March 1985

LOWER FLATHEAD SYSTEM FISHERIES STUDY

Annual Report 1985

DOE/BP-39830-1

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LOWER FLATHEAD SYSTEM FISHERIES STUDY

ANNUAL REPORT 1985

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March 1986

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TABLE OF CONTENTS

Table of Contents (Cont.)

TRIBUTARIES

Table of Contents (Cont.)

Table of Contents (Cont.)

LIST OF FIGURES

FIGURE PAGE

List of Figures (Cont.)

FIGURE PAGE

List of Figures (Cont.)

LIST OF TABLES

INTRODUCTION

The 1985 Annual Report of the Lower Flathead System Fisheries Study presents the results of research efforts funded by the Bonneville Power Administration and conducted by the Confederated Salish & Kootenai Tribes in FY85. The study began in December of 1982 and when completed in December 1987 will fulfill program measure 804(a)(3) and 804(b)(6) of the Columbia Basin Fish and Wildlife Program.

The importance of the Lower Flathead System to the Salish and Kootenai people was reported in the 1983 Annual Report of the Lower Flathead System Fisheries Study (DosSantos et al. 1983). Closed in 1938, Kerr Dam controls Flathead Lake levels between 878.7 meters (m) (2883 ft) and 881.8 m (2893 ft) and discharges into the lower Flathead River. Kerr Dam is a 60.6 m high concrete arch structure located 7.2 kilometers (km) downstream from the outlet of Flathead Lake. The facility is used primarily as a peaking operation with some use for lower level base-load (prepared answering testimony of Don Gregg presented to the U.S. Federal Energy Regulatory Commission on April 23, 1984).

While considerable effort by the State of Montana has been directed toward evaluating the impact of Kerr hydroelectric operations on the kokanee salmon (Oncorhynchus nerka) Of Flathead Lake, (Leathe and Graham 1982, Decker-Hess and McMullin 1983, Decker-Hess and Clancey, 1984), the Tribes recognized a significant data gap of how lake level fluctuations affect other fish species important to the Tribes, notably yellow perch (Perca flavescens), lake whitefish (Coregonus clupeaformis), largemouth bass (Micropterus salmonides) and northern pike (Esox lucius). In 1984 the Lower Flathead System Fisheries Study was expanded to the South Bay of Flathead Lake to assess the impact of lake level fluctuations due to Kerr operations on the distribution, recruitment, and habitat utilization of yellow perch, lake whitefish, largemouth bass and northern pike.

The study will provide a technical data base for the fisheries resources of the lower Flathead System from which an array of management/mitigation alternatives will be developed covering the present status of hydroelectric development and operation, and possible future development. The alternatives will be used by Tribal decision makers and other interested parties in making informed management decisions for the necessary level of protection, enhancement or mitigation for the fisheries resource of the lower Flathead System.

The objectives of the Lower Flathead System Fisheries Study are:

I. Assess existing aquatic habitat in the lower Flathead River and its tributaries and its relationship to the Present size, distribution, and maintenance of all salmonid species, northern pike, and largemouth bass populations.

II. Assess how and to what extent hydroelectric development and operation affects the quality and quantity of aquatic habitat in the lower Flathead River and its tributaries and life stages of existing trout, pike, and largemouth bass populations. Evaluate the potential for increasing quality habitat, and thus game fish production, through mitigation.

III. Assess existing aquatic habitat in the South Bay of Flathead Lake and its relationship to the present size, distribution, and maintenance of yellow perch, largemouth bass, northern pike, mountain whitefish (*Prosopium williamsoni*) and lake whitefish populations in the bay.

IV. Assess how and to what extent hydroelectric development and operation affects the quality and quantity of aquatic habitat in the South Bay and life stages of existing target fish populations.

V. Develop an array of fisheries management options to mitigate the impacts of present hydroelectric operations, demonstrating under each management option how fish populations would benefit and hydroelectric generation capabilities would be modified.

During fiscal year 1985, Phase Two work on the lake began and the second field season of Phase Two work on the main river and tributaries was completed. Stock assessments were conducted at five permanent sites on the main river and 10 of 22 permanent sites on the tributaries. Tributary Sites were reduced to those influenced by main river stocks. Spawning runs of rainbow (Salmo garidneri) and brown trout (Salmo trutta) from the main river were trapped at weirs installed in 1984 on the Jocko River and Mission Creek. Both streams support rainbow trout runs, but brown trout runs have only been found in the Jocko River. Data continued to be collected from radio-tagged northern pike to aid in assessing pike spawning habitat and fish movement in response to river discharge and reproductive condition.

In South Bay an evaluation of structural and vegetative cover was completed for the three evaluation periods. Water quality continued to be monitored. Fish stocks were sampled to determine the spatial and temporal distribution of fish species in response to lake level fluctuations by gill netting (70 sites), beach seining (24 sites), and fyke trapping (5 sites). Gill netting and beach seining were conducted at permanent sites during three evaluation periods; fyke nets were operated during the spring. Larval fish sampling was conducted at 32 sites from April 4 through August 22, 1985.

During the 1984-85 ice fishery season (January-March) a creel census was conducted in South Bay. Data on year class composition, age at recruitment, total harvest, and pressure was collected.

An Instream Flow Incremental Methodology study plan was developed with intensive review by the Instream Flow Group.

After development, the plan was reviewed again by an interagency group in early 1985. Study sections and transects were selected to best describe all habitat types found in the main river. Transects were surveyed and negotiations for stable flows were completed. Water releases from Hungry Horse Dam through Kerr Dam from June through October prevented stable low flows for this phase of the study. Attempts to complete this phase will be repeated in FY86.

MAIN RIVER

BY

Joseph H. DosSantos

DESCRIPTION OF STUDY AREA

The lower Flathead River is one of Montana's largest rivers, with an annual average discharge of 340 cubic meters (m^3)/second (11,700 cfs). The lower river begins at Kerr Dam, located 7 km southwest of Polson, Montana. Flowing south and west for 116 km, the river flows into the Clark Fork River near Paradise, Montana (Figure 1). Approximately 110 km of the river are within the boundaries of the Flathead Indian Reservation, the second largest Indian Reservation within the State of Montana.

The first 7 km of the lower Flathead cuts through a glacial morain forming a steep rocky canyon characterized by extensive white-water areas.

Below the canyon the lower river cuts through highly erosive lacustrine and alluvian sediments deposited during the life span of the glacial lake. These sediments have a high concentration of clay, sand, and silt; gravels comprise only a small percentage (Montague et al. 1982). Bedrock formations are found in a few areas along the river. Irrigated croplands border the eastern and southern banks of the river; to the west and north is open rangeland.

The lower Flathead River drains 386,205 hectares, and is a low gradient river. Based on general valley characteristics, gradient, and channel morphology, the lower Flathead can be dividied into four distinct river reaches (Figure 1).

