MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS
FISHERIES DIVISION
JOB PROGRESS REPORT

STATE: MONTANA

PROJECT TITLE: STATEWIDE FISHERIES INVESTIGATIONS

PROJECT NO.: F-46-R-3

STUDY TITLE: SURVEY AND INVENTORY OF COLDWATER AND WARMWATER ECOSYSTEMS

JOB NO.: V-a

JOB TITLE: FLATHEAD LAKE-RIVER SYSTEM STUDY

PROJECT PERIOD: JULY 1, 1989 THROUGH JUNE 30, 1990

ABSTRACT

A five-year fisheries co-management plan for the Upper Flathead River and Lake System in cooperation with the Confederated Salish and Kootenai Tribe was approved. Strategies described in the plan are started being implemented. Continued preparation of mitigation plans for losses in fish populations affected by hydropower development for Hungry Horse Dam through the Northwest Power Planning Council and for Kerr Dam with Montana Power Company through the Federal Energy Regulatory Commission. Project reviews, on-site inspections, and recommendations were made on 10 shoreline and 15 river habitat alteration projects to minimize impacts upon aquatic habitat in Flathead Lake and River system. Again, because of the low kokanee densities there was no summer sport fishery and a fall acoustic population estimate could not be made. A hydroacoustical survey conducted during August, 1989 estimated 22.2 million fish (222.8 fish/acre) which raised the 1989 estimate to nearly 5 times that of the 1988 estimate in Flathead Lake. Highest densities occurred along the east shoreline. An unusually large number of juvenile lake whitefish and lake trout found during this August survey in the mid-water area made up the bulk of the increase in 1989. The estimated total kokanee spawning escapement for the Flathead River system was less than 1,000 fish during 1989. Angling success for lake trout and lake whitefish was 0.4 fish/hour for commercially guided anglers and 1.8 fish/hour for non-commercial anglers from June, 1989 to May, 1990. First attempts of commercial lake whitefish sales reported sales of 844 fish weighing 1,824 pounds. Of the 3.0 million kokanee fingerlings released in the lake in 1990, 0.9 million were reared in pens, the rest reared at state hatcheries. Fingerling kokanee were distributed off shore at four southern locations. A total of 220 anglers tagged fish have been recaptured including 105 lake

trout (11.3 percent recapture rate), 90 cutthroat trout (13.5 percent), 23 bull trout (13.5 percent) and 3 rainbow trout (10.0 percent). The September, 1989 lakewide average Mysis density was $27.9/m^2$, the lowest level since 1985. The 1989 index count of 402 bull trout redds was 9.0 percent higher than the 1979-88 average count of 370 redds. Fine sediment levels increased significantly in Big Creek, a North Fork Flathead River tributary suggesting poorer trout embryo survival.

BACKGROUND

The Flathead Lake/River system located in northwest Montana consists of Flathead Lake, the main Flathead River above Kerr Dam, that portion of the South Fork Flathead River below Hungry Horse Dam, the Swan River below Bigfork Dam, the Whitefish River below Whitefish Lake, and the North and Middle Forks of the Flathead River and their major tributaries as used for spawning and rearing. The system needs to be managed as one ecosystem due to the adfluvial nature of several of the major gamefish species in the system. These adfluvial fish also interact with lake and river resident stocks, further underscoring the interdependency of the lake and river fisheries.

The major sportfish species in the lake include westslope cutthroat trout (Oncorhynchus clarki), bull trout (Salvelinus confluentus), lake trout (Salvelinus namaycush), lake whitefish (Coregonus clupeaformis) and yellow perch (Perca flavescens). The major sportfish in the river are westslope cutthroat trout, bull trout, and mountain whitefish (Prosopium williamsoni). Scattered populations of largemouth bass (Micropterus salmoides) and northern pike (Esox lucius) occur in old oxbows of the river.

Flathead Lake

Flathead Lake, measuring 125,000 surface acres, is currently the third most heavily fished water in Montana. The lake supports about 75,000 angler-days per year for trout and perch.

Kokanee (Oncorhynchus nerka) were once the predominant gamefish in the lake and abundant seasonally in the river but have declined dramatically in numbers in recent years due to a combination of hydropower impacts, predation, angling harvest and impacts from Mysis.

Flathead River

Flathead River and its forks support one of the most extensive adfluvial fishery in Montana. Westslope cutthroat and bull trout migrate as much as 140 miles to spawn in their natal stream.

PROJECT OBJECTIVES AND DEGREE OF ATTAINMENT

Lake Objectives

1. Influence management of water levels in the lake to minimize impacts on fish populations. Mitigation plans for operations of Hungry Horse and Kerr dams are being negotiated under the Northwest Power Planning Act and with Montana Power Company. Objective accomplished with state funds.

2. Maintain water quality at present levels as measured by the Montana Water Quality Bureau (WQB). Objective accomplished through the cooperative participation and review with appropriate agencies, utilizes state funds.

3. Maintain aquatic habitat at a level capable of sustaining existing fish populations. Objective accomplished through the cooperative participation and review with appropriate agencies to enforce stream and lake bed protection laws, utilizes state funds.

4. Maintain trout and salmon populations at present levels in face of projected increases of 35,000 angler days by 1992. Utilize hatchery plants if necessary. Objective attained to the degree of developing and implementing an experimental stocking strategy to restore the kokanee population by utilizing hatchery plants of 3 to 5 million kokanee fry under several rearing and release strategies.

5. Maintain the opportunity to catch large bull trout (>8 lb.) and lake trout (>15 lb.) at a catch rate of 0.1 fish/hour. Objective accomplished to the degree of developing and implementing a plan to restore the kokanee prey base and the monitoring of the seasonal lake fishery.

6. Manage for a 12-14" kokanee and a catch rate of 1 fish/hour. Objective attained to the degree of developing and implementing an experimental stocking strategy to restore the kokanee population and annual monitoring of kokanee year-class strength.

7. Develop management strategies to compensate for the introduction of <u>Mysis</u>. Objective accomplished to the degree of monitoring the annual population status of the <u>Mysis</u> population and defining effects of <u>Mysis</u> on fish populations.

8. Encourage public participation in resource issues and decisions. Objective accomplished through dissemination of information at public meetings and public input in development of a systemwide fisheries management plan.

9. Increase angler compliance with existing laws. Objective accomplished through education at public meetings and through coordinated effort of the enforcement division, utilized state funds.

10. Provide public access to popular use areas and develop more low water boat ramps. The review and implementation of development projects at existing sites and identification of sites needed for future acquisition. Objective accomplished with state funding.

River Objectives

1. Maintain, within legal limits, instream flows sufficient to maintain or enhance existing fish populations. Objective accomplished as described in the mitigation plan for operation of Hungry Horse as negotiated under the Northwest Power Planning Act. Accomplished with state funds.

2. Maintain spawning and incubations flow discharges from Hungry Horse Dam as calculated by Special Projects studies. Objective accomplished.

3. Maintain streambanks and channels in present or improved condition. Objective accomplished through the annual monitoring of streams and through the cooperative participation and review with appropriate agencies to enforce stream bed protection laws. Utilized state funds.

4. Maintain water quality at or above present levels as measure by WQB and U. S. Geological Survey (USGS). Objective accomplished.

5. Maintain fish habitat at or above present levels. Objective accomplished through the annual monitoring of spawning habitat in the main Flathead, North and Middle Fork Flathead Rivers.

6. Maintain fish populations that will provide use and harvest at present levels. Objective accomplished through the monitoring of cutthroat and bull trout populations in the North and Middle Fork tributaries.

7. Provide river access sites 4-6 hours (floating time) apart. Secure public access on currently used private ground. Objective accomplished through review of access plans in coordination with the USFS. State funded.

8. Increase public awareness of the unique nature and problems of the adfluvial fisheries. Objective accomplished through public meetings and in review of the Upper Flathead System Fisheries Management Plan.

9. Increase compliance with existing angling regulations. Objective accomplished through education at public meetings and through coordinated effort of the enforcement division. State funds.

PROCEDURES

Flathead Lake Seasonal Fishery Monitoring

Flathead Lake seasonal fishing patterns were monitored by conducting periodic angler interviews. Volunteer information was also obtained from interested anglers, professional guides and from anglers returning fish tags. Information obtained included angler effort, success and methods by season.

Volunteer Angler Tagging Program

A cooperative tagging program was continued with 8 volunteer anglers. Two individuals concentrated their tagging efforts in the river system, one marking primarily bull trout and the other cutthroat trout. Six lake anglers are deep-trollers who utilize either down-riggers or steel line outfits to catch lake and bull trout. This volunteer tagging program has continued since January, 1985.

Taggers were issued tagging kits which included a tagging gun, numbered Floy tags, scale sample envelopes, measuring tape, hanging spring-scale and data sheets.

Members of the Montana State Fishing Guide Association that operate on Flathead Lake volunteered to record information on their summer catch. A fish kill-release booklet was provided to each guide. Information requested included: date, area, species, length, weight, and description of stomach content of fish killed.

Zooplankton Abundance

We measured the abundance of the macrozooplankton species that comprise the diet of planktivorous fish at two northern stations biweekly from mid-April through May to determine the optimum release time for hatchery reared salmon fingerlings. Regular plankton monitoring (5 stations) was contracted to personnel at the University of Montana Biological Station, located at Yellow Bay. Standardized sampling techniques and equipment were used in all collections. Replicate vertical tows were made from a depth of 30 m with a 0.5 meter diameter Wisconsin net constructed of 80 micron nitex. The net was retrieved at 0.4 m/sec with an electric winch. Water temperature profiles and Secchi disk readings were obtained at each station. The samples were preserved with 95 percent ethyl alcohol. Cladocerans and copepods were identified and counted in four subsamples, using standard microscopic techniques.

The distribution and abundance of opossum shrimp (*Mysis relicta*) in Flathead Lake were determined by sampling 40 randomly selected stations in early September. This work was also contracted to the University of Montana Biological Station personnel. Fall sampling gave an estimate of year class strength, since *Mysis* has a one-year life cycle in Flathead Lake. Vertical tows, from the bottom to the surface, were made with a 1 m Wisconsin net made of 500 micron nitex.

Fish Sampling

A 420 Khz, portable echo sounder (BioSonics, Inc. - Model 105 sounder) with a through the hull mounted single 15° beam transducer was used to search for areas of fish concentrations. Survey transect data were collected while moving at 3.0 meters/sec and were preserved on a standard magnetic tape, two channel, cassette recorder. Recording threshold levels on the echogram strip chart recorder were adjusted to allow detection of fish as small as 50 mm, with the lesser scattering layer echoes being excluded. Once concentrations of fish were located with the sounder, a 2-meter fixed frame trawl was deployed to verify fish species and size.

