathead Lake is not easily over-harvested. Factors contributing to this condition are that the population has built to a very large size, Flathead is a very large lake, spawning habitat is abundant, the Mysis-based food web supports high juvenile survival rates, and the angling population in the Flathead Valley is not large. Despite our efforts we have not increased angler harvest measurably over the first five years of the Plan. We now recognize that we must employ substantially greater effort to increase the harvest of lake trout to the point that the population is reduced.

B. HOW MANY LAKE TROUT MUST BE REMOVED ANNUALLY TO REDUCE THE LAKE TROUT POPULATION?

In the above sections we concluded that the lake trout population is stable and the current harvest level is sustainable. Our goal in the initial years of the plan was simply to decrease the lake trout population, although we did not identify a specific quantity. We implemented measures that facilitated increased angler participation but only measured minor increases in harvest. It is difficult to know what level of harvest is necessary to reduce the lake trout population, because there are so many interrelated factors that drive recruitment and mortality. For example, we conclude that the current harvest of about 40,000 fish is simply restricting the lake trout population from further expansion. The low mortality rate of the lake trout population implies that harvest must be raised substantially to reach the mortality level that has resulted in population reductions in other lake trout systems. Published reports fairly consistently identify mortality rates in the range of 0.45 to 0.5 as necessary to reduce lake trout populations. We set a mortality target (0.45) to project the theoretical harvest needed to achieve a reduction in the lake trout population.

To determine the harvest level that will achieve the goal of lake trout reduction, we first estimated the current population size. Using harvest data from the creel survey and estimated population structure from gillnetting, we estimated a population of roughly 280,000 lake trout of 5 years and older (14 inches and longer). We then increased the mortality rate to 0.45 and measured the quantity of fish removed. By this method we estimate that we must increase harvest by at least 60,000 lake trout a year to begin to achieve reduction in the population.

We cannot be certain that the harvest of 60,000 lake trout per year will result in a mortality rate of 0.45, or if it will reduce the lake trout population. We will annually estimate total harvest to determine if we achieve the 60,000 fish level. We will also annually measure the mortality rate of lake trout between the ages of 7 and 15 to determine if the 0.45 level is met and to investigate the accuracy of our estimate that a harvest of 60,000 fish will result in the predicted mortality level. We will further measure the indices presented in this document to evaluate whether reduction in lake trout has been achieved. The increase in mortality will be on lake trout that are 4 years and older, the fish large enough to be part of the fishery. Initially, the number of lake trout will likely remain the same, but the population size structure will shift with reduced numbers of mid-range sized fish. This could lead to a reduction in the average size of fish caught below the slot limit. The level of reduction in larger size classes will be determined by the duration of that harvest level, which will be determined in the future. At this time we are unsure if we will achieve the 0.45 mortality rate and the 60,000 fish harvest level. We will annually monitor impacts to the lake trout fishery as harvest is increased. Dependent on our monitoring results, the harvest target can be changed. At this time, the 60,000 fish target is a best estimate and subject to adaptive management.

C. ALTERNATIVES TO ACHIEVE A HARVEST OF 60,000 LAKE TROUT PER YEAR UNTIL LAKE TROUT REDUCTION IS ACCOMPLISHED

We have developed three alternative approaches to achieve the harvest goal of 60,000 fish. Each alternative has the potential to reach the harvest goal, but to differing degrees. Alternatives differ in costs of implementation, and in social/political effects. We considered the full range of strategies addressed in the Plan, including commercial fishing and agency gillnetting. We rejected these two alternatives from further analysis and consideration at this time because of problems with marketing and food safety in the commercial fishing option, and with waste and high costs in the agency gillnetting option. Also, both are known to be very unpopular alternatives with much of the public. In addition, we decided that there was reasonable potential for success with the three alternatives, and that the status of native fish was not so dire as to warrant such extreme measures at this time.

1. Alternative 1. Maintain Current Approach

Goal: Achieve the goals of the plan with the current level of effort. This alternative maintains the social, economic, and management status quo. It is least aggressive in increasing harvest. It has the lowest chance of reducing lake trout, and leaves bull trout the most vulnerable.

