Project ID: 1991-019-01

Title: Hungry Horse Mitigation/Flathead Lake
Confederated Salish and Kootenai Tribes

A. Abstract

This project was initiated in 1992 after NPCC adopted the Hungry Horse Mitigation Plan (November 1991, see NPPC program:10.3A.10), and has received annual funding since that time. This project specifically addresses the losses on the Flathead Indian Reservation (1.2 million acres) attributable to Hungry Horse Dam. The Confederated Salish and Kootenai Tribes strive to accomplish all the necessary components of mitigation; from research into basic process questions, to assessments of bottlenecks or limiting factors, to direct implementation measures that correct limiting factors, and to monitoring both short and long term effects of our actions. The initial emphasis of this project was on monitoring and consisted of spring gillnetting, year-long creel surveys, and later expansion into an evaluation of the kokanee reintroduction experiment. We introduced research into the project in 1995 during the reintroduction experiment, in the form of bioenergetic modeling. Later research focused on the functional role of *Mysis relicta*, and the process of shoreline erosion in Flathead Lake. Implementation work also began in 1995 and has continued annually with projects such as channel reconstruction, culvert upgrades, road recontouring, riparian revegetation, off-channel watering, grazing exclusion, and lake trout reduction through fishing contests. Monitoring of ecosystem and biological responses to our mitigation projects is ongoing since 1992, and has grown to address targeted tributaries as well as biological and population changes in the lake trout of Flathead Lake. This project coordinates directly with those of Montana Fish Wildlife and Parks by cooperatively conducting projects and designing monitoring activities for the subbasin. Restoration activities for FY08 and 09 include estimates for projects to be conducted on lands acquired under the BPA Project entitled: Secure and Restore Fish and Wildlife Habitat. The Confederated Salish and Kootenai Tribes conduct a comprehensive mitigation and restoration program that is funded from multiple sources in addition to the funds provided by BPA. Most work elements listed in this project are part of the larger tribal program and are therefore funded only partially by BPA.

B. Technical and/or scientific background

The Confederated Salish and Kootenai Tribes (CSKT) and Montana Fish Wildlife and Parks (MFWP) wrote "Fisheries Mitigation Plan for Losses Attributable to the Construction and Operation of Hungry Horse Dam" in March 1991 to define the fisheries losses, mitigation alternatives and recommendations to protect, mitigate and enhance resident fish and aquatic habitat affected by Hungry Horse Dam. On November 12, 1991, the Northwest Power Planning Council (NPPC) approved the mitigation plan with minor modifications, called for a detailed implementation plan, and amended measures 903(h)(1) through (7). A long-term mitigation plan was submitted in August 1992, was approved by the Council in 1993, and the first contract for this project was signed on November 11, 1993.

The problem this project addresses is the loss of habitat, both in quality and quantity, in the interconnected Flathead Lake and River basin resulting from the construction and operation of Hungry Horse Dam. The purpose of the project is to both implement mitigation measures and monitor the biological responses to those measures including those implemented by MFWP and the USFWS. Goals and objectives of the 1994 Fish and Wildlife Program (Section 10.1) addressed by this project are the rebuilding to sustainable levels weak, but recoverable, native populations injured by the hydropower system. The project mitigates the blockage of spawning runs by Hungry Horse Dam by restoring and even creating spawning habitats within direct drainages to Flathead Lake. The project also addresses the altered habitat within Flathead Lake resulting from species shifts and consequent dominance of new species that restricts the potential success of mitigation measures.

The Flathead River Subbasin Plan identifies westslope cutthroat trout and bull trout as focal species for a long list of reasons (pages 159 through 219). These are the trout that are native within the Flathead Subbasin, they are targeted by the Hungry Horse Mitigation Plan for restoration, they receive special status under State and Federal designations, and they are considered an important cultural resource to the Confederated Salish and Kootenai Tribes. The Flathead River Subbasin Plan further prioritizes geographic areas for restoration based on a combination of factors including the presence/absence of focal species and the level of habitat degradation. These resources are prioritized with a numerical rating (pages 225 to 242), the highest of which is Class 1, which contains a complete set of native biota, generally represent intact habitats, and have high protection value. Our Secure and Restore Resident Fish Habitat Project (No. 200200300) focuses on properties within Class 1 watersheds as the highest priority for acquisition, based on the principle that protection of intact habitats is both more effective and economical than is restoration of degraded habitats. The Class 2 and 2.5 waters have low to moderate levels of degradation, contain native biota typically in conflict with non-native biota, and have good potential to be restored to the Class 1 level. This project has focused its implementation activities (i.e.: riparian fencing, road obliteration, channel reconstruction, etc.) on Class 2 and Class 2.5 waters. The Plan further identifies Class 3 and 3.5 waters in which native species are lost, and they have been highly degraded to the point that they are considered to be irreversibly altered. These Class 3 and 3.5 waters are excluded from implementation activities, except in unique cases where they contribute to the degradation of downstream waters that are in the Class 2 to 2.5 categories.

C. Rationale and significance to regional programs

This is the primary project that addresses resident fish losses on the Flathead Indian Reservation caused by Hungry Horse Dam. The Flathead Indian Reservation comprises 1.2 million acres and is crossed by about 150 km of the mainstem Flathead River and roughly half of Flathead Lake. The Confederated Salish and Kootenai Tribes have utilized BPA funding to mitigate the impacts of Hungry Horse dam within this portion of the Flathead watershed since 1992. Over that period we have established long term trends in key indicators, and through research have answered critical unknowns facilitating more effective mitigation, and have implemented a wide range of direct mitigation measures ranging from road removals to channel reconstruction.

Native populations of westslope cutthroat trout occur in a majority of streams within the Reservation, and bull trout occur within several tributaries

The Flathead River subbasin plan identifies the following primary limiting factors: 1) impoundment and hydro operations, 2) physical habitat alteration, and 3) the introduction of non-native species. We are actively addressing each of these factors with the many implementation projects described repeatedly throughout this document.

The application of science by this project is largely conventional. We have strived to conduct cost-effective projects with measurable benefits. Novel ideas we have employed in our projects include the use of science to influence decision-makers, and the engagement of the public to assist in the reduction of non-native predators. There are two key examples of these applications. First, when faced with the collapse of the kokanee fishery in Flathead Lake, there was tremendous public and manager interest in restoring the lost fishery. We employed bioenergetics modeling to illustrate that the rate of predation by lake trout on planted kokanee precluded any possibility of restoration. With this conclusion we were able to terminate an expensive and unsuccessful program and move on to effective mitigation.

Second, we have taken a novel approach to the nearly insurmountable task, in terms of the political and logistical challenge, of reducing the lake trout population in Flathead Lake. We have employed fishing contests that have successfully stimulated harvest by recruiting anglers who were initially very reluctant to participate because of their vested interest in the fishery. We think we have succeeded because we have had an extensive education effort, substantial publicity, well organized and fun events, moved gradually rather than abruptly, provided monetary prizes, and included the distribution of fish to food banks.

D. Relationships to other projects

Hungry Horse Dam blocked the passage of adfluvial trout leaving Flathead Lake and migrating into the South Fork Flathead River. The State and Tribal projects comprise the extent of efforts to mitigate the losses caused by Hungry Horse Dam. Activities between these two agencies are closely coordinated, with joint planning teams, information sharing, and occasional assistance with manpower or equipment needs on specific projects. This project and Project #199101903 jointly monitor adult trout within Flathead Lake. This project identifies off-site opportunities to create recreational and subsistence opportunities through the planting of fish in irrigation reservoirs and coordinates those needs to Project #199101904 which produces the fish in Creston National Fish Hatchery. This project then monitors the release of those hatchery fish to ensure that there is sufficient recreational benefit. This project coordinates closely with Project # 200200300, Secure and Restore Fish and Wildlife Habitat, to identify suitable properties and to evaluate them under the established criteria. This project then provides the restoration activities on properties obtained under Project # 200200300 to ensure that those properties function at the highest feasible level. In addition to the BPA programs listed above, we actively coordinate our activities with many other government agencies and private groups. Examples of these are: the Natural Resource Conservation Service, County Road Departments, the University of Montana Flathead Lake Biological Station, the Flathead Land Trust, the Swan Ecosystem Center, the Flathead Lakers, Salish and Kootenai College, and Montana Water Trust.

E. Project history (for ongoing projects)

This project was initiated in 1992 after NPCC adopted the Hungry Horse Mitigation Plan (November 1991, see NPPC program:10.3A.10), and has received annual funding since that time. Prior to the initiation of the Flathead Focus Watershed and the Secure and Restore Habitat projects, this was the only project addressing losses on the Flathead Indian Reservation attributable to Hungry Horse Dam. This project strives to accomplish all the necessary components of mitigation; from research into basic process questions, to assessments of bottlenecks or limiting factors, to direct implementation measures to correct limiting factors, and to monitoring both short and long term effects of our actions. This project began in 1992 with a monitoring emphasis in order to evaluate the success of on-going mitigation efforts within the sub-basin. That monitoring consisted of spring gillnetting, year-long creel surveys, and later expansion into an evaluation of the kokanee reintroduction experiment. We introduced research into the project in 1995 during the reintroduction experiment, in the form of bioenergetic modeling. Later research focused on the functional role of *Mysis relicta*, additional bioenergetic modeling, and the process of shoreline erosion in Flathead Lake. Implementation work also began in 1995 and has continued annually with projects such as channel reconstruction, culvert upgrades, road recontouring, riparian revegetation, off-channel watering, grazing exclusion, and lake trout reduction through fishing contests. Monitoring of ecosystem and biological responses to our mitigation projects is ongoing since 1992, and has grown to address targeted tributaries as well as biological and population changes in the lake trout of Flathead Lake. Costs expended for this time period are presented in Table 1.

Table 1. Annual BPA funding for this project in thousands of dollars, 1993 to 2005.

Year	93	94	95	96	97	98	99	00	01	02	03	04	05
Cost	23	23	23	55	66	145	65	96	146	156	144	143	143

The major results accomplished by this project are arranged in categories of monitoring, research, and implementation and are listed below.

RESULTS FROM MONITORING ACTIVITIES:

(1) Monitoring of Efforts to Reintroduce Kokanee to Flathead Lake.

We conducted detailed monitoring of a five year kokanee reintroduction experiment (1993-1997) in Flathead Lake that identified and quantified the reason for the failure of the experiment. Through extensive sampling of kokanee and lake trout we estimated predation rates by lake trout on kokanee and ultimately predicted that the lake trout population consumed 87% of the kokanee planted annually. This monitoring work provided the basis for ending the experiment and saving roughly $1 million per year in mitigation funding. This work also provided the initial information and data for monitoring lake trout biology that is being continued to the present.

We generated the following reports during this monitoring work:

Fredenberg, W., D. Carty, M. Deleray, L. Knotek, and B. Hansen. 1999. Hungry Horse Dam fisheries mitigation: kokanee stocking and monitoring in Flathead Lake, final report - 1999. Published on BPA website; Bonneville Power Administration, Portland Oregon.

Carty, D., M. Deleray, L. Knotek, and B. Hansen. 1998. Hungry Horse Dam fisheries mitigation: kokanee stocking and monitoring in Flathead Lake, progress report - 1997. Open File Report. U.S. Fish and Wildlife Service, Kalispell, Montana.

Carty, D., W. Fredenberg, L. Knotek, M. Deleray, and B. Hansen. 1997. Hungry Horse Dam fisheries mitigation: kokanee stocking and monitoring in Flathead Lake, progress report - 1996. U.S. Fish and Wildlife Service, Kalispell, Montana. Bonneville Power Administration Report: DOE/BP-60559-3. Portland, Oregon.

Hansen, B., J. Cavigli, M. Deleray, W. Fredenberg, and D. Carty. 1996. Hungry Horse Dam fisheries mitigation: kokanee stocking and monitoring in Flathead Lake. Progress report - 1995. Bonneville Power Administration, DOE/BP-65903-7, Portland, Oregon.

Deleray, M., W. Fredenberg, and B. Hansen. 1995. Kokanee stocking and monitoring, Flathead Lake, 1993 and 1994. Bonneville Power Administration, DOE/BP-65903-6, Portland, Oregon.

(2) Monitoring of Flathead Lake Fishery

We quantified the baseline angler use of the Flathead Lake fishery in 1992-3 at the beginning of BPA funding to the Confederated Salish and Kootenai Tribes. Since the development of the baseline, we initiated continuous monitoring of the fishery in 1998 that continues to the present. Continual monitoring is of such importance because the fate of native trout is dependant on our ability to reduce the overly-abundant and predacious lake trout in Flathead Lake. In addition, habitat restoration accomplished under the mitigation program will be unable reach its potential unless lake trout are reduced. This survey generates about 1500 interviews of anglers conducted on a roving, random basis. We conduct 208 random aerial counts of anglers lakewide. We estimate total pressure (Figure 1), total harvest (Figure 2), and catch rates (Figure 3) for four species of fish, in addition to many other conventional parameters of the fishery. This survey, because it targets adult trout, serves as a surrogate measure of abundance for these species, and should be responsive to large changes in abundance that integrate the responses to habitat improvements throughout the interconnected basin.

We generated the following baseline report, plus annual estimates of all parameters listed above:

Evarts, L., B. Hansen, and J. DosSantos. 1994. Flathead Lake Angler Survey, Final Report 1992-1993, Monitoring Activities for the Hungry Horse Fisheries Mitigation Plan. Report to the Bonneville Power Administration. Confederated Salish and Kootenai Tribes, Pablo, Montana. 38pp.

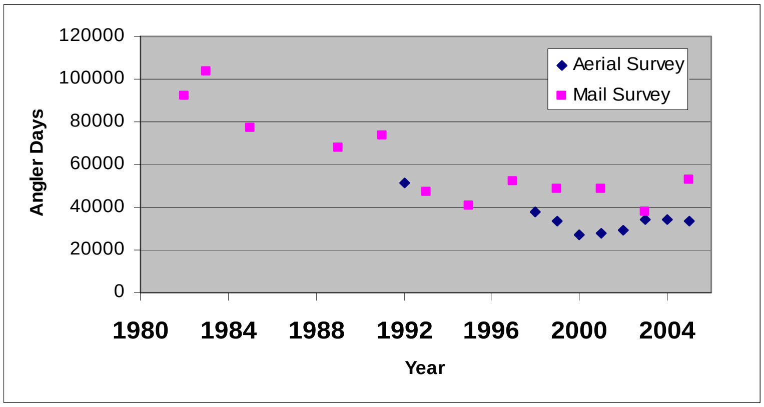


Figure 1. Estimates of annual angler pressure in Flathead Lake from aerial and mail surveys, 1982 to 2005.