The fall 1989 hydroacoustic fish survey and population estimate was contracted to BioSonics, Inc. of Seattle, WA. They used a dual-beam (5°-15°) echosounder that integrates fish sizes from acoustic data collected and preserved on VCR recording tape. Measurements of fish density and target strength in 5m depth intervals were made with a BioSonics Model 281 Echo Signal Processor. Fish targets to within one meter of the bottom were distinguished and counted by the computer analysis. Fish density (fish/m^3) in each depth stratum for each transect were calculated by BioSonics data processing software. The survey did not include South Bay, or nearshore areas where depth was less than 12.2 meters.

Fish abundance estimates were derived for six area strata of the lake by multiplying average fish density by surface area. Transect lengths to calculate average densities were measured during sampling with a digital knot log.

Species composition was determined from gill-net sampling and midwater trawling preceding and following the acoustic survey, August and September, 1989 respectively.

Experimental gill-nets, 6 x 125 feet, were generally set for 12 to 18 hours on the bottom and at middepth at the sample sites. Each net was constructed of equal length panels of 3/4, 1, 1 1/4, 1 1/2 and 2 inch nylon mesh. Monofilament gill nets, 15 x 100 feet, constructed with 3/4 and 1 inch mesh were also set at some midwater sites.

The 2-meter fixed frame midwater trawl was constructed of side panels of 1-1/2 and 1-1/4 inch mesh, with a 1/4 inch mesh cod end. The trawl was held open with a 6 x 6 foot frame of 1-inch iron tubing. A 200-foot 1/4 inch wire bridle connecter to the single or main 3/8 inch towing wire. We were able to trawl to depths of 110 feet. Attachment and angle control points were made on an adjustment bar. This bar was an 18-inch piece of 1 1/4 inch angle iron with holes drilled every 1 1/2 inches. This bar was welded mid-way on the vertical frame. Weights, varying from 3 to 10 pounds, were attached to the bottom corners of the frame to weight the net to fish deeper with less line. The trawl was towed at 1.9 to 2.2 knots (1.0 - 1.2 m/sec). Net depth was measured with a Benthos time/depth recorder, while speeds and distances were monitored by a knot log.

Total length and weight were recorded, and scales, otoliths, and stomach contents taken from lake trout, bull trout, lake whitefish and kokanee. Stomach contents were preserved in ethyl alcohol. Zooplankton in these samples were identified to species and counted, while other invertebrates were classified by order.

Fish otoliths were cleaned and stored dry in gelatin capsules to prevent breakage.

Age and Growth

Age was determined from scale impressions on heated acetate strips. Backcalculations were based the nomograph method or upon proportional increases of scales and fish body length (assumed constant proportion at all ages). Scale formation was set at 43 mm. Lake whitefish samples were from 1986-88, and from the late 1960's. Lake whitefish growth was compared with pre-Mysis collections using a von Bertalanffy growth model. Age interpretation from scales were verified using otoliths. Otoliths interpretations were made by the direct light technique which does not require preparation of the bones before examinations and by the breaking and burning technique (Chilton & Beamish, 1982 and S. E. MacLellan, Personnel Communication, 1989). The breaking and burning method aids in making interpretations of long lived fish, e.g., lake trout.

Pen Rearing of Kokanee

Kokanee were experimentally reared in net pens attached to a floating dock near the Flathead Lake Salmon Hatchery. Pen rearing was initiated to evaluate a method of providing larger fish for release in the lake. Five floating pens were constructed of 1/16" delta nylon mesh which was supported on 1 1/2" aluminum tubing frames, 10 x 12 feet. Three of the five pens were 10 feet deep and two were 5 feet deep. The top of each net was suspended 18 inches above the water surface by four corner floats made of styrene-filled tires. Fry were fed a ration based on 4 percent live body weight which was distributed during fifteen hourly feedings starting at 0600 hrs. Surface water temperatures were monitored daily.

Spawning Kokanee Escapement

Low level aerial flights, 500 feet above the river, were made during September and October along the upper Flathead River system to determine the extent and time that spawning kokanee were utilizing the river system. Two snorkelers counted kokanee spawners in McDonald Creek, a prime historic kokanee spawning tributary of the Middle Fork of the Flathead River, on October 20, 1989. Eight historically important kokanee spawning sites along the mainstem of the Flathead River were surveyed by boat on November 7, 1989. Lake shore spawning sites from Woods Bay to Skidoo Bay were observed from a slow moving boat for presence of kokanee on November 9 and 21.

Stream Habitat Quality and Populations Monitoring of Bull Trout and Westslope Cutthroat

Since 1982, FWP has gathered data annually from upper basin tributaries (Shepard and Graham, 1983). Much of this work has been contract funded and conducted in cooperation with the USDA - Forest Service, Flathead National Forest (FNF). FWP completed the 1989 data collection efforts using a combination of state and contract funds. Three separate contracts covered various aspects of the work:

1. Coal Creek Fisheries Monitoring Study No. VIII and Forest-wide Fisheries Monitoring Study (Weaver, 1990a). This study has been annually funded since 1983 by FNF and is ongoing in 1990-91;
2. Red Bench Fire - Streambed Composition Monitoring (Weaver, 1990b). This was a two-year contract (1988-89) funded by FNF and the USDI-Park Service, Glacier National Park; and
3. Study Module 8 - Flathead Basin Commission Cooperative Forest Practice, Water Quality, and Fisheries Study. This Module is part of a larger effort to determine if forest management in the Flathead Basin is affecting water quality or fisheries. Funding provided by the various cooperative members is administered by a cooperative board. In addition to a final report, this work may generate several manuscripts for submittal to professional journals.

Substrate Coring

We selected the original study areas based on annual observations of natural spawning. We only core sample in spawning habitat used by the fish. Coring sites are identified using a stratified random selection process. We use a standard 15.2cm (6.0 inch) hollow core sampler (McNeil and Ahwell, 1964) to collect four samples across each of three transects at each study area. In some sites we deviate from this procedure due to limited areas of spawning habitat.

Sampling involves working the corer into the streambed to a depth of 15.2cm. We remove all material inside the sampler and place it in a heavy duty plastic bag. We label the bags and transport them to the FNF Soils Lab in Kalispell, Montana, for gravimetric analysis. We sample the material in suspension in the water inside the corer using an Imhoff settling cone (Shepard and Graham, 1982). We allow the cone to settle for 20 minutes before recording the amount of sediment per liter of water. After taking the Imhoff cone sample, we determine total volume of the turbid water inside the cone by measuring the depth and referencing a depth to volume conversion table (Shepard and Graham, 1982).

The product of the cone reading (mg of sediment per liter) and the total volume of turbid water inside the corer (liters) yields an approximation of the amount of fine sediment suspended inside the corer after sample removal. We then apply a wet to dry conversion factor developed for Flathead tributaries by Shepard and Graham (1982), yielding an estimated dry weight (g) for the suspended material.

We oven dry the samples and sieve separate them into 13 size classes ranging from 76.1mm (3.0 inches) to less than 0.063mm (0.002 inches). We weigh the material retained on each sieve and calculate the percent dry weight in each size class. We sum these percentages, obtaining a cumulative particle size distribution for each sample (Tappel and Bjornn, 1983). We add the estimated dry weight of the suspended fine material (Imhoff cone results) to the weight observed in the pan to determine the total weight of material smaller than 0.063mm.

We reference each set of samples by using the median percentage smaller than 6.35mm (0.25inches). This size class is commonly used to describe spawning gravel quality and it includes the size range of material typically generated by land management activities. We test for annual changes in this size class using two-tailed Mann-Whitney tests. A portion of the Cooperative Forest Practice, Water Quality and Fisheries Study involves work on models allowing prediction of westslope cutthroat and bull trout embryo survival to emergence based on the percentage of material smaller than 6.35mm (0.25 inches) in the incubation environment.

Spawning areas where we have collected samples annually include three in the Coal Creek drainage and one area each in Whale, Big, Trail, Granite, and Challenge creeks. The 1989 contracts called for sampling two areas in Red Meadow Creek and one site each in Cyclone, Akokala, Quartz, and Morrison creeks in addition to the annual sites.

Substrate Scoring

Substrate scoring is a visual classification system for surface streambed materials developed by Crouse, et al. (1981), and modified by Leathe and Enk (1985). This method results in an index of particle size and embeddedness which has been shown to be indicative of rearing habitat quality, particularly for juvenile bull trout because of their close association with the substrate. We annually compute substrate scores for Big, Coal, North Coal, South Fork Coal, and Morrison creeks. We collected eight additional substrate scores as part of the 1989 contract work.

Redd Counts

We annually conduct bull trout redd counts in standardized sections in four major North Fork index streams (Big, Coal, Whale, and Trail) and four major Middle Fork index streams (Morrison, Lodgepole, Granite, and Ole). Surveys are conducted by crews of one or two persons, walking down the channel and classifying redds as definite (Class I) or probable (Class II). Shepard and Graham (1983) outlined the survey procedure used. We include both classes of redds in final totals, which are compared to counts made during previous years in the same stream sections. We use total counts as an annual index of spawner escapement from Flathead Lake.

Electrofishing Estimates

We make estimates of juvenile bull trout populations by electrofishing 150m (467 foot) sections in important rearing areas in the North Fork (three reaches of Coal, South Fork Coal, Big, Red Meadow, and Whale creeks) and Middle Fork drainages (Ole and Morrison creeks). We estimate cutthroat trout abundance in North (two reaches of Coal, South Fork Coal, and Red

Meadow creeks) and Middle Fork tributaries (Challenge Creek) also. Estimates of Age I and older fish are made by either the mark-recapture method (Vincent, 1971), two-pass method (Seber and LeCrey, 1967), or the removal method (Zippin, 1958). We use block nets on all sections and follow procedures described by Shepard and Graham (1983). Final estimates are compared over time by section to assess abundance trends and to obtain an idea of the range of annual fluctuation in population statistics. We made three additional population estimates as part of the 1989 contract work.

RESULTS AND DISCUSSION

Participation in Administration of Stream and Lake Bed Laws

Department personnel reviewed 15 projects under the Natural Streambed and Land Preservation Act, 6 under the Lakeshore Protection Act and 4 under the U. S. Army Corps of Engineers 404 dredge and fill permit program. Project review was coordinated with CS&KT Lakeshore Protection, Corps of Engineers, State Department of Highways, Flathead and Lake County Commissions and the Flathead and Lake County Soil Conservation District Board of Supervisors.

