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

STATE: MONTANA

PROJECT TITLE: STATEWIDE FISHERIES INVESTIGATIONS

PROJECT NO.: F-46-R-1

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, 1987 THROUGH JUNE 30, 1988

ABSTRACT

On-site inspections, project reviews and recommendations were made on 10 percent of the 275 shoreline and 9 river projects to minimize impacts upon aquatic habitat in the Flathead Lake and River System. A total of 2,746 angling hours or 643 angler days were expended on Flathead Lake during the spring "river mouth" fishery. Anglers caught 0.20 fish/hour and harvested 0.07 fish/hour. The total harvest included 120 bull trout, 44 lake trout, and 22 cutthroat trout. Ten volunteer anglers tagged 567 lake trout, 152 bull trout, 479 cutthroat trout, and 26 rainbow trout in Flathead lake and River. A total of 132 recaptures have been reported and include 72 cutthroat trout (15.0 percent return), 42 lake trout (7.4 percent return), 15 bull trout (9.9 percent return), and 3 rainbow trout (11.5 percent return). Summer kokanee angling and fall acoustic estimates could not be made because of the low densities of adult kokanee in the lake. Increased grazing pressure from mysid shrimp has changed the zooplankton community of Flathead Lake. Two cladocerans, _Daphnia longiremis_ and _Leptodora kindtii_, disappeared from the zooplankton community in 1986. The peak density of _Daphnia thorata_, the preferred food of kokanee, has declined from 4.7/l in 1983 to 0.9/l in 1987. The standing crop of the copepod _Diaptomus ashlandi_, the most abundant macrozooplankter in Flathead Lake, has also declined markedly. This species comprises a major part of the diet of kokanee in the winter and early spring. Young-of-the-year (YOY) kokanee food preference has not changed from _D. thorata_, however, when their numbers were low in the late spring and early summer has forced them to rely on the copepods _Dipatomus_ and _Epischura_ until June. The diet of older kokanee has not changed markedly since 1981 as they prefer _D. thorata_ and eat more efficiently. Mysid shrimp only occurred in adult kokanee stomachs during the winter period, and these were all juvenile shrimp. The mean length of both YOY and yearling kokanee collected in July and August was less than those collected in the same period in 1986. These subtle declines in growth rate corroborate our assumption about food limitation affecting juvenile fish. Juvenile mysids are a predominant food item in the diet of adult lake whitefish

during the summer period, while cutthroat trout utilized adult mysids only during the winter period. Lake trout ate mostly kokanee despite low population levels. Adult bull trout shifted from kokanee to other fish species; mysids were rarely eaten. A total of 17,956 (±2,541) angling hours (representing 6,690 angler days) were expended on the North Fork River during the summer of 1987. Catch rate averaged 0.53 fish/hr. Anglers killed 42.7 percent of the fish they caught. Cutthroat trout comprised 82.6 percent of the fish harvested followed by mountain whitefish (9.5 percent), bull trout (6.0 percent), and other fish (1.9 percent). North Fork anglers caught 8,738 cutthroat trout, 426 bull trout, 391 mountain whitefish, and 79 other fish. Stream habitat and populations of westslope cutthroat and bull trout were monitored by substrate coring, substrate scoring, electrofishing estimates, and redd counts. The 1987 count of 277 bull trout redds in the North Fork drainage was about 30 percent higher than the 1979-1986 average of 216 redds. The count for the Middle Fork drainage (149 redds) was slightly higher than the 1979-1986 average of 140 redds. Population estimates for juvenile westslope cutthroat trout in 1987 were the highest on record for the North Fork of Coal Creek (North Fork drainage) and Challenge Creek (Middle Fork drainage). Juvenile bull trout densities were the highest on record in Coal creek and Morrison Creek. A draft of a five-year fisheries co-management plan for Upper Flathead River and Lake System, in cooperation with the Confederated Salish and Kootenai Tribe (CS&KT) was completed, and will soon be available for public review. Preliminary mitigation, compensation, and protection alternatives were developed for losses in fish populations affected by hydropower development by Hungry Horse and Kerr Dams pursuant to the Northwest Power Planning Council's Fish and Wildlife Program.

BACKGROUND

The Flathead Lake/River system 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 resident stocks, further underscoring the interdependency of the lake and river fisheries.

The major sportfish species in the lake include westslope cutthroat trout (*Salmo clarki lewisi*), kokanee (*Oncorhynchus nerka*), 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, kokanee, and mountain whitefish (*Prosopium williamsoni*). Scattered populations of largemouth bass (*Micropterus salmoides*) and northern pike (*Esox lucius*) occur in old oxbows of the river.

Although they are interdependent, the lake and river systems also have some unique problems and objectives and the following discussion will follow each system separately.

Flathead Lake

Flathead Lake is currently the third most heavily fished water in Montana. The lake supports about 75,000 angler-days per year for trout and salmon. Fishing pressure is expected to increase to 100,000 mandays by 1990 if the salmon fishery recovers.

Kokanee populations have declined in recent years in part because of the impact of fluctuating lake levels on lakeshore spawning success. There is also concern that nutrient loading and residential development along the lakeshore will degrade water quality and impact fish populations. Overharvest by anglers has also impacted the number of salmon in some segments of the fishery and variable natural recruitment has not always produced the desired size of salmon due to density dependent growth. There is also concern that the recent introduction of *Mysis* will dramatically impact kokanee numbers or growth.

There is also concern that overuse and overharvest is affecting the quantity and quality of lake trout fisheries. Anglers want an increased opportunity to catch large lake and bull trout. There is also the concern that non-native species will impact existing native populations of species of special concern (westslope cutthroat trout and bull trout).

As use of the fisheries increases, regulations will need to become more complex to sustain the fishery and noncompliance with regulations may interfere with meeting fishery objectives. Increased use will also put more pressure on access sites and some sites on private ground may be closed.

Development of other resources may destroy spawning habitat and diminish water quality. The public needs to become more informed on resource issues and to participate more in management decisions.

Flathead River

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

Habitat loss is a primary concern since the entire lake/river fishery is essentially dependent on natural reproduction. It is therefore crucial to maintain spawning and rearing habitat by preventing or mitigating the impacts of land and water use that diminish water quality or quantity, alter streambeds and banks, or destroy fish habitat. Angling harvest must also be controlled to ensure adequate spawning escapement and to maintain populations of species of special concern (westslope cutthroat trout and bull trout).

As angling use grows, additional access will have to be developed and regulations may become more complex. Angler compliance with regulations will become more important in meeting fishery objectives.

The public will have to be encouraged to become more involved in resource issues as other agencies increase their resource development activities. The public will also have to be involved more in fish management programs to build support for the programs.

PROJECT OBJECTIVES AND DEGREE OF ATTAINMENT

Lake Objectives

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

2. Maintain water quality at present levels as measured by the Water Quality Bureau (WQB). Objective accomplished through the cooperative participation and review with appropriate agencies to enforcement of stream and lake bed laws, 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 enforcement of stream and lake bed 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 a short-term plan to restore the kokanee population by utilizing hatchery plant of from 3 to 5 million kokanee fry.

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 short-term plan to restore the kokanee population and the monitoring of the spring bull trout fishery in the lake near the mouth of the Flathead River.

6. Manage for a 12-14" kokanee and a catch rate of 1 fish/hour. Objective attained to the degree of developing and implementing a short-term plan to restore the kokanee population by utilizing hatchery plant and the gathering and analyzing annual monitoring of kokanee year-class.

7. Develop management strategies to compensate for the introduction of *Mysis*. Objective accomplished to the degree of monitoring the annual population status of the *Mysis* population and inroads to the areas of serious impacts the *Mysis* have on other fish populations.

8. Encourage public participation in resource issues and decisions. Objective accomplished through dissemination of information at public meetings and through co-management plan review.

9. Provide public access to popular use areas and develop more low water boat ramps. Objective accomplished through area selection and review of plan development of boat ramp near Bigfork and recreational area development near Somers which utilized state funds.

River Objectives

1. Maintain, within legal limits, instream flows sufficient to maintain or enhance existing fish populations. Objective accomplished to the degree as described in the mitigation plans for operations of Hungry Horse and Kerr dams as is being negotiated under the Northwest Power Act and with Montana Power Company, utilized state funds.

2. Maintain spawning and incubations flow discharges from Hungry Horse Dam as calculated by Special Projects studies. Objective accomplished to the degree as described in the mitigation plans for operations of Hungry Horse and Kerr dams as is being negotiated under the Northwest Power Act and with Montana Power Company.

3. Maintain streambanks and channels in present or improved condition. Objective accomplished through the annual monitoring of waters to maintain existing or prescribed levels of water quantity and quality; and through the cooperative participation and review with appropriate agencies to enforcement of stream and lake bed 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 through the annual monitoring of waters to maintain existing or prescribed levels of water quantity and quality.

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

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

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

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

9. Increase compliance with existing angling regulations. Objective accomplish through education at public meetings and through coordinated effort of the enforcement division, utilized state funds.

PROCEDURES

Flathead Lake Spring Bull Trout Fishery

A partial angler census was conducted on Flathead Lake from 19 March through 27 May 1988 in an area surrounding the mouth of the Flathead River to measure angler pressure and harvest. The modified version of the direct interview and count technique established by the Montana Department of Fish, Wildlife and Parks (MDFWP) (McFarland and Roche 1987) was used.

Census data was collected and analyzed in biweekly intervals (a total of five sample periods) with weekend and weekdays treated separately. Sampling schedules were randomly selected with at least two days per sample period.

Pressure data was gathered as instantaneous angler boat counts made from a high vantage point located on a rock outcrop above Bigfork, Montana. Although the entire area was visible to the naked eye, binoculars (7x35 mm) were used to make the boat counts. Three counts were made per day with starting times (0700-0900 hours) staggered one hour, and then continued every 4-hours. Because of the ease of counting the contracted observer made 192 counts on 69 days of the 70 day season. The average party size was determined from the interview data.

Boat interviews were made on a party basis. Interview information included: number of anglers per boat, origin, trip completed or not, fish species preference (if any), and the number of fish caught, kept and released. Information on fish size and growth was limited and will not be summarized here.

Interviews were made on 11 days, representing 6 weekend days and 5 weekdays, with no holidays occurring during the census.

Data gathered were entered into the Department's computer system and analyzed. Average catch rates by species were calculated for the entire 70-day census. Pressure estimates were obtained by calculating the average number of anglers per count and expanding it by the fishable hours per day and the number of days per period. A 12-hour fishing day was used for the analysis.

Volunteer Angler Tagging Program

The cooperative tagging program was continued with 10 volunteer anglers who release many fish they catch in the Flathead system. Two individuals selected concentrated their tagging efforts in the river system, one marking bull trout and the other primarily cutthroat. Eight lake anglers represent 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 recording sheets.