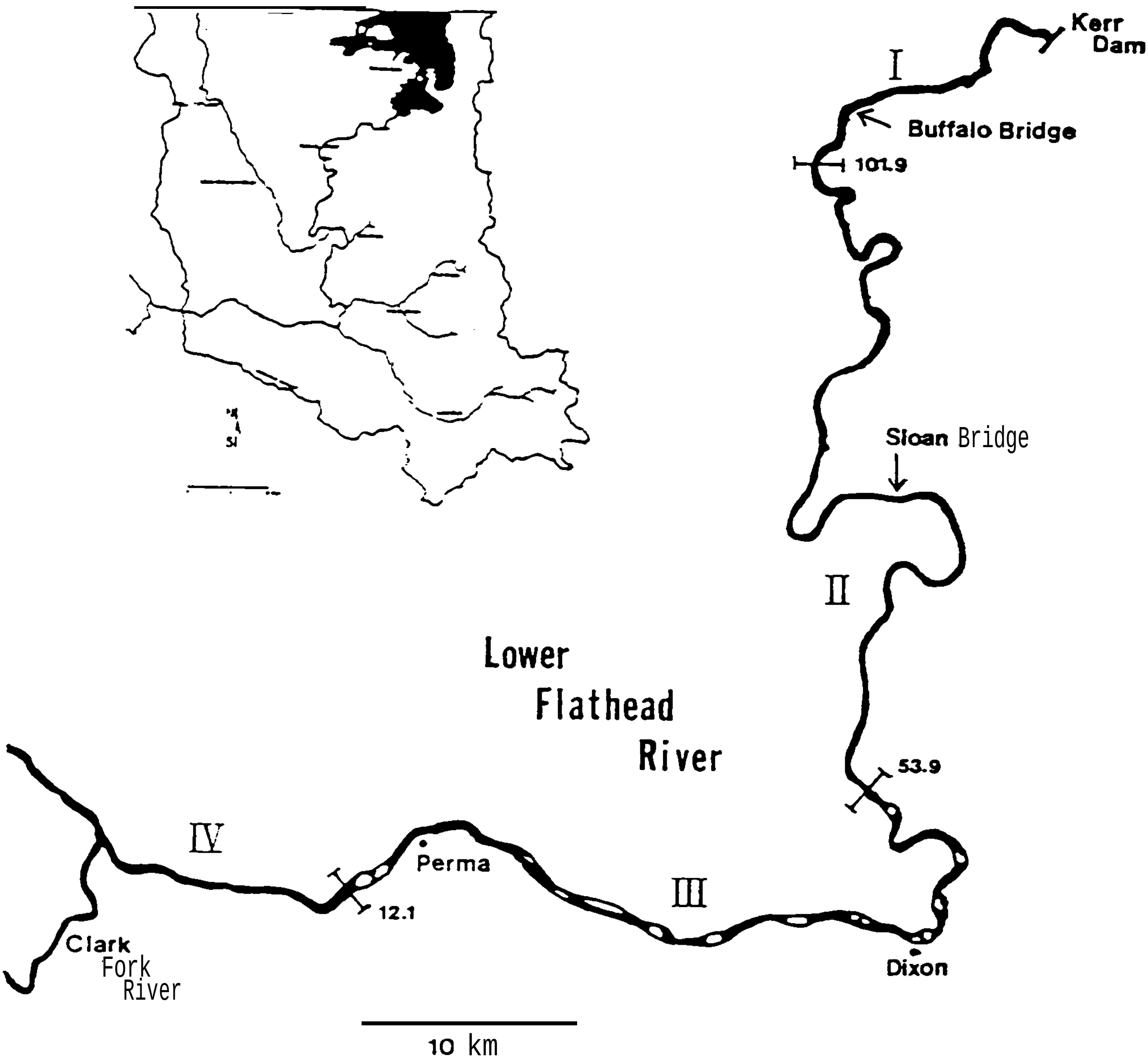

Figure 1. Reach breaks of the lower Flathead River.

Reach I of the lower Flathead extends from Kerr Dam (River Kilometer (RK) 116) to the mouth of White Earth Creek (RK 102). Gradient is 1.5 m/km, and the river has an average width of 114 m. The river is confined in a steep rocky canyon for the first 6 km of this reach, after which the canyon widens. The channel bottom is composed of a large boulder-bedrock mixture blending into a cobble-gravel mixture toward the end of the reach. The canyon portion of this reach is primarily a whitewater area characterized by deep pools and several sets of rapids. The lower section of the reach is a smooth, fast flowing glide with two riffle areas. This river reach is subject to severe water level fluctuations due to hydropower peaking operations at Kerr Dam. At the United States Geological Survey (USGS) gaging station downstream from Kerr Dam, water levels have fluctuated from 0.6 to 2.4 m in three hours.

The Buffalo study section, extends from RK 109.4 to RK 102.9, representing 46 percent (%) of Reach I in the lower Flathead River. The study section has an average width of 114 m and a gradient of 1.5 m/km. The channel substrate is composed of a large boulder-rubble mixture blending into a cobble-gravel mixture toward the end of the section. The section is a single channel, fast flowing glide containing two riffle areas, subject to rapid water level fluctuation of up to 2.4 m due to the hydropower peaking operations at Kerr Dam. No tributaries enter this study section, and the only boat access is Buffalo Bridge (RK 104.6) (Figure 2).

Reach II of the river extends from the mouth of White Earth Creek (RK 102) to 2 km downstream of Moss's Ranch (RK 54). Average gradient and river width within this reach are 0.6 m/km and 128 m, respectively. Throughout this reach the river gradually widens, but maintains a single channel. With the exception of a few small islands and constrictions of the river channel, the flow is a smooth glide. Major tributaries enter this reach at RK 72 (Little Bitterroot River) and RK 67 (Crow Creek).

The reach is typified by large meandering bends bordered by high, eroding clay cliffs. River banks are generally steep with benchlands beyond; the channel substrate ranges from solid bedrock to sizeable areas of silt deposition.

The Sloan study section extends from.RK 75.6 to RK 69.2, representing 13.4% of Reach II. The study section has an average width of 128 m and a gradient of 0.6 m/km. Channel substrate is composed of primarily a cobble-gravel mixture, interspersed with large boulders; silt deposition occurs along shoreline areas. This section is a single channel smooth glide. The Little Bitterroot River enters this study secticn at RK 72; its delta constricts the main river channel to approximately one half its average width, forming a fast turbulent chute. Pablo A Canal, an irrigation canal, also empties into this section at RK 69.9. The boat access point is Sloan Bridge (RK 71.4) (Figure 2).