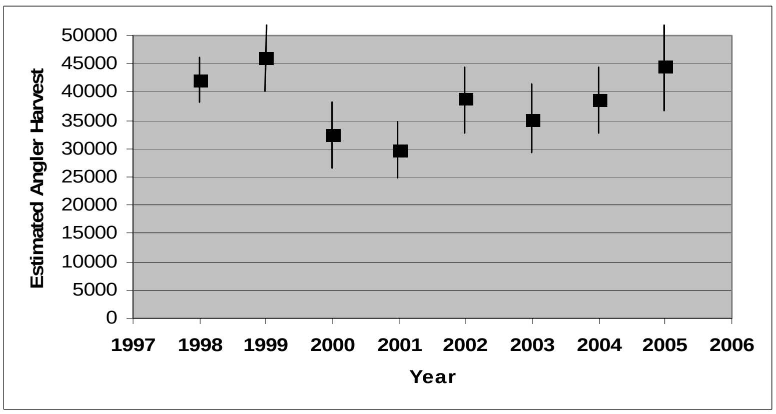


Figure 2. Estimates of annual harvest of lake trout (95% confidence intervals) in Flathead Lake, 1998 to 2005.

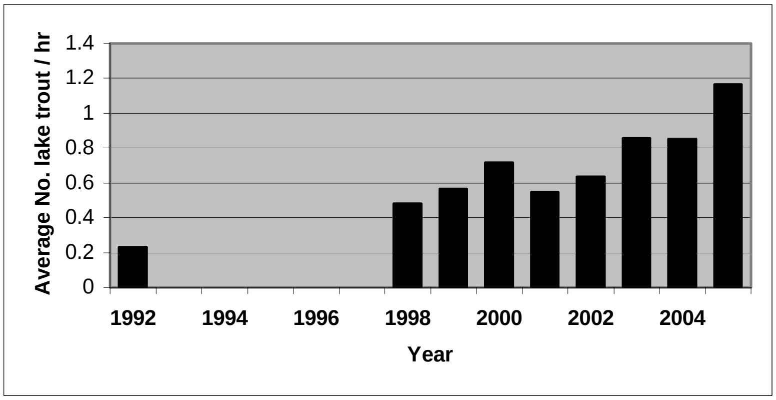


Figure 3. Average number of lake trout caught per hour by anglers targeting lake trout from boats in Flathead Lake, 1992-2005.

(3) Monitoring of Native Species Abundance in Flathead Lake

We have annually monitored the relative abundance of native westslope cutthroat and bull trout since 1992 by gillnetting fixed locations within Flathead Lake in spring (Figure 4). This work is done cooperatively with MFWP and when combined with previous data constitutes a 25 year period of record. This index, because it targets adult adfluvial trout, also serves as a measure of the biological responses to habitat improvements throughout the interconnected basin. Although there is high variability in these data, they have great utility because they span such a large period of record. These are the focal species identified in the Hungry Horse Mitigation program, and these data provide a historic record as well as annual check-points.

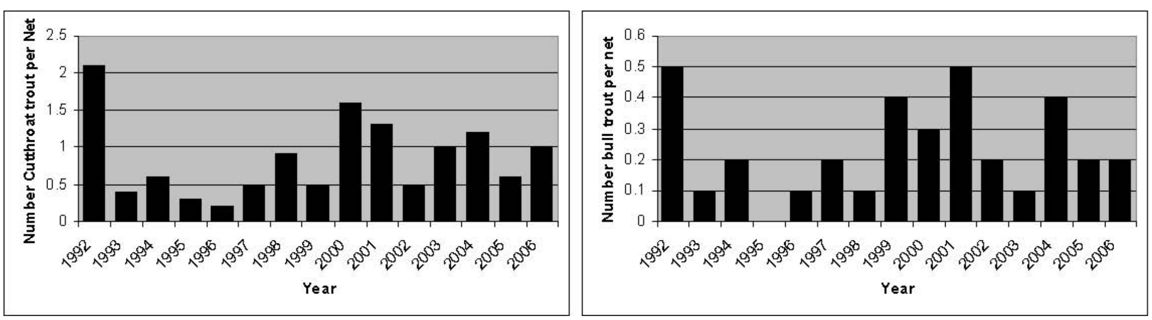


Figure 4. Number of westslope cutthroat trout caught per floating net (left graph), and number of bull trout caught per sinking net (right graph) during spring in Flathead Lake, 1992-2006.

(4) Monitoring of parameters of lake trout biology

We have been quantifying parameters of lake trout biology since 1996 when monitoring of the kokanee experiment clearly indicated that lake trout predation was a factor limiting the abundance of most other species residing in Flathead Lake. We have measured age at maturity (Figure 5), growth rate (Figure 6), year class strength (Figure 7), fecundity and mortality rate (Figure 8) as indicators of population change, and as indicators of the potential for compensation in response to increasing exploitation. These parameters have great utility as indirect measures of lake trout abundance, because we do not have effective tools to more directly measure their abundance. These indices will inform us of our progress in reducing the lake trout population and will then be correlated with anticipated increases in native trout. None of these parameters currently indicates a declining lake trout population, but in fact shows signs of compensation to increasing density in the form of reduced growth rate and increased age at maturity. The most critical parameter is the annual measure of mortality rate, and it has remained relatively unchanged over the period of measurement.

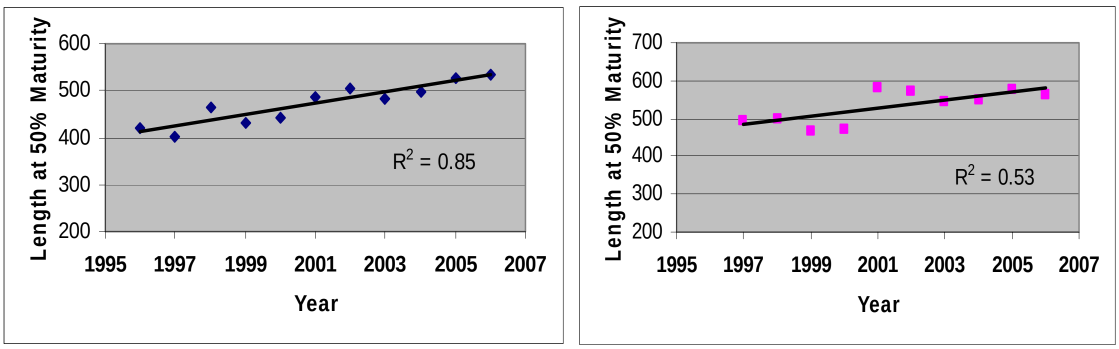


Figure 5. Length at which 50% of male lake trout (left) and female lake trout (right) were mature, 1996 to 2006.

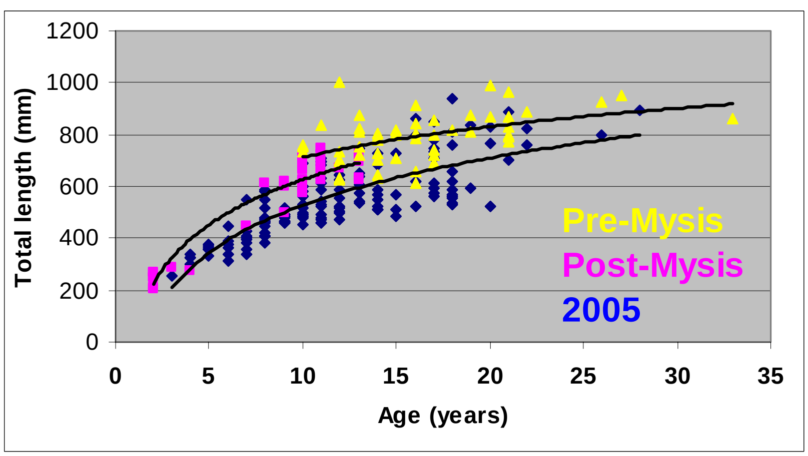


Figure 6. Growth rates of lake trout in Flathead Lake summarizing three time periods.

Figure 7. Age distribution of lake trout captured in fall 2006.

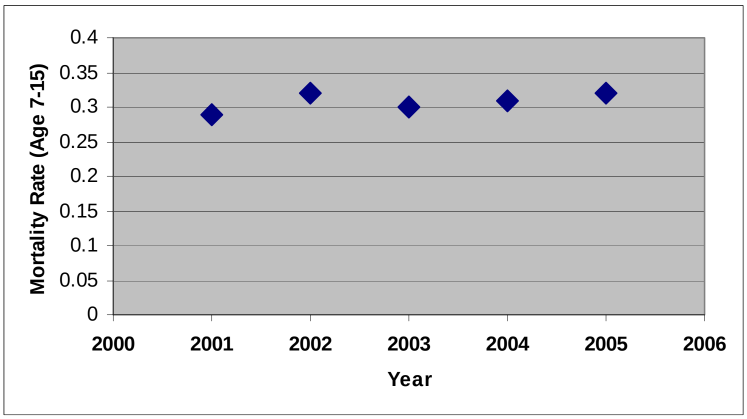


Figure 8. Mortality rates computed from gillnetting samples collected in Flathead Lake, 2001 to 2005.

RESULTS OF RESEARCH ACTIVITIES:

(1) Bioenergetics modeling of Kokanee Losses from Predation in Flathead Lake

We developed a bioenergetic model in cooperation with Montana Fish, Wildlife and Parks, to quantify consumption rates of planted kokanee by lake trout in Flathead Lake during 1995 and 1996. The project resulted in the conclusion that lake trout consumed 87% of planted kokanee within one year of their release. This information served to remove the doubt held by some managers and certain segments of the public concerning the degree to which lake trout were responsible for the decline of native trout. We have used this information to guide our management and support our program to reduce lake trout, which is a necessary prerequisite to recovery of native trout.

We generated the following report summarizing this research:

Beauchamp, D. 1996. Estimating predation losses under different lake trout population sizes and kokanee stocking scenarios in Flathead Lake. Report to Montana Fish, Wildlife and Parks, 50pp.

(2) Investigation of the Ecological Role of *Mysis relicta* in Flathead Lake

We determined the limiting factors in *Mysis relicta* population dynamics in Flathead Lake. This work resulted in the conclusion that the *Mysis* population is not resource-limited but is top-down controlled. These results completely changed our understanding of the trophic dynamics of Flathead Lake. Formerly, the predominant conclusion was that kokanee collapsed because of an inability to compete with *Mysis relicta* for zooplankton. These results clarified the degree to which top-down control was acting in Flathead Lake, and the dominant role of introduced predators. It laid the groundwork for subsequent research and implementation work by redefining the limiting factor controlling not only kokanee reintroduction, but the viability of populations of focal species such as westslope cutthroat trout and bull trout. After this work managers funded bioenergetics work to further define the level of predation exerted by lake trout, and initiated programs to begin reducing lake trout, an action that up to that point had been both unpopular and not accepted as a necessary step in protection of focal species.

We generated the following reports summarizing this research:

Wicklum, D. 1998. *Mysis relicta* 2000: Filling (some of) the holes in our ecological knowledge. Report to Confederated Salish and Kootenai Tribes, 26pp.

Wicklum, D. 1999. The ecology of Mysis relicta in Flathead Lake. Report to Confederated Salish and Kootenai Tribes, 52pp.

(3) Bioenergetics modeling of Flathead Lake Foodweb

This work addresses the Bull trout Objectives (BT1-4) and Westslope Cutthroat trout Objectives (WCT 1-2) of the Flathead Subbasin Plan (pages 39 to 48) by employing the strategy from the Plan to “evaluate the effect of introduced fishes on native trout”.

We developed a lakewide, multispecies bioenergetic model that quantified predation rates on bull and westslope cutthroat trout. From this work we learned that 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).

We found that lake trout fed heavily on mysids, fish, and other benthic invertebrates. Mysids were the most important component of the energy budget for lake trout ≤ 625 mm total length (TL) (Figure 9). 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.

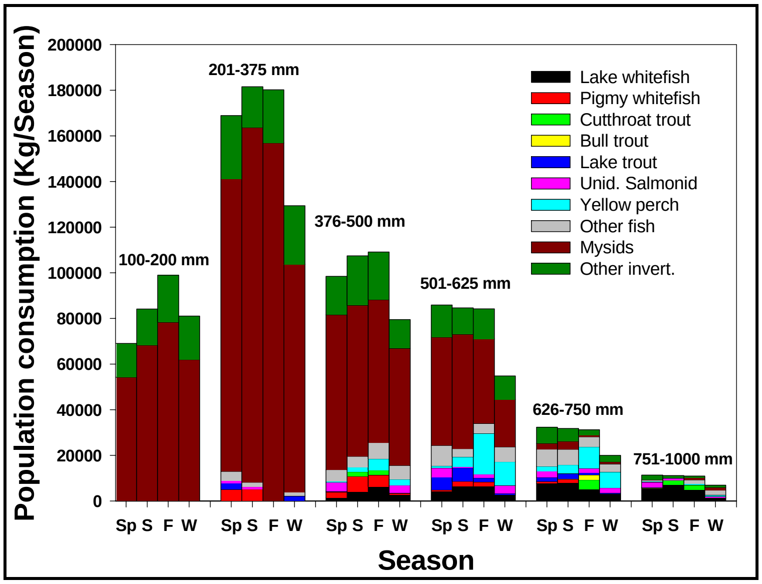


Figure 9. Components of lake trout diet in Flathead Lake, 1998-2001.

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 ≥ 626 mm TL. Cannibalism was exhibited by lake trout > 200 mm TL and was heaviest by 501-625 mm TL lake trout.

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.

This work was the last step in quantifying the level of predation by lake trout on focal species (westslope cutthroat trout and bull trout) and a defining step in determining that predation is the strongest factor limiting the survival of focal species within the interconnected Flathead Lake and River system.