Actions: 1) Maintain current angler regulations,
2) Continue angler education efforts,
3) Continue two fishing events per year at current level.

Expected Result: Harvest of lake trout will likely continue to increase, possibly reaching 50,000 by 2008. The fishing events will likely grow, even with no change in approach, because of continued interest and broader understanding of the events. Mortality rates of lake trout will increase but there is a low likelihood of reaching the threshold level of 0.5 necessary for reduction of the population. Angler catch rates would likely change very little. It is also possible that catch rates will continue to trend upward as they have done over the last decade. Bull trout would likely continue at the current stable but low level of abundance, leaving them more vulnerable to dangerous declines caused by unforeseen events such as drought, fire, accidents, etc.

2. Alternative 2: Substantially Increase Harvest by General Angling Public

Goal: Achieve the goals of the plan with greatly increased agency effort. This alternative has moderate social, economic and management costs. It is moderately likely to achieve the total harvest goal of 60,000 lake trout annually.

Actions: 1) Increase bag limit to 50,

2) Expand fishing events

   a) increase prize money to $25,000 per event,
   b) increase number of prize categories
      a. increase each weekend prize
   c) increase advertising and promotion.

3) Develop educational video on lake trout fishing techniques
4) Develop a harvest model to predict the effects of various harvest scenarios over time.

Expected Result: Fishing contests must generate a harvest of 20,000 lake trout in addition to the harvest by the general public of about 40,000 fish. To achieve this goal the spring event must generate 14,000 fish and the fall event 6,000 fish. We project the number of anglers required to achieve this goal based on the following assumptions:

1) there will be an increase of 10 fish in the average per trip catch of those anglers that have been limited by the 20 fish bag limit, and
2) the number of participants in each contest will grow by 25% because of added incentives.

In the last spring event there were 250 bag limits generated and in the last fall event there were 80 bag limits generated. Therefore the increased bag limit will likely generate at least (250+80) = 330 * 10 additional fish = 3300 total additional fish per year. Assuming the annual harvest of 40,000 as an average baseline, there is the need to harvest 16,700 additional fish to meet the goal of 60,000 total harvest after subtracting the 3,300 fish attributed to the 50 fish bag limit. Assuming that the average of about 25 fish per participant continues in the future, there must be a total of 425 in the spring and 230 in the fall event to harvest 16,700 additional fish. This represents about a 40% increase from averages of the 2004-06 period (Figures 23 and 24).

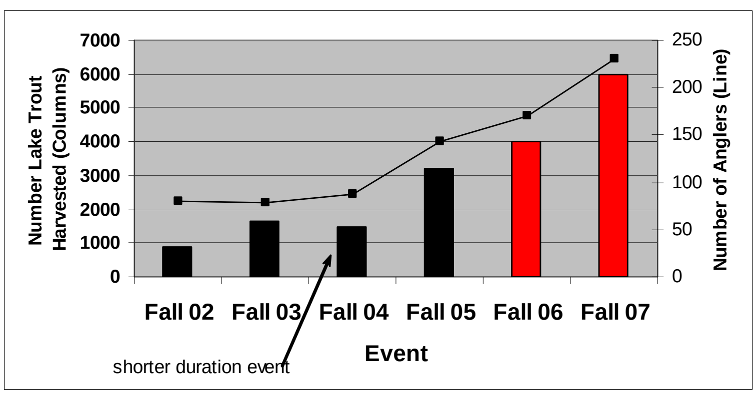

Figure 23. Past harvest results in Fall Mack Days and projected future harvest needs for lake trout reduction in Flathead Lake, 2002 to 2007.