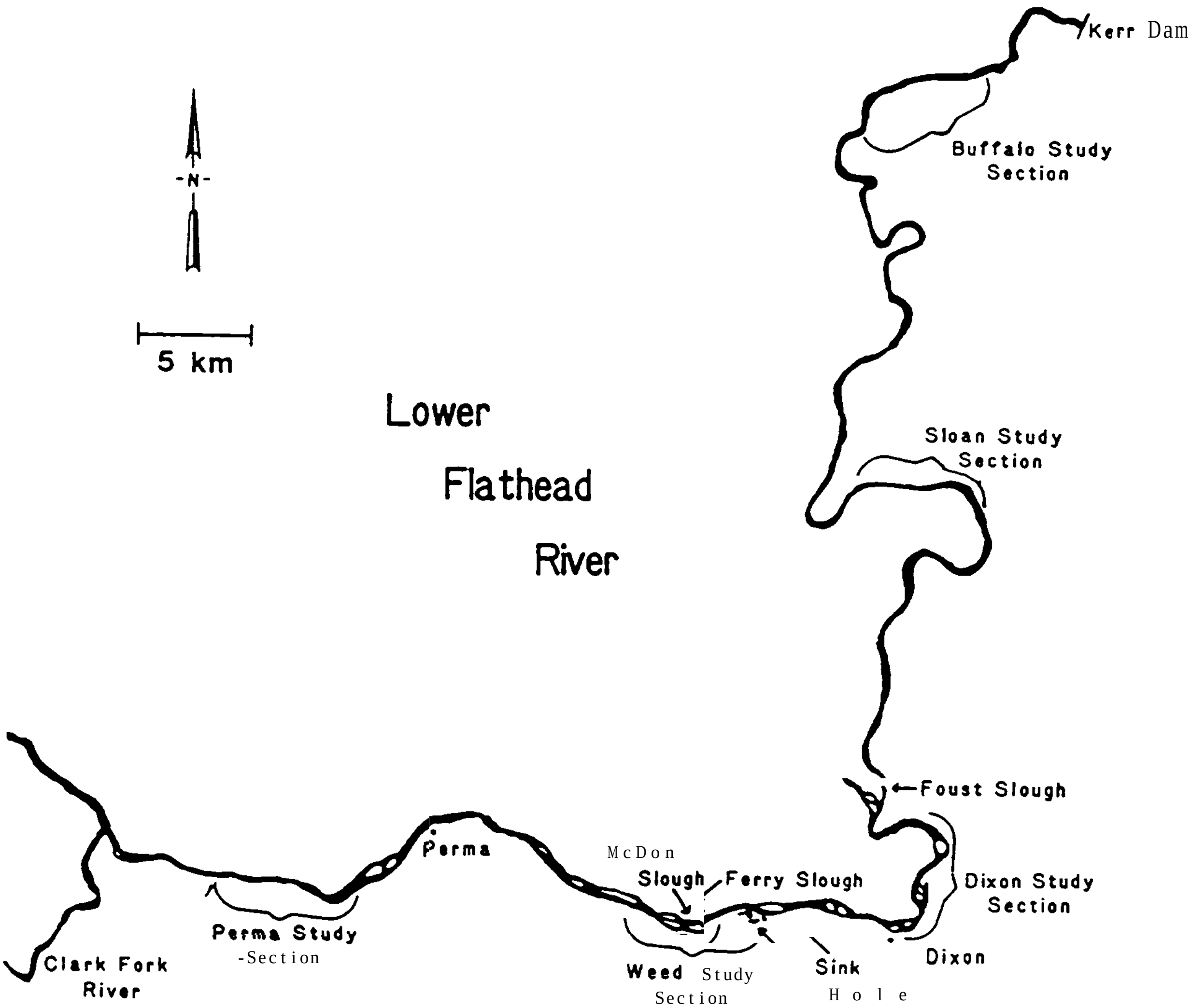

Figure 2. Permanent **study** sections and important backwater areas of the lower Flathead River.

Reach III of the river extends from RK 54 to RK 12. Average gradient and river width within this reach are 0.3 m/km and 104 m, respectively. Habitat is variable, and the river channel is braided. Major island complexes, gravel bars, and extensive backwater areas are common. McDonald Slough (RK 29) has a surface area of 5.2 hectares and a maximum depth at average river discharge of approximately 4.5 meters. By mid-summer, a heavy growth of aquatic macrophytes completely encircles this backwater, leaving only the deepest water free of vegetation. The “Sink Hole” (RK 34) has surface area of 12.6 hectares and a maximum depth of 5.4 meters (Figure 2). Growth of aquatic macrophytes is similar to that which occurs in McDonald, however there is more open water in the “Sink Hole”.

Permanently wetted backwaters range from 0.4 to over 12 hectares. River banks are most notably overgrazed and unstable within this reach. Water level fluctuations in this reach are less pronounced than in Reach I or II, but may vary as much as 0.3 m in six hours at the bridge near Dixon, Montana (United States Fish and Wildlife Service (USFWS), unpublished data).

The Dixon study section, extends from RK 47.1 to RK 42.9, representing 15.4% of Reach III. Average gradient and channel width within this section are 0.3 m/km and 104 m, respectively. Channel substrate is primarily gravels with extensive areas of silt deposition. The river channel is braided; major islands complexes, gravel bars, and high water channels are common. Two major tributaries enter this study section; Mission Creek at RK 45.2 and the Jocko River at RK 40.9 (Figure 2).

The Weed study section extends from RK 32.2 to RK 25.7 and represents 15.4% of Reach III. General river characteristics, gradient and channel width are similar to the Dixon section. This section has two large backwater areas and only one small intermitant tributary, Magpie Creek, entering at RK 27.2 (Figure 2).

Reach IV extends from RK 12 to the confluence with the Clark Fork River. The final 6 km of the lower Flathead River are outside the Flathead Indian Reservation boundary. Average gradient and channel width of this reach is 0.2 m/km and 198 m, respectively.

The Perma study section extends from RK 12.1 to RK 5.6 and represents 53.31 of Reach IV. With the exception of one bedrock intrusion, substrates are primarily gravel with sizeable areas of sand and silt deposition. One small, mid-channel island is also present.‘ Three small intermitant tributaries; Seepay, Burgess and Robertson Creeks, also enter this study section. The boat access point is Robertson Creek (RK 6.4) (Figure 2).

METHODS

Physical Habitat Evaluation

Kerr Dam Flow Releases

Staff gages were installed at RK 37.8 and 31.1 in 1983 and RK 40.2 and 27.2 in 1984 to monitor water level fluctuations. In 1985 a staff gage was installed at the mouth of Foust Slough (RK 49.9) and another gage, damaged by ice, reinstalled in Ferry Slough (RK 31.1, Figure 2). Gages were usually read once a day during the northern pike spawning season. Daily water level fluctuations at other specific spawning areas were calculated as described by DosSantos et al. (1983). Daily discharge records recorded at RK 115, approximately one kilometer below Kerr Dam, were provided by the USGS. Discharge recordings at this USGS station began in August of 1907.

Water Tempeatures

Water temperatures were recorded at two permanent sites along the lower Flathead River using continuously recording 90-day Ryan thermographs installed at Sloan (RK 71.4) and old Perma (RK 17.6) bridges. Dixon bridge (RK 40.21, used as a thermograph location during 1983, was destroyed by ice in January 1984. Daily water temperature recording by the USGS at their gage house (RK 115) directly below Kerr Dam was discontinued as of 1 October 1983.

Substrate Analysis

Substrate samples were taken within three of the five permanent study sections in those areas where habitat variables (gravel size, water depth, and water velocity) appeared suitable for salmonid spawning (Darling et al. 1984). Samples were collected during March 1985, before high water, when substrates were most embedded. A total of 18 samples were collected: six from the Buffalo, four from Dixon and six from Weed study section. One paired sample was taken from a large gravel bar located at RK 48, which is not included within any permanent study section. No suitable gravel for sampling was found in the Sloan study section (Darling et al. 1984) and no samples were taken at Perma due to early high water conditions.

Replicate samples were randomly taken in suitable gravel areas using a 15.24 centimeter (cm) throat diameter McNeil sampler (McNeil and Ahnell 1964) following field procedures outlined by Shepard and Graham (1983). Substrate samples were individually labeled, bagged and returned to the laboratory. Suspended material in the corer was estimated by measuring the amount settling in a one liter (1) Imhoff cone within 25 minutes, and relating this amount to the known water volume in the corer.

Samples were transferred to drying trays and oven dried at 260°C for 16 hours. After drying, samples were shaken through a sieve series stacked as follows: 63 millimeters (mm), 16 mm, 6.35 mm, 2 mm, 0.063 mm and pan. Each fraction was weighed individually, and percent composition was calculated. The percentage of substrate smaller than each of the sieve sizes was plotted against particle (sieve) size (mm) on log-probability paper. A linear regression equation was fitted to-substrate sizes 16 mm and smaller.

Tappel and Bjorn (1983) found that lines passing through data points for two sieve sizes closely approximate lines determined by the least squares regression procedure for the entire gravel mixture. For samples from two river systems (Idaho and Washington), a line passing through data points for the 9.5 mm and 0.85 mm particle size was the best approximation, and by considering these two particle sizes, salmonid embryo survival can be implicitely related to a range of particle sizes in a natural gravel mixture. We compared the relative percentages of substrate smaller than 0.85 and 9.5 mm to results from Idaho laboratory studies by Irving and Bjorn (1984) to estimate trout embryo survival from hatching to emergence from the gravel.

Northern Pike Habitat Evaluation

Radio-tagged northern pike were tracked using a hand-held directional loop antenna and a programable scanning receiver (Darling et al. 1984). Tracking operations were normally conducted by floating mid-channel downstream in an open boat.

During poor weather, tracking operations were conducted on land. When individual fish could not be located using the above methods, aerial surveys proved to be effective.