We generated the following reports summarizing this research:

Kershner M. and D. Beauchamp. 2001. A preliminary evaluation of lake trout and lake whitefish predation on the Flathead Lake food web structure. Report to Confederated Salish and Kootenai Tribes, 30pp.

Beauchamp, D., M. Kerschner, N. Overman, J. Rhydderch, J. Lin, and L. Hauser. 2006. Trophic Interactions of Nonnative Lake Trout and Lake Whitefish in the Flathead Lake Food Web. Report to the Confederated Salish-Kootenai Tribes.

(4) Investigation of Erosion Rates on the Shoreline of Flathead Lake

This work addresses the Lakes Objective (L1) of the Flathead Subbasin Plan (page 37) to restore lake shoreline conditions within Class 2 and 2.5 lakes to a habitat restoration score of reference lakes. For this work we have employed the strategy from the Plan to "implement shoreline restoration techniques to stabilize shorelines that are destabilized by fluctuating lake levels".

We have worked cooperatively with the Flathead Lake Biological Station to quantify wind frequency and intensity (Figure 10); prerequisite data for quantifying erosion rates. We quantify erosion rates by means of erosion pins that illustrate vertical and horizontal changes in the lake bed and banks (Figure 11). We now have six years of record of changes in bed and bank position at site in East Bay of Flathead Lake (Figure 12), and have used these data to draw relationships with factors such as storm events, substrate and vegetative condition, and lake elevation. We designed a series of studies to quantify ambient wave energy in multiple locations within Flathead Lake, to correlate the wave energy to erosion rates, to correlate biological diversity and abundance with shoreline

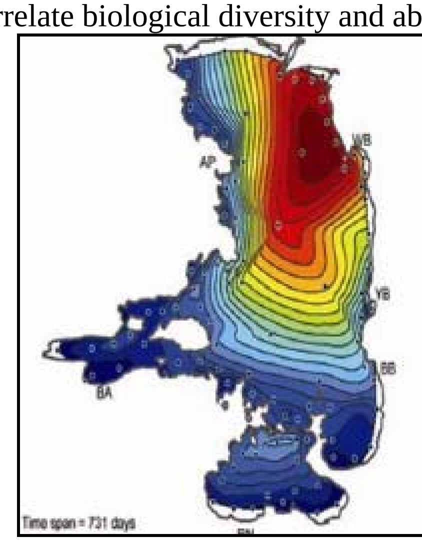


Figure 10. Cumulative wave power in Flathead Lake generated from data collected in 2004 and 2005. Dark blue is weakest grading to red that is the strongest.

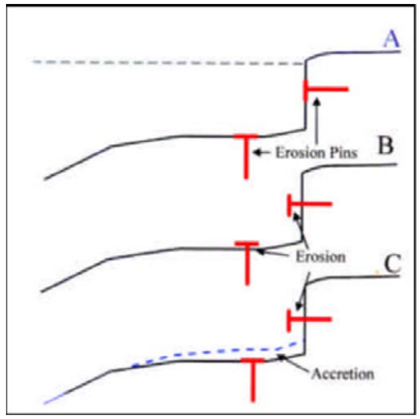


Figure 11. Graphic depiction of the placement of erosion pins and examples of measurements of erosion and accretion.

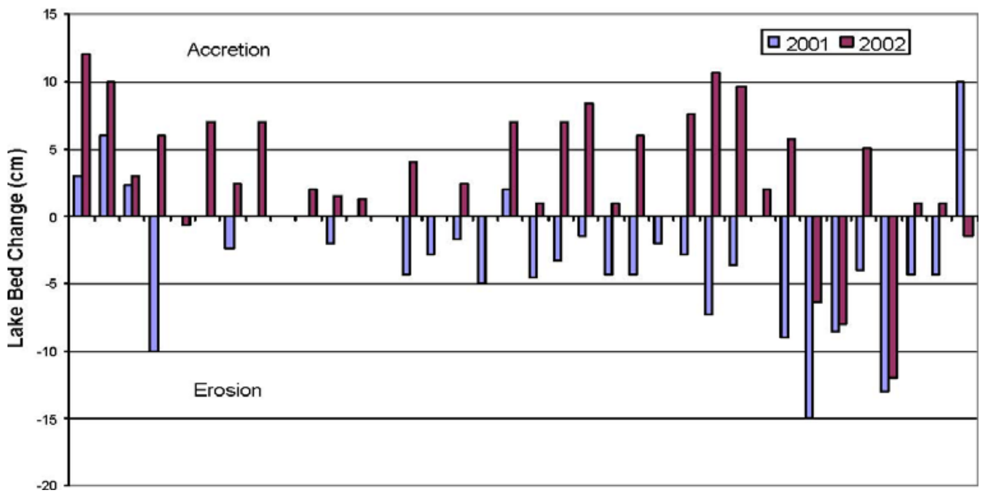


Figure 12. Rates of lake bed erosion as measured by vertical erosion pins in East Bay of Flathead Lake, 2001 and 2002.

condition, and to test natural gravel beach designs in real environments. We are mapping littoral cells that can be grouped because they behave in a similar manner and are recommending erosion control treatments that mimic stable natural beaches. We have documented high diversity of organisms in undisturbed shore areas and will be contrasting that result with more simplified environments such as walled shorelines.

We have also correlated the timing of erosive wave events with the compounding negative effect of full pool elevation (Figure 13). Through this work we have demonstrated that a high percentage of annual lakeshore erosion occurs during fall when storms are frequent and lake elevation is high. We have used this information to change the management of lake levels resulting in earlier (mid September) and more rapid drawdowns of the lake in the fall than occurred historically.

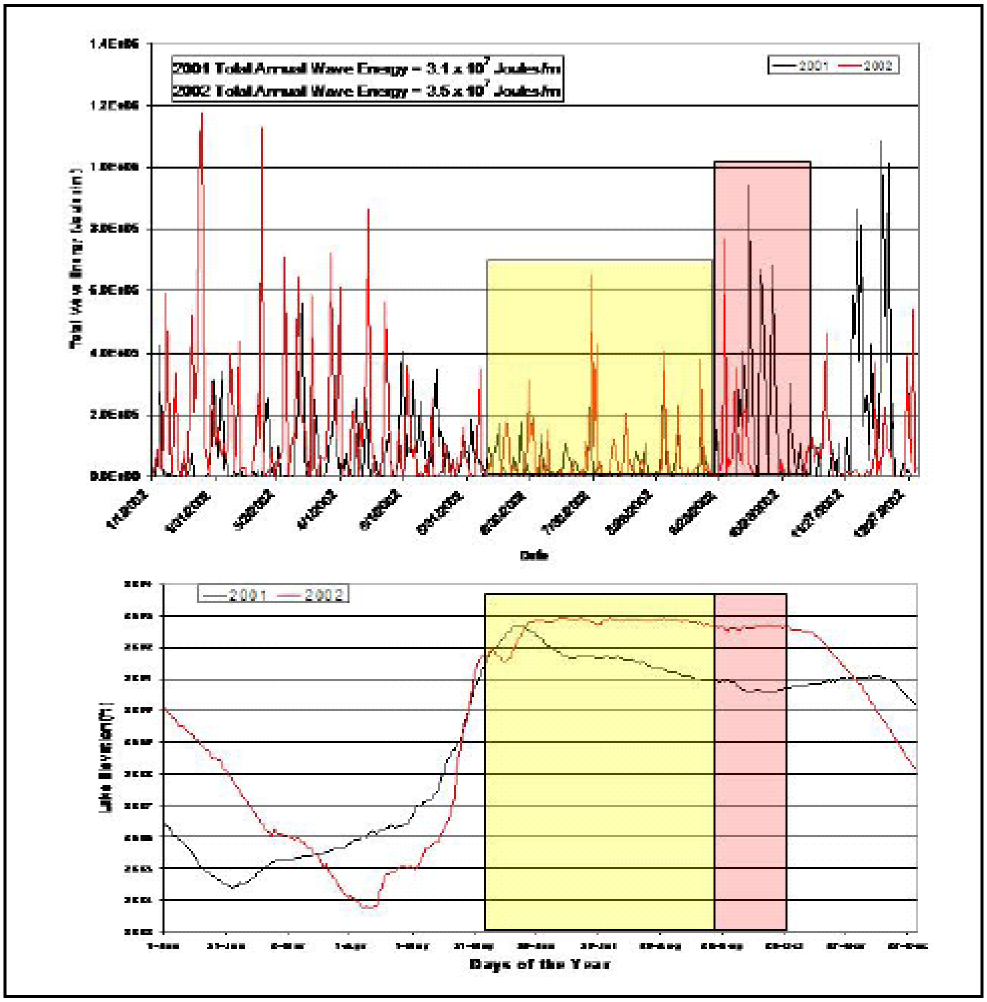


Figure 13. Times series of wave power (top) in Flathead Lake and lake elevation (bottom) indicating the erosive conditions created during fall when full pool levels concide with the highest frequency of storm events, 2001 and 2002.

We know the importance of littoral habitats and of terrestrial invertebrates to westslope cutthroat trout, and consider the combined effects of shoreline erosion and development to represent a serious potential threat to this focal species. These effects are not easily quantified, although we are working cooperatively with the University of Montana Flathead Lake Biological Station to quantify biological differences between natural shorelines and simplified developed ones. Because the changes in littoral habitat are so large and nearly irreversible, we think that it is prudent to proactively pursue this work.

We generated the following reports summarizing this research:

Lorang, M. 2002. Flathead Lake Erosion Study, Phase I Report. Flathead Lake Biological Station, The University of Montana. Report to the Confederated Salish and Kootenai Tribes, 16pp.

Lorang, M. 2004. Flathead Lake Erosion Study, Phase II Report. Flathead Lake Biological Station, The University of Montana. Report to the Confederated Salish and Kootenai Tribes, 13pp.

Lorang, M. 2006. Flathead Lake Erosion Study, Phase III Report. Flathead Lake Biological Station, The University of Montana. Report to the Confederated Salish and Kootenai Tribes, 16pp.

Results of Implementation Activities:

(1) Channel Reconstruction at Polson Golf Course

We created a small and defined perennial channel, 1500 m in length, in 1996 from an area receiving canal seepage and stormwater runoff. We planted westslope cutthroat trout eggs in the new channel that is now a tributary to Flathead Lake and have documented successful outmigration of cutthroat trout. To date we have not documented the return of adults to this tributary, but will continue to monitor this possibility.

(2) Three Culvert Upgrades in Dayton Creek

This work addresses the Tributary Objectives (T4, T5) of the Flathead Subbasin Plan (page 29-32) to reduce the delivery of fine sediments and to restore passage within Class 2 and 2.5 streams. This work employs the strategy from the Plan to “upgrade stream crossings”.

We first completed a watershed assessment of Dayton Creek which is a major direct tributary to Flathead Lake. It is identified in the Flathead SubBasin Plan as a Class 2 watershed and a priority for restoration of native trout. Its health also has direct implications for the health of Flathead Lake, identified in the Flathead SubBasin Plan as a Class 2 lake. We removed three undersized and failing culverts that were passage barriers and chronic sediment sources (Figure 14). We replaced these culverts with over-sized open-arch culverts (Figure 15) in cooperation with the Lake County Roads Department, and expect them to last for many decades and to withstand greater than 100 year flood events. These crossing sites were chronic problems, having a history of repeated failures resulting in sediment delivery to the lake (Figure 16). We have not documented any sediment plumes emanating from Dayton Creek since these upgrades were completed. While there are still sediment sources remaining to be addressed in the Dayton watershed, we consider the work completed to date to have eliminated the most severe cases. While insufficient time has passed to fully determine the effectiveness of these actions, and although we do not have quantitative measures of turbidity, suspended sediment, or substrate embeddedness, we conclude that these actions were very effective in restoring the historic sediment delivery rates that are necessary to maintain ecosytem function and achieve the goals of the mitigation program.

Figure 14. Failing culvert on Ronan Creek, 1999.

Figure 15. Open-arch culvert in Ronan Creek two years after replacement of the failing culvert in Figure 14.

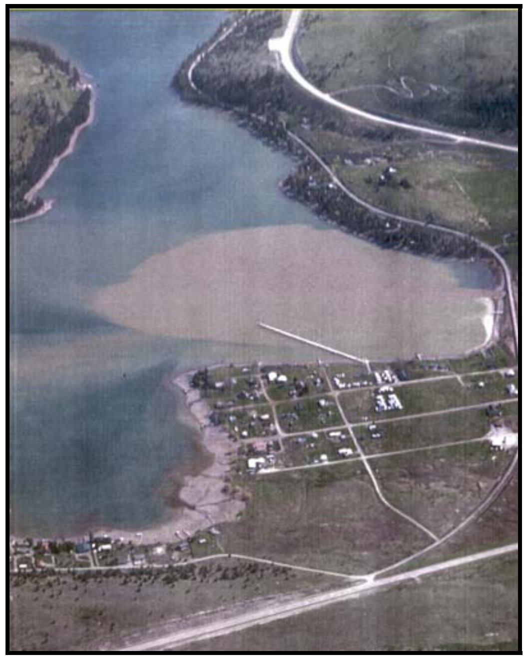


Figure 16. Sediment plume in Flathead Lake resulting from road-crossing failures in the Dayton Creek watershed.

(3) Passage Barrier Removal in Skidoo Creek

This work addresses the Tributary Objective (T5) of the Flathead Subbasin Plan (page 31) to reduce the delivery of fine sediments and to restore passage within Class 2 and 2.5 streams. For this work we have employed the strategy from the Plan to "upgrade stream crossings".

We corrected one culvert passage barrier in Skidoo Creek by reconstructing a degraded portion of channel and providing proper streambed elevation into a perched culvert. This action corrected the problem of fish passage that had existed in Skidoo Creek in its lower reaches near Flathead Lake. We have not yet documented an increase in westslope cutthroat trout abundance attributable to this project because several other factors limiting the abundance of these fish are still acting in this watershed. The factor with the strongest effect is competition with brook trout, and we plan to address the problem of brook trout in 2008 with piscicide treatment. After removal of brook trout we expect that benefits of removing the passage barrier will be realized. We will measure those benefits by stock assessments that quantify density and size of fish above the barrier.