Zooplankton Abundance

We measured the abundance of the macrozooplankton species that comprise the diet of planktivorous fish at six stations on Flathead Lake. The sampling stations were chosen to represent shallow, near shore, and limnetic fish habitats. Samples were collected biweekly from May through September. Replicate tows were made from a depth of 30 m with a 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 25 randomly selected stations in early September. Fall sampling gave an estimate of year class strength, since Mysis relicta 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. Zooplankton sampling sites are on file at MDFWP Region One Fisheries.

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 areas of fish concentrations. Survey transect data were collected 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 0.5 inches, with the lesser scattering layer echoes being excluded. Once concentrations of fish were located with the sounder, a 4-meter box trawl was employed to verify fish species and size.

The single towing line mid-watertrawl was constructed of side panels of 1 1/2 and 1 1/4 inch mesh, with a 1/4 inch mesh cod end which was fixed with a detachable screened bucket. The trawl was opened with a pair of 2 x 4-foot otter boards attached to the mouth of the net by three 40-foot legs. A 200-foot bridle, 1/4 inch wire, preceded the boards. The main towing wire was 3/8 inch wire with a length capable of trawling at depths to 110 feet. The trawl was towed at 1.9 knots (1.0 m/sec). Net depth was measured with a Benthos time/depth recorder, while speeds and distances were monitored by a knot log.

Juvenile kokanee and lake whitefish were collected primarily from the northwest quadrant of Flathead Lake with the mid-trawl. Gill nets set overnight in the thermocline collected yearling and older fish. Trawl hauls, all conducted at night, were directed to sampling young-of-the-year fish, though older fish were also captured incidentally. Periodic seasonal bottom set gill nets and creel checks provided the additional fish samples used in the food item summary.

Total length and weight were recorded, and scales, otoliths, and stomach contents taken from all 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.

Approximately half of the stomachs collected, were preserved and analyzed in the lab; the remainder were field checks where stomach content data included a tabulation of occurrence of food items.

Kokanee otoliths were cleaned and stored dry in gelatin capsules before embedding them in Spurr's Medium. This epoxy matrix prevented breaking the otoliths while grinding them for microscopic analysis. Saggittal sections of the otoliths (saggittae) were ground on 600 grit emery paper to the depth of the sulcus, and then polished on 1500 grit jewelers' paper. The radius of successive daily growth increments was measured along the dorsal axis of each otolith by projecting the 1000x image onto a video display with a Dage-MTI Model 66 camera. Increment radii were then measured by hand on the video image.

Compiling the data from each year class yielded a linear relationship between otolith radius and fish length. The growth history, and average growth rate, of individual fish could then be back-calculated from the successive increment radii (Brothers 1987; Bradford and Geen 1987). The daily periodicity of the otolith increments was verified on fish held for 30 days in aquaria at the Somers Hatchery (Beattie et al. 1988).

Pen Rearing of Kokanee

Experimental pen rearing of kokanee was conducted in the lake waters offshore from the Flathead Lake Salmon Hatchery. Pen rearing was initiated to evaluate a method of providing larger fish for release in the lake. The lake pens would alleviate the necessity for large hatchery rearing raceways. Two floating pens were constructed of 1/8" delta nylon which was supported on 1 1/2" aluminum tubing frames, 10 x 20 feet and 20 feet deep. The top of each net was suspended 18 inches above the water surface by four corner floats made of styrene-filled tires. Pens were covered with 1" plastic netting to exclude predators. Automatic fish feeders fed the fry a daily ration of 4 percent live body weight during six 30-second feeding periods which were regulated by a timing clock.

Two lots of 400,000 kokanee each were test reared in the pens. The first rearing was conducted from 4 May through 4 June 1987. The second lot started on 9 June and had to be released prematurely on 23 June with the onset of high mortalities brought on by a bacterial gill infection. Both groups of fry were marked by feeding doses of T-50 oxytetracycline mixed into the feed. The first group received the drug for six days prior to release, and the second group for four days.

Water temperature, at the surface and at the bottom of the pens, was recorded by a Taylor multiprobe recording thermograph. Pens required periodic cleaning with stiff brushes to reduce algal growth.

Pressure and Harvest Procedures North Fork of the Flathead River

A census was conducted on the North Fork of the Flathead River from 24 May through 7 September 1987 to measure angler pressure and harvest. The procedure used was a modified version of the direct interview and count technique established by the MDFWP (1985). This creel program was designed to measure efforts of both boat and shore anglers. The work was accomplished by one person, who was both the interviewer and angler/boat counter. Although the census was started after the first two weeks of the fishing season on this river, starting on 16 May, little angling pressure was missed since this was the run-off season when the river runs turbulent and roily.

Census data was collected and analyzed in biweekly intervals (a total of 8 sample periods) with weekend and weekdays treated separately. Sampling schedules were randomly selected for the 8 two-week periods with each sample period. The first 4 sample periods were represented by 4 weekday and 2 weekend days, while the remainder of the sample periods were represented by 1 weekday and 1 weekend day for a total of 34 sample days during the 107-day season. Holidays were treated as weekend days and included Monday, 25 May (Memorial Day), Saturday, 4 July (Independence Day), and Monday, 7 September (Labor Day).

The river was divided into three sections to assess differential use patterns. Sections were the same as previous North Fork Census conducted in 1975 (Hanzel 1977) and 1981 (Fredenberg and Graham 1982). Popular boat access and floating times on the North Fork of the Flathead River are listed in Table 1. Section #1, located in the lower 18 miles (29 km) of river, included the river from Blankenship Bridge to Camas Creek. Section #2, the mid area 15 miles (25 km) in length, included areas from Camas Creek to Polebridge, and Section #3, the upper 25 miles (40 km), included the river from Polebridge to the Canadian Border. This river was designated part of the National Wild and Scenic Rivers System in 1976. Section #1 is classified as "Recreational", while Sections #2 and #3 are designated as "Scenic".

Table 1. Popular boat access points, river location and raft floating times on the North Fork of the Flathead River; float times determined between an access point and the next lower area.

Popular Boat Launching Sites	Mile[1] Post	Floating Times[2] Peak	Average	Low
		- - - -in hours- - - -		
Canadian Border	59	1.58	4.0	6.0
Ford R. Station	45	1.75	3.0	4.0
Polebridge	34	2.50	5.0	6.0
Big Creek	16	1.25	2.5	4.0
Glacier Rim	4	0.58	1.5	1.5
Blankenship Bridge	-	-	-	-

[1] River mile post above start of North Fork River at Blankenship Bridge.

[2] Raft floating time at various water stages; prepared by U.S.F.S. Recreational Specialist, Glacier View Ranger District, 1987.

<u>Peak</u> - flood stage; late May and early June
<u>Average</u> - mid-July
<u>Low</u> - late August and early September

Pressure data was gathered as instantaneous angler counts made while driving the North Fork River road from Blankenship to the Canadian border. Although travel time for counts was about 1.5 hours they were considered to be instantaneous in the analysis. The road parallels the river nearly the entire 59 miles (95 km) of the river and provides ample opportunity to view of the major public accesses and count anglers. Normally, 3 counts were made at morning, mid-day, and afternoon each 12-hour census day; each requiring about 1.5 hours. Starting times were staggered, from 7:00 a.m. to 10:00 a.m. with successive counts occurring approximately 2.5 to 3 hours later. Because of the close proximity of the road and access areas, interviews were conducted during the counting trips. The time between counting trips was spent checking private access areas and interviewing anglers and boaters at the more popular access points.

The clerk interviewed anglers on a party basis. Although emphasis was directed toward collection of completed trips, contacts were made with as many anglers as possible to maximize the data base. Interview information gathered included: number of anglers, origin, shore or boat fishing, area fished, time fishing started, total hours fished, trip completed or not, fish species preference (if any), and the number of fish (by species) caught, kept, and released. Some fish lengths and scale samples were collected; however, this data was limited and will not be summarized in this report. Sampling was accomplished on 34 days, representing 18 weekdays and 16 weekend days or holidays.

Whenever the clerk encountered more anglers than he was able to interview during the counting trips, a checking station at Canyon Creek was manned as anglers were leaving the area. The station data provided the opportunity for additional catch data as well as more completed trip information from both the day-users and overnight campers. Station location, four miles (6.5 km) upstream from Blankenship Bridge, was selected since it was the lowest most convenient stopping point along the North Fork Road. Angler logs were issued to local residents along the river to collect data on this segment of use generally not censused by the count and interview technique. The logs recorded data similar to that collected during the interviews. Residents were asked to return logs to the MDFWP at the end of the fishing season.

Data gathered from the interview and counts were entered into the MDFWP's regional computer system and were analyzed with a program developed by the MDFWP that had been modified to run on microcomputers by McFarland and Roche (1987).

Average catch rates by species were calculated by river section for the entire season. Comparisons of boat and shore angling success were made. Pressure estimates by river section and sample period were obtained by calculating the average number of anglers per count and expanding it by the fishable hours per day and the number of days per period. A total of 12 hours each day (0700 hrs to 1900 hrs) was used throughout the season. Weekend and weekday pressure was calculated collectively within each sample period.

During the individual angler interviews all angling information was recorded from all waters (other lakes and tributaries) of the North Fork Drainage; however, only data from the main North Fork River was summarized in this analysis.

Stream Habitat Quality and Populations of Bull Trout and Westslope Cutthroat

Substrate Coring

Substrate coring (McNeil and Ahnell 1964; Shepard and Graham 1983; Weaver and Fraley 1988) involved removing streambed samples using a hollow core sampler; very fine silt was measured with a fine silt settling cone. Substrate cores were collected from seven known bull trout spawning areas (Whale, Coal, South Fork Coal, North Coal, Big, Trail and Granite creeks) and one cutthroat spawning area (Challenge Creek) in the North and Middle fork drainages. After extraction from the streambed, samples were transported to the USFS lab, dried, and separated by 12 sieves ranging in size from .002 to 3.0 inches. The mean percentage of material smaller than 6.35 mm (0.25 inch) and 1.70 mm (0.07 inch) in cutthroat spawning areas, and percentage less than 6.35 mm (0.25 inch) in bull trout spawning areas was compared to information from previous years.

Measures of fine materials have been considered indicative of egg incubation habitat quality for cutthroat and bull trout. Average survival to emergence in each spawning area sampled was calculated using predictive equations developed for cutthroat trout (Irving and Bjornn 1984) and bull trout (Weaver and White 1985).

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 embeddedness which is considered indicative of rearing habitat, particularly for bull trout juveniles because of their close association with the substrate. Substrate scoring was completed on four streams in the North Fork drainage (Big, Coal, North Coal and South Fork Coal) and on one stream in the Middle Fork drainage (Morrison).

Bull Trout Redd Counts

Bull trout redd counts were conducted in four major North Fork index streams (Big, Coal, Whale, Trail) and four major Middle Fork streams (Morrison, Granite, Lodgepole and Ole). Surveys were conducted by crews of two walking down the channel and classifying redds as definite (Class 1) or probable (Class 2) following methods in Shepard and Graham (1983). Both classes of redds were used in final totals, which were compared to counts in previous years from the same stream sections.