Tracking operations were extremely accurate once the general area of occupation was determined. Individual fish were sighted on many occasions. Pike locations were pinpointed by gradually reducing the receiver’s gain. Total water depth and predominate substate type were recorded at each location. Water velocities were also measured at the locations using a Marsh McBirney Model 201 electronic current meter. Using a 1.2 ❑ top-setting wading rod, the probe was lowered 1.2 m into the water and turned to record the highest occuring water velocity.

Spawning Surveys

The inlets of one known and four suspected northern pike spawning areas were trapped from 20 March to 31 May 1985, using 1.2 m diameter double-throated fyke nets and 1.5 x 1.0 x 1.0 m box traps. Two off-channel shallow benches of the main river were also trapped using 1.2 m diameter double-throated fyke nets. All captured fish were weighed, measured, sexed and tagged, then released above the trap.

Aerial and boat surveys were conducted in the spring to identify main river areas used by spawning salmonids.

Stock Assessment

Stock assessment data were collected at four permanent study sections located in the four reaches of the main river during the fall of 1985. Fish were collected at night using boat-mounted electrofishing gear (Leob 1957), following guidelines presented by Vincent (1971 and 1983) and Peterman (1978).

River reach III originally contained two study sections, Weed and Dixon. The Dixon study section was established due to special interest in tributary inflow (Mission Creek and the Jocko River), whereas the Weed section was representative of reach III. Since catch rates and species composition in 1983 and 1984 for target fish were comparable between the two study sections, the representative reach, Weed, was sampled, while the Dixon study section was not in 1985.

Main river study sections are 6.4 km long. Two electrofishing passes per run were made along each bank within each study section. Two days were required to make either a mark or recapture run at each study section. Recapture runs followed marking runs by seven-days (Vincent 1971 and 1983).

Population estimates were attempted in fall 1985 at two backwater areas (RK 34 and RK 29) to assess population levels of largemouth bass. Two passes were made around the vegetation-free perimeter for both the mark and recapture runs.

Target fish species were weighed, measured, sexed (if possible), scale samples taken for aging, tagged with either a numbered "T" or fry tag, and released. Mountain whitefish were excluded from this year's stock assessment.

Target fish species population estimates were made using an adjusted Peterson estimate (Ricker 1975). Population estimates were described as fish per kilometer (fish/km) at the 80% confidence interval. Catch per unit effort (CPUE) for each target fish species was determined, and defined as catch per one hour of actual fish sampling. Pair-wise comparisons were made using CPUE data.

Instream Flow Incremental Method

Study Plan Development

To evaluate instream flow needs in the lower Flathead the Water Surface Profile model (Bovee 1982) was selected because the lower river has a simple channel with few regions of rapidly varied flows (ie: abrupt changes in stream gradient). Field measurements taken at two study sites at flows of 91 and 283 m^3/second (3,200 and 10,000 cfs) will enable the model to predict effects on weighted useable area (WUA) from 36 to 708 m^3/second (1,280 to 25,000 cfs).

Close contact with the Instream Flow Group in Fort Collins, Colorado was maintained during study plan development. On 6 February 1985 an interagency coordination meeting was held to present, discuss and review the proposed study Plan.

Personnel from the U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey, University of Montana Biological Station, Bureau of Indian Affairs and Montana Power Company attended. The complete IFIM study plan for the lower Flathead River is presented in Appendix A.

River Segmentation

As previously described, the lower Flathead River was divided into four distinct river reaches (Figure 1, DosSantos et al. 1983). For the purposes of IFIM segmentation the river was divided into two large macrosegments.

IFIM river segment I extends from RK 108.5 to RK 54, encompasses river reach I and II and characterizes the single-channel portion of the lower Flathead River. Aside from a slight gradient difference, the lower section of river reach I (RK 108.5-102) below Buffalo Rapids, has macrohabitat features similar to river reach II (RK 102-54). Repeating hydrological features of pool, riffle, run, and river widths are similar.

IFIM river segment II, encompassing river reach III and IV, from RK 54 to RK 6, characterizes the braided channel portion of the lower Flathead River. The upper half of river reach IV (RK 12-6) has macrohabitat features similar to the single channel portion of river reach III (RK 54-12) (Darling et al. 1984). Gradient and channel width are similar.

Selection Study

IFIM study sites were chosen to proportionally include all the geomorphic macrohabitat features present within that particular river segment, as well as accessibility by land and inclusion with pre-existing study sections.

Transect Placement

The downstream-most transect within each IFIM study area was placed to transect the hydraulic control which influences all other upstream transects within that study area. All other transects are habitat descriptors chosen to best represent habitat types found throughout that river segment. Standard survey techniques described by Bovee and Millhous (1978) and Trihey and Wegner (1981) were used for the establishment of these transects.

RESULTS

Phvsical Habitat Evaluation

Kerr Dam Flow Releases

Discharges from Kerr Dam, in excess of 306 m^3/second (10,800 cfs) during the 1985 northern pike spawning season (April, Hay, June) provided adult fish better access to known spawning areas than in 1984 (Figure 3). Record low flows experienced during the later part of May 1984 were not seen this year. Flows remained well above 312 m^3/second (11,000 cfs) during May and June of 1985. May 1985 flows were 37 to 53.5% greater than those observed in 1984; June flows averaged 30% lower than 1984. Discharges from Kerr during July and August 1985, critical periods for fry development of northern pike and largemouth bass, were also greater than 1984.

Temperature Monitoring

Average monthly low, mean, and high river water temperatures recorded at Sloan (RK 71.4) and Perma (RK 17.6) during 1984 are presented in Figure 4. The USGS discontinued all temperature monitoring after 30 September 1983.

River water temperatures observed during 1984 showed a consistent seasonal warming pattern similar to that recorded in 1983. Water temperature reached a high of 24.1°C in August compared to 26.3° C the previous year. Daily