(4) Determination of Overlap in Distribution of Westslope Cutthroat Trout and Brook Trout

This work addresses the Westslope Cutthroat Trout Objective (WCT1, WCT2, and WCT3) of the Flathead Subbasin Plan (pages 44-47) to maintain genetically pure local populations and to eradicate species that compete with native species within Class 2 and 2.5 streams. For this work we have employed the strategy from the Plan to "evaluate potential effects of introduced fishes on westslope cutthroat trout, to conduct genetic inventories, and to eradicate introduced species in Class 2 and 2.5 streams".

We have determined the distribution of westslope cutthroat trout and the overlap in distribution with brook trout in four key streams that flow directly into Flathead Lake. This is a first step in designing projects for the eradication of brook trout. These streams flow directly into Flathead Lake and currently support purestrain populations of westslope cutthroat trout and brook trout. These streams are all identified in the Flathead SubBasin Plan as Class 2 streams that support native biota and have the potential to be restored to Class 1 status. These populations of native trout will likely only survive if brook trout are removed. We have verified through PINE PCR genetic methods the purity and therefore the conservation value of these remaining westslope cutthroat populations. We are still in the process of defining the upstream extent of the brook trout distribution in each stream in order to complete the baseline information that is necessary to define the brook trout removal program. This work requires many years to complete. We are nearing completion of the data collection phase and plan to begin the brook trout removal phase in 2008. We do not expect to measure quantitative benefits from this work. Benefits may be measured in terms of increases in density of westslope cutthroat trout in stream reaches currently dominated by brook trout. The largest anticipated benefit is the improvement in the long-term viability of these isolated populations of westslope cutthroat trout, which we will monitor indefinitely.

(5) Removal of One Dam on DuCharme Creek

This work addresses the Tributary Objectives (T2, T4, and T5) of the Flathead Subbasin Plan (pages 27 to 31) to improve channel stability, reduce the delivery of fine sediments, and to restore passage within Class 2 and 2.5 streams. For this work we have employed the strategy from the Plan to "restore stream channels, removing sediment sources, and eliminate barriers in Class 2 and 2.5 streams".

We removed one dam (Figure 17) and reconstructed 200 m of stream channel (Figure 18) on DuCharme Creek, identified as a Class 2 stream within the Flathead SubBasin Plan. We removed this dam as a preventive action because of the certainty that its failed state would worsen to the point of total failure resulting in the release of thousands of yards of sediment. The primary benefit of this action was the removal of a potential threat to the health of this watershed and Flathead Lake, and therefore we do not expect it to yield measurable increases in native fish at this time. In the long term we plan to eliminate several other problems within the watershed that will result in the increase of range and abundance of native trout.

Figure 17. In-channel dam in DuCharme Creek prior to removal.

Figure 18. DuCharme Creek with in-channel steps through former dam site.

(6) Obliteration of 18 miles of Road

This work addresses the Tributary Objectives (T1, T2, T4 and T5) of the Flathead Subbasin Plan (pages 26 to 31) to restore riparian habitats, improve channel stability, and reduce the delivery of fine sediments within Class 2 and 2.5 streams. For this work we have employed the strategy from the Plan to “remove roads and recontour road prisms wherever possible to reduce road densities”.

We have removed and recontoured a total of 18 miles of roads within six westslope cutthroat trout watersheds throughout the Flathead Reservation. Specifically these are the North Fork of the Jocko River, Camas Creek, Antoinne Creek, Skidoo Creek, South Fork Valley Creek, and Hewolf Creek. All of these streams are identified in the Flathead SubBasin Plan as Class 2 watersheds, all contain westslope cutthroat trout populations, and the North Fork of the Jocko River contains bull trout. The example in Figure 19 illustrates the elimination of the riparian zone by a streamside road and the subsequent recontouring and restoration of riparian vegetation in Figure 20. Figure 21 illustrates one example of a perched culvert that presented a barrier to fish passage, and Figure 22 illustrates the stream condition immediately following removal of the culvert. Figure 23 illustrates one example of sediment production resulting from a failed culvert and subsequent erosion of the road surface and fill slope. Figure 24 illustrates the site after the road had been removed and the road prism had been recontoured.

Figure 19. Streamside road along the North Fork Jocko River, 2004.

Figure 20. North Fork Jocko River following removal of the streamside road and transplanting of woody vegetation on the same site, 2004.

Figure 21. Perched culvert barrier on tributary of North Fork Jocko River, 2005

Figure 22. Site of removal of perched culvert barrier on tributary of North Fork Jocko River, 2005

Figure 23. Road failure in Skidoo Creek, 2005

Figure 24. Recontoured site of road failure in Skidoo Creek, 2005.

(6) Nine Angling Contests to Reduce Lake Trout

This work addresses the Bull Trout Objectives (BT1, BT2, BT3, and BT4) and Westslope Cutthroat Trout Objectives (WCT1, WCT2, WCT3, and WCT4) of the Flathead Subbasin Plan (pages 39 to 47) to maintain local populations, and to suppress non-native species in Class 2 and 2.5 streams and lakes. For this work we have employed the strategy from the Plan to "implement control of non-native fishes where found to be feasible and appropriate".

We have conducted two fishing contests annually in Flathead Lake since 2003. Flathead Lake is identified in the SubBasin Plan as a Class 2 lake. The Flathead Lake system is one of the largest and most functional adfluvial systems remaining in the Columbia basin. It supports populations of bull and westslope cutthroat trout that utilize well over 20 major tributaries in the interconnected basin. This is a program we are building to cost-effectively reduce the lake trout population in Flathead Lake without alienating the angling public. These contests have grown rapidly to the point of generating a harvest of over 12,000 lake trout in 2006 (Figure 25). Although the rate of growth in contests is promising, our analysis indicates that the current level of harvest has not resulted in a reduction in the lake trout population.

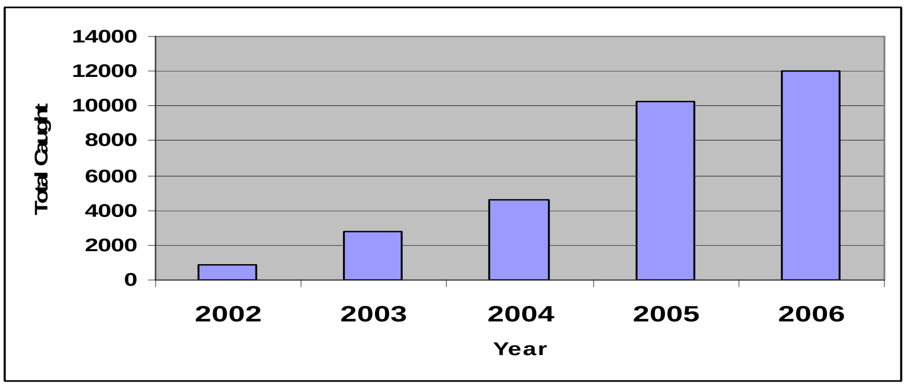


Figure 25. Annual harvest of lake trout in fishing contests sponsored by CSKT on Flathead Lake, 2002 to 2006.

(7) Restoration of 1000 ft of shoreline in Flathead Lake

This work addresses the Lakes Objectives (L1) of the Flathead Subbasin Plan (pages 37 to 38) to restore lake shoreline condition within Class 2 and 2.5 lakes. For this work we have employed the strategy from the Plan to "implement shoreline restoration techniques to stabilize shorelines that are destabilized by fluctuating lake levels".

We restored 1000 feet of gravel beach at an actively eroding shoreline at Blue Bay Tribal Campground on Flathead Lake (Figures 26 and 27). We have monitored this project annually by measuring 11 fixed transects to determine elevational changes over time. Results indicate stability in the form of insignificant change in the beach profile over three years of measurements (Figure 29). Benefits from this work include improvements in littoral habitat, reduction in nutrient loading, and utilization of the site as a demonstration project to educate other lakeshore owners.

Figure 27. Blue Bay beach illustrating vertical bank and receding shoreline, 2001.

Figure 28. Blue Bay beach two years following beach restoration work, 2004.

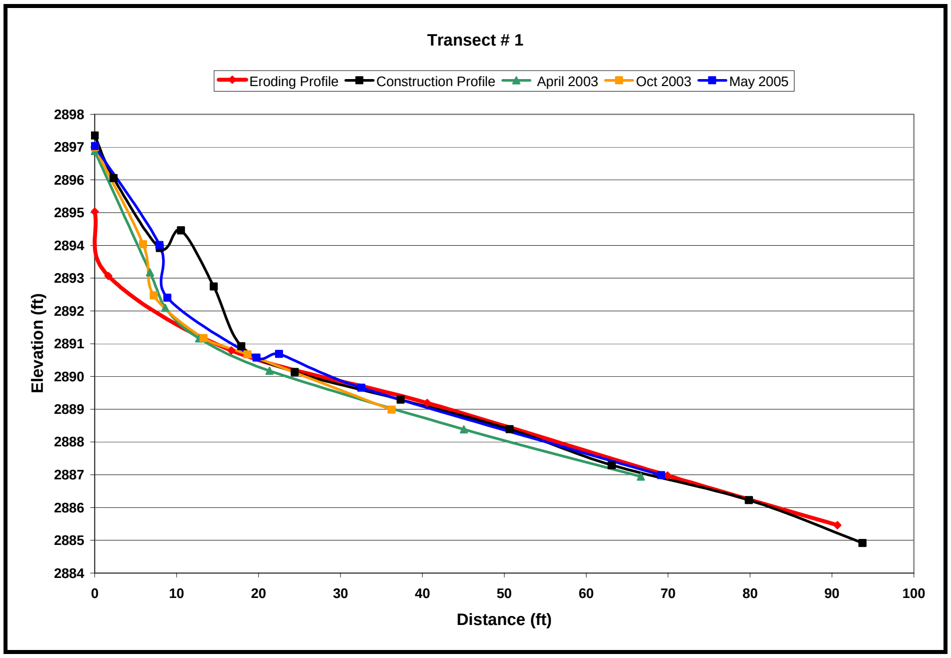


Figure 29. Beach profiles at Blue Bay campground depicting the erosion profile, the construction profile, and three years of subsequent monitoring profiles.

(8) Riparian Area Restoration by Cattle Exclusion

This work addresses the Tributary Objectives (T1, T2, T3 and T4) of the Flathead Subbasin Plan (pages 26 to 30) to restore riparian habitats, channel stability, habitat diversity, and to reduce sediment delivery within Class 2 and 2.5 streams. For this work we have employed the strategy from the Plan to "revegetate denuded riparian areas, and to improve grazing practices".

We have independently or in cooperation with landowners, constructed 26,000 m of fence in 13 separate projects to exclude cattle from sites on eight Class 2 streams. Our fencing projects have typically taken place on private land with a minimum of 100 ft. setbacks from stream banks and with substantial cost-shore from the landowner (Figures 30 and 31). Through inventories of Class 2 watersheds, we have identified several corrals that span streams and have been historically used to hold cattle within riparian areas. Through coordination efforts with private landowners we have been able to cost-share the removal of two corrals, one on Dayton Creek (Figures 32 and 33) and one on Centipede Creek. After removal we re-planted native vegetation in the riparian zone. Monitoring of this activities has consisted of ensuring compliance by the landowners, photo-points, and determining changes over time in width/depth ratios of the channels.

Figure 30. Example of stream prior to cattle exclusion by fencing.

Figure 31. Example of vegetative recovery in stream one growing season following cattle exclusion by fencing.

Figure 32. Corral spanning Dayton Creek, 1996

Figure 33. Same location as Figure 30 following exclusion of cattle and planting of willows.

(9) Maintain and Restore Populations of Western Pearlshell Mussels

Western pearlshell mussels (*Margaritifera falcata*) play an important ecological role in streams and have been of great cultural importance to the Salish and Kootenai people. According to tribal elders mussels were historically very common in streams of the Reservation. We have identified five previously undocumented populations on the Flathead Reservation that are still reproducing, and four non-reproductive populations consisting of only very large individuals. We also quantified a selection of habitat criteria within sites supporting mussels. We have developed habitat relationships to predict potential historic distributions, and to identify possible locations for reintroduction. We have begun describing the genetic character of these populations to assist in the decision process for potential relocation of mussels into vacated habitats. We have quantified abundance of identified populations by quadrant sampling, measured size structure and evaluated reproductive success. These results have provided the information that should allow us to proceed toward the goal of restoring mussel populations where they have been lost.

(10) The Practice of Adaptive Management

We have carefully attempted to practice adaptive management in all of our projects. The most notable example is in the implementation and subsequent completion of the kokanee reintroduction experiment. Kokanee had been the major fishery in Flathead Lake for six decades preceding their collapse in 1987. Public and agency support for re-introduction drove a misguided effort to plant kokanee, even though the causes of their demise were not addressed. Bioenergetic modeling provided a clear indication of the futility of continued planting, facilitating an adaptive management shift on the part of the agencies. Subsequent adaptation has come in the form of the identification of a biologically and socially acceptable means of reducing the predacious non-native lake trout in Flathead Lake. Agency sponsored fishing contests are a rare tool and the one that became the adaptive solution to the over-population of lake trout.

F. Proposal biological objectives, work elements, and methods

The Flathead Indian Reservation occupies the lowermost portion of the Flathead River watershed, comprising about 1.2 million acres. Aquatic conditions within the Reservation range from pristine in numerous wilderness streams to dramatically degraded in some valley streams. We have identified numerous limiting factors across these varied conditions of the Reservation. Our program strives to address these limiting factors in a comprehensive fashion over a wide landscape. We categorize these limiting factors into three primary types as described in the Flathead River SubBasin Plan (p. 18) as 1) impoundment and hydro operations, 2) physical habitat alteration, and 3) the introduction of non-native species. Our activities address these limiting factors by 1) information gathering both in the form of physical and biological assessments, and in the form of direct research to answer critical unknowns, 2) implementation of projects to correct the limiting factors, and 3) monitoring to evaluate the effectiveness of projects and to track the trajectory of physical and biological restoration.