Electrofishing Estimates

Estimates of juvenile bull trout were made by electrofishing 500-ft (150 m) sections in important rearing areas of the North Fork drainage (three reaches of Coal Creek, South Fork Coal, Big, Red Meadow, Whale creeks) and Middle Fork drainage (Ole and Morrison creeks). Estimates of juvenile cutthroat abundance were made in important rearing areas in the North Fork drainage (two reaches of Coal Creek, South Fork Coal, Red Meadow creeks) and Middle Fork drainage (Challenge Creek). Electrofishing estimates of Age I and older fish were made by either the mark-recapture method (Vincent 1971) or the two-pass method (Seber and LeCren 1967). Block nets were used on all sections. Final estimates were compared to estimates made in the same sections in previous years to assess abundance trends.

FINDINGS, RESULTS & DISCUSSION

Participation in Administration of Stream and Lake Bed Laws

To assist in protecting and maintaining aquatic habitat along with the participation in the administration of the Natural Streambed and Land Preservation Act along Flathead River and Lake Department personnel conducted on-site inspections, reviewed plans and made recommendations to the appropriate agencies (Shoreline Protection Office-CS&KT, Flathead and Lake counties and Soil Conservation Boards) on 10 percent of the 275 shoreline applications and 9 river modification proposals. Three projects that were violations of the 404 Corps of Engineer jurisdiction were also reviewed.

On the lake, a major redesign of the site at Somers has been completed, and the project will be implemented in 1989. The project will include a double-wide ramp, expanded parking, and a dock to accommodate the heavy use at this site.

The boat ramp and dock at Westshore State Park had minor maintenance to facilitate boat launching. The boat ramp at Wayfarers State Park was extended with assistance from the Community of Bigfork to facilitate boat launching during periods of lake drawdown.

On the river system, the major activity on the Flathead River was in designing a major site protection project on the Kiwanis Lane access east of Kalispell. The project should be implemented in 1989 and will protect the site from off-road vehicle use that has occurred in the past. Modifications were also reviewed on three river access projects submitted by the USFS. Two of these projects occurred on the North Fork of the Flathead River and the other on the Middle Fork.

Mitigation and Compensation for Fish Affected by Hydro-Development

Mitigation, compensation and protection alternatives were developed for losses in fish populations affected by hydropower in reservoirs and downstream river reaches pursuant to the Northwest Power Planning Council's Fish and Wildlife Program (Fraley, et al. 1988 and Zubik 1986). The construction of Hungry Horse Dam on the South Fork of the Flathead River has resulted in estimated annual losses of 65,500 cutthroat and 1,965 adult migratory bull trout from the Flathead Lake and River system. In addition, operations of Hungry Horse and Kerr Dams, the latter being located on the Flathead River below Flathead Lake, caused annual losses of 94,000 river-spawning and 65,000 lakeshore-spawning kokanee adults. Water level fluctuations caused by Hungry Horse Dam resulted in: 1) altered thermal patterns of receiving river, 2) indirect losses in phytoplankton and zooplankton production, 3) alteration and reductions in standing crop of river organisms and insects, 4) reduced fish growth in late summer and fall.

Mitigative measures include: 1) 3,500 cfs minimum flow in the Flathead River to protect salmonid eggs and juveniles, 2) adjustment of Flathead Lake levels during the fall and winter to prevent dewatering of lakeshore kokanee redds, 3) improvement of fish passage to restore migrations between the Flathead and Swan systems, and 4) biological rule curve for operation at Hungry Horse Reservoir.

To compensate for fisheries losses, enhancement of spawning and rearing habitat, introductions of hatchery juveniles and spawning channels were recommended.

The protection of 41 stream reaches in the upper Flathead River drainage (241 miles) from future hydropower development for species of special concern and for outstanding sport fisheries and their essential spawning habitat were also recommended to the Northwest Power Planning Council.

These and other measures will be considered by various agencies in developing an overall fisheries restoration plan which should be flexible, and employ principles of adaptive management. Effectiveness of the plan may be limited by heavy reliance on hatchery fish. Although mitigation efforts may not restore fish populations to pre-dam levels, substantial benefits should be realized.

Upper Flathead System Fisheries Management Plan

The Department is currently developing a fisheries comanagement plan for Flathead Lake and its major tributaries, above the lake, with the CS&KT which controls the south half of Flathead Lake.

The recent dramatic decline of kokanee has dictated a re-evaluation of management direction with the Flathead Lake and River system. There is considerable public demand to either restore kokanee populations and/or create other fishing opportunities, and to manage for native species. The management plan is designed to review the current situation, address public and agency concerns, and suggest management strategies for the next five years, 1989-1994, to ensure that Flathead Lake and River remain a productive fishery.

Five public meetings were held during February, 1988, to solicit public comment on the future of fisheries management in the system. Meetings were held in Pablo, Bigfork, Polson, Kalispell, and Missoula. Information was received from 101 participants through their answers to questionnaires handed out at each meeting.

A draft management plan is being developed which addresses native species management, the future possibilities of kokanee restoration, habitat protection and potential for future hatchery fish supplementation. The draft includes a review of fish population status by species and an overview of present fish habitat within the basin; as well as, social and political issues will be addressed. Species specific management goals, strategies needed to reach these goals, habitat protection activities and fisheries management alternatives are offered.

The draft plan is scheduled to be completed by mid-August and released for public review period until November 1, 1988, with the final plan being released in early 1989.

Flathead Lake Spring Bull Trout Fishery

A total of 192 boat counts were made on 69 days within the area surrounding the mouth of the Flathead River (approx. 1,000 surface acres) between 19 March through 27 May 1988. The average boat count varied throughout the season reflecting influences of both angling success and weather. Average counts per two-week period were: #1- 1.8, #2- 2.6, #3 4.5, #4- 2.6, #5- 4.8. The highest boat count of 34 boats was recorded during the mid-day count on Sunday, 23 April. High counts for the other two count periods were: 13 at 0830 hrs on 16 April, and 19 at 1700 hrs on 17 April.

A total of 38 boat interviews were made with 17 representing completed trip parties. Party data, showed an average of 2.1 anglers/boat and average trip length of 4.27 hours.

A total of 2,746 angling hours or 643 angler days were expended during this "Spring River Mouth" fishery. Pressure gradually increased as spring weather warmed, dropped off during a cool, rainy and windy period (Period #4, April 30 through May 13), and then again regained the former peak (Figure 1). A majority (81.6 percent) of local anglers (with home origin within a 50 mile radius) preferred bull trout.

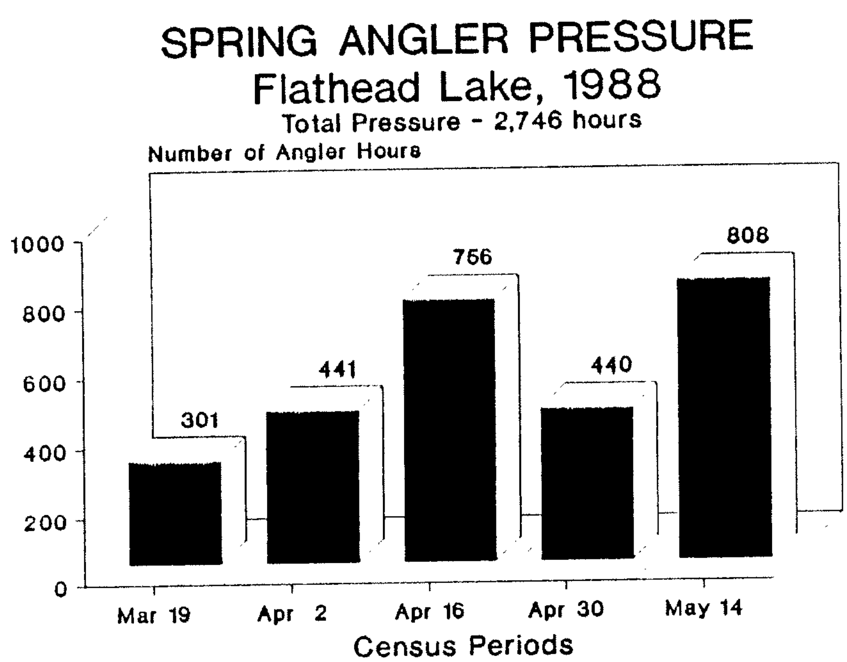

Figure 1. Spring angling pressure, by two-week census period, Flathead Lake, 1988.

Nearly three-fourths of all game fish caught during this spring season were bull trout (393); followed by lake trout (120) and cutthroat trout (33) (Figure 2). Anglers utilizing this spring fishery tend to release more fish than they kill (Figure 3), with two-thirds of all bull and lake trout caught released back to the water, while one-third of the cutthroat trout caught were released.

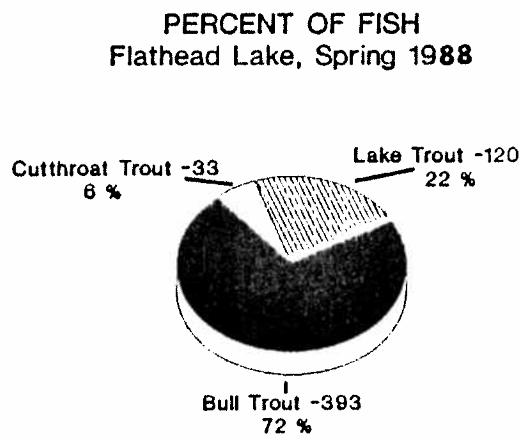

Figure 2. Species composition of fish caught during spring river mouth angling, Flathead Lake, 1988.

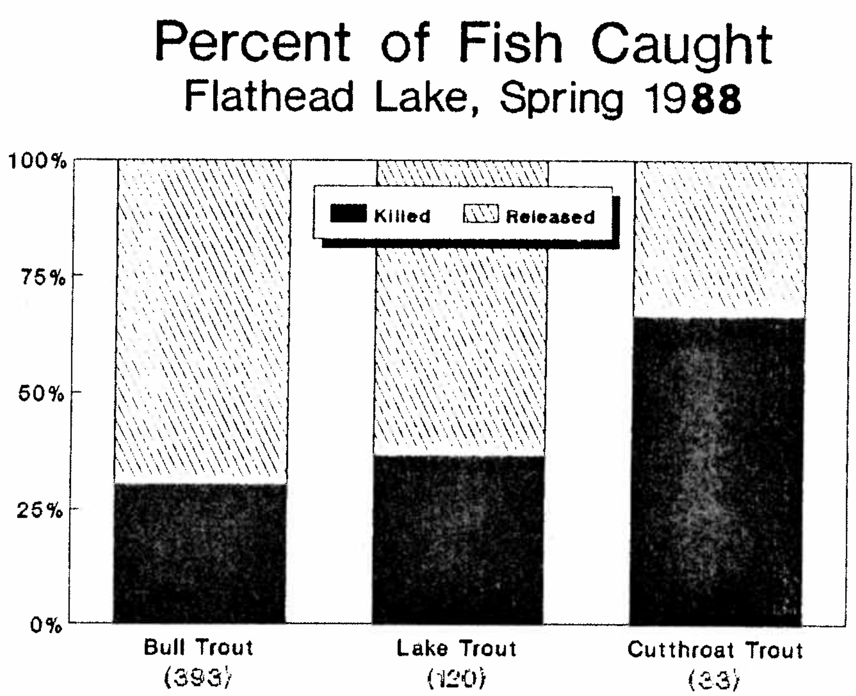

Figure 3. Percent of fish kept and released, by species during spring river mouth fishery in Flathead Lake, 1988. Numbers of fish in parentheses.