Mitigation for Fish Affected by Hydro-Development

Construction and operation of Hungry Horse, Kerr and Bigfork Dams have negatively affected important fisheries in the basin. Operation of Hungry Horse Dam caused an estimated annual loss of 96,300 river spawning kokanee. Operation of the dam also negatively affects the fishery in Hungry Horse Reservoir. The construction of Hungry Horse Dam in the South Fork Flathead River resulted in annual estimated losses of 65,500 migratory westslope cutthroat juveniles and 1,965 migratory bull trout adults. Operation of Kerr Dam caused a loss of an estimated 131,000 lakeshore spawning kokanee and unquantified losses of other fish species (Fraley, et al. 1989; Zubik and Fraley, 1988; Beattie, et al. 1990). Construction of Bigfork Dam blocked the Swan River for an unquantified number of migratory fish from Flathead Lake.

Mitigation for these losses is being pursued through three related processes. Mitigation for Hungry Horse Dam is being negotiated through the Northwest Power Planning Council under the Northwest Power Planning Act (NWPPA). The Department and the Confederated Salish and Kootenai Tribes will present the mitigation plan to the Power Planning Council in November,1990. A mitigation plan for fisheries and wildlife affected by Kerr Dam was presented to the Federal Energy Regulatory Commission (FERC) by Montana Power Company in July, 1990. The plan was jointly developed with the Department, Confederated Salish and Kootenai Tribes and the U.S. Fish and Wildlife Service. The Department is working closely with the Pacific Power and Light Company to address fisheries concerns relating to Bigfork Dam. Mitigation measures proposed through these three processes included: (1) stream habitat improvement and imprint planting; (2) direct introduction of hatchery juveniles into Flathead Lake and/or Hungry Horse Reservoir; (3) improved fish passage; (4) stream flow recommendations; (5) recommendations of water levels to protect reservoir fisheries; (6) installation of a selective withdrawal system in Hungry Horse Dam; (7) a fish ladder and fish screen at Bigfork Dam, and; (8) evaluation and monitoring.

The Department of Fish, Wildlife and Parks recommended 41 stream reaches, comprising 241 stream miles, for protection from future hydropower development under the NWPPA Protected Areas program. The reaches were recommended because of their values for essential spawning habitat for species of special concern, and/or for important sport fisheries. The Northwest Power Planning Council adopted the recommended stream reaches into the program in 1988.

Flathead Lake Seasonal Fisheries Monitoring

We collected angler effort and success data from twenty four parties fishing from boats during November 1989 through May 1990 (Table 1). Use totaled 84 angler days during which 330 hours were spent catching 577 fish, at a rate of 1.8 fish/hr. Lake trout was the predominant species taken (93.1 percent). Other species caught included 16 bull trout, 16 lake whitefish and 8 cutthroat trout. Angling techniques included deep trolling with steel line or down-riggers and vertical jigging, a technique that is gaining in popularity on Flathead Lake. The highest monthly angling success rate of 3.5 fish/hr was experienced during December, 1989 while the poorest success of 0.7 fish/hr. occurred in November, 1989. The highest daily catch rate occurred on 12/13/89 when 2 anglers fished 8 hours and caught 50 lake trout and 4 lake whitefish, for a success rate of 6.8 fish/hr. One-third of all parties experienced success rates higher than 2.0 fish/hr. One group of three anglers fished from shore for 3 hours during early December and caught 15 lake trout, a success rate of 1.7 fish/hr. These fish ranged is size from 1.5 to 4 pounds.

Table 1. Monthly summary of creel information collected from anglers on Flathead Lake. November 1989-May, 1990.

Date	Party	No. Anglers	Hours	Total Fish	Lake Trout	Bull Trout	Lake Whitefish	Cutthroat	Catch Rate
11/89	2	4	10.0	14	2	-	12	-	0.7
12/89	5	10	31.5	111	104	-	7	-	3.5
01/90	1	2	12.0	13	13	-	-	-	1.1
02/90	1	2	4.3	18	18	-	-	-	2.1
03/90	7	11	46.5	126	101	9	8	8	2.7
04/90	3	9	60.5	112	105	7	-	-	1.9
05/90	17	46	164.5	196	194	1	1	-	1.2
Total	36	84	329.5	577	537	16	16	8	1.8

These data suggest that fishing around Flathead Lake by boat and/or shore during the winter and spring of 1989-90 was exceptionally good. While most fish caught were in the 2 to 5 pound range, an occasional large trout was taken. Over 10 percent of all the fish weighed more than 10 pounds. The flesh of most smaller lake trout was "pink" colored and was highly rated as a delicacy and was sought by many anglers.

Anglers seeking perch in the most southern areas of the lake, Polson Bay, noted that both while ice fishing or on open water that more lake trout were being observed and caught in this shallow bay area. Most lake trout reported from Polson Bay were fish that ranged from 2 to 5 pounds. The largest reported lake trout from Polson Bay was a 9 pound fish caught off the City Dock on June 9, 1990.

Volunteer Angler Tagging Program

To date, volunteers have tagged a total of 1,882 fish: 1,090 in the lake and 792 in the river. Fish tagged in the lake included 1,005 lake trout, 84 bull trout and 1 cutthroat trout. Fish tagged in the river included 675 cutthroat trout, 86 bull trout, 30 rainbow trout (Oncorhynchus mykiss) and 1 lake trout.

The average length and weight of 167 lake trout tagged since 1 July 1989 was 29.3 inches and 12.3 pounds. A total of 85, or 50.9 percent, of the tagged fish measured 27.9 inches or less. The average length of 105 cutthroat trout tagged in the river was 16.6 inches, with the largest fish measuring 20.0 inches. One 18-inch bull trout was tagged in the river this last year.

A total of 220 recaptures have been reported since the start of this tagging program. They included 105 lake trout (11.3 percent return); 90 cutthroat trout (13.5 percent return); 23 bull trout (13.5 percent return) and 3 rainbow trout (10.0 percent return). Recapture percentage in the past has been calculated from total fish tagged divided by the number of recaptures. Present yearly figures were derived by utilizing number of tagged fish recaptured divided by the number of "available tagged fish". This value represents the number of tagged fish each year minus number of recaptures that year plus the number of tagged fish caught and then returned to the water. Use of "available tagged lake trout" gives slightly higher recaptures percentages and also allows for yearly comparison of recaptures percentages of fish tagged monthly through 4 1/2 years of this program (Table 2).

Three-fourths of the 40 lake trout returns since 1 July, 1989 were recaught in the same area they were tagged. The length of time between recaptures for all lake trout averaged 556 days (1.5 years). Slight movements exhibited by the returns showed that the large (> 10 pound) lake trout during late fall move from the mid-lake congregation area to the southeast and northern portions of the lake. They then move back again to the deep mid-lake zone the following spring. These same movements have occurred in previous seasons. Smaller sized lake trout also move from the mid-lake concentrations into shallow water along both shorelines during spring, fall and winter. Average time to recaptures was 10 days less than 1988 returns. This however, is somewhat misleading for time spans calculated yearly did not decrease but instead increased (Table 2). Annual time spans have increased from 44 days for fish tagged in 1990 to 609 days in 1986. Eleven lake trout returns have been recaptured longer than 1,000 days after tagging. The longest time between recaptures was 1,894 days (5.2 years).

When return percentages are calculated on fish tagged each month and/or year (Table 2); the percent of return is much higher that the combined total. Recapture percentages of 22.7, 17.2, 14.9 12.3, and 11.3 percent for the years 1986 through 1990, respectively. We can conclude from this that the recapture percentage is higher than previously reported and that we could expect from 15 to 20 percent return for angler caught fish after a time span of 600 days since tagging. Such a high return rate also suggests that fish are surviving angler handling and tagging. It also suggests that we are not experiencing high mortalities with our catch and release angling regulation that requires returning to water many large(>26") lake trout.

Thirty-one of all recaptured lake trout (30 percent) were released back to the water after tag number and color was noted.

Average length of tagged lake trout has decreased since 1986. The percent of the angler caught fish less than 28 inches has increased from 23.5 percent in 1981 to 50.9 percent in 1989. This suggests an increase in the number of small fish in the lake which should make more small fish available to anglers.

Since 1 July 1989, 4 cutthroat recaptures have been reported. All were fish tagged in the river system and were recaptured within 10 miles of the tagging site. Average time span for the returns this last year was 284 days with a range from 206 to 465 days.

Three of the four bull trout recaptures were from fish caught at the mouth of the Flathead River and recaptured in the lake. Average time span between recaptures of all bull trout was 435 days, ranging from 217 to 675 days. Some fish showed movements as much as 15 miles south of the tagging area. The other bull trout recapture was a fish tagged in the river that had moved up river 50 miles into the North Fork of the Flathead River, in 1,119 days.

No rainbow trout tag recaptures were reported during the period.

Table 2. Monthly lake trout tagging, recapture and percent returns data and yearly time span between recaptures, Flathead Lake, 1986-1990.

	Year	Month	Number Tagged	Number Returned	Percent Returned	Average No. Days to Recapture	Number Releases
	1986	January	0	0			
		February	0	0			
		March	9	1	11.1		
		April	0	0			
		May	91	18	19.7		
		June	43	7	16.2		
		July	6	2	33.3		
		August	4	0	0.0		
		September	2	1	50.0		
		October	0	0			
		November	0	0			
		December	0	0			
Total			155	29	22.7	609	5
	1987	January	18	4	22.2		
		February	25	5	20.0		
		March	18	3	16.6		
		April	21	4	19.0		
		May	81	8	9.8		
		June	86	12	13.9		
		July	55	8	14.5		
		August	20	2	10.0		
		September	10	1	10.0		
		October	15	0	0.0		
		November	0	0			
		December	1	0	0.0		
Total			350	47	17.1	603	13
	1988	January	7	1	14.2		
		February	6	1	16.6		
		March	3	0	0.0		
		April	2	0	0.0		
		May	33	5	15.1		
		June	25	1	4.0		
		July	27	2	7.4		
		August	29	5	17.2		
		September	26	0	0.0		
		October	27	1	3.7		
		November	0	0			
		December	10	1	10.0		
Total			195	17	14.8	477	6
	1989	January	10	2	20.0		
		February	2	0	0.0		
		March	0	0			
		April	6	0	0.0		
		May	69	2	2.8		
		June	51	4	7.8		
		July	9	0	0		
		August	0	0			
		September	18	0	0		
		October	6	0	0		
		November	0	0			
		December	41	1	2.4		
Total			211	9	12.3	265	2
	1990	January	1	53	1.8		
		February	12	1	8.3		
		March	19	0	0		
		April	3	0	0		
		May	0	0			
		June	6	0	0		
Total			93	2	11.3	44	1
GRAND	TOTAL	January	88	8	0.0		
		February	44	7	15.9		
		March	49	4	8.1		
		April	32	4	12.5		
		May	274	33	12.0		
		June	211	24	11.3		
		July	97	12	12.3		
		August	53	7	13.2		
		September	56	2	3.5		
		October	48	1	2.0		
		November	1	1	100.0		
		December	52	2	3.8		
Total			1005	105	11.3	556	27

Volunteer Catch and Kill Records

Six of twelve members of the Montana Charter Boat Association that operate on Flathead Lake volunteered to keep records of their catch from May to September 1989. Their records of 253 days on the lake showed 577 anglers expended 2,228 hours of fishing, and caught a 997 fish. A catch of 837 lake trout predominated. Other species caught included 91 bull trout, 50 lake whitefish and 2 westslope cutthroat trout. The combined average summer angling success was 0.4 fish/hr; however, daily success rates often exceeded 2 fish/hr. Four percent, or 11 of 253 trips, were termed unsuccessful because no one in the party caught any fish that day. Poorest success by all guides occurred during a period from late July to early August. The experience of the guides should increase angling success but seldom was it higher than that of experienced non-commercial anglers. Availability of guided angling trips on the lake has more than tripled the last two years and provides more opportunities to many new anglers to the lake.