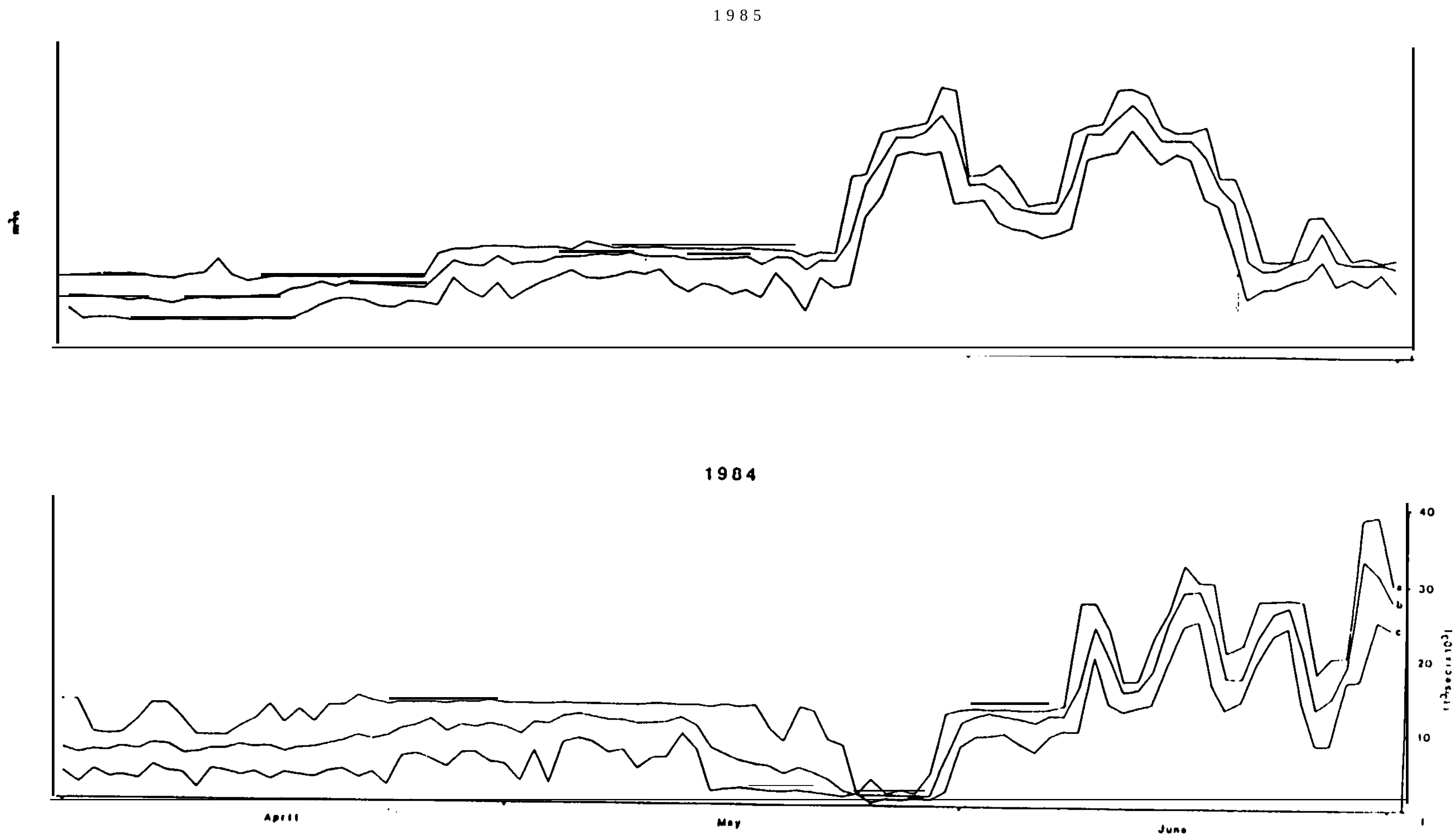

Figure 3. Daily discharges [maximum (a), mean (b), and minimum (c) from Kerr Dam for April, May and June 1984 and 1985 recorded at RK 114.9.

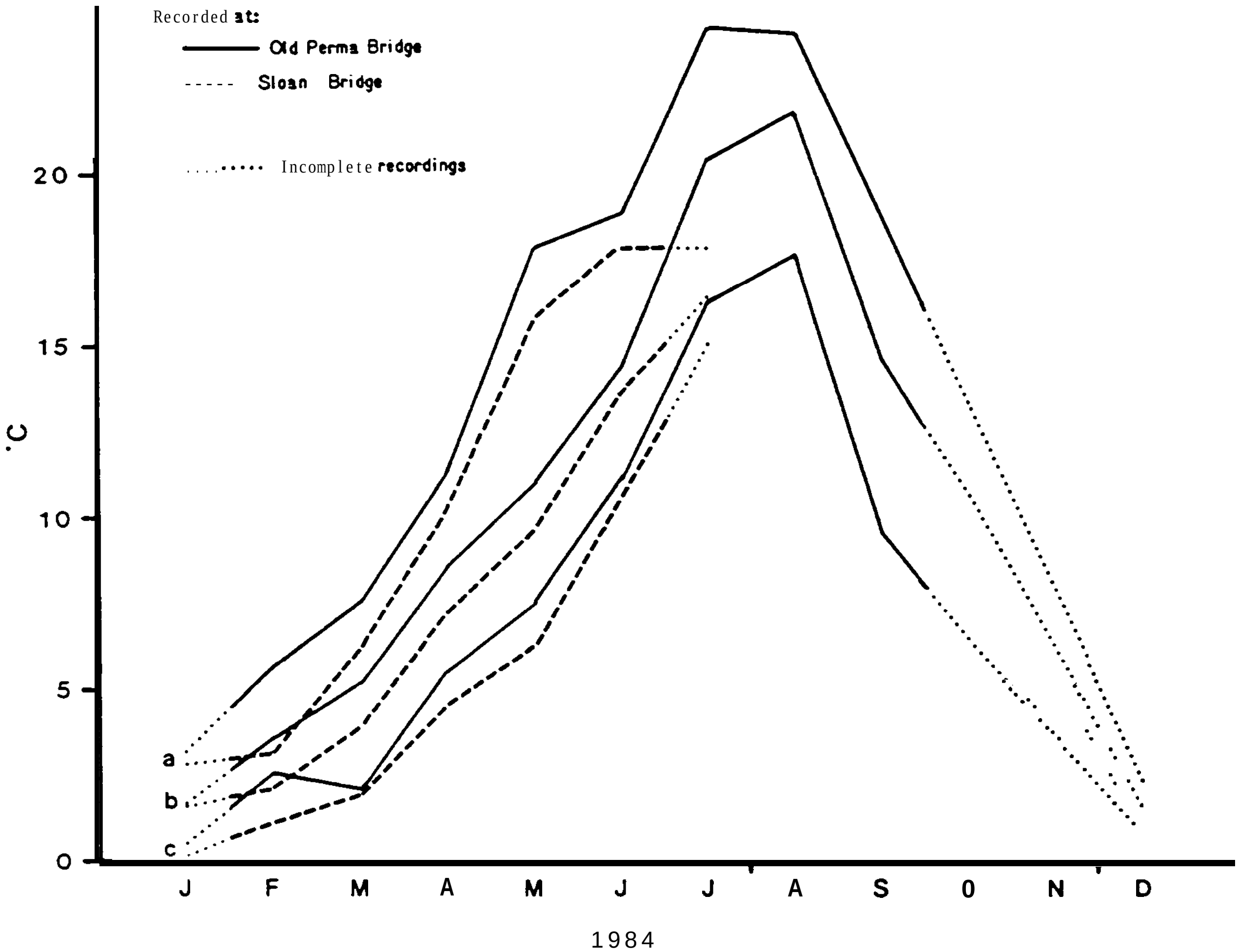

Figure 4. Water temperatures [monthly maximum (a), mean (b), and minimum (c)] for the lower Flathead River recorded at Sloan (RK 71.4) and Old Perma Bridge (RK 17.6).

fluctuations in 1984 river water temperatures increased from 2.0°C in January to a maximum of 10.3 °C in May. From June to October 1984, fluctuations in daily water temperatures ranged from 6.9 °C to 9.3 °C and averaged 7.7 °C. In December 1984, water temperature fluctuation was only 1.5 °C. River water temperatures observed during 1985 showed a consistent seasonal warming pattern similar to that recorded in both 1983 and 1984.

Substrate Analysis

Gravels from 16 to 63 mm predominated most samples from potential spawning gravels taken in the lower Flathead River (Figures 5 and 6). With few exceptions, the remaining fractions generally representing 20% or less of the total sample. Comparisons of our data with the Idaho laboratory results of Irving and Bjorn (1984) studying the relationship of sediment and trout embryo survival infer main river rainbow trout embryo survival in the Buffalo study section averages 28% using the substrate combinations of 0.85 mm and 9.5 mm (Figure 7, Appendix B).

In the Dixon study section, an average 31% survival by rainbow trout embryos is expected based on the combination of 0.85 and 9.5 mm fractions. Based upon similar evaluation criteria average survival in the Weed study section would be 61%. The combined percentages of fines smaller than 0.85 and 9.5 mm for the two samples from the gravel bar located at RK 48 predicts 52% survival (Figure 7).

