Summary of Results from Project No. 199101901
Hungry Horse Mitigation / Flathead Lake
1992 to Present

The following summary identifies many of the "results" of this project. The Independent Scientific Review Program raised the issue of results in its review of the FY07-09 project proposal. The results listed under the categories of monitoring and research are in the form of reports, or biological indices, or in some cases an interpretation of the management or conservation value of the work. The "results" for the implementation category are listed both in terms of biological and physical changes.

MONITORING

Completed Projects

1) **Kokanee Experiment : 1993-1997**

Summary:

In cooperation with the other mitigation projects in the basin, we monitored the kokanee reintroduction experiment in Flathead Lake conducted by Project No. 199101904. We quantified the survival of kokanee or the five year experiment, and measured the predation rates by lake trout on kokanee.

Results:

We determined that kokanee could not survive in Flathead Lake because of excessively high predation rates by lake trout. This work led to the termination of the kokanee experiment, and the saving of about $1,000,000 per year. This work laid the groundwork for subsequent research into the ecology of lake trout and their potential to negate efforts to recover native species in the Flathead system. We generated the following reports during this period.

Reports:

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.

Ongoing Projects

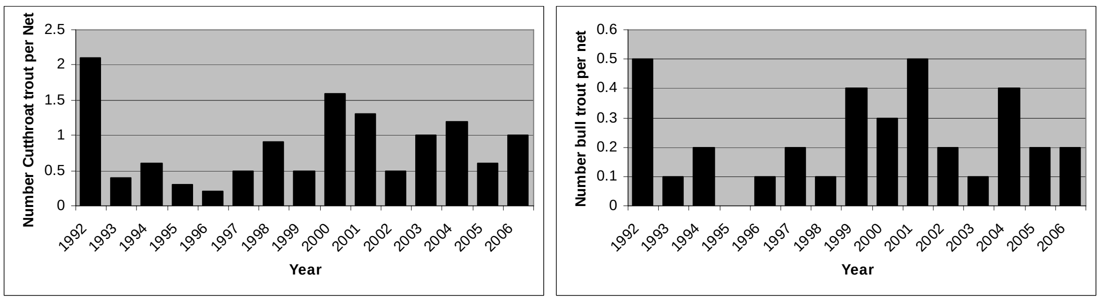
1) **Monitor native species in Flathead Lake: 1992 to present**

Summary:

We annually set six floating and six sinking gillnets in Flathead Lake in cooperation with Montana Fish, Wildlife and Parks during spring to monitor the abundance of native species. The data generated by this sampling program contributes to a long-term monitoring index of abundance of westslope cutthroat trout and bull trout in the Flathead system. This is an important monitoring tool intended to measure the effect on native adfluvial trout of mitigation projects taking place throughout the interconnected basin.

Results:

Both native trout have trended downward over the last 20 years. High sampling variability makes it impossible to discern a trend in recent years.



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, 1992-2005.

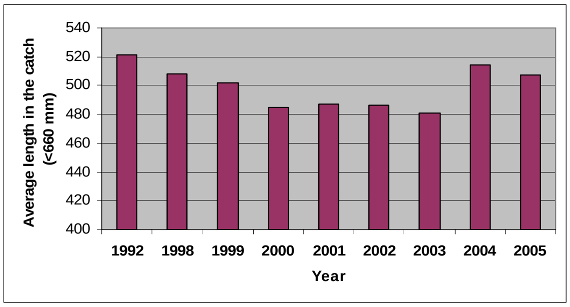
2) Monitor Flathead Lake fishery: 1992, and 1997 to present

Summary:

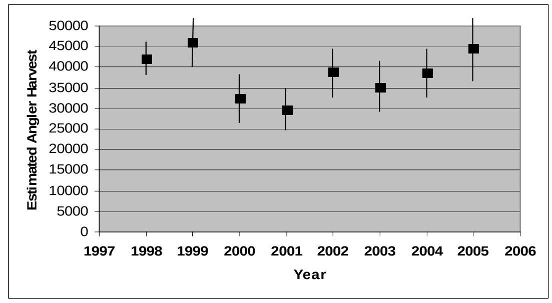
We conduct daily roving interviews of anglers to determine catch and harvest rates in addition to several other parameters. We conduct random aerial counts of boats and shore anglers to determine angling pressure. The creel survey is another tool to measure the effect on native adfluvial trout of mitigation projects throughout the interconnected basin. The survey also currently serves as a critical tool to evaluate our efforts to increase the harvest of lake trout in order to reduce that population.