We propose to address the following biological objectives of the Flathead River SubBasin Plan through our specific work elements. The objectives are placed in categories of limiting factors identified in the Plan. There is of course much overlap between categories, but for simplicity sake each objective is only listed once. The first limiting factor, impoundment and hydro operations, is addressed by 1) restoring the hydrograph and 2) improving the hydraulic regime. The second limiting factor, physical habitat alteration, is addressed by 1)improving channel stability, 2) improving habitat connectivity, 3) improving habitat diversity, 4) improving riparian condition, 5) improving shoreline condition, 6) protecting Class I watersheds, 7) reducing fine sediments, 8) reducing lake pollutants, 9) reducing overgrazing, 10) reducing the rate of land conversion, 11) improving forest management, 12) improving riparian forest management, 13) reducing non-native species in riparian areas, and 14) reducing roads.

The third limiting factor, the introduction of non-native species, is addressed by 1) maintaining the number of local bull trout populations, 2) increasing bull trout population sizes, 3) increasing bull trout population stability, 4) reducing non-native species, 5) increasing the number of westslope cutthroat populations, 6) increasing westslope cutthroat trout population size, and 7) maintaining tribal subsistence and angler harvest.

Objective #1: Quantify trends in abundance of native species within Flathead Lake

Background: Hungry Horse Dam blocked the upstream passage of adfluvial trout moving into the South Fork of the Flathead River, removing greater than one third of the available spawning habitat for these metapopulations (MFWP and CSKT 1991). Mitigation of the impacts of this loss of spawning habitat and reproductive potential within the Flathead Lake metapopulation consists of efforts to restore degraded habitat within the interconnected Flathead system. Flathead Lake is the adult habitat for adfluvial populations of westslope cutthroat and bull trout that utilize the entire tributary system that feeds the lake. Flathead Lake is identified in the Flathead SubBasin Plan as a Class 2 lake indicating its importance in restoration of native species. Monitoring of adults within the lake is an important measure that should integrate changes occurring anywhere within the interconnected watershed. In addition there are many measures by the MFWP and CSKT to reduce competition from non-native fishes to further benefit and restore the losses from the dam. The success of all these efforts is measured by many methods, especially the use of long-term sampling techniques that incorporate changes in a biologically meaningful period of time.

1. Work Element: ID 157 Collect/ generate/ validate field data
Work Element Title: *Quantify relative abundance of westslope cutthroat trout and bull trout species in Flathead Lake by gillnetting.*
Method: We conduct annual gillnetting during spring at two fixed locations with six floating and six sinking experimental nets. Montana Fish Wildlife and Parks conducts the remaining portion of the survey to accomplish a lakewide inventory. This monitoring objective is a necessary component of mitigation, providing feedback on the population responses to mitigation measures. Measurements target the adult population of adfluvial bull and westlsope cutthroat trout. We expect the response of the adult segment of these populations to habitat improvements to be gradual because of generation times necessary for population changes, but consider them to be the most useful indicator of successful restoration of native stocks of fish. This monitoring was initiated in 1981, and has effectively demonstrated a wide range of changes in relative abundance of species within the Flathead Lake fish community (Figure 34).

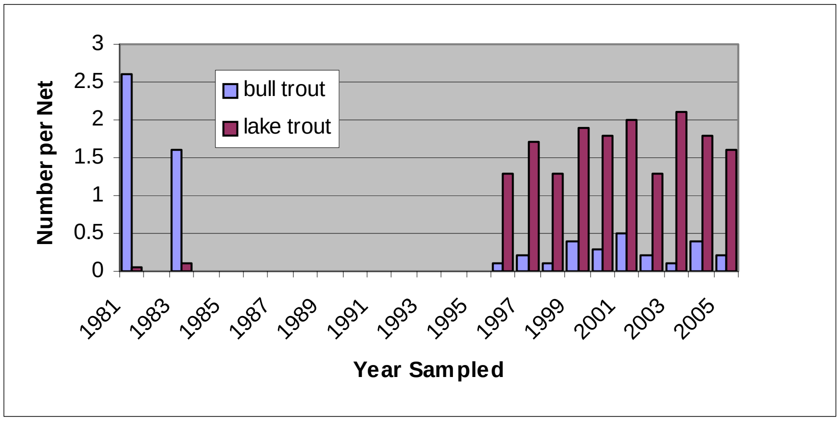


Figure 34. Catch rates in gillnets of lake trout and bull trout during spring in Flathead Lake, 1981 to 2005.

Monitoring: This work element is a monitoring activity to quantify biological responses to restoration activities within the entire watershed. As such, there are no biological results to report from this work, but rather it is the indicator on a basin-wide scale, of biological benefits to adfluvial trout.
Funding: This work element costs about $6,000 annually and is funded entirely by BPA.

2. Work Element: ID 157 Collect/ generate/ validate field data
Work Element Title: *Quantify angler harvest and pressure within the Flathead Lake fishery with a creel survey*
Method: We quantify catch and harvest rates with conventional roving and access site interviews, and quantify pressure through aerial counts. We interview an average of 2000 anglers per year and conduct 208 aerial counts of anglers per year. The sampling design stratifies the lake into five geographic units based on uniformity of the fishery within each, and stratifies each week into weekdays and weekend days based on average differences in activity and angler populations. Estimates of means and standard deviations are generated for each key parameter for every two week period and combined into a final annual estimate. This objective is a critical element of the mitigation program, providing the feedback loop to determine whether harvest of nonnative trout is adequate to achieve goals for native species restoration. Trends in harvest and pressure generated in this survey are directly applied to management goals in Flathead Lake for reduction in lake trout and increases in native species. Catch rates have been increasing (Figure 35) and peak catches occur in the 500 mm TL size group (Figure 36).

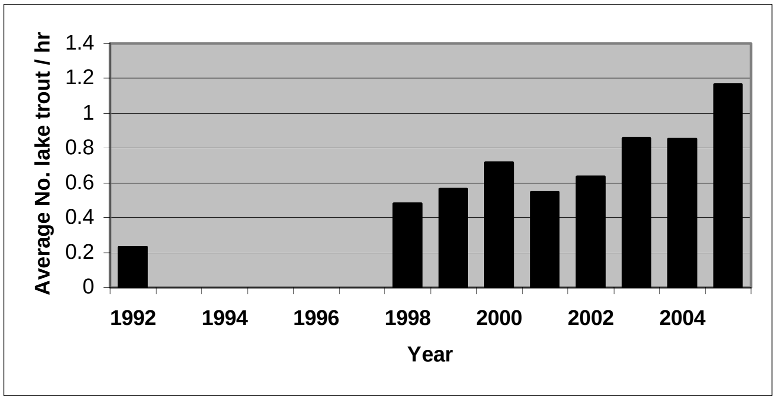


Figure 35. Average number of lake trout caught per hour by anglers targeting lake trout from boats in Flathead Lake, 1992-2005.

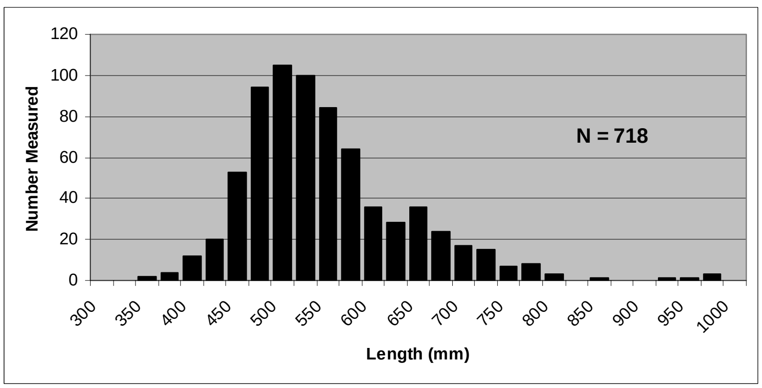


Figure 36. Lengths of harvested lake trout in Flathead Lake, 2005 to 2006.

Monitoring: This work element is specifically a monitoring activity. It provides a surrogate measure of abundance and a direct measure of harvest of four populations of fish in Flathead Lake. As such, there will be no biological results to report from this work.

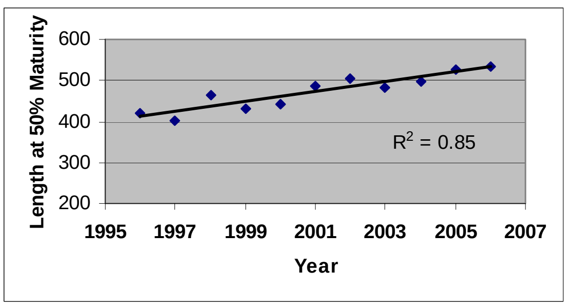
Funding: This work element costs about $110,000 annually, of which $80,000 is provided by BPA.

Objective #2: Increase westslope cutthroat trout and bull trout abundance by reducing predation by lake trout in Flathead Lake.

Background: Lake trout were introduced into Flathead Lake in 1905 and persisted for seven decades as a small population dominated by older individuals. Lake trout have been demonstrated by several sources to be responsible for the reduction of native trout. For example, there is an inverse relationship in their relative abundance over time (see Figure 13), and through bioenergetic analysis we know that lake trout consume large percentages of the annual production of each species (Beauchamp 2006). This degree of predation is thought to overwhelm many of the other factors limiting the abundance of these species, and therefore restoration, and even long-term survival of native trout within the interconnected Flathead system depends on the reduction of lake trout. To reduce lake trout we must: 1) understand their ecology and population dynamics in Flathead

Lake, 2) measure population parameters to quantify the resiliency and compensatory abilities of this population, and 3) establish biological indicators that reflect changes in the population.

1. Work Element: ID157 Collect/ generate/ validate field data
Work Element Title: *Quantify changes in lake trout population dynamics*
Method: Collect lake trout during fall by setting 48 gillnets consisting of 12 mesh sizes placed in five geographic strata and five depth strata. Measure age at maturity, length at maturity (Figure 37), fecundity, growth rate, mortality rate, and year class strength (Figure 38). This objective is the product of adaptive management. The need for this information was apparent as we learned that the lake trout population that greatly expanded during the 1980's created a bottleneck in Flathead Lake that suppressed the species targeted for mitigation. These parameters have utility as surrogates for absolute abundance estimates that are costly and technically difficult to acquire, and as components for population and bioenergetic modeling of the predation effects of lake trout.



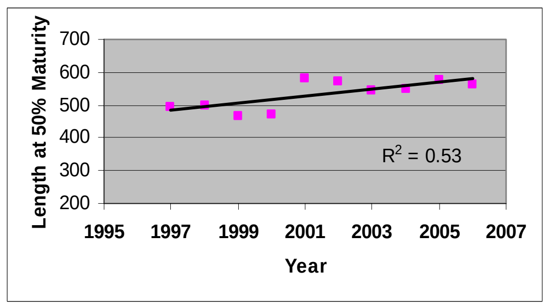


Figure 37. Length at which 50% of male lake trout (left) and female lake trout (right) were mature, 1996 to 2006.

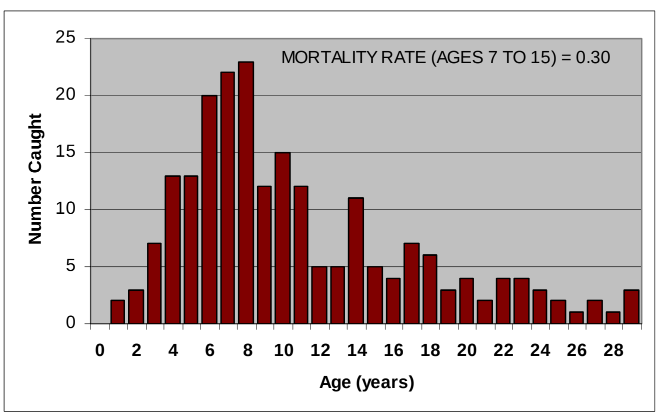


Figure 38. Age distribution of lake trout captured in fall 2006.

Monitoring: This work element is specifically a monitoring activity. Its utility is to provide surrogate measures of population trends in lake trout and to quantify the compensatory ability of the population in response to increasing exploitation. Past results of this work have been to establish a baseline of biological parameters that we can use as a reference for comparison. The most important parameter is mortality rate, which is a measure of the change in the abundance of successive year classes over the range of ages from 7 to 15. This age range is controlled by the fact that lake trout are not fully recruited to the sampling gear until they are about 500 mm TL, in addition to the fact that juveniles are less active and do not recruit to the passive sampling gear at the same rate as adults.. Past results have indicated a very consistent mortality rate (Figure 39). This index is the most critical measure of the success of the program to reduce lake trout. Future results of the lake trout reduction program will be determined first by an increase in the mortality rate, and ultimately by whether the rate exceeds 0.5. This target mortality level is well described in the literature as the level that typically cannot be replaced by even robust populations (Payne et al. 1991).

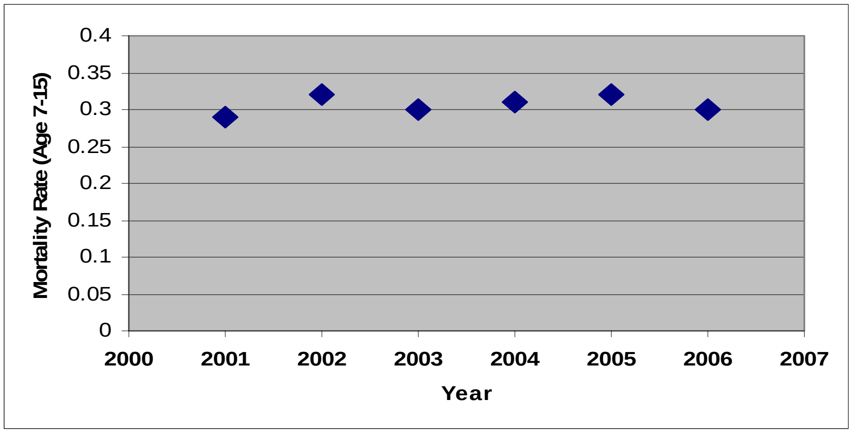


Figure 39. Mortality rates of lake trout between the ages of 7 and 15, Flathead Lake, 2001 to 2006.

Funding: This work element costs about $30,000 annually, of which $10,000 is provided by BPA.

2. Work Element: ID157 Collect/ generate/ validate field data
Work Element Title: *Research food web interactions in Flathead Lake*
Method: We have completed two separate bioenergetics studies of the trophic dynamics of the fish community in Flathead Lake (Beauchamp 1996: Beauchamp et al. 2006). The first focused on the fate of introduced kokanee in Flathead Lake, and the second quantified the trophic interactions within the current fish community. We now clearly understand the dominant role of lake trout in the Flathead Lake fish community (Figure 40).