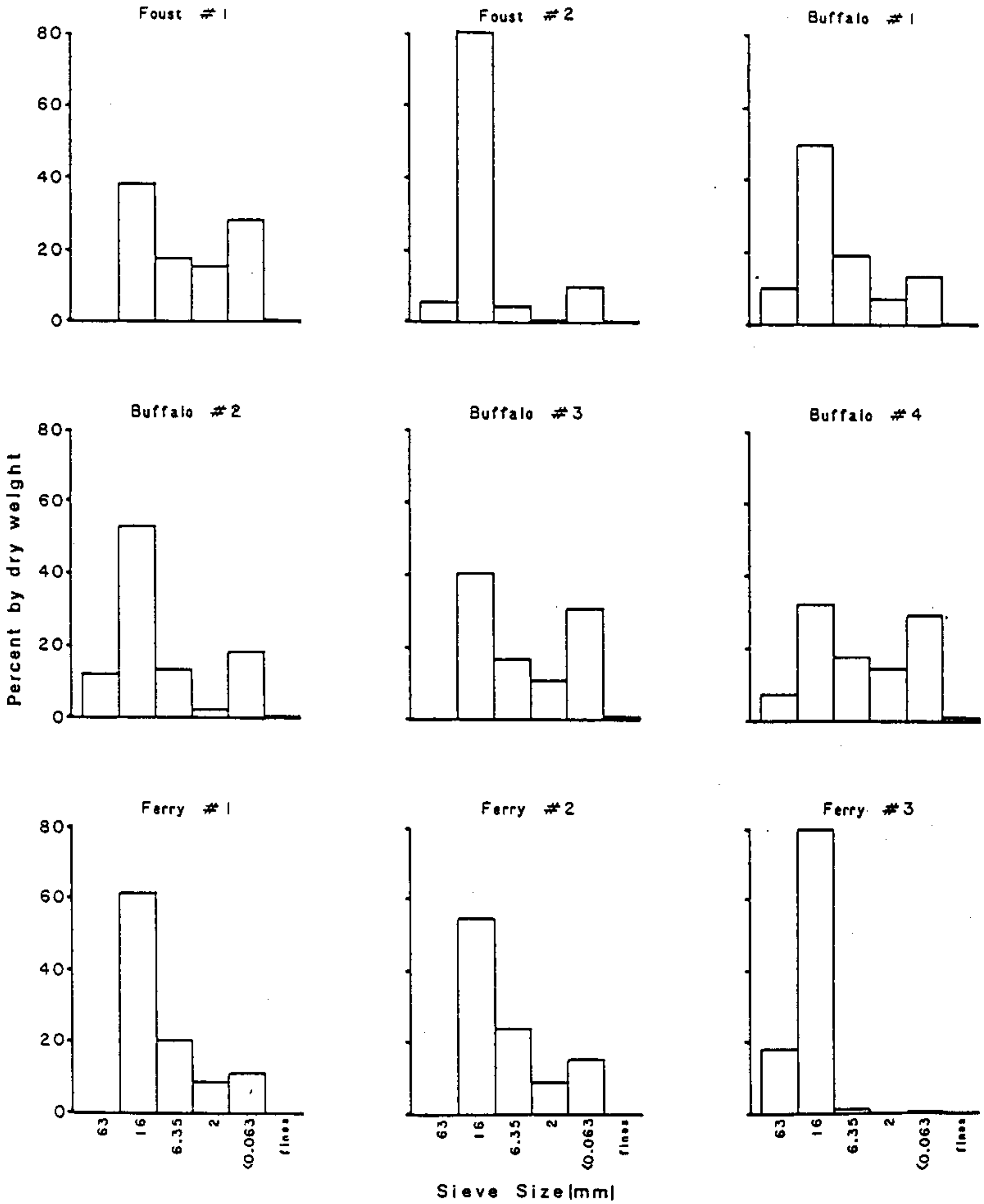

Figure 5. Substrate composition of gravels collected from select areas in the lower Flathead River during spring 1985.

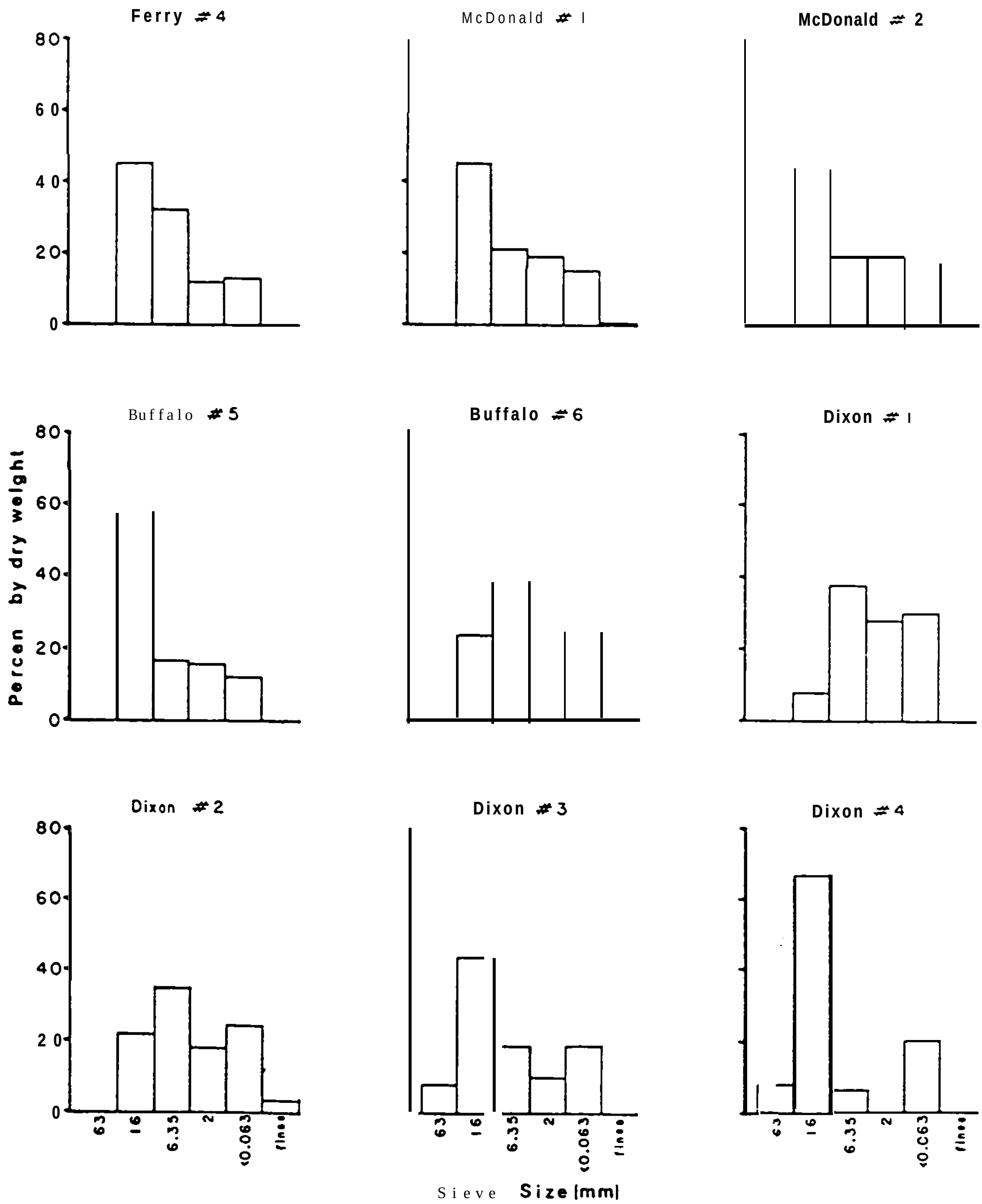

Figure 6. Substrate composition of gravels collected from select areas in the lower Flathead River during spring 1985.