The average bull trout caught was 22.2 inches long and weighed 4.5 pounds. The largest weighed 14 pounds. The average lake whitefish was 20.4 inches long and weighed 2.7 pounds. Both cutthroat trout were 14 inches in length.

The average lake trout was 26.3 inches long (783 fish) and weighed 7.1 pounds (832 fish) (Figure 1 and 2). The largest was taken off Wild Horse Island and weighed 31 pounds. Two percent of the lake trout landed weighed more than 20 pounds. About half (42.9 percent) of the fish were larger than 26 inches. (Note--fishing regulations allow seven lake trout of which only one can be longer than 26 inches.) More large lake trout were taken by guided anglers early spring, late April to mid-June. Size of catch during the rest of the summer did not favor any size group.

Guides reported information on the stomach contents on 282 lake trout (Figure 3). Stomachs from 198 fish (69.2 percent) were empty. Of the remaining stomachs checked, 79 (27.6 percent) had fish remains while 9 (3.2 percent) contained only mysids. Fish species identified in stomachs containing fish were: lake whitefish in 43 (57.3 percent); yellow perch in 26 (34.7 percent); kokanee in 6 (8.0 percent); and 4 with small unidentifiable fish (5.3 percent). Most (64 percent) of the fish feeding on lake whitefish had ingested fish 1-3 inches long. The remainder ate whitefish from 6 to 12 inches in length. Most lake trout feeding on lake whitefish were caught in the area around the Woods Bay. Lake trout feeding on yellow perch ate predominately perch from 1 to 3 inches in length. Only one 6 inch perch was reported. Lake trout utilizing yellow perch were caught in all parts of the lake. Kokanee were found in lake trout caught in the northern half of the lake. Three age groups of kokanee, ages 2, 3, and 4, were found in the stomachs. They ranged in size from 3 to 12 inches. The unidentified small fish remains were all from fish caught in the Woods Bay area suggesting that these remains were probably juvenile lake whitefish. Mostly adult sized mysids were observed eaten by the lake trout. These fish were all caught in the southern deeper mid-lake zones.

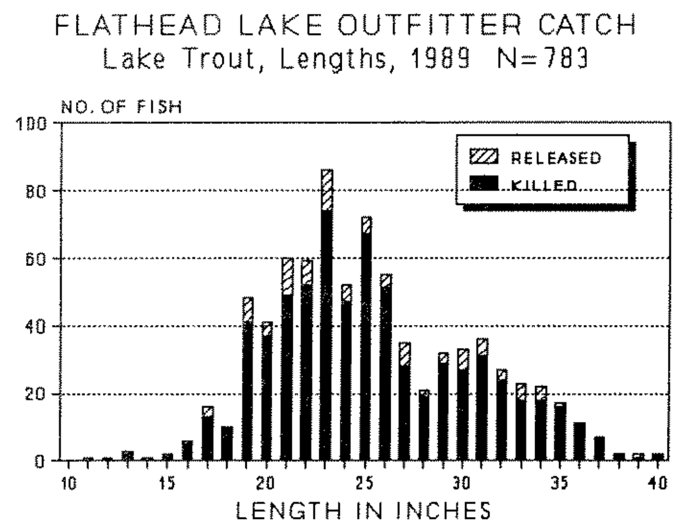

Figure 1. Length Frequency of lake trout caught by commercially guided anglers on Flathead Lake, summer, 1989.

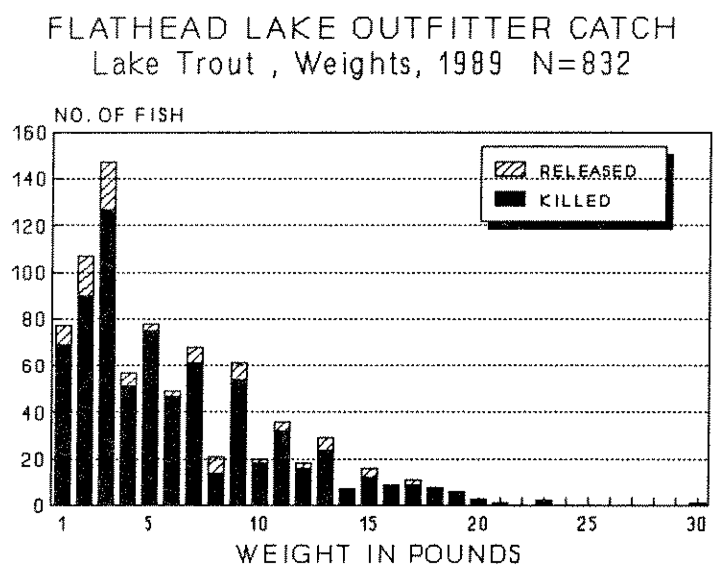

Figure 2. Weight frequency histogram of lake trout caught by commercially guided anglers on Flathead Lake, summer, 1989.

Lake Trout Length Weight Relationship

Length and weight measurements were obtained from 557 lake trout collected by gill nets, in creel checks and from guide catch data. A log regression analysis was made to predict

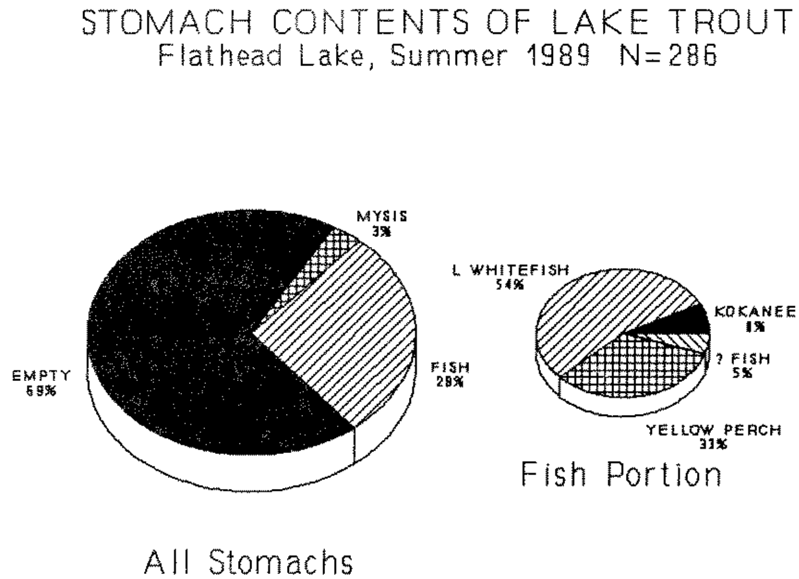

Figure 3. Stomach contents of lake trout caught by commercially guided anglers on Flathead Lake, summer 1989.

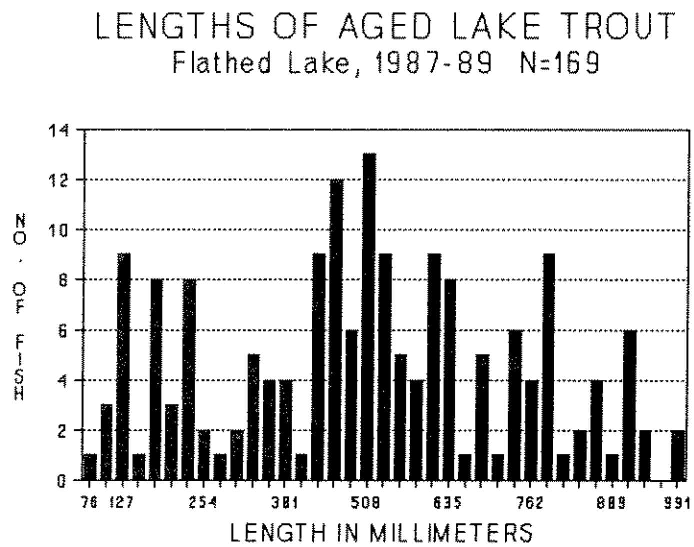

Figure 4. Length frequency-histogram of lake trout used for aging, Flathead Lake, 1987-1989.

length from weights. Following is the formula:

Fish Length = (Log of Intercept X Weight)^Slope
or
Fish Length = 2.77934 X Fish Weight$^{\wedge 0.27025}$

The analysis produces a correlation coefficient (r^2) of 0.9048 with a standard error of the estimate at 0.0816. Predicted lengths for the following weights were calculated:

2 lbs. - 19.4 inches
5 lbs. - 24.9 inches
8 lbs. - 28.3 inches
10 lbs. - 30.0 inches
20 lbs. - 36.2 inches

Lake Trout Age Analysis

An analysis of 171 lake trout scales was summarized from fish collected during 1987 to 1989 (Table 3). Ages ranged from 1 to 11 years on fish that ranged from 76 to 990 mm in length. Age determinations from lake trout scales becomes more difficult as the fish grows older. Older fish tend to grow more in girth or weight than in length. Age determinations for lake trout in Flathead Lake becomes difficult after they reach Age 7 and older. Backcalculated lengths at annulus and modes of length frequency fit well up to that age (Table 3 and Figure 4). Samples of otoliths and scales were taken from 54 fish and can be used to verify ages. Examination of otoliths were first attempted by direct lighting but failed to give reliable results in aging because the bones were too thick to pass light, rendering the early growth indistinguishable. Several otoliths were prepared by breaking and burning. Determinations from this method were better than by direct light, however, the same problems occurred with slow growth and indistinguishable annuli. Time will be spent to develop this technique before all the otoliths are altered by breaking and burning.

Table 3. Backcalculated lengths at annulus formations for lake trout, Flathead Lake, 1987-1989.