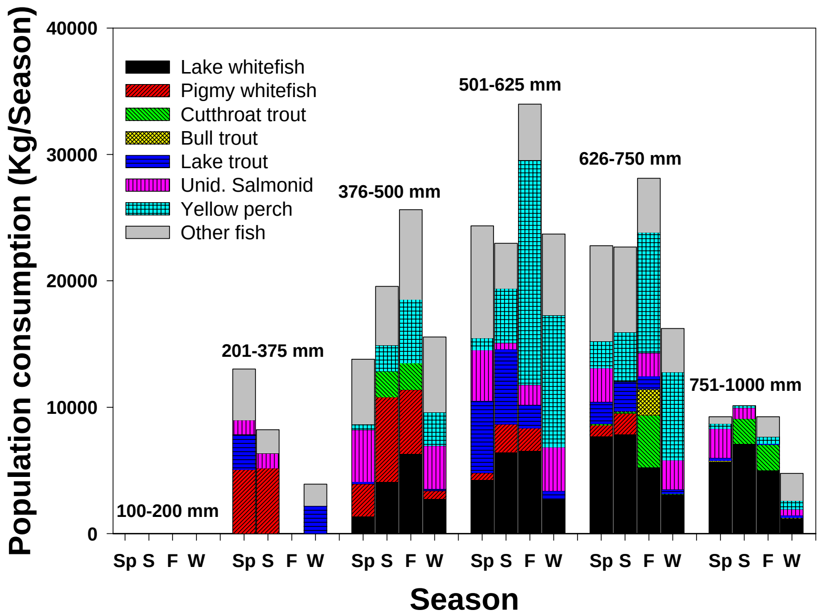


Figure 40. The vertebrate diet of lake trout by length group in Flathead Lake.

We will continue to use this work element to respond to both prescribed and unintended changes in the food web. We will use the model to improve our capability to predict the system responses to our ongoing efforts to suppress nonnative fish.

Monitoring: This work element is a research activity that provides the basic knowledge and understanding of the Flathead Lake ecosystem necessary to guide mitigation decisions. Past results of this on-going work are the quantification of the mortality of native trout from predation by lake trout, that indicated that the level of predation was a significant threat to native trout. Expected future results will be a determination of the nature and degree of trophic adjustments that may occur if we succeed in reducing lake trout. This work is important for making more informed decisions as we undertake deliberate and large-scale efforts to manipulate the fishery.

Funding: This work element has cost about $50,000 annually, of which $20,000 was provided by BPA. Future costs to BPA under this work element are expected to be less than $5,000 annually.

3. Work Element: ID 190 Remove and /or Exclude Animals

Work Element Title: Conduct fishing contests for lake trout in Flathead Lake

Method: Lake trout predation on westslope cutthroat and bull trout in Flathead Lake is great enough to threaten the continued survival of these species in the lake and river system. We have conducted extensive research on these factors and are in the early stages of implementing measures to reduce these non-native fish. We currently conduct two fishing contests per year in Flathead Lake targeting lake trout less than 28 inches. Anglers receive lottery tickets for fish submitted which represent chances to win a portion of the $20,000 in prizes. Fish are filleted and distributed to area food banks. Angler participation and harvest has increased by double nearly every year since this project began in 2002. In 2006 over 12,000 lake trout equaling about six tons of biomass were removed from Flathead Lake.

Monitoring: This work element is monitored by comparing the number of lake trout harvested annually to the harvest target. We developed the harvest target based on an estimate of the number of fish necessary to exceed the annual reproductive capacity of the population. We employed the following method to develop the harvest target:

Step 1: We first connected the relative data describing age class structure with the absolute data quantifying harvest to estimate the total population size by age. To do this we used the following procedure:

We used 153 otoliths collected from lake trout gathered from gillnetting in fall 2005 to develop a mean length at age relationship (Figure 41).

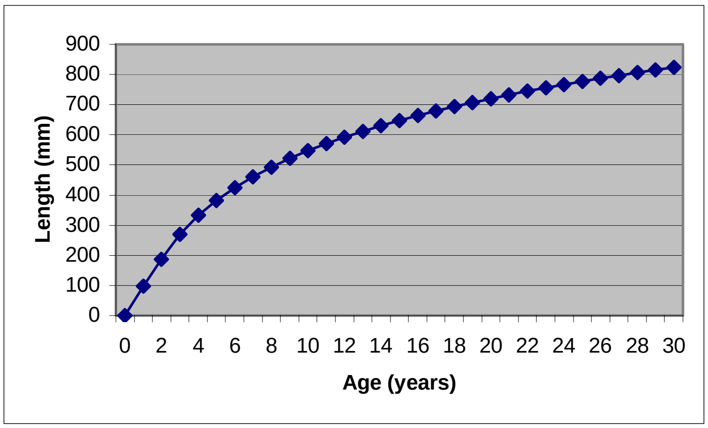


Figure 41. Length at age relationship for lake trout in Flathead Lake, 2005.

Step 2: We estimated the relative strength of age classes within the lake trout population, using data from fall gillnetting. We started with age 7, the first year class fully recruited to the gillnets, and calculated a mortality rate (Robson and Chapman 1961) for ages 7 to 15 (Figure 42).

Figure 42. Age structure and mortality rate of lake trout population estimated from gillnetting samples collected in fall 2005.

Step 3: Based on creel surveys, we determined the proportion of fish removed from each age class of lake trout harvested by anglers (Figure 43). Annual angler harvest has roughly equaled 40,000 lake trout over the last several years. Assuming a 10% hooking mortality, the total fish killed in the recreational fishery is about 44,000. We multiplied the proportion of fish removed in each year class by the total fish (44,000) to determine the number annually removed from each year class.

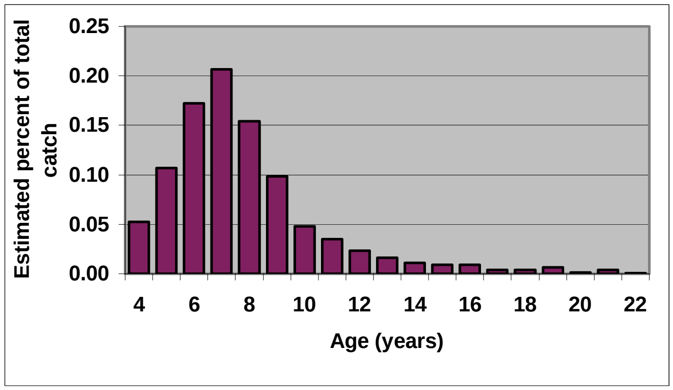


Figure 43. Estimated ages of lake trout measured in the creel, 2003 to 2004 (N = 1252).

Step 4: We constructed a theoretical population that resembles the population structure estimated from gillnet catches, that when subjected to a mortality rate of 0.32 (for ages 7 to 15) produces a harvest of 44,000 fish distributed among the year classes by the same proportion as observed in the harvest (Figure 44 and 45). We incrementally increased the mortality factor, based on published estimates of early survival, to account for natural mortality (Matuszek et al. 1990, Ferreri et al. 1995, and Walters et al. 1980).

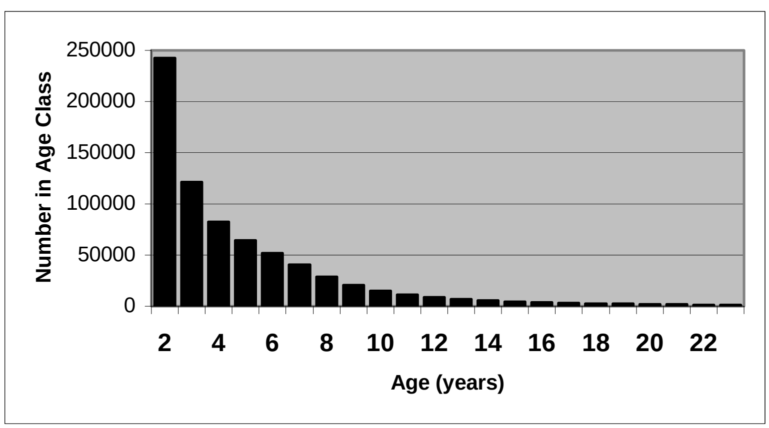


Figure 44. Theoretical population structure between age 2 and 23 existing in 2006.

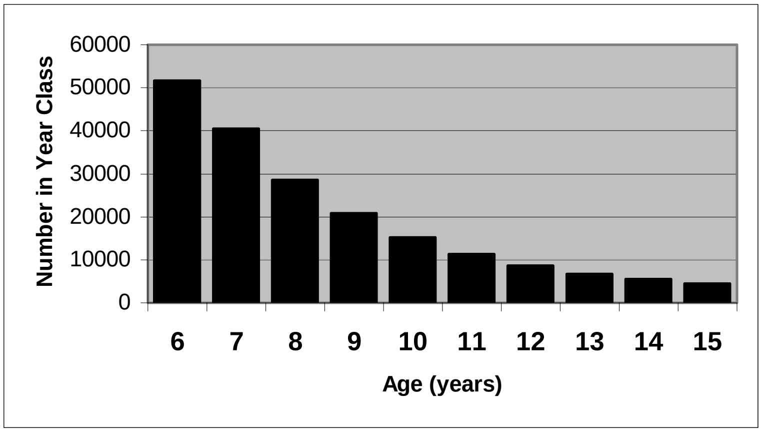


Figure 45. Theoretical population structure specifically from ages 6 to 15 to display the ages for which the mortality rate equals 0.32.

Step 5: We determine the harvest necessary to increase the mortality rate of the theoretical population from 0.32 to 0.5. Although we do not know the specific mortality rate that will reduce the Flathead population, there are many examples of populations with mortality rates of less than 0.5 that are sustainable (Payne et al. 1990)

We incrementally increased the harvest rate on the theoretical population until the population structure indicated a mortality rate of 0.5 between the ages of 7 and 15 after four years. We found that a reduction of 25% was required to reach the target mortality rate (Figure 46).

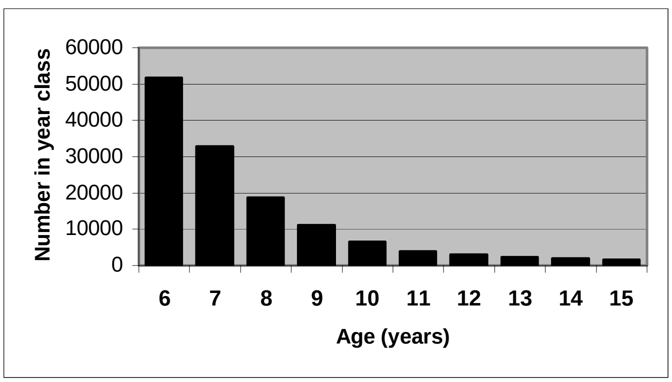


Figure 46. Theoretical population structure after a 25% reduction from 2006 levels that results in a mortality rate of 0.52.

We tabulated population size by year to determine the changes in abundance. We started with our best estimate of the current population and simulated the increase in mortality rate or harvest (Table 2). This is assuming no change in recruitment success over the four years.

Table 2. Estimated population size by year, simulating a mortality rate of 0.5 for the ages 7 through 15, from present to 2010. M equals natural mortality and F equals fishing mortality.

Estimated number of fish at each age							
Age	M	F	2006	2007	2008	2009	2010
0	0.995	0	210,000,000	210,000,000	210,000,000	210,000,000	210,000,000
1	0.79	0	1,155,000	1,155,000	1,155,000	1,155,000	1,155,000
2	0.5	0	242,550	242,550	242,550	242,550	242,550
3	0.32	0.003	121,275	121,275	121,275	121,275	121,275
4	0.2	0.018	82,220	82,220	82,220	82,220	82,220
5	0.13	0.08	64,592	64,592	64,592	64,592	64,592
6	0.08	0.15	51,699	51,699	51,699	51,699	51,699
7	0.068	0.24	40,429	32,747	32,747	32,747	32,747
8	0.068	0.22	28,637	23,196	18,788	18,788	18,788
9	0.068	0.22	20,818	16,862	13,658	11,063	11,063
10	0.068	0.2	15,134	12,258	9,929	8,043	6,515
11	0.068	0.18	11,284	9,140	7,403	5,997	4,857
12	0.068	0.16	8,623	6,985	5,658	4,583	3,712
13	0.068	0.13	6,751	5,468	4,429	3,588	2,906
14	0.068	0.12	5,474	4,434	3,592	2,909	2,356
15	0.068	0.1	4,490	3,637	2,946	2,386	1,933
16	0.068	0.1	3,766	3,050	2,471	2,001	1,621
17	0.068	0.1	3,159	2,559	2,072	1,679	1,360
18	0.068	0.1	2,650	2,146	1,738	1,408	1,141
19	0.068	0.1	2,222	1,800	1,458	1,181	957
20	0.068	0.1	1,864	1,510	1,223	991	802
21	0.068	0.1	1,564	1,564	1,267	1,026	831
22	0.068	0.08	1,312	1,312	1,312	1,062	861
23	0.068	0.08	1,125	1,125	1,125	1,125	911
24	0.068	0.08	964	964	964	964	964
25	0.068	0.04	827	827	827	827	827
26	0.068	0.035	740	740	740	740	740
27	0.068	0.035	665	665	665	665	665
28	0.068	0.035	598	598	598	598	598
29	0.068	0.03	538	538	538	538	538
30	0.068	0.03	487	487	487	487	487
31	0.068	0.03	440	440	440	440	440
Total Population Age 1-31			1,881,894	1,852,387	1,834,411	1,823,172	1,815,956
Total Harvest			45,698	77,465	67,246	61,330	57,583

Step 3. Check the accuracy of the theoretical population by determining if it would generate sufficient recruitment.

Because we cannot empirically verify the accuracy of our harvest model, we cross-checked the harvest model with estimates of recruitment. We generated the population estimate from ages for which we had reliable data from both gillnetting and angler-harvest surveys. We estimated mortalities from those most reliable ages backward to the earliest ages for which we had no data. The backward projection of mortality rate to age 0 produced an estimate of 210,000,000 eggs to sustain the population. To estimate total reproductive capacity of the theoretical population we assumed an even sex ratio, and applied the maturity schedule measured in 2005 to generate total egg production. By this method we estimate total production to be 215,325,417 eggs, or within 2% of the alternate method.