Spring anglers had an average catch rate of 0.20 fish/hour and harvest rate of 0.07 fish/hour. Although this success rate appears low it is twice as successful as anglers fishing the entire lake during the spring season in 1981. Average catch rates for the three game fish species caught were: 0.14, 0.04 and 0.02 fish/hour for bull, lake, and cutthroat trout, respectively. A total of 186 fish were estimated to have been harvested during the census. Of this total kill figure, 120 were bull trout, 44 lake trout and 22 cutthroat trout. Approximately half of the anglers enjoyed success by catching at least one fish per trip.

This spring fishery is popular since it is one of the only open water (no ice) opportunities in the area. It usually hits a peak just prior to the time these fish enter the Flathead River on their spawning migration. However, success is short lived and does not always occur during periods of peak pressure (Figure 4). During 1988, over 64 percent of the fish caught were taken during one two-week period, 30 April through 13 May. Pressure during this period dropped to half the previous period because of adverse fishing weather. As weather improved and pressure again increased, angling success dropped to near zero.

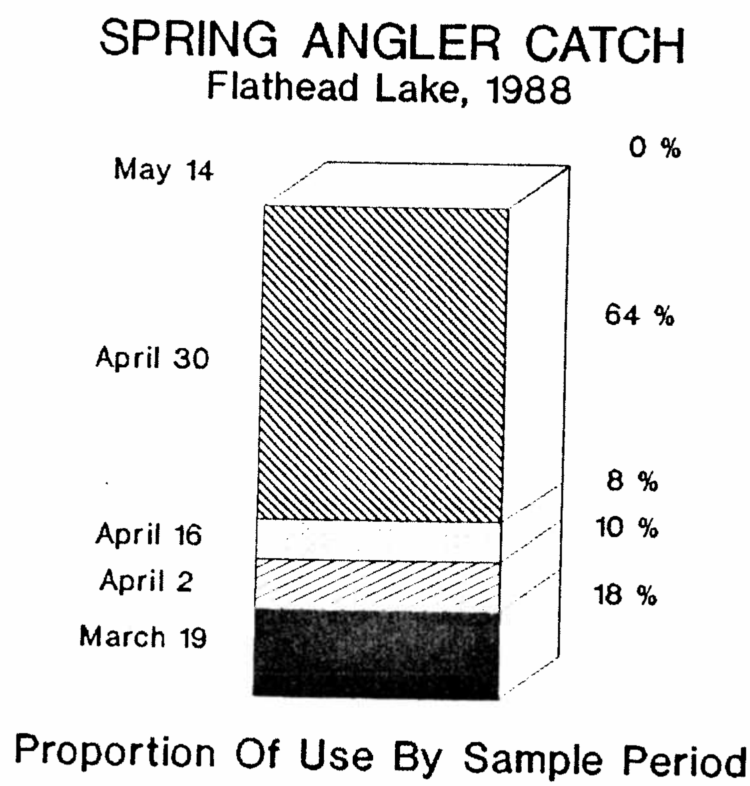

Figure 4. Proportion of fish caught by two-week sample periods in river mouth fishery, Flathead Lake, spring, 1988.

Volunteer Angler Tagging Program

Ten anglers volunteered to continue their tagging program with our Department. Two anglers concentrated their efforts on the river; one marking bull trout and the other marking primarily cutthroat trout. All lake taggers were primarily tagging lake trout.

To date we have tagged a total of 1,224 fish: 636 in the lake and 588 in the river. Tagged lake fish included 567 lake trout, 68 bull trout and 1 cutthroat trout. River fish tagged included 478 cutthroat trout, 84 bull trout and 26 rainbow trout.

The average length and weight of 167 lake trout tagged since 1 July 1987 was 29.9 inches and 10.7 pounds. A total of 63, or 37.7 percent, of the tagged fish measured 28 inches or less. The largest lake trout tagged was 41 inches. The average length of 13 bull trout tagged was 17.9 and 20.2 inches in the lake and river, respectively. Although not part of the tagging program, an unusually large bull trout weighing 21.25 pounds was reported caught during June, 1988, by an angler off the mouth of the Swan River near Bigfork. This is the largest bull trout we have recorded in over twenty years from the lake. The state record bull trout, reportedly taken in 1916 somewhere in the Flathead River system, weighed 25.6 pounds. The average length of 87 cutthroat trout tagged in the river was 15.9 inches, with the largest fish measuring 20.5 inches.

A total of 132 recaptures have been reported since the start of this tagging program and include 72 cutthroat trout (15.0 percent return); 42 lake trout (7.4 percent return); 15 bull trout (9.9 percent return) and 3 rainbow trout (11.5 percent return).

Since the last reporting period ending 1 July 1987 (Hanzel 1987), 14 cutthroat recaptures have been reported. Six of these returns were recaptured within 20 miles of the tagging area within 12 days of tagging. The remainder showed little movement within the river area after a considerable longer time lapse between recaptures, averaging 212 days. One exception showed a 15.5 inch cutthroat trout moving over 30 miles downstream from the tagging area in the river and recaptured 69 days later in the lake half way down the west shore near Table Bay. All bull trout recaptures, 3 since last reported, were from fish tagged in the lake. The average length of time between recaptures was 512 days. The maximum movement of over 100 miles was on a 26-inch bull trout that was tagged in the lake just east of Wild Horse Island and was recaptured in the North Fork of the Flathead River 3 miles north of the US-Canadian border. This movement took place after the fish was tagged in April, 1987, and was recaptured the in mid-July, 1988, 451 days after tagging. The other bull trout recaptures showed movements of less than 5 miles within the lake. A total of 21 recaptures of lake trout were received since last reported. As a group, these lake trout showed little movement between recaptures. Most tagging and recaptures occurred while angling on the mid-lake bar. The average time span between recaptures was 448 days. While most lake trout were recaptured during the months of June through August, most fish were tagged during the months of February through June.

There has been a decrease in the average length of the tagged lake trout since 1986; lengths were 31.3, 30.6, and 29.9 inches for the years 1986 (155 fish), 1987 (235 fish), and 1988 (167 fish) respectively. A decrease in size was also reflected in the percent of fish less than 28 inches, where percentages of smaller fish increased from 27.7 to 30.6 and then to 37.7 percent for 1986 and 1987 respectively. These size changes were brought about by an increase in number of fish caught in the mid-range lengths, from 24 to 32 inches (Figure 5). Previous length distributions from the 1960-1970's (141 fish) and 1981-85 (109 fish) were more similar to the distribution found in 1988 rather than those in 1986. These data suggest that the size structure of catchable lake trout can fluctuate without experiencing major impacts such as a marked decline in the abundance of kokanee. It should be noted, however, that during the summers of 1987 and 1988 the basic physical appearance (condition factor) of lake trout appeared poorer with fewer very large fish (>30 pounds) being taken. Unfortunately, weights obtained on lake trout by the volunteer taggers could not be use to calculate condition factor because they did not possess accurate weight scales. Even if weights taken were true weights, they would not entirely reflect the true condition of the fish, since a fish weight can vary 2 to 3 pounds or more depending on the volume of stomach contents.

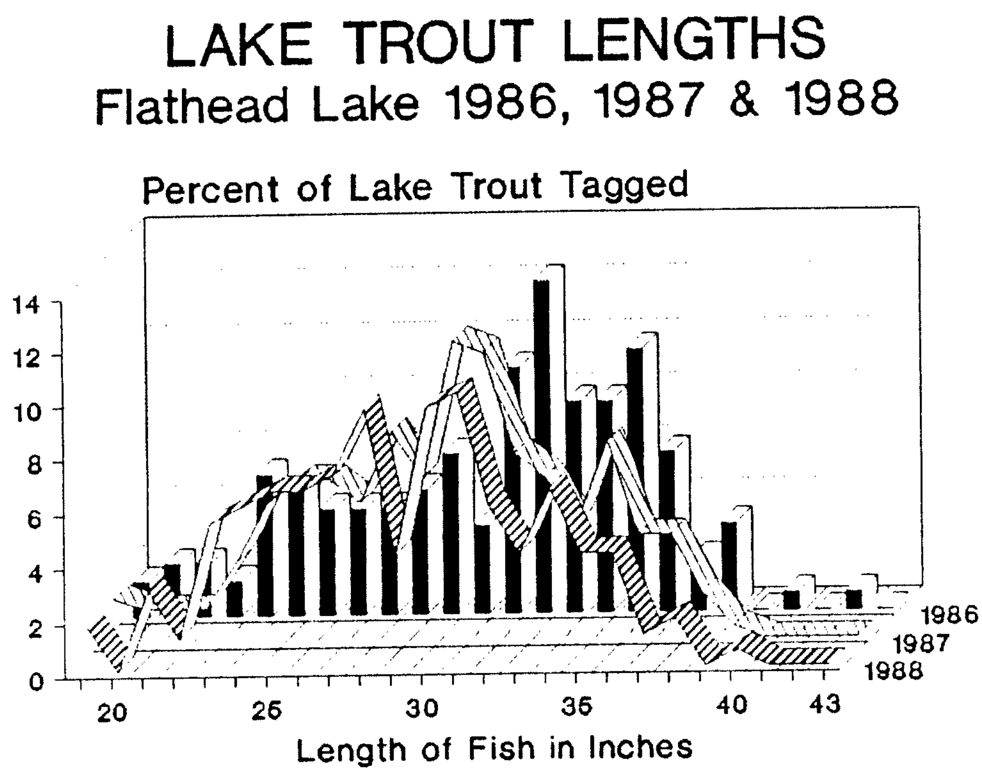

Figure 5. Length frequency histogram of lake trout tagged for 1986, 1987, and 1988, in Flathead Lake.

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 (1986a). Periodic creel surveys of the popular kokanee fishing areas throughout the summer 1987 failed to record a single catch of a salmon signifying the impact of low kokanee density on angling success. Before the summer season ended in early September, most kokanee anglers had abandoned their efforts on Flathead Lake.

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 during which fish data was collected and recorded on magnetic tape. Densities of fish, as observed fish targets on echograms, during the surveys were at such low levels that fish could not be captured with mid-water trawling and the surveys were abandoned. Without the species and size verification data provided by mid-water trawl catches, a kokanee density estimate could not be made. Such an estimate was made in 1986 (Hanzel 1987a) and was believed to be an erroneous kokanee estimate because the associated trawling data was not available.