Results:

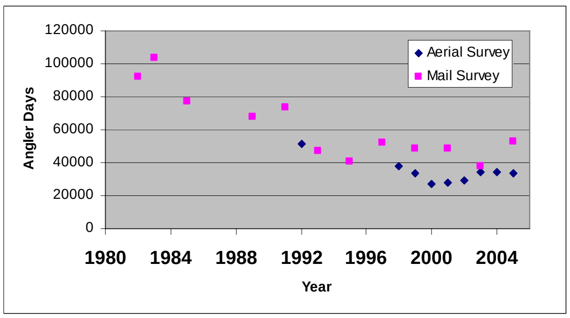
We have estimated total harvest, total pressure and catch rates in Flathead Lake annually for four species of fish. Catch rates of lake trout have uniformly increased during the sample period, while total harvest has increased only a small amount. Angler pressure has been fairly constant over the last ten years.



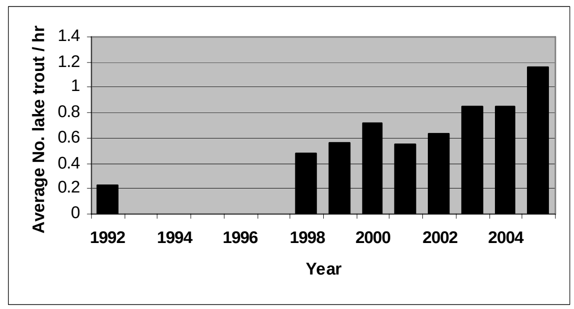
The average length of lake trout caught by anglers, 1992 to 2005.



The estimated harvest of lake trout with 95% confidence interval, 1997-2005.



Average annual angling pressure gathered both by aerial and mail surveys, 1980-2005.



Average catch rate for lake trout in Flathead Lake, 1992 – 2005.

Reports:

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.

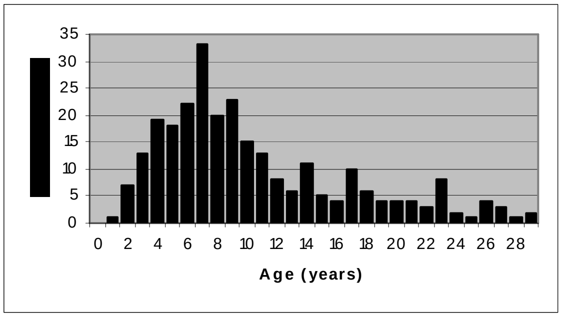
3) Monitor lake trout biology: 1997 to present

Summary:

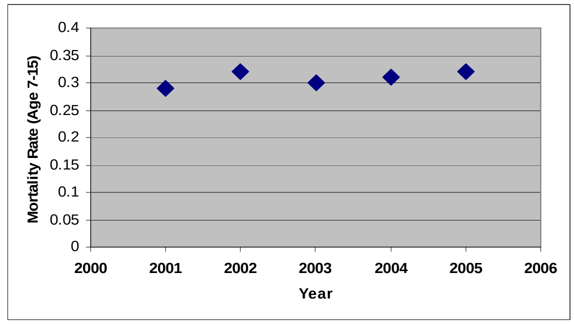
We set 48 gillnets (12 meshes per net) throughout Flathead Lake during October and November. This survey is designed to sample all benthic-oriented species and all size groups. Sample sites are selected randomly within five depth strata and five geographic strata. From these samples we are able to estimate many parameters of lake trout biology allowing us to monitor their role in the ecosystem and their potential to undermine mitigation and/or restoration projects.