In 2008 we will implement a mark and recapture estimate as a means to provide verification of the method described above. The spring contest generates at least 8,000 lake trout constituting a very large recapture sample collected in an extremely cost-effective manner.

Finally, the results of this work will be determined judged by our ability to achieve the harvest target. To date we have been very successful in annually increasing harvest (Figure 47). While during some years we have achieved a doubling of harvest compared to the previous year, we have still not achieved the harvest target of 20,000 lake trout. The agencies are testing angling as the primary tool for reduction of lake trout through 2008. We intend to fully test this tool and consider this work to be of utility to the many other agencies attempting to reduce lake trout in lakes throughout the west.

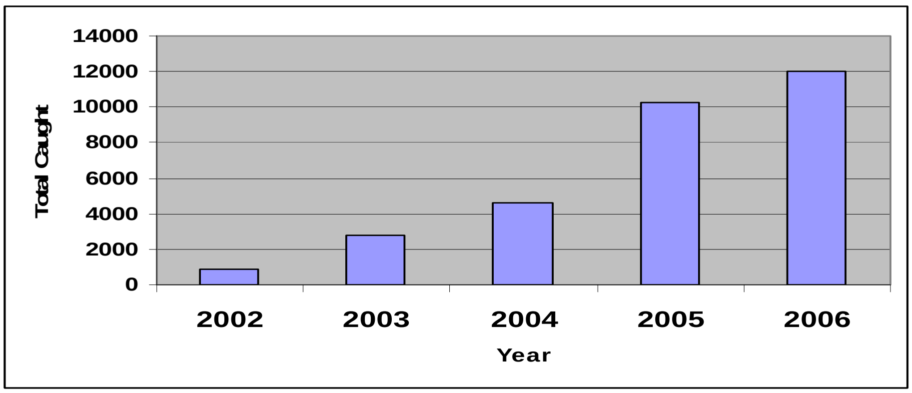


Figure 47. Number of lake trout harvested annually in fishing contests on Flathead Lake, 2002 to 2006.

Funding: This work element costs about $120,000 annually, of which $10,000 is provided by BPA.

4. Work Element: ID 190 Remove and/or Exclude Animals
Work Element Title: Remove brook trout from westslope cutthroat trout streams
Method: Brook trout typically replace, by means of competitive interactions, westslope cutthroat trout in small streams in Montana. The first working hypothesis of the Flathead SubBasin Plan is that "The presence of non-native species and introgression are the primary factors limiting productivity of focal species on a subbasin scale". Brook trout are common in many small tributaries on the Flathead Indian Reservation that also support westslope cutthroat trout. Many of these streams are also isolated from future invasions by downstream barriers that preclude invasion of brook trout from downstream sources. These are important candidate streams because they are not subject to invasion, are small enough to treat effectively, and represent important conservation value. Six of these streams have been identified for piscicide treatment. NEPA work will begin in 2007, with treatments planned to begin in 2008.
Monitoring: This work element will be monitored by bi-annual population sampling following two years of piscicide treatments to determine if any brook trout have

persisted. Results will be evaluated by the absence of brook trout over repeated sampling events, and ultimately by the long-term survival of each population of westslope cutthroat trout.
Funding: This work element may cost about $50,000 annually, of which $25,000 will be provided by BPA.

Objective #3: Replace lost angling opportunity with hatchery-reared fish released in irrigation reservoirs
Background: Many of the losses attributable to Hungry Horse Dam cannot be recovered within the finite resources remaining within the interconnected Flathead system. Accordingly we coordinate with Hungry Horse Mitigation Project # 199101904 to plant hatchery-reared rainbow trout in off-channel irrigation reservoirs on the Flathead Indian Reservation. This stocking program serves to replace the angling opportunity lost to the impacts from Hungry Horse Dam, and to partially direct angling pressure away from populations of native trout that are targeted for restoration and protection. This objective addresses our responsibility to monitor the success of this activity to ensure that the investment translates into an acceptable return to the creel. We are currently planting three small irrigation reservoirs on the Flathead Indian Reservation. They range in size from 1500 acres to 30 acres and are shallow and productive.
Work Element: ID157 Collect/ generate/ validate field data
Work Element Title: *Monitor off-site stocking*
Method: It is not cost-effective to conduct conventional creel surveys on these water bodies to generate annual estimates of pressure, catch rate, and harvest. The costs of conventional surveys would exceed the cost of the planting program. Instead we rely on information obtained from a known group of anglers that utilize each of these water bodies. In addition to these angler reports, we conduct periodic sampling efforts to measure over-winter survival and growth rates of released fish.
Monitoring: We will monitor the results of the planting program by a combination of angler interviews and fishery assessments. We do not have hard thresholds to judge success of this work element, but rather determine success based on a subjective evaluation of a variety of measures. Positive angler responses primarily constitute success of this program, and our feed-back in all years of this planting program has been very positive. In addition, because these are not intended to be within-year put-and-take fisheries, we determine growth rate and over-winter survival. We think this approach has proven to be a cost-effective and clearly sufficient method to judge the success of this project.
Funding: This work element costs about $2,000 annually, all of which is provided by BPA.

Objective #4: Develop understanding of western pearlshell mussel habitat requirements, current distribution, and methods for restoration
Background: Western pearlshell mussels (*Margaritifera falcata*) play an important ecological role in streams and have been of great cultural importance to the Salish and Kootenai people. According to tribal elders mussels were historically very common in streams of the Reservation. This is an on-going objective that we have been conducting over the last four years to determine the current distribution of populations. We have

identified five previously undocumented populations that are still reproducing, and four non-reproductive populations consisting of only very large individuals. We also quantified a selection of habitat criteria within sites supporting mussels. We are working to quantify habitat relationships to predict potential historic distributions, and to identify possible locations for reintroduction. We have begun describing the genetic character of these populations to assist in the decision process for potential relocation of mussels into vacated habitats.

Work Element: ID157 Collect/ generate/ validate field data

Work Element Title: *Inventory status and habitat associations of western pearl mussels*

Method: We have been surveying streams within the Flathead Indian Reservation since 2003 for mussels according to the protocol of Strayer and Smith (2003). We quantify abundance of identified populations by quadrant sampling that is expanded based on the length of stream supporting mussels. We measure size structure (Figure 24) and screen fine sediments to determine the presence of early year classes to evaluate reproductive success. We measure habitat variables and correlate them to the distribution of mussels. We collect tissue samples and describe genetic differences between populations. We will evaluate suitable habitats where mussels are absent for the purpose of possible reintroductions.

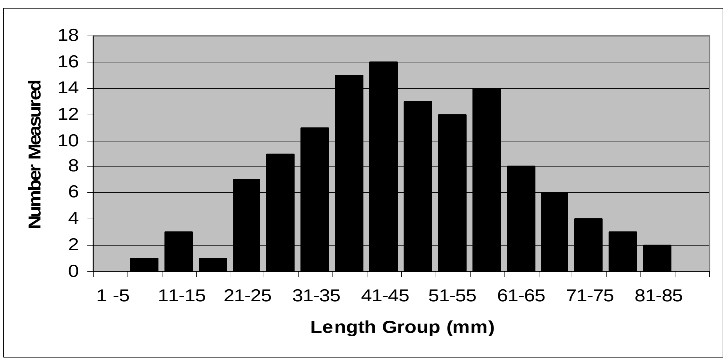


Figure 24. Length distribution of one isolated population of mussels found on the Flathead Reservation.

Monitoring: This work element combines elements of biological inventory, habitat quantification, and reintroduction. Inventory procedures are consistent with those described in Strayer and Smith (2003). Habitat measurements focus on substrate size, water temperature, and associations between mussel locations and the nearest dominant feature of habitat. Genetic procedures have been conducted by Utah State University. Protocols and decision criteria for reintroduction of mussels are in the development stage and will be conducted with extreme caution in order to avoid the hybridization impacts that result in loss of genetic diversity that is a product of local adaptation. Expected results of this work will be to further define the range of extant populations on the Flathead Reservation, identification of suitable sites for reintroduction, and restoration of at least one population where they are currently extinct.

Funding: This work element costs about $8,000 annually, of which $4,000 is provided by BPA.

Objective #5: Preserve and restore littoral habitat within Flathead Lake

Background:

1. Work Element: ID 55 Upland Erosion and Sedimentation Control
Work Element Title: *Research shoreline erosion processes*
Method: Research and monitoring includes measurements of wind and wave energy, timing and duration, and change in shoreline position and particle size. We will conduct site-specific studies of the rate and extent of shoreline erosion in Flathead Lake, implement and monitor restoration projects, and disseminate information about project results. Research is currently being conducted at a site along the northeast shoreline of East Bay, Blue Bay and the Polson waterfront. Demonstration projects will be the primary means of conveying treatment technologies to other interested agencies and landowners.
Monitoring: This project monitors on-going erosion at several sites within Flathead Lake. Nested pairs of erosion pins are installed into the full pool shoreline at several study sites. Erosion pins are simply 3' long pieces of 3/8" re-bar fitted with plastic caps. One erosion pin is set horizontally and flush with the bank, and the other is set vertically and flush with the lake bottom. As waves erode the bank and lakebed the pins become exposed allowing a lineal measure of land loss. Conversely, if sediment is deposited the amount of accretion can be measured. Each nested pair of erosion pins was located in the field with a GPS and their position plotted on a geo-rectified aerial photograph. This system of erosion pins is measured annually. Past results of this work consist of quantification of wave climates throughout the lake, documentation of shoreline erosion rates in two locations, and restoration of two beach segments. Expected future results are to continue to quantify erosion rates at ongoing study sites, and to restore two beach segments of roughly 500 m each.
Funding: This work element costs about $30,000 annually, of which $15,000 is provided by BPA.

Objective #6: Reduce the rate of invasion of non-native species
Background: Competition with invasive species is potentially the most serious threat to native species. We are currently working to reduce several, i.e. lake trout, brook trout and yellow flag iris. The threat of human-transported invaders will continue and must be addressed to reduce the rate of new invasions. We have installed a traveler's advisory radio broadcast system to inform travelers entering the Reservation from the southern access point as a means to reduce this threat.
Work Element: ID 99 Outreach and education
Work Element Title: Maintain AM advisory radio system.
Method: We recently obtained an AM advisory radio system in cooperation with Montana Fish Wildlife and Parks. We have installed the system at a location at the southern boundary of the Reservation that is the most heavily traveled entry point to the Reservation. We will conduct annual maintenance of the system, interview listeners to determine effectiveness of the message, and update the advisory messages.
Monitoring: We have not yet begun to implement this work element and have not yet developed monitoring protocols. We will develop our educational message and advisory with Montana Fish, Wildlife and Parks who have substantial experience with this tool. We expect to rely on the experience of MFWP and university advisors to ensure that the message translates into changed behaviors and prevention of the transport of exotic species. We do not at this time intend to rigorously monitor the efficacy of this tool,

primarily because it is difficult to demonstrate the reduction in transport of exotic species, and to attempt to do so would be very cost-ineffective for a project of this scale.
Funding: This work element costs about $3,000 annually, all of which is provided by BPA.

The following Objectives #7 and #8 are presented in general terms. They describe the approach of the CSKT in restoring habitat on the Flathead Indian Reservation. We are unable to identify specific applications at this time for several reasons. Through the process of watershed planning and landowner coordination we will develop projects to implement over the 2007 to 2009 period. These objectives also address the restoration work that will be conducted on lands acquired under Project 200200300, which generates credits to retire the losses attributed to the construction and inundation impacts from Hungry Horse Dam. Only in rare cases will the parcels acquired be in pristine condition and not in need of restoration work. We therefore cannot anticipate at this time the specific projects that will develop as these parcels are acquired and evaluations identify the restoration needs. Watershed assessments, limiting factor analysis, project identification, and some of the design work will be conducted in-house. Construction and some of the design work will be undertaken through contracts.

Objective #7: Restore ecosystem structure and function on the Flathead Reservation
Background: Hungry Horse Dam blocked the upstream passage of adfluvial trout moving into the South Fork of the Flathead River, removing greater than one third of the available spawning habitat for these metapopulations (MFWP and CSKT 1991). While we cannot create new aquatic resources to replace those lost to inundation from the dam, we can elevate the productivity of existing aquatic resources by restoring currently degraded habitats that are functioning below their potential.

We will do this work on private and tribal lands within the Flathead SubBasin consistent with our practices over the last 12 years. In addition, this project will address the restoration needs on all properties acquired under Project #200200300, Secure and Restore Fish and Wildlife Habitat. That project is designed to acquire lands, for protection in perpetuity, of the ecological processes and functions necessary to sustain native fish in the Flathead SubBasin. Its purpose is to replace the 125 km of stream lost to inundation from Hungry Horse Dam. It is therefore important that the distance of stream existing on acquired lands be functioning in its highest possible capacity so that the true distance and function of replacement stream segments most closely approximate the quantity of stream lost to inundation. Because these lands have not yet been acquired, we cannot specify the exact restoration activities that will be acquired. Accordingly, for the purposes of our ongoing restoration program, as well as the restoration of lands to be acquired under Project #200200300, we list here the full range of work elements that capture the types of work that we have experience conducting and are likely to be applied during the 2007 to 2009 planning period.

1. Work Element: ID 47 Plant vegetation
Work Element Title: Restore riparian vegetation and function

2. Work Element: ID 34 Develop Alternative Water Source

Work Element Title: Develop off-channel water sources

3. Work Element: ID 40 Install Fence
Work Element Title: Protect riparian areas from grazing by fencing

4. Work Element: ID 33 Decommission Road
Work Element Title: Restore watershed function by recontouring roads

5. Work Element: ID 30 Realign, Connect, and/or Create Channel
Work Element Title: Reconstruct degraded stream channels.

6. Work Element: ID 55 Upland Erosion and Sedimentation Control
Work Element Title: Construct wetlands to remediate polluted irrigation return flows

Method: This objective is closely tied to the biological objectives of the Fish and Wildlife Program, the objectives of the Flathead Subbasin Plan, and to the established direction of the Tribal Fisheries Program. There are many examples in which we have employed each of these work elements with BPA funding to address limiting factors within sub-watersheds of the Flathead Reservation. We will continue to employ these work elements to address the numerous locations where the ecosystem structure is altered and the ecosystem is functioning well below capacity.