Zooplankton Dynamics

Mysid shrimp were introduced into Flathead Lake by natural downstream drift from Swan Lake, Whitefish Lake, or Ashley Lake. They were transplanted into these tributary lakes in 1968 and 1975 from Waterton Lake, B.C. in an effort to improve the forage base for sport fish populations (Rumsey 1987). Mysid shrimp were first collected in Flathead Lake in 1981. Yearly monitoring since then documented an exponential increase in their abundance until 1985 (Figure 6). Sampling in 1986 and 1987 indicates that their rate of increase has slowed. The lakewide average density in 1987 was $108/m^2$ although the maximum density encountered exceeded $500/m^2$. Mysids are most abundant in water deeper than 30 m, but their abundance varies widely in any depth range. Acoustic surveys on Flathead Lake bear out our contention that mysids are patchily distributed 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.

Increased grazing pressure from mysid shrimp has changed the zooplankton community of Flathead Lake (Figure 7). Previous work (Potter 1978) and annual monitoring since 1981 (Leathe and Graham 1982; Beattie et al. 1986) has provided an excellent baseline from which to measure changes in zooplankton dynamics. As in other lakes where mysid shrimp have become established (Rieman and Bowler 1979; Morgan et al. 1978), the standing crop of cladocerans and copepods in Flathead Lake has declined, and the summer pulse of cladocerans has been delayed. Two cladocerans, *Daphnia longiremis* and *Leptodora kindtii*, disappeared from the zooplankton community in 1986. The peak density of *D. thorata*, the preferred food of kokanee, has declined from 4.7/l in 1983 to 0.9/l in 1987. *Daphnia thorata* were formerly present at measurable density at limnetic sampling sites as early as April. In 1987 it was not present until mid-June. A similar change in peak density and pulse timing of *Bosmina longirostris* has occurred. The standing crop of the copepod Diaptomus ashlandi, the most abundant macrozooplankter in Flathead Lake, has also declined markedly. This species comprises a major part of the diet of kokanee in the winter and early spring.

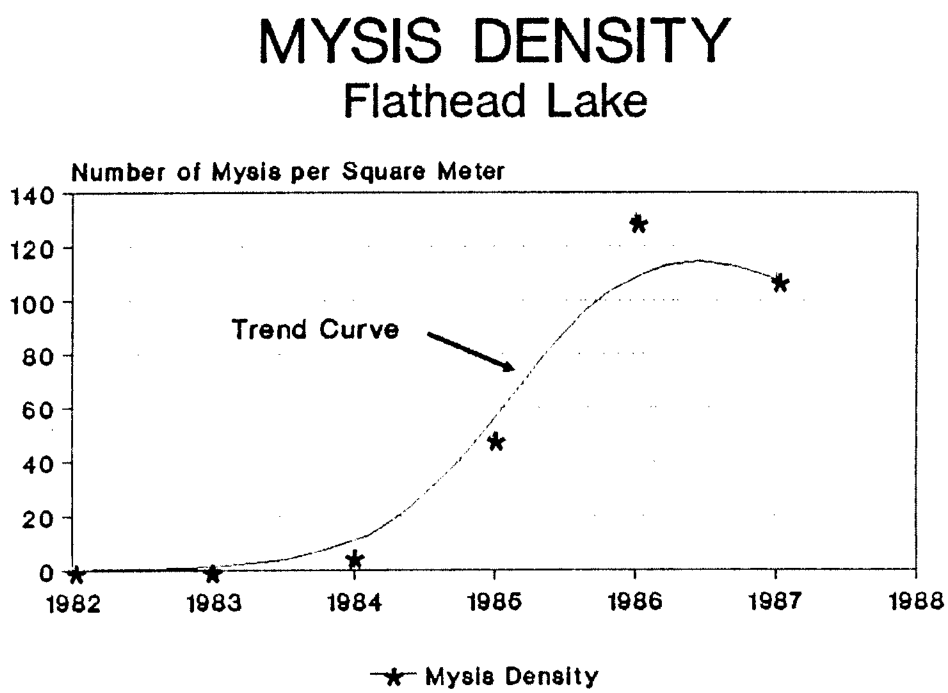

Figure 6. Average density of Mysis in Flathead Lake, from 1982 to 1987. Line depicts trend curve of Mysis densities.

Kokanee Food Habits

The diet of YOY, yearling, and older kokanee was analyzed to detect changes in food habits that might follow change in the zooplankton community. We have assumed that YOY kokanee are most susceptible to food limitation, because they enter the lake from riverine spawning areas in May when zooplankton availability is still low and YOY are too small to forage efficiently. The food preference of YOY kokanee has not changed, though shortage of D. thorata in the late spring and early summer has forced them to rely on the copepods Dipatomus and Epischura until June. They select D. thorata even when it is present only in widely dispersed patches, as evidenced by undetectably low densities at zooplankton monitoring stations. The largest aggregations of kokanee fry are in the shallow northwest quadrant of Flathead Lake, where Daphnia thorata are more abundant than at deeper sites in May.

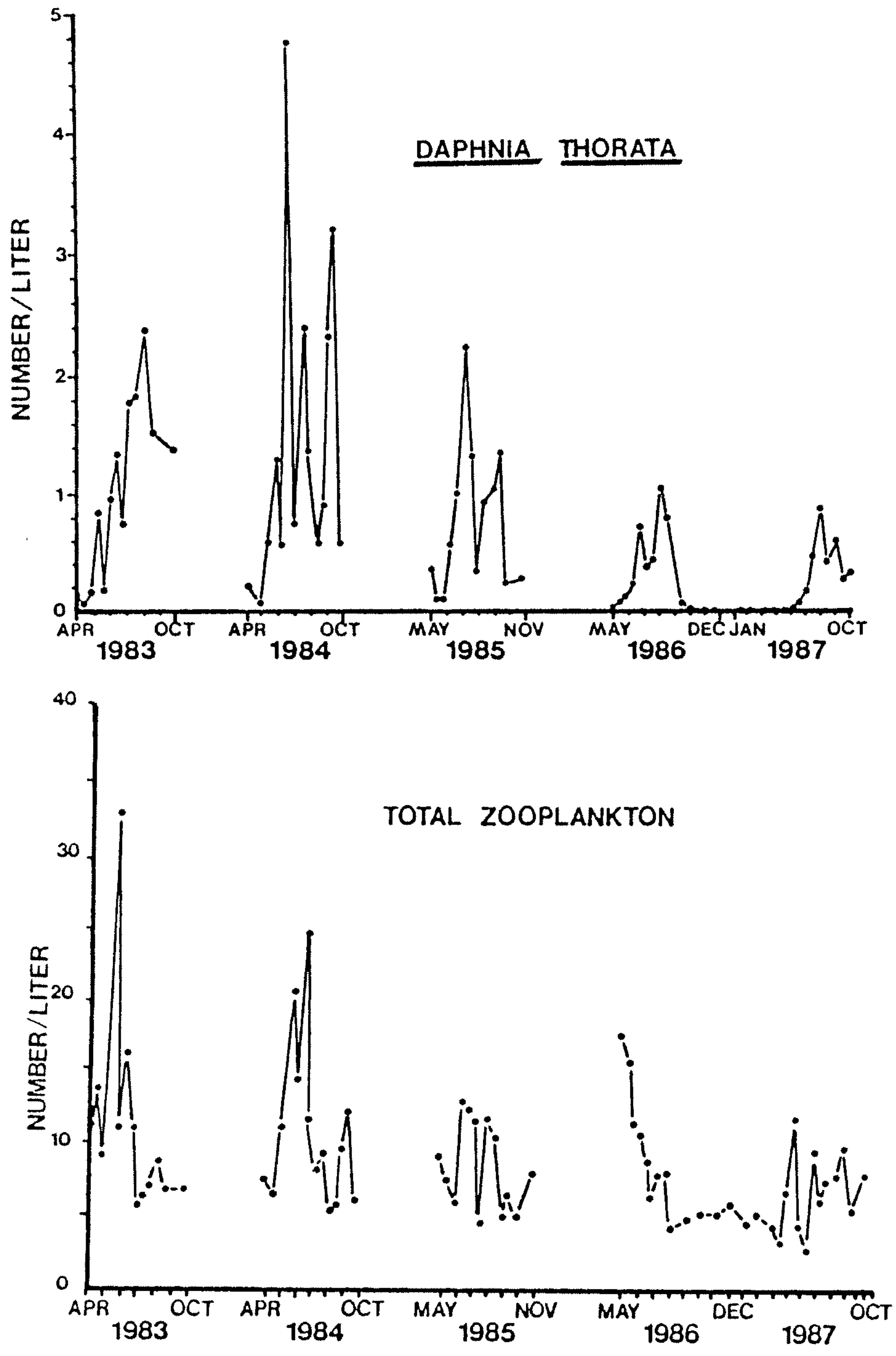

Figure 7. The abundance of Daphnia thorata (upper half) and total zooplankton (lower half) at a northern station on Flathead Lake, 1983 to 1987.

The diet of older kokanee has not changed markedly either. Yearling and older fish do exploit widely dispersed patches of D. thorata more efficiently, as the cladoceran is found more frequently in the stomachs of these older year classes than in YOY fish. Adult fish have not shown increased preference for other zooplankton or insect larvae in comparison to earlier studies (Leathe and

Graham 1982) when cladocerans were more abundant. We have not investigated the relative nutritive value of various zooplankton species, but we assume that the energetic consequences of having to look harder and longer for preferred cladocerans are unfavorable. Mysid shrimp only occurred in adult kokanee stomachs during the winter period, and then only 7.5 percent of the samples were juvenile shrimp less than 10 mm in length. But, in these samples, shrimp made up as much as 77.4 percent of the stomach content.

Growth Rates of Juvenile Kokanee

We measured the growth rate of YOY and yearling kokanee collected in 1986 and 1987 to detect possible changes associated with the reduced availability of preferred food. Analysis of otolith microstructure suggested that YOY kokanee grew more slowly in 1987 than in 1986. The mean length of both YOY and yearling kokanee collected in July and August of 1987 was less than those collected in the same period in 1986.

These subtle, but statistically significant, declines in growth rate corroborate our assumption about food limitation affecting juvenile fish but there is no direct link to the marked decrease in survival rate. From 1981 to 1985 fry-to-adult survival (spawning escapement/outmigrant fry abundance) was about 2.5 percent. Fry-to-adult survival declined to 0.6 percent in 1986 and to near zero in 1987. We know that fry production in the Flathead River system in 1983 and 1984, the years when the 1986 and 1987 adult year classes were born, was near 10 million fish. So the increased mortality occurred after the fry entered Flathead Lake.

Various factors are considered to contribute to the decline in kokanee survival. Surviving adult (Age II+ and III+) kokanee are not, however, in poor physical condition. We have no evidence that any disease or parasite is affecting survival.

Lower food availability and reduced growth rate probably increase vulnerability to predation. There are some indications that the lake trout population in Flathead Lake has increased, perhaps in part due to juvenile survival increasing because juvenile lake trout are foraging on mysid shrimp. Reduced food availability may cause kokanee, which normally feed in large schools, to disperse and lose the protection from predation that schooling affords.