		Fish Length (mm) at Annulus Formation										
Year	No.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1987	35	98	160	175	370	382	465	543	532	624	630	
1988	58	(94)	149	285	332	458	531	679	680	823	735	728
1989	76	(113)	177	269	391	432	443	605	648	766	839	872
Combined	169	98	164	239	383	437	475	628	650	789	735	824

() = Number I+ annulus fish that year; first year lengths from II+ fish.

Commercial Lake Whitefish Fishery

A free commercial whitefish license is available for upper Flathead River system and Flathead Lake. This license allow the angler to sell their whitefish (either mountain or lake whitefish) but fish must be captured by hook and line. Commercial anglers must observe the daily and possession limit of 100 fish. The commercial sale of whitefish is an additional incentive to anglers to seek out and catch this abundant fish. Each commercial angler is required to submit a report of their sales to the Department every March, the starting date of our license year. This report must include the water from which the fish were caught, date, name of buyer and number and pounds of fish .

Two commercial reports were received during March, 1990. They reported sales of 844 lake whitefish weighing a total of 1,824 pounds. The average size of the fish sold was about 2.2 pounds. They expended 26 days to catch these fish by jigging lures at depths ranging from 45 to 180 feet. While the lake whitefish were available to the anglers from June through November, best whitefish catch rates were during late-July and first part of August. The best day of both reported anglers was a catch of 76 fish by two anglers fishing for 6 hours (12 total hours) for a catch rate of 6.33 fish/hour. Average weights of several size groups were calculated by fishermen. They were: 19-20 inch fish weighing 1.6 pounds; 20-22 inch fish weighing 3 pounds; and the "Jumbo" 24-26 inch fish weighing 4.5 to 6 pounds. The largest lake whitefish taken during the 1989 summer period was 30.0 inches long and weighed 9.4 pounds. The State record weighed 10.0 pounds and was caught in St. Marys Lake in 1987.

Lake Whitefish Growth

A comparison of pre- and post-Mysis growth rates of lake whitefish was made by Beattie, et al. 1990 and Tohtz, 1990. They found similar growth patterns in older lake whitefish. Younger fish, ages O to 3, showed slower growth for the post-Mysis years (1986-1989). Some growth compensation was exhibited by older fish.

Adult Kokanee Monitoring

Adult kokanee populations have been monitored in the past by conducting angler creel surveys during the summer fishing season and by calculating populations estimates of kokanee (10 inches and larger) using hydroacoustic techniques previously described by Hanzel (1986). Periodic creel surveys of the popular kokanee fishing areas during the summer of 1989 verified accounts of 5 adult kokanee being taken by anglers. These were reported from the west shore near Rollins and in Skidoo Bay.

Low densities of kokanee also severely hindered attempts to estimate number of large salmon using hydroacoustical techniques during early September. Over 70 miles of acoustic transects were made during early September to record fish distributions. Densities of salmon were at such low levels that a density estimate could not be made.

Hydroacoustic Estimate of Fish Abundance

A hydroacoustic survey was conducted on the lake during the nights of August 4 - 10, 1989. We estimated 22.2 million fish in Flathead Lake in August, 1989 (Table 4). This figure translates to an overall fish density of 222.8 fish/acre (550.5 fish/hectare). Because of sampling design, this estimate would primarily include species that inhabit deeper limnetic zones in the lake, i.e. bull trout, lake trout, kokanee, lake whitefish and pygmy whitefish (Prosopium coulteri). This estimate excludes those species living primarily in the littoral zone, i.e. cutthroat trout, yellow perch, squawfish (Ptychocheilus oregonensis), peamouth (Mylocheilus caurinus) and suckers (Catostomus and C. macrocheilus).

Table 4. Numbers of fish estimated from acoustic survey by fish size and lake area, Flathead Lake, August 1989.

Lake Area	Lake Area By:		Numbers of Fish by Size (Inches)						Total Fish
	Acres	Hectares	1/2	1 - 4	4 - 8	8 - 12	14 - 22	>22	
1	19829.3	7806.0	353732.7	366840.1	227636.6	59232.0	13439.2	829.6	1021710.1
2	17960.9	7268.4	612303.4	815380.3	391724.6	46627.5	14028.3	935.2	1880999.4
3	14820.5	5997.6	4175132.6	5208414.9	3102431.7	620357.1	126010.0	3877.2	13236223.5
4	28297.7	11451.5	656966.2	598912.5	341532.7	76429.1	23981.4	2616.2	1700438.0
5	11553.5	4675.5	568518.0	719237.7	415455.5	122215.7	27723.1	1952.3	1855102.3
6	8040.9	3254.0	745880.7	974517.5	589395.7	210833.1	50599.9	2811.1	2574975.2
Total	99962.8	40453.0	7112533.6	8683303.0	5068176.8	1135694.5	255781.9	13021.6	22268510.4

Fish density varied from 1.3 to 22.1 fish/100 m^2 among the six areas. The highest density occurred in Area 3 (Figure 5) which represents the east shoreline from Woods Bay to Yellow Bay out to the mid-lake bar. Small fish targets, based on target strengths less than -59 db (1/2 -1 inch in length) made up a third (31.9 percent) of the lakes' population. These small fish represented 58.9 percent of the estimate from Area 3. We are uncertain what fish would be represented by this size of fish during this season and may drop this portion of the estimate. Without this small fish group, the lake estimate would be 15.2 million or three times the numbers estimated in 1988.

The 1989 fish estimates by size group and lake area are presented in Table 4. Although targets strengths (decibel units) can be converted to an assigned fish length, converted lengths have overlapping modes disallowing a true assessment of fish sizes. It is only after converted fish lengths are doubled that you can distinguish different size groups. i.e. between 1 and 2 inch fish, 4 and 8 inch fish or 12 and 24 inch fish. Use of converted target strengths to fish size included adjacent size groupings. Such conversions are not precise and should only be used as a tool in the expansion of total fish numbers. Figure 6 illustrates the dominant number of fish in Area 3 and the abundance of the small fish targets. It also illustrates the consistency of the size groups between the other lake areas. Mid-water trawling in Area 3 at depths ranging from

40 to 120 feet found a predominant catch of juvenile lake whitefish (4 to 7 inches long). Small (6 - 8 inch) lake trout were also found sharing this midwater zone with the lake whitefish. Partial explanation for the extreme differences in fish number in Area 3 from 1988 and 1989 surveys can be understood by comparing the two echograms of the same area Figure 7. One was recorded during the August acoustic survey, the other two months later. Fish were clearly absent from the latter survey and had apparently moved or dispersed from the area after the first survey. The second or follow up acoustic survey was conducted to record late fall fish distribution patterns that could be compared to surveys conducted for kokanee, 1979 - 1985. During the second survey we found no high density concentrations of fish anywhere in the lake. The lowest average area density occurred in the northern portion of the lake (Area 1). One third of the 1989 fish population estimate was found within the 10-15 meter (32 to 50 feet) depth interval (Figure 8). The thermocline was also within this depth interval.

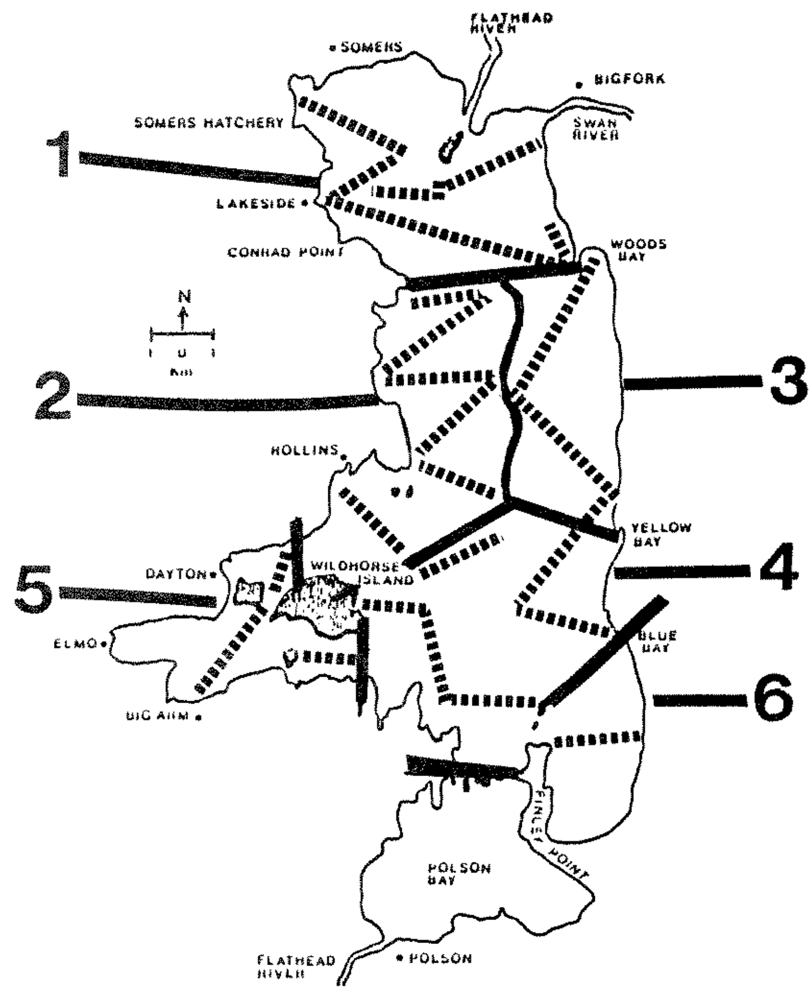

Figure 5. Map of Flathead Lake showing locations of acoustic transects and lake areas, August 1989.

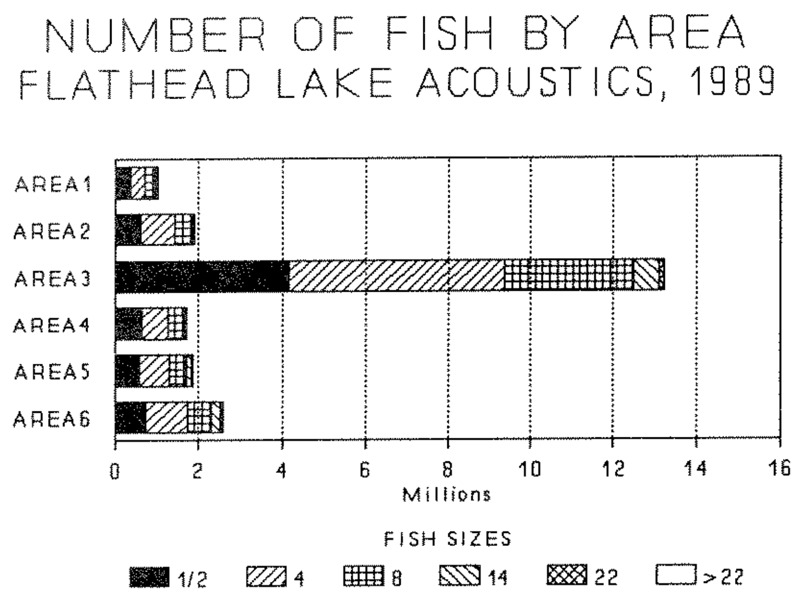

Figure 6. The number of fish by size group within six lake areas of Flathead Lake in 1989.