Monitoring: 1) Restore riparian vegetation and function; We will rely primarily on photopoints to document change in this parameter. In large cases we will rely on baseline surveys of riparian condition using fixed plots in which species, age and density are measured, and repeated periodically after treatment.

2) Develop off-channel water sources; In most cases this activity will be a contributing factor in the improvement of riparian condition and will require compliance monitoring to ensure that the intent of the mitigation action is being observed.

3) Protect riparian areas from grazing by fencing; We will rely primarily on photopoints to document change in this parameter. In large cases we will rely on baseline surveys of riparian condition using fixed plots in which species, age and density are measured, and repeated periodically after fencing is in place. This action also requires compliance monitoring to ensure that the intent of the mitigation action is being observed.

4) Restore watershed function by recontouring roads; In almost all cases we will rely on photopoints to document this improvement in habitat and rely on the conclusions from copious research that these actions provide tangible benefits. Detailed monitoring would be costly and unlikely to demonstrate benefits because of confounding factors, high variability, and the need for lengthy time scales. For example, McCaffery and others (2007) found that a 40% change in fine sediments would be required to detect a statistically significant change in fine streambed sediments.

5) Reconstruct degraded stream channels; We will rely largely on photopoints to indicate the stability of reconstructed features of channel dimension. Detailed measures will often be employed, specifically the use of cross-sectional elevations, bed elevations throughout the channel profile, and channel pattern locations as recorded by GPS and survey locations.

6) Construct wetlands to remediate polluted irrigation return flows; We anticipate the use of this work element on several sites, and will measure discharge, suspended sediment levels, and nutrient levels before and after treatment.

Funding: This work element may cost about $100,000 annually, all of which will be provided by BPA.

Objective #8: Restore connectivity of habitats and migratory capacity of native trout
Background: There are several populations of migratory bull and westslope cutthroat trout within the Flathead Indian Reservation. Some populations have been lost and we may potentially restore them, while others are in decline and suffering the effects of fragmentation. There will be many opportunities during the 2007 to 2009 period to correct these fragmentation problems and work toward restoration or protection of the migratory life history. There are three work elements addressing this limiting factor.

1. Work Element: ID 84 Remove/Install diversion
Work Element Title: Remove/upgrade passage barriers,

2. Work Element: ID 184 Remove/Install diversion
Work Element Title: Install ladders at irrigation diversion sites,

3. Work Element: ID 85 Remove/Modify Dam
Work Element Title: Remove in-channel dams

Method: We will identify passage barriers within the range of native trout on the Flathead Reservation that are restricting the availability of usable habitat. We will identify suitable barrier removal methods and procedures to restore channel condition.
Monitoring: These activities will be monitored primarily through ongoing population monitoring that will document density shifts over time following the removal of the barrier. In specific cases tagging or radio-tracking tools will be used to verify the movement of fish through the area of the barrier.
Funding: This work element may cost about $50,000 annually, all of which will be provided by BPA.

Objective #9: Maintain communication and coordination between agencies and public
Work Element: ID118 Coordination
Work Element Title: Conduct new and ongoing coordination with public and private entities engaged in watershed management.
Method: We work with Tribal programs, MFWP, USFWS, NRCS, local conservation districts, NGO's etc. to identify problems and solutions within the watershed. We coordinate with all entities on restoration and enhancement efforts to prevent duplication and enhance communication and cooperation. We work with landowners, interest groups and agencies to identify funding and cost share opportunities to multiply the benefits derived from the BPA funding.

Monitoring: We do not specifically monitor the effectiveness of the coordination work but are continually soliciting feedback and evaluation on ways to maintain and improve our coordination efforts.
Funding: This work element costs about $95,000 annually, all of which is provided by BPA.

Objective #10: Obtain required permits, agency approval and public support to conduct mitigation activities.
Background: The Confederated Salish and Kootenai Tribes operate under their own controlling Ordinances (CSKT 1985; 1990; 1995; 1996; 1999), and also observe the federal regulations of the Army Corps of Engineers, the Environmental Protection Agency, and the U.S. Fish and Wildlife Service. Nearly all the objectives listed above can only be accomplished after obtaining the full list of required permits.
Work Element: ID 165 Produce Environmental Compliance Documentation
Work Element Title: Conduct NEPA and permitting compliance for project implementation
Method: We will utilize the NEPA professionals on staff with the CSKT to conduct scoping, develop alternatives, receive public comment, and prepare environmental assessments for projects listed above.
Monitoring: We judge the effectiveness of this work element based on the timeliness in which we receive permits for our work. We have not been forced to postpone or lengthen any project timelines because of permitting delays.
Funding: This work element costs about $10,000 annually, of which $6,000 is provided by BPA.

Objective #11: Conduct administrative activities needed to accomplish mitigation projects
Background: These are the administrative activities necessary to make on the ground mitigation happen, and to provide for reporting of the results.
Work Element: ID 114 Identify and Select Projects
Work Element: ID 119 Manage and administer projects
Work Element: ID 132 Prepare Annual Report
Funding: This work element costs about $10,000, of which $4,000 is provided by BPA.

Monitoring and Evaluation Procedures:

We employ a broad and lengthy list of monitoring and evaluation procedures to determine the biological results of our activities. Details are provided in the description provided above for each Work Element. We select and tailor our monitoring protocols to each habitat project in order to achieve the highest resolution in data at the least cost. In larger projects we collect a suite of baseline measures to be periodically replicated after the completion of the improvement in habitat. In most cases we quantify both fish and macroinvertebrate abundance. We often measure physical parameters within the project site that may include channel dimension, pattern and profile, bank and riparian condition, as well water chemistry and temperature regime. The biological parameters may be collected within the site, or at the nearest long term collection site. In addition, we collect numerous data sets at the basin-level that are intended to integrate changes in habitat throughout the basin, including those conducted by other agencies.

G. Facilities and equipment

The Confederated Salish and Kootenai Tribes have a 23 foot and an 18 foot welded aluminum boat, and several smaller boats and portable electroshocking equipment to sample small water bodies. We have an office facility consisting of 10 individual offices and three large storage bays for field equipment. We have a field station on Flathead Lake, that includes a laboratory, storage space, a marina, and a boat house with two bays having direct access by rail to the water. We have microscopes, computers, full Geographic Information System capability, and a fleet of vehicles.

H. References

Beauchamp, D., M. Kerschner, N. Overman, J. Rhydderch, J. Lin, and L. Hauser. 2006. Trophic Interactions of Nonnative Lake Trout and Lake Whitefish in the Flathead Lake Food Web. Report to the Confederated Salish-Kootenai Tribes.

Confederated Salish and Kootenai Tribes (CSKT). 1985. Aquatic Lands Conservation Ordinance 87A. Confederated Salish and Kootenai Tribes. Pablo, Montana.

CSKT. 1990. Water Quality Management Ordinance 89B. Confederated Salish and Kootenai Tribes, Pablo, Montana

CSKT. 1995. Proposed Rules--Surface Water Quality Standards and Antidegradation Policy. Confederated Salish and Kootenai Tribes, Pablo, Montana. 45 pp.

CSKT. 1996. Flathead Reservation Comprehensive Resources Plan Volume I. Confederated Salish and Kootenai Tribes. Pablo, Montana.

CSKT. 1996. Flathead Reservation Comprehensive Resources Plan Volume II. Confederated Salish and Kootenai Tribes. Pablo, Montana.

CSKT. 1999. Flathead Indian Reservation Forest Management Plan. Final Environmental Impact Statement. Confederated Salish and Kootenai Tribes. Pablo, Montana.

CSKT and Montana Department of Fish, Wildlife and Parks. 2000. Flathead River Subbasin Summary. Confederated Salish & Kootenai Tribes. Pablo, Montana.

DosSantos, J.M., C., Hunter, L. Lockard, B. Marotz and J. Vashro. 1992. Hungry Horse Dam Fisheries Mitigation Implementation Plan. Report to the Northwest Power Planning Council, Montana Fish, Wildlife and Parks, Kalispell, and the Confederated Salish and Kootenai Tribes, 50pp.

Knotek, W. L., M. Delaray and B. Marotz. 1997. Hungry Horse Dam Fisheries Mitigation Program--Fish Passage and Habitat Improvement in the Upper Flathead River Basin. Report to Bonneville Power Administration. Montana Fish, Wildlife and Parks, Kalispel

Evans, D., J. Casselman, and C. Willcox. 1991. Effects of exploitation, loss of nursery habitat, and stocking on the dynamics and productivity of lake trout populatins in Ontario lakes. Lake Trout Synthesis, Response to Stress Working Group. Ontario Ministry of Natural Resources. Ontario, Canada.

Ferreri, C.P., W.W. Taylor, and D.B. Hayes. 1995. Evaluation of age-0 survival and its effects on lake trout rehabilitation in the Michigan waters of Lake Superior. Journal of Great Lakes Research 21 (suppl. 1):218-224.

Matuszek, J.E., B.J. Shuter, and J.M. Casselman. 1990. Changes in lake trout growth and abundance after introduction of cisco into Lake Opeongo, Ontario. Trans. Am. Fish. Soc. 119:718-729.

McCaffery, M., T.A. Switalski, L. Eby. 2007. Effects of road decommissioning on stream habitat characteristics in the South Fork Flathead River, Montana. Transactions of the American Fisheries Society 136:553-561.

Montana Bull Trout Scientific Group (MBTSG). 1996. Middle Clark Fork River Drainage Bull Trout Status Report. The Montana Bull Trout Restoration Team, Helena, Montana. 37 pp.

MBTSG. 1995. Flathead River Drainage Bull Trout Status Report. The Montana Bull Trout Restoration Team, Helena, Montana. 46 pp.

MBTSG. 1995. South Fork Flathead River Drainage Bull Trout Status Report. The Montana Bull Trout Restoration Team, Helena, Montana. 33 pp.

MBTSG. 1997. Swan River Drainage Bull Trout Status Report. The Montana Bull Trout Restoration Team, Helena, Montana. 42 pp.

MBTSG. 1998. The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout. The Montana Bull Trout Restoration Team, Helena, Montana. 78 pp.

Payne, N., R. Korver, D. MacLennan, S. Nepszy, B. Shuter, T. Stewart, and E. Thomas. 1990. The harvest potential and dynamics of lake trout populations in Ontario. Lake Trout Synthesis, Population Dynamics Working Group. Ontario Ministry of Natural Resources. Ontario, Canada.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic Habitat Requirements for Conservation of Bull Trout. United States Department of Agriculture, Forest Service, Ogden, Utah. 37pp.

Robson, D., and D. Chapman. 1961. Catch curves and mortality rates. Transactions of the American Fisheries Society. 90(2):181-189.

Strayer, D. and D. Smith. 2003. A guide to sampling freshwater mussel populations. American Fisheries Society Monograph No. 8. American Fisheries Society, Bethesda, Maryland.

Tribal Fisheries Program. 1993. Fisheries Management Plan for the Flathead Indian Reservation. Confederated Salish and Kootenai Tribes, Pablo, Montana . 65 pp.

Confederated Salish and Kootenai Tribes and Montana Fish, Wildlife & Parks. 2004. Flathead Subbasin Plan: Part I: Flathead River Subbasin Assessment. Part II: Flathead River Subbasin Management Inventory. Part III: Flathead River Subbasin Management Plan. A report prepared for the Northwest Power and Conservation Council. Portland, OR.

Wicklum, D. 1999. Mysis relicta 2000: Filling (some of) the holes in our ecological knowledge. Flathead Lake Biological Station. Prepared for The Confederated Salish and Kootenai Tribes.

Wicklum, D. 2000. Mysis relicta 2000: Filling (some of) the holes in our ecological knowledge. Flathead Lake Biological Station. Prepared for The Confederated Salish and Kootenai Tribes.

I. Personnel

Barry Hansen (0.25 FTE), Biologist II

- 17 years experience with CSKT
- Bachelor of Science, Tulane University, New Orleans, Louisiana, 1974
- Master of Science, University of Montana, Missoula, Montana, 1988
- Certified Fisheries Scientist #2155 (American Fisheries Society)
- Confederated Salish and Kootenai Tribes, Fisheries biologist conducting mitigation, monitoring, research, and review.
- Formerly employed by Montana Fish, Wildlife and Parks, the U.S. Forest Service, Student Conservation Association, and environmental consultants.

Lynn DuCharme (1.0 FTE), Watershed Coordinator

- 9 years experience with CSKT
- Bachelor of Science, Stockton State University, Pomona, New Jersey, 1991
- Master of Science, Montana State University, Bozeman, Montana, 1993
- Confederated Salish and Kootenai Tribes, Watershed Coordinator (1997 – present)
- Formerly self employed and with the Gallatin County Health Department

Les Evarts (0.05 FTE), Project Manager

- 18 years experience with CSKT
- Bachelor of Science, Montana State University, 1981
- Master of Science, Ohio University 1985
- Confederated Salish and Kootenai Tribes, Fisheries Program Manager
- Formerly employed by Montana Fish, Wildlife and Parks (1986-1989)

Rusty Sydnor (0.05 FTE), Restoration Botanist

- 4 years experience with CSKT, 5 years private consulting
- Bachelor of Science, North Carolina State University, 1993
- Master of Science, Colorade State University 1999

Craig Barfoot (0.05 FTE), Biologist II

- 6 years experience with CSKT
- Bachelor of Science, University of South Dakota, 1989
- Master of Science, Montana State University, 1993
- 9 years experience with the Columbia River Research Lab

Clint Folden (0.05 FTE), Biologist I

- 14 years experience with CSKT

Cindy Benson (0.4 FTE), Fisheries Specialist

- 10 years experience with CSKT

Mountain Wahl (1.0 FTE), Fisheries Technician II

- 5 years experience with CSKT

Richard Folsom (0.1 FTE), Fisheries Technician II

- 10 years experience with CSKT

Joe Santos (0.1 FTE), Fisheries Technician II

- 12 years experience with CSKT