During these five years substantial fishing harvest occurred in summer, fall, and winter. A 1985 creel survey estimated the annual harvest to be 130,000 fish (Hanzel 1986); the spawning escapement in the fall of 1985 was estimated to be 150,000 fish (Beattie and Clancey 1987). The only substantial sport harvest that occurred in the last two years was a harvest of 37,000 in the spring of 1986. Further study of the kokanee population will attempt to identify the age class or classes where mortality is occurring.

Food Items of Other Fish

This information is an accumulation of stomach contents of fish caught through periodic seasonal sampling (May, 1986 through June, 1988) by various sampling techniques to define food item preferences and to establish present utilization of mysis shrimp.

Lake Whitefish

The primary spring and summer food item of 42 juvenile lake whitefish was zooplankton while 121 older whitefish preferred dipteran larvae, pelycopod clams and mysids. Mysids occurred in stomachs from mid-June through August. There was an average of 246 mysids and 34 clams per stomach in adult fish collected during the period June through August. The smallest lake whitefish containing mysis shrimp was 116 mm long.

Lake Trout

A total of 123 lake trout stomachs (26-1986, 66-1987, 31-1988) were collected and analyzed for frequency of occurrence of stomach contents. Since numbers of seasonal samples were small, all sample periods were pooled for this analysis.

Juvenile lake trout (<12.5") had a strong preference for mysids (92 percent of stomachs). Mysid use was strongest during the winter and spring months. None of the juvenile lake trout had empty stomachs. Other items included dipteran larva, zooplankton, mollusks and unidentified fish remains.

Larger lake trout (>12.5 ") had a strong preference for fish (86.7 percent of stomachs that were not empty). Of the fish utilized, kokanee were the preferred species representing from 30 to 60 percent of the occurrence of fish. Utilization of kokanee was highest in winter. Other species identified included pygmy whitefish (Prosopium coulteri), sculpin (Cottus cognatus), and yellow perch in order of their frequency of occurrence. Of all fish utilized by lake trout, kokanee represented the only large forage species greater than 5 inches. Sizes of salmon utilized by lake trout ranged from 8 to 10 inches, representing 2- and 3-year-old fish. Over 40 percent of the large lake trout stomachs were empty.

These same major food item preferences for lake trout, with the exception of the occurrence of Mysis, were first described by Leathe and Graham (1982). During this earlier study, Mysis were in the early stages of becoming established in the lake and were few in number. It is interesting to note that even through the numbers of kokanee in the lake during 1986 and 1987 were very low, lake trout were utilizing salmon as their primary food item. It appeared that during 1986 and again in 1987, lake trout failed to switch to lake whitefish even though whitefish numbers were increasing and kokanee numbers were very low. If kokanee numbers remain low and larger lake trout are not able to utilize an alternate prey species, there may be a significant reduction in the size of the trout due to the lack of an ample forage base.

Bull Trout

A total of 60 bull trout stomachs were collected from November, 1985 to June, 1988. Bull trout larger than 9 inches were exclusively piscivorous (96 percent of stomach that were not empty). Yellow perch made up 86 percent of the fish occurring in stomachs. The perch were young-of-the-year fish averaging 2.3 inches in length. Other fish eaten included lake whitefish, kokanee, sculpin, northern squawfish (Ptychocheilus oregonensis), peamouth (Mylocheilus caurinus), and pygmy whitefish, in their order of frequency of occurrence. Mysids were found in 3 (6 percent) of the bull trout stomachs, but in these instances they were the only items in the stomach.

Present limited sampling did indicate that bull trout appeared to have substituted other fish, primarily lake whitefish, in place of the low numbers of kokanee during the spring. During other seasons, bull trout depend upon the yellow perch, mountain whitefish, peamouth and northern squawfish for food.

Westslope Cutthroat

A total of 14 cutthroat trout stomachs were collected from fish ranging in length 9.1 to 17.3 inches. Seasonal limited sampling did show cutthroat consume insects during the summer months and mysids and insects during the winter period. Mysids were eaten in 6 of 9 winter stomachs and were all adult shrimp (>0.39 inches). Other items eaten during the winter included zooplankton, mollusks and unidentified fish remains.

Leathe and Graham (1982) found that terrestrial insects and adult or pre-emergent aquatic insects were the principal food of cutthroat trout during most seasons on Flathead Lake. It appears that with the advent of Mysis, cutthroat are able to capture the mysids during the winter period as the shrimp become more widely distributed throughout the water column and move into the shallow littoral areas.

Pen Rearing of Kokanee

Kokanee were experimentally reared in two pens placed off-shore from the Flathead Lake Salmon Hatchery near Somers from 4 May to 23 June, 1987. Kokanee, were stocked in the pens at a density of 200,000 per net. Salmon growth progressed significantly for three weeks in the pens and then leveled off to only meager increases. The length of the first lot of fry increased from 44.6 mm to 56.8 mm to release on 4 June, a total of 30 days in pens. The second lot was stocked in the pens on 9 June but did not show the same initial growth as did the first lot, with little growth during their total 13 days in the pens. The average length of fry when released on 23 June was 47.7 mm.

Surface water temperatures were 60° F. or higher the entire length of the pen rearing experiment, peaking at 65° F. on 23 June on the day of final release of fish. Stress caused by crowding was first observed when water temperatures at the pen bottom first rose to 60° F. on 20 June. Within three days, high mortalities were occurring in one of the pens and the entire lot of fish were released. The dying fish were checked by MDFWP's Fish Health Specialist who identified the infection as a myxobacteria, better known as "bacterial gill disease". Normally the disease is successfully treated when encountered in hatchery facilities; however in this situation, normal treatment with drugs and of reducing stress by thinning the fish could not be administered. It was felt therefore that the best treatment was to release the fish as soon as possible to reduce densities and allow the fry to seek out more favorable water temperatures. Once they were released in the lake, it was thought fish would recover on their own.

It was estimated that 19 percent of the total 1987 year class production of 4.8 million fry (est. 3.7 million natural recruitment from McDonald Creek) was hatchery fish. One million fry were artificially reared and released at the Flathead Lake Somers Hatchery site (0.8 million pen-reared and 0.1 million released directly into the lake). An attempt was made to evaluate natural and artificial fry mortality by marking all hatchery fry with tetracycline and comparing the percent of marked (hatchery) and unmarked (wild) fry sampled with the mid-water trawl. Although the sample size of trawl caught fish was small the proportion of hatchery-reared fish to naturally-produced fish was near the estimate of fish in the system and suggested equal survival between hatchery and naturally produced fry, or as least similar survival of the two sources of fry. This evaluation was hampered by the failure of the pen-reared fish to retain strong tetracycline marks on their skeletal structures. Although a mark was readable on a small sample of fish retained in the hatchery, it was not distinct. Only one positive and three doubtful marks were identified from all young fish captured with the trawl. Failure to retain the mark probably was due to the exposure of fish in the pens to constant sun (ultraviolet) light and the short drug application periods of four and six days.

1987 Summer North Fork Census

A total of 211 anglers counts were made during the 34 census days from 4 May through 7 September 1987. Although 3 counts were scheduled each day, only 20 percent of the third counts were made because of time constraints to cover the entire stretch of river. The average number of anglers per count was 14.1 anglers (variance = 0.998), which was represented by 9.2, 1.8, and 3.1 for river Sections #1 through #3, respectively. Peak counts recorded in each period by count trip by river section were as follows: Section #1 - 23, 34 and 14; Section #2 - 3, 12 and 4; Section #3 - 12, 12 and 5.

A total of 275 interviews were made during the census period, of which 85.8 percent were completed trips (Table 2). Three-fourths of all interviews were made in river Section #1. The partial checking station at Canyon Creek provided a third (32.4 percent) of the total interviews and was determined to be a valuable source of angling data.

Table 2. Number of parties and anglers interviewed by river section, North Fork Flathead River, summer 1987.

	Census Interviews			
Number	River Sec. #1	River Sec. #2	River Sec. #3	Sections Combined
Parties	207	25	43	275
Anglers	437	53	91	581

The average trip length of completed boat trip of 5.07 hours was nearly double the 2.68 hours trip length of shore anglers. Only minor differences in trip length between the river sections were noted. The average number of angler per boat party (2.4/boat) was only slightly higher than the average size of the shore party (2.1/party).

A total of 17,956 (±2,541 hrs) angling hours (6,690 angler days - average trip length of 2.68 hrs) were expended on the North Fork River during this summer period. The majority of use occurred in Section #1 followed by nearly equal pressure from two other Sections (Figure 8). Boaters expended 41.6 percent of the interviewed effort while representing 26.6 percent of anglers. Four-fifths of the use came from "area anglers" or those that reside in the counties of northwest Montana (Flathead County - 77.3 percent and other western counties - 11.2 percent). Non-residents accounted for 10.4 percent of angling use.

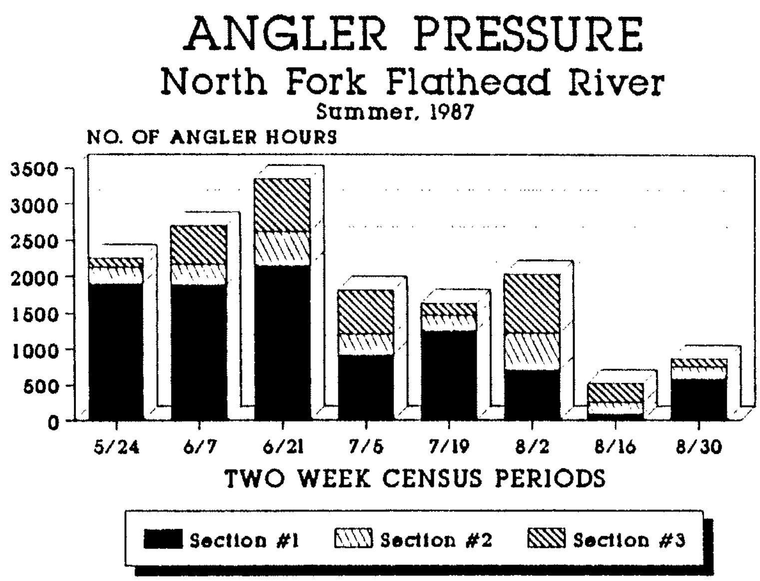

Figure 8. Angler pressures (fishing hours), by two-week census periods, by river section for the North Fork of the Flathead River, summer 1987.

Over half of the total angling pressure occurred during the first month of the survey (first three census periods - 24 May through 4 July); thereafter, use gradually trailed off (Figure 8). Section #1 use was highest during the early season; whereas, use in Sections #2 and #3 increased during the third census period (starting 21 June) and continued throughout mid-summer (until 15 August). This angler use pattern describes the strong fishing preference for bull trout anglers as they followed the adult fish upstream. By the time migrating bull trout reach Section #2 angling preference starts to shift toward cutthroat trout and then continued that way through the remainder of the season. By mid-July most migrating adult bull trout had already passed through Section #1 and were either found in upper sections or in their spawning tributaries. Cutthroat trout and whitefish are the other species available to the angler after mid-summer.