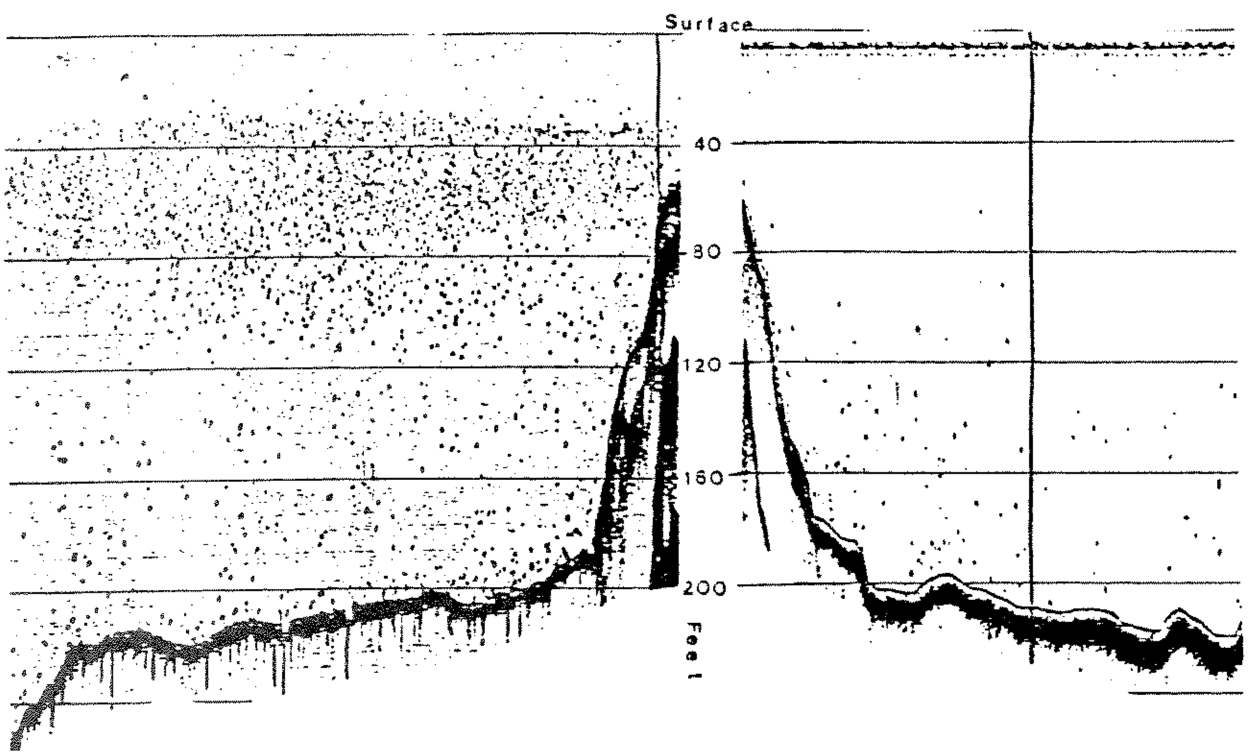

Figure 7. Acoustical echogram showing fish distributions in the same eastshore area on two dates. (Left side--August 8, 1989; right side--October 4, 1989.)

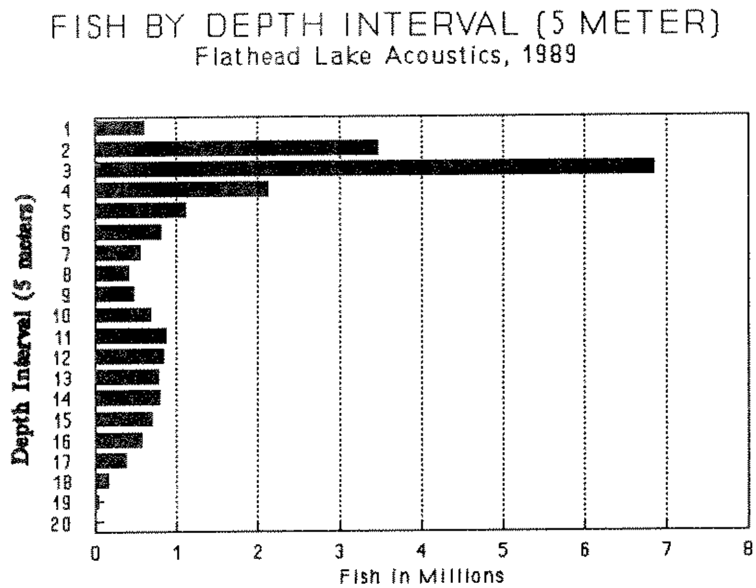

Figure 8. Numbers of fish by depth interval (5 meter) on Flathead Lake, August, 1989.

Fish targets near the bottom were summarize in relationship to that depth zone in relationship to the water surface. This method of analysis does not allow for separation or an estimation of total number of bottom oriented fish. A bottom oriented analysis can done and would be advantageous in Flathead Lake since this habitat zone is preferred by large lake trout and lake whitefish. Densities of these near bottom fish can be made by adjusting the analyzing computer to summarized targets oriented from the bottom rather than the normal analysis which is oriented to the surface. Future acoustic tape data will include a summary of fish oriented from the bottom. The 1989 tapes will be summarized again, but oriented from the bottom. This will allow comparisons of the 1989 and 1990 acoustic estimates of near-bottom fish.

Fish sampling in 24 selected areas indicated population structures similar to 1989. Bull trout comprised from 6 to 28 percent of the limnetic fish community. Lake trout made up 5 to 38 percent and lake whitefish 45 to 89 percent. No kokanee were collected during the 1989 verification sampling, thus disallowing any estimate of salmon. Pygmy whitefish were sampled along the west shoreline where they comprised 15 to 45 percent of the catch in the midwater and near-bottom zones.

The 1989 estimate of large fish targets (-39db) or fish longer than 22 inches or weighing more than 5 pounds, was 13,021 fish, about half of the 1988 estimate. Since similar instruments were use to collect the data and targets of this size would rarely be missed, selection of transect locations and fish distributional differences between years explains the low 1989 large fish estimate. The reason could also be a large decrease in the population of large fish. The importance of seasonal fish distribution patterns between years rather than harvest is partially substantiated by a very successful lake trout fishery from winter through the summer. Time of the annual survey and transect selection play an important role if comparisons of year populations are to be made.

Since we could not follow kokanee fingerlings after the mass release of 3.0 million fish during July, we concluded that these fish either experienced very high mortality during the summer or dispersed into a low overall density. Either result would preclude an estimation of their abundance. Although with kokanee population low, evidence of a higher numbers of salmon in the lake is suggested with a higher incidence of salmon being taken by the casual anglers and a more frequent occurrence of kokanee found in stomachs of the larger piscivous fish.

Kokanee Spawning Escapement

Aerial flights along the upper Flathead River system on September 25 and October 18 failed to observe any kokanee in 75 miles of the lower Flathead River. On October 17, two snorkelers failed to see any spawning kokanee in Mcdonald Creek, a prime historic kokanee spawning tributary of the Middle Fork of the Flathead River. They did however count 20 fresh kokanee redds along its reach of three miles. A boat survey of eight historical kokanee spawning sites along the mainstem of the Flathead River on November 7, 1989 enumerated 4 fish and 22 redds at the House of Mystery Site near Columbia Falls, MT. No other fish or redds were observed at the other river spawning sites.

No spawning kokanee or redds were observed, on November 9th and 21th, along the 18 miles of east shoreline from Woods Bay to Skidoo Bay. Casual observers did report some spawning fish on December 11th, below the Bigfork Dam on the Swan River.

It was estimated that the total salmon spawning escapement for the Flathead River system was less than 1,000 fish during 1989.

Mysis Monitoring

Mysis

Mysid shrimp were introduced into Flathead Lake by natural downstream drift from Swan Lake or Whitefish Lake (Rumsey, 1987). Mysid shrimp were first collected in Flathead Lake in 1981. Yearly monitoring documented the exponential increase in their abundance until 1985 (Figure 8). Mysis numbers have steadily decreased since 1986 when their numbers peaked at $132/m^2$. The lakewide average density in 1989 was $27.9/m^2$, a point below the sudden rise in the 1985 density. Mysids were most abundant in water deeper than 30 m, but their abundance varied widely in any depth range. Acoustic surveys on Flathead Lake indicate mysid distribution is patchy in all areas of the lake. Adult mysids do not migrate into the epilimnion after summer water temperature exceeds 14° C. in the surface layer.

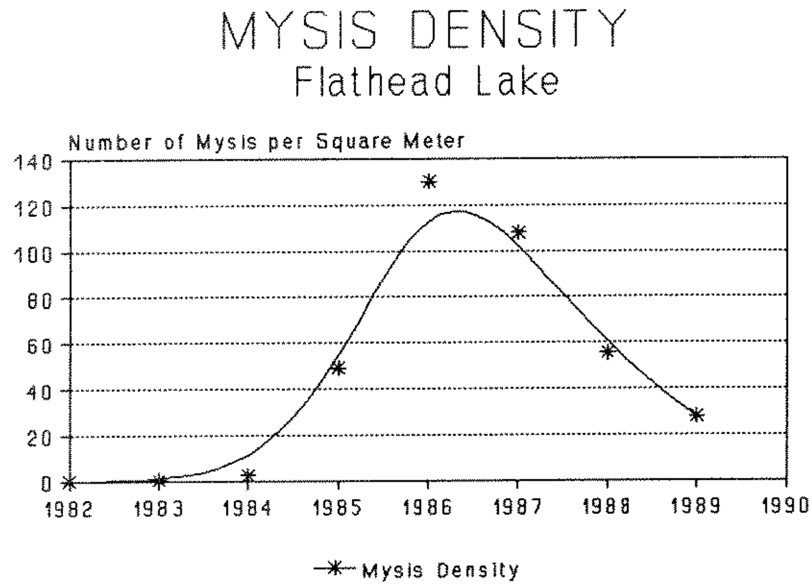

Figure 9. Average density of Mysis in Flathead Lake, 1982-1989. Line depicts trend curve of Mysis densities.

Densities and age distribution of Mysis have fluctuated. The Youngest age class has made an increasing contribution to the overall population density each year.