Results:

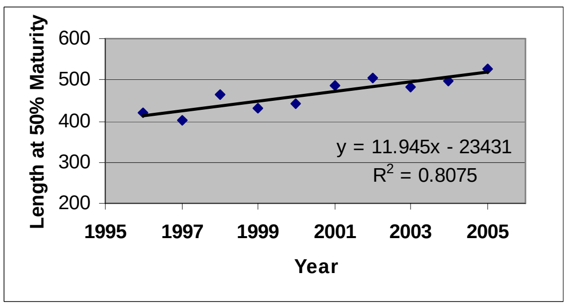
We have quantified population structure, mortality rate, growth rate, age at maturity and fecundity of lake trout since 1998. These parameters allow us to monitor the abundance of lake trout, and to measure our efforts to reduce the population. This information is critical because predation by lake trout on native trout has the potential to negate any mitigation measures conducted within the interconnected Flathead watershed. These data provide no evidence to date that lake trout abundance is declining, despite our expanding efforts to increase harvest.



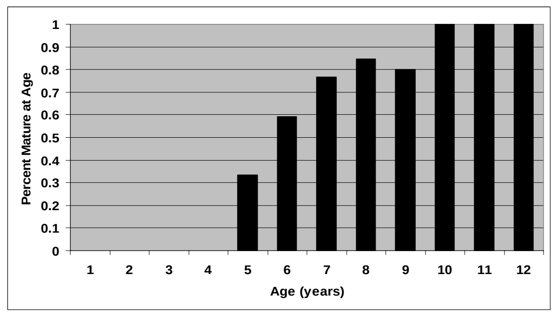
Estimated age structure of lake trout in Flathead Lake, 2005.



Estimated mortality rate of lake trout in Flathead Lake, 2001-2005.



Changes in length at maturity in male lake trout in Flathead Lake, 1995-2005.



Percent maturity of male lake trout at age in Flathead Lake, 2004.

Reports:

Confederated Salish and Kootenai Tribes and Montana Fish, Wildlife and Parks. 2006 Phase II of the Five Year Review of the Flathead Lake and River Fisheries Co-Management Plan,Technical Synopsis and Management Recommendations Section, Presented to The Flathead Reservation Fish and Wildlife Board, 31pp.

RESEARCH

Completed Projects

1) **Mysis life history and bioenergetics: 1997 – 2002**

Summary:

We compared life history characteristics (duration of lifecycle, growth rate, survivorship and fecundity) for *Mysis relicta* Löven in Flathead Lake between 1988 and 1998. Our purpose was to examine the differences between characteristics present at the height of the population explosion with those present after the population had declined and stabilized. This work focused on the cause of the population decline. This question had great bearing on whether *Mysis* were controlled from bottom-up or from top- down processes. The answer greatly influenced our understanding of the limiting factors that controlled our ability to recover native fish in the Flathead as directed by the Hungry Horse Mitigation program.

Results:

We learned, contrary to the conventional wisdom of the time, that the amount of energy available to *Mysis* as *Daphnia* was sufficient to account for the observed *Mysis* production in 2000. When considering the energy available as total macrozooplankton modeled, in 81% of the days the zooplankton production was greater than the *Mysis* energy requirement by greater than a factor of five. Similarly, during 65% of the days the zooplankton production was greater than the *Mysis* energy requirement by greater than a factor of 25. These results completely changed our understanding of the trophic dynamics of Flathead Lake. This information clarified the degree to which top-down control was acting in Flathead Lake, and the dominant role of introduced predators.

Reports:

Wicklum, D. 2001. Mysis relicta 2000: Filling (some of) the holes in our ecological knowledge. Flathead Lake Biological Station, The University of Montana. Report to the Confederated Salish and Kootenai Tribes, 26pp.