An average seasonal catch rate of 0.53 fish/hr was experienced by the North Fork anglers. Angling success by species and river section is summarized in Table 3. Slightly less than half of all fish caught (42.7 percent) were killed, which represents an average catch rate of 0.22 fish killed/hr. Cutthroat and bull trout were the only fish reported released back to the water. Cutthroat trout made up the bulk of the fish harvested (82.6 percent), followed by mountain whitefish (9.5 percent), bull trout (6.0 percent, and others (1.9 percent) (Table 4). The "others" category include a group of fish identified in the field by the clerk as rainbow trout. Since rainbow trout have been only rarely observed by trained personnel in the North Fork further reference to the "others" could be partially or totally composed of rainbow-cutthroat hybrids or misidentified cutthroat. Expanding the seasonal catch rate North Fork anglers would have handled 8,738 cutthroat trout, 426 bull trout, 391 mountain whitefish, and 79 others.

Only three anglers logs, or 10 percent of those issued, was returned with information on angling. Data by these users represented four angler days and was not included in this summary.

Average catch rate of boaters interviewed was higher than that experienced by shore anglers (1.18 vs. 0.63 fish/hr respectively). Boaters caught 56 percent of the total fish recorded and released a higher percentage of fish back to the water. Boaters returned 64.9 percent of the bull trout and 80.7 percent of the cutthroat trout caught while shore anglers returned 34.8 percent of their bull trout and 50.5 percent of their cutthroat trout.

Three-fourths of the total fish harvested were caught in river Section #1. Harvest in the other sections was near equal, #2-15.4 and #3-13.6 percent. The percent of fish harvested by river area was directly related to the angling pressure. The harvest of cutthroat trout decreased as you progress upstream. The catch of bull trout and mountain whitefish in river Section #3 reflected higher harvest rates than was experienced for cutthroat trout.

Over half (56.4 percent) of the 275 parties interviewed caught fish; of those parties that preferred to fish for cutthroat trout, 71.2 percent were successful in catching at least one fish. Parties of bull trout anglers were only successful 39.2 percent of the time in catching one fish.

The 1987 summer fishing season was considered somewhat abnormal with unseasonably warm air temperatures during May. This early warming pattern encouraged the migrating fish to ascend the river faster and reach the mid- and upper-areas of the North Fork River earlier than normal. Migrating bull trout normally reach the Polebridge area about mid-July; in 1987 they were in the area by late June. This early pattern of movement into the upper areas of the North Fork River could have reduced the numbers and time fish were available to North Fork anglers. The increased speed of upstream movement could have made it more difficult for anglers to locate fish, therefore reducing effort and success.

Table 3. Average catch rate of fish by species caught and kept by river section, North Fork Flathead River, summer 1987.

	River Sec. #1	River Sec. #2	River Sec. #3	Sections Combined
Cutthroat Trout				
Caught	0.53	0.51	0.28	0.49
Kept	0.21	0.21	0.05	0.19
Bull Trout				
Caught	0.02	0.01	0.04	0.02
Kept	0.01	0.01	0.02	0.01
Mountain Whitefish				
Caught	0.01	0.02	0.05	0.02
Others				
Caught	0.01	0.01	0.01	0.01
Combined				
Caught	0.56	0.54	0.37	0.53
Kept	0.24	0.24	0.13	0.22

Table 4. Number and percent of fish harvested by species and river section, North Fork Flathead River, summer 1987.

	River Sec. #1	River Sec. #2	River Sec. #3	Sections Combined
Cutthroat Trout				
No. Harvested	2,646	555	194	3,395
Percent	(77.9)	(16.4)	(5.7)	
Bull Trout				
No. Harvested	157	16	73	246
Percent	(63.8)	(6.5)	(29.7)	
Mountain Whitefish				
No. Harvested	100	48	243	391
Percent	(25.6)	(12.3)	(62.1)	
Others				
No. Harvested	14	16	49	79
Percent	(11.7)	(20.3)	(62.0)	
Combined				
No. Harvested	2,918	634	559	4,111
Percent	(71.0)	(15.4)	(13.6)	

The 1987 angler pressure of 17,956 hours on the North Fork of the Flathead River was a 22 percent reduction in effort since the last census on the river in 1981 (Fredenberg, W. and P. Graham 1982). Although a downward pressure trend has been experienced on the North Fork since 1975 (Hanzel 1977), proportionate angling pressure by river section (Figure 9) surprisingly has remained the same during the last three surveys that covers this 13-year span. The 1987 catch rate of 0.5 fish/hour for all fish on the North Fork for cutthroat trout represented the lowest success rate measured, previous success rates were 0.6 and 0.7 fish/hour, for the years 1975 and 1981, respectively.

The catch continues to be predominated by cutthroat trout with 86.1, 91.0 and 82.6 percent of the catch for 1975, 1981 and 1987, respectively. Catch rates for cutthroat trout were similar in the 1975 and 1987 surveys at 0.5 fish/hour, with the 1981 census showing the highest success rate of 0.7 fish/hour. It is not known whether the reduced angling success reflects a decreased number of fish available in the main North Fork River since fish populations estimates were not conducted on the main stem of the river. However, estimates of two year old and older cutthroat trout produced in four population monitoring streams, suggests that production has been either normal or slightly above normal in three out of four streams.

A reduction in the 1987 bull trout harvest, by 61 percent or 158 fish, from the 1981 harvest can be partially explained with the implementation of a reduced daily creel limit, from two to one fish, between the 1981 and 1987 seasons. Overall catch rate of 0.02 fish/hour for bull trout has not changed since 1975; only the kill or creeled rate was reduced by half (0.1 fish/hour).

Although the harvest of mountain whitefish in the North Fork has never been large (less than 1,100 fish annually), the 1987 harvest of 400 fish was lower than previous surveys. Their 1987 catch rate of 0.02 fish/hour was a slight decrease from the 0.03 fish/hour measured in the pervious creel surveys.

The Glacier View Ranger District recreational personnel (USFS Flathead Forest) have been monitoring boater use in the North Fork of the Flathead River since 1978 (unpublished information). A technique using a fixed movie camera set to shoot single frames (approx. 30 second intervals) filmed summer boating use (Memorial Day to Labor Day). Total boat use for the river, for the period 1978 to 1984, was calculated from data gathered at one camera site (Canyon Creek) located in River Section #1. In this estimate the upper or scenic section use was estimated to be double that of recorded use at the lower camera site. Since 1984, two camera sites have been used, the same lower site plus an up-river site (Polebridge) located in the scenic portion of the river. Boating use has gradually increased since 1978 to the present 802 boats per year, an increase of 40 percent in 11 years (Figure 10). Although there is no field data, anglers were estimated to account for more than 80 percent of the boats on the river. Boat angler pressure has increased over shore angler pressure since 1975, accounting for 13, 29, and 42 percent of total pressure in 1975, 1981, and 1987 respectively.

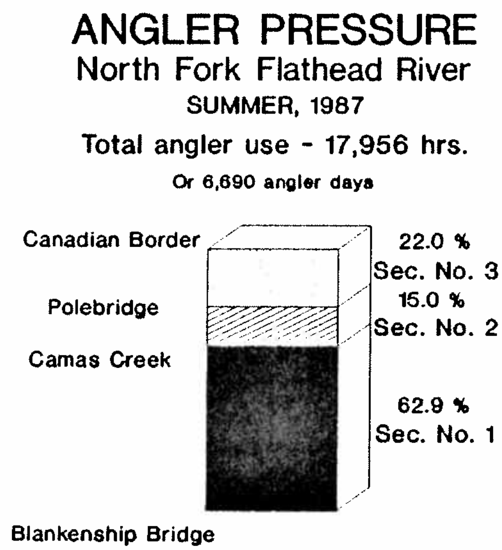

Figure 9. Proportionate angler use, percent of pressure, by river section in the North Fork of the Flathead River, summer, 1987.

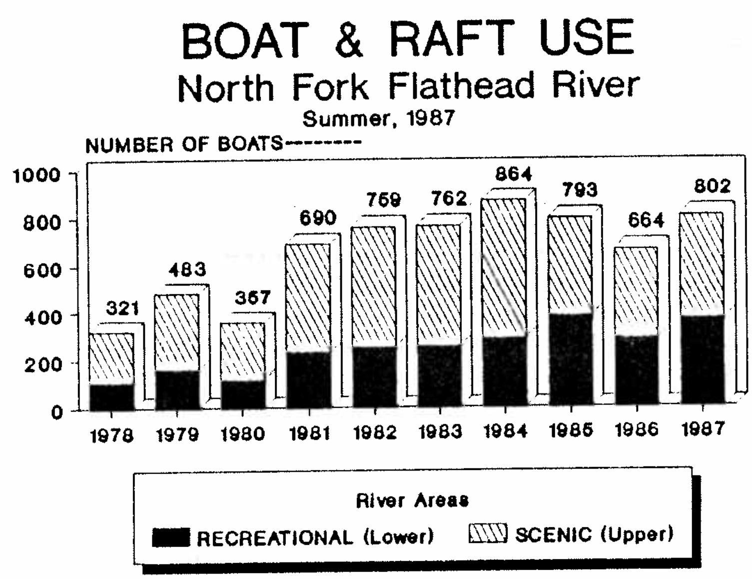

Figure 10. Estimated annual boat use, by river area, on the North Fork of the Flathead River for the period 1978 through 1987. Data compiled by USFS, Recreational Specialist, Glacier View Ranger District.

Stream Habitat Quality

Stream Substrate Composition

The percentage of materials ≤0.25 inches in bull trout spawning areas sampled in 1987 was highest in Granite Creek (44 percent) and Coal Creek at Dead Horse bridge (41 percent) in 1987 (Table 5). These levels are considered high and resulted in embryo survival estimates of less than 20 percent. These two stream reaches are in drainages of extensive timber harvest which may have accounted for the high levels of small materials in the substrate. Percentages of materials ≤0.25 inches in Big, Whale, and Trail creeks were less than 30 percent, indicating good incubation survival (Table 5).

Table 5. Summary of annual mean cumulative percentages of substrate material smaller than 6.35 mm (0.25 inches) in diameter and mean predicted survival to emergence from core samplings of undisturbed sites in known bull trout and cutthroat trout spawning areas.

Stream	Spawning area	Species	Year	n	% Sediments % <6.35 mm	Predicted survival(%) to survival
				North Fork Drainage		
Whale Creek		bull trout				
			1981	6	22	>75
			1982	8	35	46
			1983	11	34	51
			1984	11	28	>75
			1985	11	19	>75
			1986	12	30	71
			1987	11	28	>75
Coal Creek						
	Dead Horse Bridge	bull trout				
			1981	10	33	56
			1982	19	38	30
			1983	20	37	35
			1984	18	33	56
			1985	20	36	51
			1986	16	35	46
			1987	18	41	19
North Coal		bull trout	1985	12	34	39
			1986	12	29	>75
			1987	12	--	--
Big Creek		bull trout				
			1981	6	22	>75
			1982	9	28	>75
			1983	11	28	>75
			1984	10	27	>75
			1985	12	29	>75
			1986	12	23	>75
			1987	8	27	>75

Table 5. (Continued).