Artificial Kokanee Enhancement

A total of 3.0 million kokanee fingerlings were released into Flathead Lake during early June, 1990. These fish are a part of a four year experimental recovery program to plant from 3 to 5 million fish annually. The planting strategy is to hold the fish in the hatcheries until late June. Two-third of the fish planted were 3.7 inches in length, the remainder were approximately 2.3 inches long.

Present hatchery facilities were able to rear 2.6 million kokanee fry for Flathead Lake. A release date during the first week in June was scheduled when macrozooplankton at planting sites started to increase. Since plankton were more numerous in the southern areas of the lake and in locations where water depths were greater than 120 feet, four release areas were selected in the southern areas of the lake and were located in offshore areas. Release sites included Table Bay and Rollins Bay along the westshore and Yellow Bay and Blue Bay along the westshore. Fish at the release sites were transferred from the hatchery truck into 33 gallon plastic garbage cans and transferred to the off-shore release sites. Interested sportsmen volunteered the use of their boats and time to aid us in distributing salmon. After being released, most of the salmon moved directly to the deeper offshore waters. Surface water temperatures were 49° F. on planting day.

Pen Rearing of Kokanee

A total of 0.9 million kokanee were reared in five pens at the Flathead Lake Salmon Hatchery near Somers. Fish to be pen reared were in excess of available state hatchery capacity. Fry were "feed trained" in the hatchery for two weeks prior to being stocked in the pens. Fish were stocked at a density of 200,000 per net and at a size of 1,800/pound. Fish were placed in the pens on May 15 and were released at the pen site after dark on June 6, 1990.

Predation at Release Sites

To assist us in quantifying predation of the newly released fish, news of the kokanee plant was publicized through the local media to alert anglers to report the occurrence of small kokanee in the stomachs of fish they caught. There were three reports of hatchery sized kokanee being found in lake trout stomachs. All lake trout found to be eating small kokanee were caught in vicinity of a release site and occurred within 5 weeks of the plant. One report described finding 31 small (2.5 inch) kokanee in the stomach of a 5 pound lake trout. As was expected, some of the kokanee released would soon be eaten by many of the predators available in the lake; however, it is believed that the open deep water release technique reduced the immediate predation and should increase overall kokanee survival.

Stream Habitat Quality

Substrate Coring

The median percentage of substrate material smaller than 6.35mm ranged from 30.8 percent in the Trail Creek sampling area to 48.0 percent in Big Creek's sampling area (Table 5). None of our annual sampling sites showed a significant change ($P<0.05$) with the exception of Big Creek. Samples collected from Big Creek during 1989 contained significantly more ($P<0.05$) material smaller than 6.35mm than the 1988 samples. We sampled across identical transects during both years. We recommended a survey of Big Creek above or study area to attempt to identify contributing sediment sources. This is the second consecutive year that samples taken at this site have shown a significant increase in material smaller than 6.35mm.

With the exceptions of Akokala Creek, all sites sampled under the Red Bench Fire contract contained significantly less ($P<0.05$) material smaller than 6.35mm during the post-fire sampling than before the burn. At this point we cannot determine whether the changes resulted from the fire itself or from a high flow event which occurred during early November, 1989. We recommended additional sampling in these areas.

Preliminary information on embryo survival to emergence indicates that westslope cutthroat trout experience a 74 percent mortality when 40 percent of the of gravel in the incubation environment is smaller than 6.35mm. Observed mortality increased to 96 percent at 50 percent gravels smaller than 6.35mm. We could not determine when the mortality occurred. Testing with bull trout embryos yielded almost identical results at 40 and 50 percent smaller than 6.35mm. The dominant cause of mortality in the bull trout testing was entombment of alevins by high levels of material smaller than 6.35mm.

Table 5. Summary of median cumulative percentages of substrate material smaller than 6.35 mm (0.25 inches) in diameter from annual McNeil core samplings in known cutthroat and bull trout spawning areas.

Stream	Species	Year	Sample Size	Median % Sediments <6.35mm
	<u>North Fork Drainage</u>			
Whale Creek	bull trout	1981	13	26.7
		1982	11	31.2
		1983	12	32.6
		1984	12	28.9
		1985	11	19.3
		1986	12	27.6
		1987	12	27.9
		1988	12	36.9
		1989	12	35.4
Coal Creek-- Dead Horse Bridge	bull trout	1981	20	34.0
		1982	20	39.2
		1983	20	39.3
		1984	20	31.7
		1985	20	36.2
		1986	20	34.8
		1987	20	41.1
		1988	20	39.0
		1989	20	39.8
North Coal Creek	bull trout	1985	12	34.8
		1986	12	29.3
		1987	12	30.2
		1988	12	39.4
		1989	12	37.8
South Fork Coal Creek	bull trout	1985	12	35.8
		1986	12	31.1
		1987	12	31.4
		1988	12	31.4
		1989	12	36.1

continued

Table 5 continued

Stream	Species	Year	Sample Size	Median % Sediments <6.35mm
	North Fork Drainage - continued			
Big Creek	bull trout	1981	12	21.6
		1982	10	31.3
		1983	12	28.2
		1984	12	27.1
		1985	12	28.6
		1986	12	21.6
		1987	12	29.0
		1988	12	39.8
		1989	12	48.0
Trail Creek	bull trout	1981	19	23.3
		1982	19	22.0
		1983	12	27.2
		1984	12	27.4
		1985	12	26.5
		1986	12	29.2
		1987	12	27.4
		1988	12	30.0
		1989	12	30.8
	Middle Fork Drainage			
Granite Creek-- Trail Crossing	bull trout	1982	12	44.6
		1986	6	50.6
		1987	6	47.6
		1988	6	44.6
		1989	6	39.0
Other Sites		1982	--	---
		1986	8	32.6
		1987	6	39.8
		1988	6	44.0
		1989	6	44.4
Challenge Creek	cutthroat trout	1986	12	---
		1987	12	33.4
		1988	12	41.0
		1989	12	43.5

Substrate Scoring

All substrate scores calculated for 1989 were above the critical standard for juvenile rearing habitat (9.0) developed by Leathe and Enk (1985) (Table 6). Scores above 11.0 indicate good rearing habitat quality: only Coal Creek at Dead Horse Bridge and Akokala Creek had scores below this level in 1989 (Table 7). No definite trends are apparent when comparing data from previous years. All additional areas sampled under the 1989 contracts had substrate scores above 11.0 (Table 7).

Table 6. Summary of annual substrate scoring in important westslope cutthroat and juvenile bull trout rearing areas in the Flathead drainage.

Streams	Rearing Area	Year	Substrate Score
	North Fork Drainage		
Big Creek	Skookoleel Bridge	1986	12.2
		1987	11.5
		1988	11.2
		1989	11.8
Coal Creek	Dead Horse Bridge	1983	10.3
		1984	10.2
		1985	11.6
		1986	12.3
		1987	10.0
		1988	9.8
		1989	9.6
North Coal Creek		1983	14.0
		1984	12.2
		1985	13.5
		1986	14.2
		1987	13.7
		1988	13.0
		1989	12.3
South Fork Coal Creek		1985	12.8
		1986	12.0
		1987	12.2
		1988	12.0
		1989	11.8
	Middle Fork Drainage		
Morrison Creek	Reach IV	1986	12.3
		1987	12.8
		1988	12.8
		1989	13.0

Table 7. Results of measurements used to index spawning and rearing habitat condition, spawner use, and fish populations in additional areas sampled during 1989 as part of the Flathead Basin Commission's Cooperative Forest Practice Study.

Area/Drainage	Stream	MN[1]	SS[2]	RC[3]	P[4] Wct	P[4] DV
North Fork	Big Creek	48.0	11.8	24	*	83±11
	Coal Creek	39.8	9.6	50	-----	65±50
	NF Coal Creek	37.8	12.3	29	51±9	44±18
	SF Coal Creek	36.1	11.8	33	59±10	14±2
	Cyclone Creek	31.0	11.3	31	104±8	*
	Red Meadow Creek (below)	40.1	11.8	--	64±55	20±15
	Red Meadow Creek (above)	36.8	12.3	--	-----	-----
	Whale Creek	35.4	11.5	119	*	33±11
	Trail Creek	30.8	13.1	51	*	47±3
	Akokala Creek	36.6	9.2	--	-----	-----
	Quartz Creek	34.9	13.0	--	-----	-----
Middle Fork	Challenge Creek	43.5	12.4	19	137±18	*
	Granite Creek	43.2	---	31	-----	-----
	Morrison Creek	39.2	13.0	63	*	130±31
	Lodgepole Creek	---	---	43	-----	-----
	Ole Creek	---	---	21	*	45±2

[1]MN = Median cumulative percentages of substrate material smaller than 6.35mm (0.25 inches) in diameter from McNeil core sampling.
[2]SS = Mean substrate score.
[3]RC = redd counts.
[4]Population estimates and 95% confidence intervals for westslope cutthroat or juvenile bull trout in 150m electrofishing sections; * = species present but not in estimatable numbers.

Fish Population Monitoring

Redd Counts

We completed the 1989 bull trout redd counts between 27 September and 30 October. Based on the number of redds observed in the annual monitoring streams, the 1989 spawning run appeared slightly above average in the North and Middle Fork drainages (Table 8). Field crews identified 402 bull trout redds in index streams; approximately 9.0 percent higher than the 1979-1988 average annual count of 370 redds (Figure 10). We conducted bull trout redd counts in five additional spawning areas, observing 142 more redds (Table 7). There are unmonitored sections in several of the streams listed in Table 8, as well as other streams which are used by spawning bull trout. Our numbers do not represent the total annual spawning runs. We estimate our annual counts represent about 35 percent of total redd numbers.

Table 8. Bull trout redd counts for sections of tributaries chosen for monitoring in the Flathead drainage.

Stream	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
					North Fork Drainage						
Big	10	20	18	41	88	9	9	12	22	19	24
Coal	38	34	23	60	61	53	40	13	48	52	50
Whale	35	45	98	211	141	133	94	90	143	136	119
Trail	34[a]	31[a]	78	94	56	32	25	69	64	62	51
TOTAL	117	130	217	406	280	227	168[b]	184	277	269	244
					Middle Fork Drainage						
Morrison	25[a]	75	32[a]	86	67	38	99	52	49	50	63
Granite	14	34	14[a]	34	31	47	24	37	34	32	31
Lodgepole	32	14	18	23	23	23	20	42	21	19	43
Ole		19	19	51	35	26	30	36	45	59	21
TOTAL	71	142	83	194	156	134	173[b]	167	149	160	158
GRAND TOTAL	188	272	300	600	436	361	341	351	426	429	402

[a]Counts may be underestimated due to incomplete survey.
[b]High flows may have obliterated some of the redds.