2) Mysis life history and bioenergetics: 2001

Summary:

We sought to resolve outstanding questions about the diets of *M. relicta* and the possibility that some diet components may digest too rapidly to be quantified. Bioenergetic analysis indicated that the diet consisted almost exclusively of Daphnia, a species that was greatly reduced in density relative to the pre-*Mysis* abundance. This question had to be answered to resolve whether the bioenergetic results were accurate. This information was additionally important because the conventional wisdom that was controlling management decisions was that Daphnia were too rare to support the *Mysis* population. The question was explored with controlled feeding experiments followed by gut analyses.

Results:

We learned that all lifestages of copepods are consumed by *Mysis* and that all can be observed in the foregut. These results confirmed the findings in the bioenergetics study and conclusively reinforced the understanding that *Mysis* in Flathead Lake are not forage-limited and therefore are very likely to be limited from above.

Reports:

Wicklum, D. and J.A. Stanford. 2001. The productivity of Flathead Lake. Flathead Lake Biological Station, The University of Montana. Report to the Confederated Salish and Kootenai Tribes, 14pp.

3) Bioenergetic study of the fish community of Flathead Lake

Summary:

We quantified the trophic interactions of the lake trout and lake whitefish by using population abundance, annual growth, seasonal diet, depth distribution, and temperature data during June 1998-August 2001. We used bioenergetics model simulations of size-structured, seasonal consumption rates on key prey species.

Results:

Lake trout fed heavily on mysids, fish, and other benthic invertebrates. The primary prey fishes were lake whitefish and yellow perch, followed by pygmy whitefish, lake trout, and other salmonine fishes. Predation on westslope cutthroat trout occurred during summer-fall by lake trout >375 mm TL, whereas predation on bull trout was concentrated primarily in October by lake trout $\geq$ 626 mm TL. 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 $MT \cdot yr^{-1}$). Because 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.

Reports:

Beauchamp, D., M. Kershner, 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. Washington Cooperative Fisheries and Wildlife Research Unit, University of Washington. Report to the Confederated Salish-Kootenai Tribes, 31pp.

Ongoing projects

Flathead Lakeshore erosion study: 2001 to present

Summary:

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 condition, and to test natural gravel beach designs in real environments.

Results:

We have documented erosion rates and correlated them to wave energy in concert with the full pool condition. We are mapping littoral cells that 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 wilth more simplified environments such as walled shorelines.

Reports:

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.

HABITAT RESTORATION

The monitoring section listed above addresses the large scale monitoring effort underway that operates at the basin level, concentrating on the adult stage of adfluvial trout. The following habitat-improvement projects each have their own monitoring procedures that are employed at the project level.

We excluded cattle from an over-grazed portion of Ronan Creek in 2000. Within two years channel width decreased, depth increased, and in-channel habitat diversity increased. We have not yet measured persistent increases in fish abundance. We expect that with additional time and completion of other restoration work within this watershed we will be able to measure substantial increases in the standing stock of resident fish.

Ronan Creek prior to cattle exclusion, 2000.

Ronan Creek after cattle exclusion, 2002.

We removed a corral that spanned Dayton Creek in 2000. We accommodated the needs of the rancher by means of off-channel water tanks fed by a piped infiltration system. Within two years of exclusion of cattle, the channel width decreased, depth increased, and in-channel habitat diversity increased. Fish abundance has increased within this reach.

Dayton Creek within corral, 1998.

Dayton Creek after removal of corral, 2002.

We installed a fence to exclude cattle from Thorne Creek in 2004. Improvements in channel dimension have begun. We have not yet demonstrated increased production of fish within this reach. The primary benefit of this project was to improve degraded habitat within a stream that supports an isolated population of westslope cutthroat trout that is limited in part by the small amount of available habitat.

Thorne Creek prior to cattle exclusion, 2004

Thorne Creek one year after installation of the fence.

We removed a culvert in Skidoo Creek because it frequently failed and diverted flow onto the road surface where it caused erosion and sediment delivery to the stream. We recontoured the associated road spur, eliminating the sediment-routing effect of this forest road. This action expanded the range of an isolated population of westslope cutthroat trout, and reduced the delivery rate of fine sediment to the stream. There is likely no population change that is attributable to this action, although this action should substantially improve the long term survival probability of this isolated population.