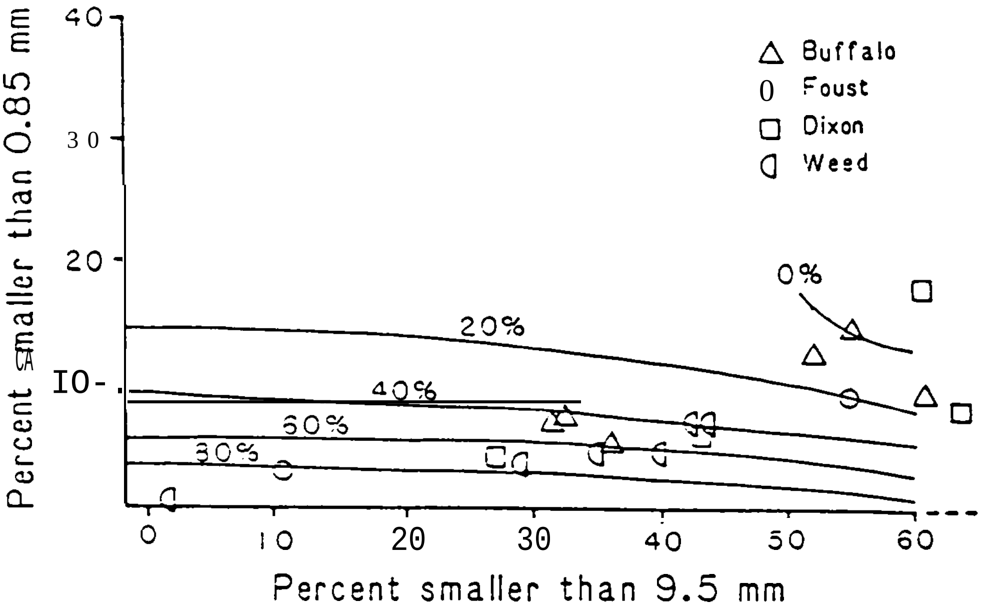

Figure 7. Predicted rainbow trout embryo survival in the lower Flathead River related to various combinations of natural spawning gravel. (Adapted from Irving and Bjorn 1984).

Fish Populations

Largemouth Bass

Largemouth bass are primarily backwater[1] residents of the lower Flathead and have not been collected in this study above RK 54. They are rarely found in main channel areas, and then only in the lowest gradient areas (< 0.3m/km). During this study, they have only been captured in the Weed and Perma study sections, showing a maximum CPUE of only 0.6 (Table 1).

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1 backrater: any place regarded as stagnant; having an upstream inlet channel which flows only at relatively high river discharges (> 20,000 cfs).

Table 1. Catch per unit effort for largemouth bass from the Weed (RK 32.2 to 25.7) and Perma (RK 12.1 to 5.6) study sections.

Sampling Period		Weed	Perma
Fall	1983	0.0	0.3
Spring	1984	0.0	0.0
Fall	1984	0.1	0.4
Fall	198s	0.0	0.6

Largemouth bass have been found in off-channel backwater areas at RK 54, 50, 49, 43, 36, 34 and 29. No permanent backwater areas exists downstream from RK 29.

Population estimates were attempted in the fall of 1985 within two backwater areas. Heavy macrophyte growth in McDonald Slough[2] limited gear efficiency, so an estimate was attempted in the “Sink Hole”. Boat electrofishing yielded a CPUE for largemouth bass of 12.6 and a population estimate of 433 (+ 213), or approximately 34 bass/hectare for the "Sink Hole". Average length for all bass handled (N = 41) was 303 mm (Age 4). Sizes ranged from 131 to 515 mm. Other sampling efforts conducted throughout the year captured only six additional largemouth bass (Appendix C).

From 1 March 1983 through 30 September 1985, a total of

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2 slough: a still backwater which has some intergravel flow; well scoured upstream inlet channel flows at moderate river discharges (> 10,000 cfs).

188 largemouth bass have been captured, averaging 307 mm (Age 4). Catches of bass have been predominated by Age 4 and older fish, comprising 76% of the total catch. Age 2 and 3 largemouth bass comprised 12 and 11%, respectively, of the total catch (Figure 8), averaging 169 and 221 mm in length, respectively.

Northern Pike

Northern pike have been collected throughout the length of the river. Though primarily thought of as backwater

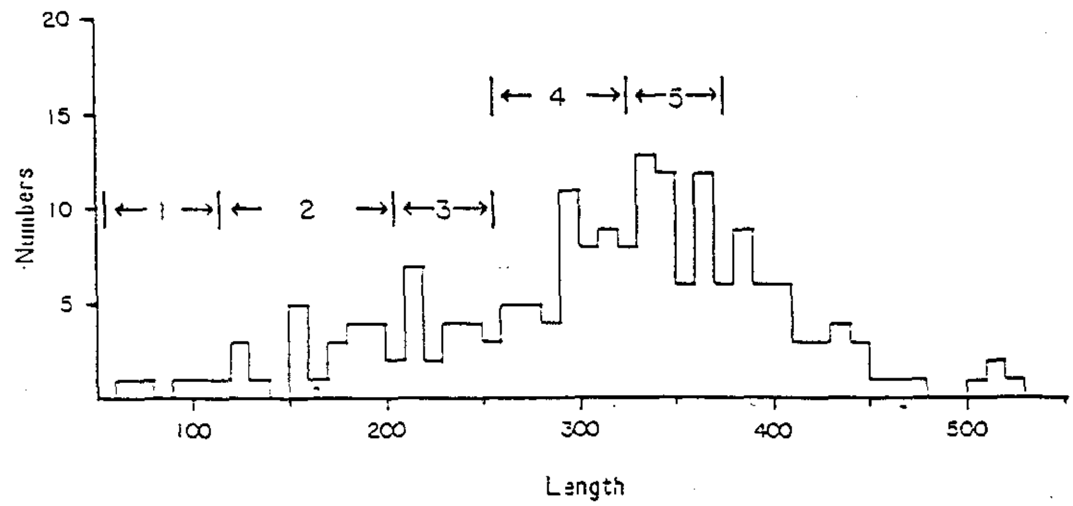

Figure 8. Length frequency distribution of 188 largemouth bass collected from the lower Flathead River 1 March 1983 through 30 September 1985 and their ages based on scale analysis.

residents, they are commonly found in main channel eddies[3] along the entire course of the river. CPUE data has consistently shown that the center of the northern pike concentration is within river Reach III, and their abundance tapers off both upstream and downstream (Table 2). A total of 82 northern pike were tagged during 1985 sampling efforts, averaging 596 mm (age 4) in length (Appendix c).

Table 2. Catch-per-unit-effort for northern pike within the five permanent river study sections.

Year	Season	Buffalo	Sloan	Dixon	Weed	Perma
1983	Fall	0.76	0.57	1.90	3.68	0.01
1984	Spring	0.23	0.88	1.62	1.11	0.11
1984	Fall	***	0.61	0.19	1.64	0.66
1985	Fall	0.47	0.69	***	1.73	1.00
Mean CPUE		0.49	0.69	1.24	2.04	0.44

***not sampled

Based on radio tracking locations, slackwater[4] areas chosen by northern pike during non-spawning daylight hours range from 2.3 to 3.2 m in depth, with water velocities not

3 eddy: an upstream-circling current, a whirlpool; usually associated with a obvious identation of the shoreline.

4 slackwater: a broad expanse of shallow water where there is no upstream and virtually no downstream current; not associated with irregularities of the shoreline.

exceeding 0.2m/second (0.6 ft/second). Off channel staging areas[5] used by pike during spawning ranged from 1.2 to 2.3 ❑ in depth with water velocities not exceeding 0.5 m/second (1.6 ft/second). Habitats occupied by radioed pike were usually totally vegetated.

Northern pike in varying stages of reproductive condition were captured at two known backwater spawning areas and two previously unsampled main channel slackwater areas during the spawning season.

Fifty-one pike were captured and tagged between 19 March 1985 and 6 June 1985; 6% were immature at the time of capture (Table 3). Of the mature spawners captured and sexed, 79% were males and 13% were females, resulting in male-female sex ratio of 5.9 to 1.0. Of the 51 spawners, 17 (33%) were recaptures from previous sampling efforts. Radio tracking data have shown that male pike will stay near spawning areas for approximately three months, while, female pike are only on the spawning areas for approximately one month (Figure (0.