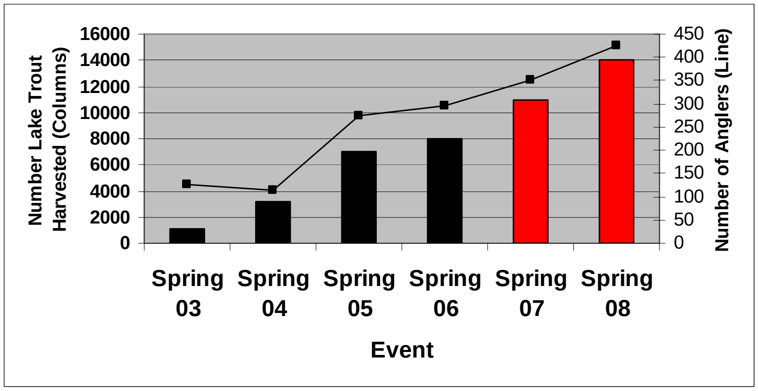

Figure 24. Past harvest results in Spring Mack Days and projected future harvest needs for lake trout reduction in Flathead Lake, 2003 to 2008.

3. Alternative 3: Increase Harvest and Reduce Recruitment

Goal: Achieve the goals of the plan with greatly increased agency effort. This alternative applies the same measures as Alternative 1, but in addition addresses the concern that some of the lake trout with the highest fecundity are not currently open for harvest. To date recruitment (population gains) has roughly equaled mortality (population losses) resulting in the stable population described above. This Alternative more broadly addresses the recruitment potential of the population than do the other Alternatives by targeting formerly protected fish that make the highest individual contribution to recruitment. This alternative does not change management costs, but would likely have the greatest social and economic costs of the three alternatives because it could influence the trophy portion of the fishery that is heavily marketed. It has slightly greater likelihood of achieving the total harvest of 60,000 lake trout annually in the long term than do the other Alternatives.

Actions: 1) Increase bag limit to 50,
2) Reduce slot limit to two fish greater than 30 inches,
3) Expand fishing events
   d) increase prize money to $25,000 per event,
   e) increase number of prize categories
      a. increase each weekend prize
   f) increase advertising and promotion.
Develop educational video on lake trout fishing techniques
5) Develop a harvest model to predict the effects of various harvest scenarios over time.

Expected Result: The increased harvest from the fishing events is the same in this alternative as it is in Alternative 2. The predicted increase in harvest that is unique to this alternative is the result of a change in the slot limit, which does not allow harvest of lake trout between 30 and 36 inches. The increase in harvest will be relatively small due to the relatively low number of fish in this length group, and the fact that lake trout of slot length are not recommended for consumption. This Alternative introduces another means of reducing lake trout, which is to reduce the population's reproductive capacity. Fish greater than 30 inches represent about 19% of the egg production from the entire population. We do not know the percent reduction in this category of fish that this two-fish limit would produce. For example, a 10% reduction would reduce the egg production by 1.9%, and a 50% reduction would reduce the egg production by 9.5%. We also do not know if egg production is directly related to recruitment, meaning that each unit of loss in egg production causes a similar unit of loss in recruitment. There may be other factors besides egg production that limit recruitment and if so, reducing the total numbers of large fish may not reduce the egg production below the critical level that would reduce recruitment. A 10% reduction in fish between 30 and 36 inches would probably not affect angler catch rates of these fish, while we think a 50% reduction would likely cause a meaningful reduction in opportunity for these large fish.

In summary, while we think this Alternative will bring the greatest likelihood of achieving the harvest target, we think it comes with the greatest risk in the near term to the fishing opportunity in Flathead Lake. We think this alternative has risks to fishing opportunity that do not outweigh the potential benefits to native fish.

Table 2. Summary of effects for three proposed Alternatives in Flathead Lake fisheries management.

Parameter	Alt. 1 No Change	Alt. 2A Enhanced Contests	Alt. 2B Enhanced Contests and Slot Limit Change
Angler catch rate	No change to possible increase	Possible small increase to small decrease	Possible small increase to small decrease
Chance of increasing harvest	Low	Moderate	Moderate
Change in bull trout abundance	Unchanged	Potentially up	Potentially up
Angler participation	Slight increase	Increase	Increase to possible decrease
Agency costs	$50,000	$75,000	$75,000
Local economy	Unchanged	Possible decrease to possible increase if balanced by other species	Possible decrease to possible increase if balanced by other species

D. RECOMMENDED ALTERNATIVE

Alternative 2: Substantially increase harvest by using the angling public
The management team thinks that this alternative has the best combination of features to achieve the multiple objectives of the Plan.