Skidoo Creek flowing down a logging road before eroding the road prism and returning to the main channel.

Same site during recontouring and slash covering.

We removed an undersized perched culvert on Kellys Creek in 2005 that eliminated both a source of fine sediments and a barrier to fish migration. This action expanded the interconnected habitat of the North Fork Jocko River system. We expect an increase in fish abundance in both Kellys Creek and the North Fork Jocko River, although this has not yet been measured.

Perched and undersized culvert in tributary to North Fork Jocko River, 2005.


Removal of perched culvert on a tributary to North Fork Jocko River, 2005.

We recontoured this road on the banks of the North Fork Jocko River in 2005. This action will reduce the fine sediment loading to the stream and partially restore the natural hydrologic processes of the watershed. We do not anticipate a measurable biological response to this action.


Road 3001 within the riparian area of the North Fork Jocko River, 2005.


Road 3001 after recontouring and placement of slash over the disturbed soil surface, 2005.

We removed a privately owned, in-channel, earthen dam on DuCharme Creek in 2002 that was acting as a fish passage barrier and as a chronic sediment source to the stream and to Flathead Lake. The project provided long-term stability to the retained sediments by constructing rock weir steps that have adequate mass to withstand large flood events. This project reconnected portions of the DuCharme stream system and eliminated an enormous potential source of sediment to the stream and Flathead Lake. We anticipate minor increases in standing stocks of fish from this action. The primary benefit is the removal of a serious threat to the water quality of the lake and this tributary.

In-channel dam on DuCharme Creek prior to removal, August 2002.

Completion of construction phase of rock weirs, August 2002.

We removed a feedlot that spanned Centipede Creek in 2002. We accommodated the needs of the rancher by means of off-channel water tanks fed by a piped infiltration system. The primary benefit from this action is reduced nutrient loading to the stream and to Flathead Lake. We have not yet measured a biological response to this action because several other limiting factors have not yet been addressed.


Feedlot on Centipede Creek, 2002.


Set-back of corral on Centipede Creek after fence construction, 2002.

We cost-shared a bank stabilization project with a landowner on Dayton Creek in May 2003. The landowner's backyard encroached on the stream and the replacement of riparian vegetation with lawn resulted in chronic bank erosion. We excavated and reshaped the vertical bank, and planted woody vegetation. This action improved habitat and reduced sediment loading to Dayton Creek and Flathead Lake, but we have not measured biological change related to this action.


Eroding vertical bank on Dayton Creek prior to reshaping.


Bank of Dayton Creek after reshaping and armoring.

We replaced a poorly designed culvert on Ronan Creek in 2001 that was in imminent risk of failure. The labor and equipment were provided by the county while the Tribes provided the new design and the materials. The poorly placed culvert had caused high flows to be routed over the road resulting in the need for chronic repairs. We rerouted the stream to create a stable approach and replaced the under-sized culvert with a bottomless arch culvert. We expect this action to result in improved passage at the site and small increases in the productivity of resident and adfluvial fish. The greatest benefit is the removal of a high-risk site that could have contributed many hundreds of yards of fine sediment to the stream and Flathead Lake.

Ronan Creek crossing at Red Lake Road prior to reconstruction.