We counted westslope cutthroat trout redds in two streams as part of the 1989 contract work. We found 31 and 19 migratory cutthroat trout spawning sites in Cyclone and Challenge creeks respectively (Table 7).

Electrofishing Estimates

The 1989 juvenile bull trout population estimates appeared within the range observed during past years (Table 9). The probability of first pass capture ($\hat{p}$) during this year's electrofishing in several sections was slightly lower than the recommended level of 0.60

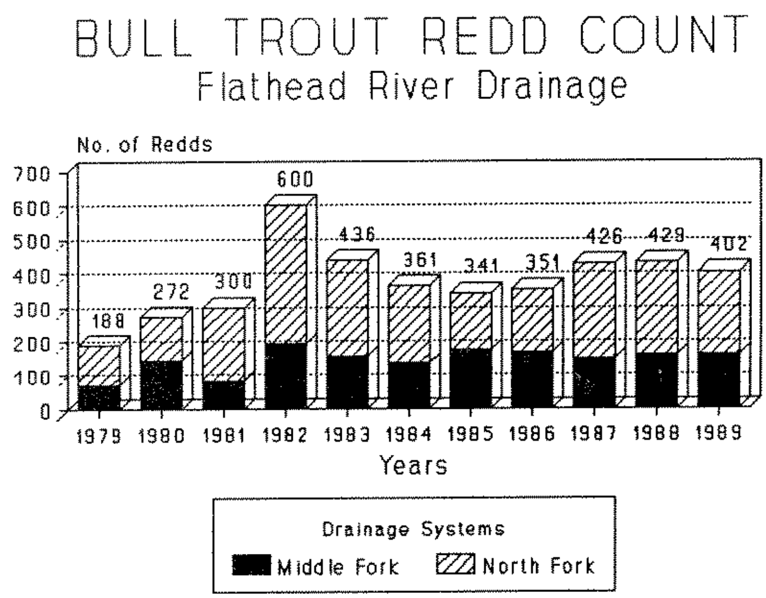

Figure 10. Number of bull trout redd counts for North and Middle Fork tributaries and combined totals for Flathead River drainage, 1979-1989.

(Shepard and Graham, 1983b). Generally, when we handle a substantial number of fish during an effort, we will make a third electrofishing run if this level of $\hat{p}$ is not obtained. Since we had adequate values of $\hat{p}$ for cutthroat trout and a considerable period of record exists for comparison, the information to be gained by a third pass did not seem to justify (Shepard and Graham, 1983b).

Westslope cutthroat trout population estimates for the Coal Creek drainage in 1989 appeared quite similar to past years (Table 10). Both sections contain substantial populations. We observed several young-of-the-year westslope cutthroat trout in the North Coal section. Spawning and incubation probably takes place in the general vicinity of the 317 Bridge, although high spring flows prevented us from detecting where.

Time-trend information collected during our eight-year study period shows considerable fluctuations in fish population statistics (Table 10). Platts and Nelson (1988) reported a similar pattern and magnitude of maximum and mean annual variation in populations of cutthroat and bull trout in their Idaho study streams. Of particular interest is the magnitude of fluctuation in estimated juvenile bull trout numbers in the two sections of Coal Creek (Table 9).

Our electrofishing section in the South Fork Coal Creek is located near the downstream end of an area where past land management activities resulted in major channel changes. A length of channel in this area was artificially straightened and deepened in the early 1970s to eliminate braiding and low summer flows. The channel area around the North Coal electrofishing section appears much more stable. Although roads are located on both sides of the stream above this site, the riparian area remains intact.

These observations suggest channel instability may result in larger fluctuations in juvenile bull trout numbers. The long-term effects of an increase in the magnitude of population fluctuations within any given stream segment cannot be adequately assessed with existing data. However, this information tends to support the selection of bull trout as an indicator species in monitoring for potential land management effects. Continuing examination of population fluctuations may yield some index value for assessing effects of land management.

Table 9. Summary of electrofishing population estimates for Age I+ bull trout in 150m sections selected for annual monitoring between 1982 and 1989.

Creek	Section	Date	Pop. Est.	95% C.I.	P Value
	North Fork Drainage				
Coal	Cyclone Bridge	08/10/82	50	±43	.40
		08/24/83	34	± 7	.71
		08/30/84	52	±13	.63
		08/10/87	18	± 3	.78
		08/16/88	18	± 3	.78
		1989	---	---	---
	Dead Horse Bridge	08/05/82	97	±23	---
		08/23/83	99	±33	---
		08/28/84	85	± 7	---
		08/26/85	159	±61	---
		09/05/86	152	±45	---
		09/01/87	179	±55	---
		09/06/88	131	---	---
		09/15/89	65	±50	---
	North Coal Bridge	08/04/82	17	± 9	.60
		08/25/83	18	± 3	.78
		08/29/84	48	±12	.63
		08/27/85	41	± 5	.77
		09/03/86	29	±12	.59
		09/05/87	47	±17	.56
		08/16/88	39	± 5	.67
		09/08/89	44	±18	.54

continued

Table 9 continued

Creek	Section	Date	Pop. Est.	95% C.I.	p Value
South Fork Coal	Section 26	08/28/85	62	± 8	.74
		08/06/87	12	± 2	.48
		08/08/88	24	± 2	.85
		09/29/89	14	± 2	.83
Big	Skookoleel Bridge	09/15/86	47	± 5	.78
		08/19/87	48	± 6	.75
		08/18/88	67	± 6	.56
		09/22/89	83	±11	.54
Red Meadow	1st Bridge RMC Rd	08/15/83	75	±11	.69
		09/16/86	69	± 8	.74
		08/18/87	47	± 4	.82
		10/28/88	44	±19	.54
		09/09/89	20	±15	.50
Whale	Shorty Creek	08/22/83	38	± 8	.69
		09/04/86	32	---	.74
		08/13/87	63	±17	.60
		1988	---	---	---
		09/25/89	33	±11	.60
	Middle Fork Drainage				
Ole	Fielding Trail	09/13/82	25	±12	.57
		09/12/86	39	± 5	.76
		08/27/87	42	±14	.60
		1988	---	---	---
		10/12/89	45	± 2	.90
Morrison	Reach IV	09/01/82	95	± 6	.82
		08/1983	70	±11	.69
		09/25/85	93	±27	.54
		08/27/86	114	±15	.67
		08/25/87	138	±10	.76
		08/30/88	126	±15	.69
		08/23/89	130	±31	.56

Table 10. Summary of electrofishing population estimates for Age I+ westslope cutthroat trout in areas for monitoring between 1982 and 1989. Data are from Weaver and Fraley (1988), MDFWP (1988) and FNF (1988).

Creek	Section	Date	Pop. Est.	95% C.I.	P Value
		North Fork Drainage			
Coal	Cyclone Bridge	08/10/82	41	±18	.55
		08/24/83	17	± 7	.64
		08/30/84	25	±11	.56
		08/10/87	23	± 2	.66
		08/16/88	25	± 6	.70
		1989	---	---	---
	North Coal Bridge	08/04/82	32	± 6	.74
		08/25/83	27	± 4	.82
		08/29/84	31	± 9	.65
		08/27/85	36	±12	.33
		09/03/86	40	±11	.64
		08/05/87	63	± 2	.91
		08/16/88	51	± 9	.69
		09/08/89	51	± 9	.69
South Fork Coal	Section 26	08/28/85	63	±35	.33
		08/06/87	43	± 4	.47
		08/08/88	43	± 3	.83
		09/29/89	59	±10	.67
Red Meadow	1st Bridge RMC Rd.	08/15/83	121	± 5	.46
		09/16/86	69	±12	.63
		08/18/87	58	± 4	.88
		10/28/88	75	±18	.60
		09/09/89	64	±55	.38
		Middle Fork Drainage			
Challenge	Skyland Rd. Bridge	09/23/80	90	±33	---
		07/18/81	183	±50	---
		07/15/82	78	± 5	.82
		07/22/83	66	± 7	.76
		08/28/86	112	± 9	.76
		08/24/87	209	± 9	.80
		08/31/88	152	±18	.66
		08/24/89	137	±18	.66

The fact that westslope cutthroat trout populations in the same sections do not respond similarly to bull trout is probably due to differences in habitat preferences between the two species. Juvenile bull trout are extremely substrate oriented; westslope cutthroat trout typically occupy positions higher up in the water column.

Activity assessment and risk analysis information is being collected as part of the current Flathead Basin Commission's Cooperative Forest Practice Study. As this information becomes available, fluctuations in the various fish population statistics may become more meaningful in determining how various land management activities or specific forest practices may or may not relate to the fishery. The importance of a continuous period of record cannot be overemphasized.

RECOMMENDATIONS

1. Negotiate Flathead Lake level management or mitigation with BPA through the Northwest Power Planning Act and with Montana Power Company to maintain levels that are sufficient to maintain or enhance fish populations at existing levels.

2. Proceed with the implementation of the strategies of five-year Flathead River and Lake Fisheries Management Plan with the cooperation of the CS&KT.

3. Evaluate the feasibility of using artificially reared late-summer kokanee releases in the lake in an effort to restore and increase kokanee numbers to meet angler demands. Assess and identify the impact of the Mysis population in the lake on kokanee and other fish species.

4. Monitor trout species in the lake and river to evaluate the effectiveness of present regulations in regulating harvest and to monitor present growth conditions. Acoustical data should be summarized by depth intervals oriented to both the surface and to the bottom.

5. Annually monitor the bull trout spawning escapement by enumerating redds on selected streams in the North and Middle Fork River drainage as part of a system population evaluation.

6. Monitor bull, cutthroat and lake trout populations through a cooperative angler tagging program to establish annual population status levels and catch rates to aid in the maintenance of fish populations that can sustain acceptable use and harvest levels.

7. Annually monitor stream bottom substrate composition and population estimates of juvenile bull trout and cutthroat trout on selected streams in the North and Middle Fork River drainage to assess fish embryo survival as stream environments change resulting from man's activities.

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Date: September 13, 1990

Waters Referred to:

Akokola Creek 08-0110
Big Creek 08-0680
Challenge Creek 08-1420
Coal Creek 08-1620
Flathead Lake 07-6400
Flathead River 07-1560
Granite Creek 08-3080
Lodgepole Creek 08-4240
Middle Fork Flathead River 08-4740
Morrison Creek 08-4940
North Fork Coal Creek (no code)
North Fork Flathead River 08-5100
Ole Creek 08-5150
Quartz Creek 08-5650
Red Meadow Creek 08-5760
South Fork Coal Creek 08-6620
Trail Creek 08-7330
Whale Creek 08-77

Key Words: Flathead Lake, Flathead River, Co-Management Plan, kokanee, bull trout, lake trout, westslope cutthroat trout, pen-rearing, Mysis, substrate sediments.