Stream	Spawning area	Species	Year	n	% Sediments % <6.35 mm	% Predicted survival (%) to survival
North Fork Drainage continued						
Trail Creek		bull trout				
			1981	12	23	>75
			1982	16	22	>75
			1983	10	27	>75
			1984	9	28	>75
			1985	12	29	>75
			1986	12	30	71
			1987	10	27	>75
S.F.Coal Creek		bull trout				
			1985	12	37	24
			1986	12	32	59
			1987	12	33	57
			Middle Fork Drainage			
Granite Creek		bull trout				
			1982	10	42	8
			1986	8	52	0
			1987	12	44	14
Challenge Creek		cutthroat trout				
			1986	12	40	5
			1987	12	34	12

Comparison of annual concentrations of fine materials in bull trout spawning areas reveal few definite trends (Table 5). Levels of fine materials in Coal Creek at Dead Horse bridge were the highest on record in 1987; levels in Granite Creek were considerably lower in 1987 than in 1986, indicating possible recovery of habitat quality. The percentage of material less than 0.25 inches in Challenge Creek, a cutthroat spawning area, was lower in 1987 than in 1986, but still produced very low predictions of embryo survival (12 percent).

Substrate Scoring

All substrate scores (Table 6) were above the critical standard for juvenile salmonid rearing habitat (9.0) developed by Leathe and Enk (1985). Substrate scores above 11.0 are indicative of good rearing habitat quality. Only Coal Creek at Dead Horse bridge had a score (10.0) below this level in 1987. No definite trends can be discerned comparing 1987 data to information collected from previous years (Table 6).

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 Br.	1986	12.2
		1987	11.5
Coal Creek	Dead Horse Br.	1983	10.3
		1984	10.2
		1985	11.6
		1986	12.3
		1987	10.0
North Coal		1983	14.0
		1984	12.2
		1985	13.5
		1986	14.2
		1987	13.7
South Fork Coal		1985	12.8
		1986	12.0
		1987	12.2
	Middle Fork Drainage		
Morrison	Reach IV	1986	12.3
		1987	12.8

Fish Population Surveys

Bull Trout Redd Counts

Counts of bull trout redds in 1987 were the highest since 1983 in most North and Middle fork tributaries (Table 7). The 1987 count of 277 redds in the North Fork drainage was about 30 percent higher than the 1979-1986 average of 216 redds. The count for the Middle Fork drainage (149 redds) was slightly higher than the 1979-1986 average of 140 redds. The redd count in Morrison Creek (49 redds) was lower than the 1979-1986 average 59 (redds). This may have been related to low flows and the presence of a channel debris barrier located 5.5 km upstream from the Middle Fork Flathead River. The contribution of each drainage and the annual trend of numbers of bull trout redds is depicted in Figure 11.

Table 7. Bull trout redd counts for selected areas of tributaries chosen for monitoring in the Flathead drainage (from Montana Department of Fish, Wildlife and Parks 1988).

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

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

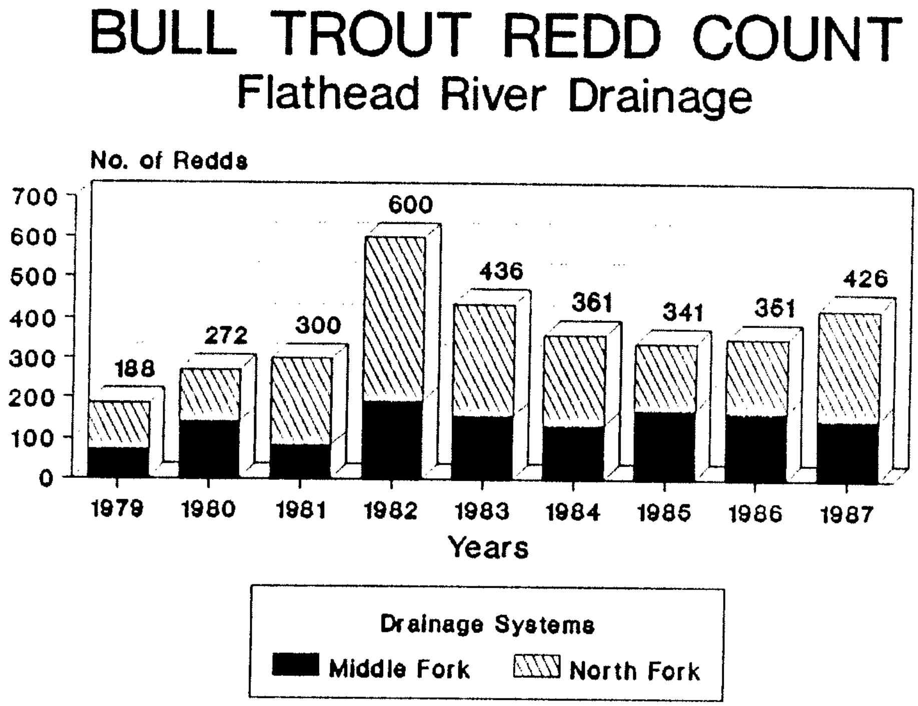

Figure 11. Number of bull trout redd counts for North and Middle Fork tributaries and combine totals for Flathead River drainage, 1979 to 1987.

Electrofishing Estimates of Juvenile Bull and Cutthroat Trout

Estimated juvenile bull trout populations showed substantial annual fluctuations in most sections censused during the period of record (Table 8). Low probability of capture during the first pass of a two-pass estimate ($\hat{p}$) indicates the estimate may be questionable. Shepard and Graham (1983) recommended a $\hat{p}$ of 0.6 or greater for reliable two-pass estimates. Considering this, the 1987 juvenile bull trout estimate for the South Fork of Coal Creek (12 ± 2) must be viewed cautiously, especially with only a single year of prior data. All other juvenile bull trout estimates during 1987 approached or exceed acceptable levels of $\hat{p}$ (Table 8).

Bull trout abundance in Morrison Creek (Middle Fork drainage) and Coal Creek at Dead Horse bridge (North Fork drainage) in 1987 were the highest on record. This is a significant finding because of the five to six year period of record on these index tributaries. Increased abundance may have been related to higher spawner escapement levels in 1982. However, analysis of spawner escapement and juvenile abundance in subsequent years reveals a weak relationship (Weaver and Fraley 1988).

Table 8. Summary of electrofishing population estimates for Age I+ bull trout in areas selected for monitoring between 1982 and 1987. Data are from Weaver and Fraley (1988), MDFWP (1988) and FNF (1988).

Drainage	Creek	Section	Date	$\hat{N}$	95% C.I.	$\hat{p}$
North Fork	Coal	Cyclone Br.	8/10/82	50	±43	.40
			8/24/83	34	± 7	.71
			8/30/84	52	±13	.63
			8/10/87	30	± 2	.52
		Dead Horse Br.	8/5/82	97	±23	--
			8/23/83	99	±33	--
			8/28/84	85	± 7	--
			8/26/85	159	±61	--
			9/5/86	152	±45	--
			9/1/87	179	±55	--
		North Coal Br.	8/4/82	17	± 9	.60
			8/25/83	18	± 3	.78
			8/29/84	48	±12	.63
			8/27/85	41	± 5	.77
			9/3/86	29	±12	.59
			8/5/87	47	±17	.56
	South Fork Coal	Section 26	8/28/85	62	± 8	.74
			8/6/87	12	± 2	.48
	Big	Skookoleel Br.	9/15/86	47	± 5	.78
			8/19/87	48	± 6	.75
	Red Meadow	1st Br. RMC Rd.	8/15/83	75	±11	.69
			9/16/86	69	± 8	.74
			8/18/87	47	± 4	.82
	Whale	Shorty Cr.	8/22/83	38	± 8	.69
			9/4/86	32	--	.74
			8/13/87	63	±17	.60
Middle Fork	Ole	Fielding trail	9/13/82	25	±12	.57
			9/12/86	39	± 5	.76
			8/27/87	42	±14	.60

Table 8 continued.

Table 8. (Continued).

Drainage	Creek	Section	Date	$\hat{N}$	95% C.I.	$\hat{p}$
	Morrison	Reach IV	9/01/82	95	± 6	.82
			8/18/83	70	±11	.69
			9/25/85	93	±27	.54
			8/27/86	114	±15	.67
			8/25/87	138	±10	.76

[a]/ Population estimates for 300 m sections.
[b]/ Population estimate for a 122 m section.

Population estimates for westslope cutthroat trout in 1987 were the highest on record for the North Fork of Coal Creek (North Fork drainage) and Challenge Creek (Middle Fork drainage) (Table 9). However, estimates were relatively low in other reaches of the Coal drainage, and in Red Meadow Creek. Low $\hat{p}$ values for estimates in the South Fork Coal Creek make these estimates questionable.

Table 9. Summary of electrofishing population estimates for age I+ westslope cutthroat trout in areas for monitoring between 1982 and 1987. Data are from Weaver and Fraley (1988), MDFWP (1988) and FNF (1988).

Drainage	Creek	Section	Date	$\hat{N}$	95% C.I.	$\hat{p}$
North Fork	Coal	Cyclone Br.	8/10/82	41	±18	.55
			8/24/83	17	± 7	.64
			8/30/84	25	±11	.56
			8/10/87	23	± 2	.66
		North Coal Br.	8/4/82	32	± 6	.74
			8/25/83	27	± 4	.82
			8/29/84	31	± 9	.65
			8/27/85	36	±12	.33
			9/3/86	40	±11	.64
			8/5/87	63	± 2	.91
	South Fork Coal	Section 26	8/28/85	63	±35	.33
			8/6/87	43	± 4	.47
	Red Meadow	1st Br. RMC Rd.	8/15/83	121	± 5	.46
			9/16/86	69	±12	.63
			8/18/87	58	± 4	.88
Middle Fork	Challenge	Skyland Rd. Br.	9/23/80	92	±33	--
			7/18/81	183	±50	--
			7/15/82	78	± 5	.82
			7/22/83	66	± 7	.76
			8/28/86	112	± 9	.76
			8/24/87	209	± 9	.80

[a]/ Population estimate for a 300 m section.

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. Finalize the five-year Flathead River and Lake Fisheries Management Plan with the cooperation of the CS&KT so that it can be implemented immediately and used as a basis in future fisheries mitigation planning.

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.

5. Annually monitor the bull trout spawning escapement by enumerating redds on selected streams in the North and Middle Fork River drainages 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.

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Prepared by: Delano A. Hanzel, John Fraley, and Will Beattie

Date: August 15, 1988

Waters Referred to: Flathead Lake 07-6400
Flathead River 07-1560
North Fork Flathead River 08-5100
Big Creek 08-0680
Coal Creek 08-1620
Whale Creek 08-7700
Trail Creek 08-7330
Middle Fork Flathead River 08-4740
Ole Creek 08-5150
Lodgepole Creek 08-4240
Granite Creek 08-3080
Morrison Creek 08-4940

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