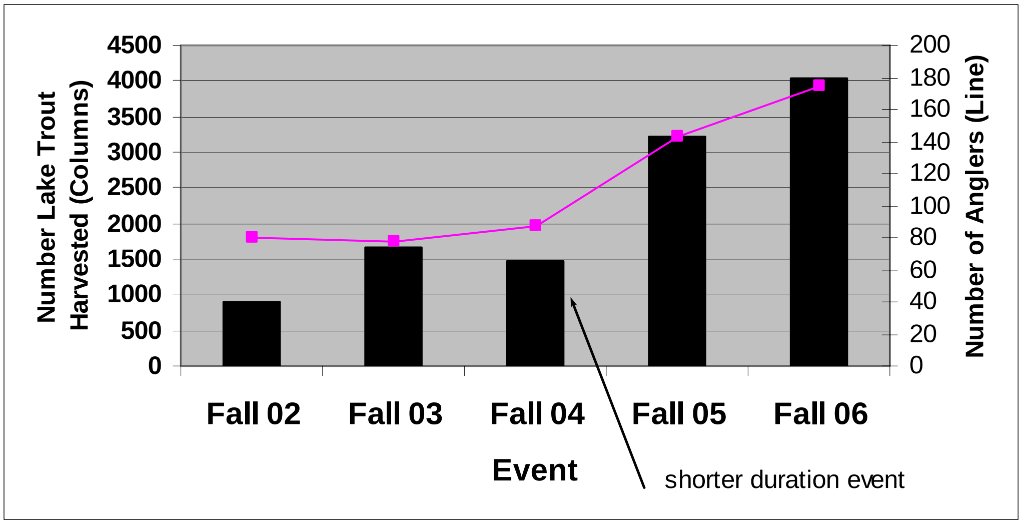
Open arch culvert and new approach channel on Ronan Creek.

We restored a segment of the west shore of Flathead Lake that was rapidly eroding in 2003. We employed dynamic equilibrium beach principles to preserve the littoral zone while eliminating the need to construct a cement retaining wall that would compromise the near-shore environment. Monitoring since construction has indicated a stable profile.

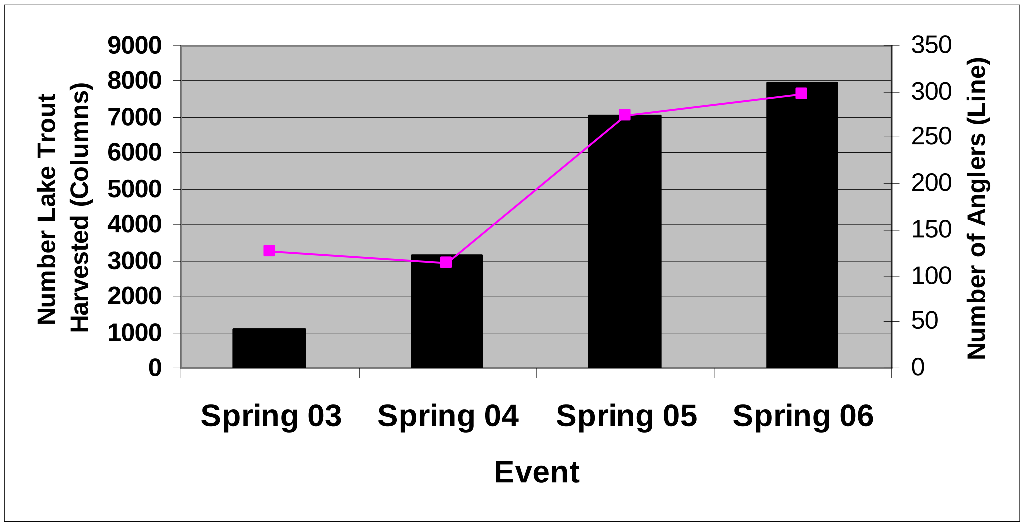
West-facing beach illustrating the eroding vertical bank.

Same beach after restoration, illustrating energy dissipation of waves as they approach the back-beach.

We have conducted nine fishing contests for lake trout in Flathead Lake since 2002. These contests have generated a total harvest of nearly 31,000 lake trout. The contests have been growing briskly and have been well received by the public. We anticipate their continued success resulting in a reduction in lake trout abundance that represents an easing of the bottleneck that currently impedes the success of all mitigation efforts conducted within the interconnected Flathead basin.



Number of lake trout harvested and anglers participating in fall fishing events in Flathead Lake, 2002 to 2006.



Number of lake trout harvested and anglers participating in spring fishing events in Flathead Lake, 2003 to 2006.