Tag returns and radio tracking have shown two distinct movement patterns for spawning northern pike. It appears that most fish move relatively short distances (up to 12 km)

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5 staging area: relatively shallow (< 3 m deep) benches close (within 0.5 km) to shallow spawning areas, in which groups of sexually mature northern pike congregate.

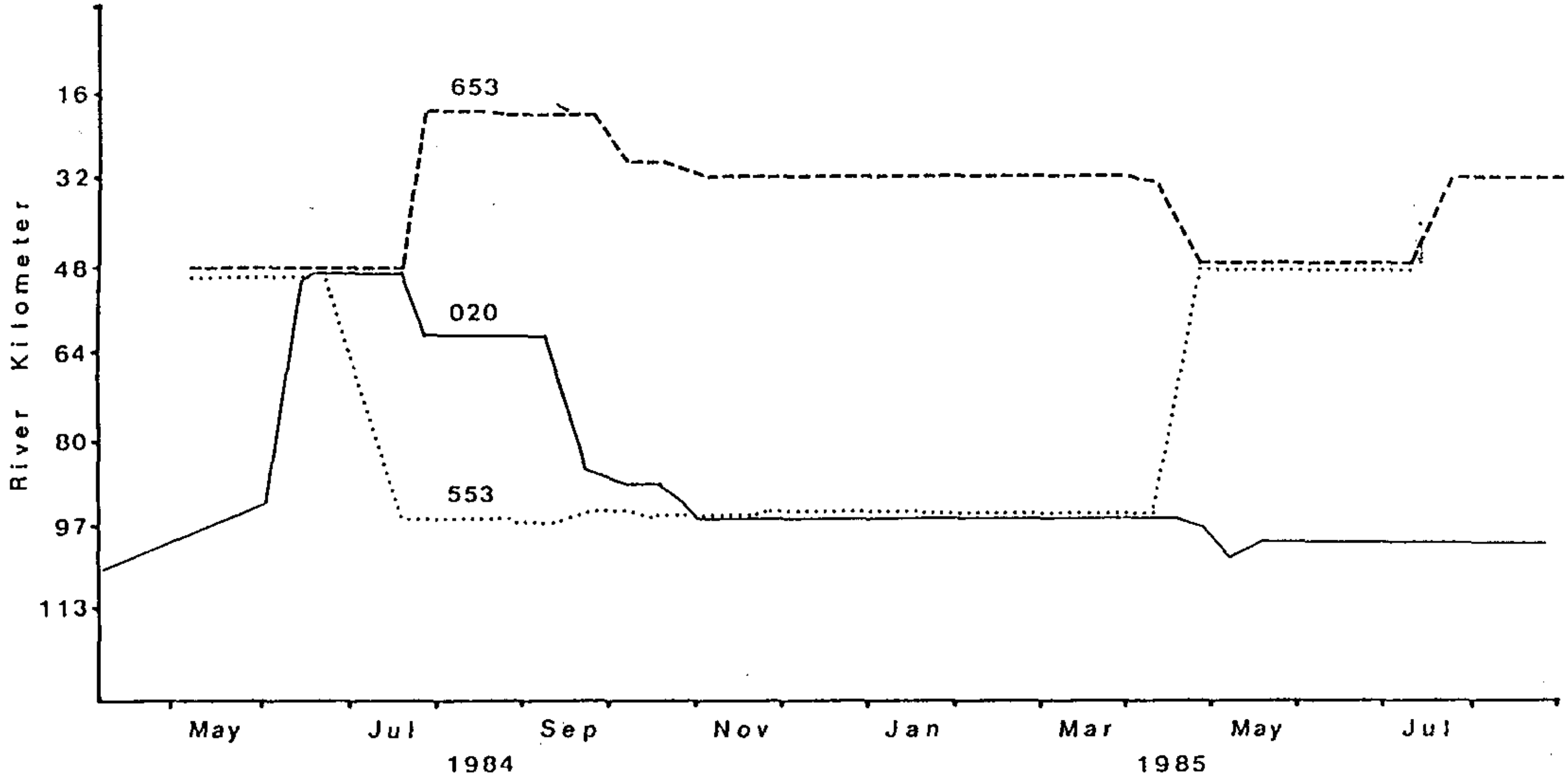

Figure 9. Seasonal movements of two male (653 and 553) and one female (020) radio tagged northern pike within the lower Flathead River.

for spawning purposes, where others show movements during the spawning season of up to 56 km.

Table 3. Method of capture, numbers, reproductive condition and average length for northern pike captured during the spring of 1985.

Capture Method	Northern Pike Immature	Male	Female
Netting	1	20	0
Trapping	2	21	7
Total	3	41	7
Average length (mm) (range)	351.0 (280-454)	673.61 (513-975)	708.14 (626-905)

Salmonids

Mountain whitefish were excluded from the 1985 stock assessment. Stock assessment investigations in 1983 and 1984 showed population levels of whitefish were comparable to other western Montana rivers of similar size (Darling et al. 1984).

Catches of cutthroat trout (*Salmo clarki*) were higher in three of four study sections this fall, as were catches for bull trout (*Salvilnus confluentius*) (Tables 4 and 5). These two species are the least common of all sallmonids found in the lower Flathead River, and low numbers have prevented any population estimates in the past. A successful estimate was made for cutthroat trout this year from the Weed study section: 3 fish/km + 1. The fish averaged 272 mm in total length. During all 1985 sampling efforts, a total of nine cutthroat trout were tagged, averaging 282 mm TL.

Table 4. Catch-per-unit-effort for cutthroat trout within the five permanent river study sections.

Year	Season	Buffalo	Sloan	Dixon	Weed	Perma
1983	Fall	0.08	0.07	0.06	0.42	0.00
1984	Spring	0.08	0.18	0.08	0.42	0.00
1984	Fall	***	0.00	0.19	0.00	0.00
1985	Fall	0.28	0.20	***	0.60	0.00
Mean CPUE		0.15	0.11	0.11	0.36	0.00

***not sampled

Table 5. Catch-per-unit-effort for bull trout within the five permanent river study sections.

Year	Season	Buffalo	Sloan	Dixon	Weed	Perma
1983	Fall	0.00	0.00	0.00	0.00	0.00
1984	Spring	0.00	0.00	0.08	0.14	0.17
1984	Fall	***	0.00	0.00	0.08	0.07
1985	Fall	0.09	0.10	***	0.22	0.00
Mean CPUE		0.03	0.03	0.03	0.11	0.06

• ** not sampled

Five bull trout were captured and tagged during 1985, averaging 378 mm in length.

Catches of rainbow trout were consistent with previous sampling periods, and as in 1984, found to be highest in the Weed study section (Table 6). Insufficient numbers of rainbow trout were captured in the Buffalo, Sloan, and Perma study sections during fall 1985 to make population estimates. An estimate of 16 fish/km was made for the Weed study section. A total of 23 rainbow trout were tagged during 1985, averaging 272 mm TL.

From 1 March 1983 through 30 September 1985 a total of 163 rainbow trout have been captured. Age 2 fish ranged from 200 to 289 mm, comprising 66% of the total catch. Age 3 rainbow trout ranged from 290 to 389 mm and comprised 29% of all fish handled. Age 1 and 4 rainbow trout comprised 2.4 and 3.1%, respectively, of the total catch (Figure 10).

Table 6. Catch-per-unit-effort for rainbow trout within the five permanent river study sections.

Year	Season	Buffalo	Sloan	Dixon	Weed	Perma
1983	Fall	0.15	0.22	1.40	1.54	0.18
1984	Spring	0.08	0.18	1.78	1.18	0.79
1984	Fall	***	0.21	2.23	0.70	0.22
1985	Fall	0.09	0.10	***	1.95	0.15
Mean CPUE		0.11	0.18	1.80	1.34	0.33

***not sampled

Catches of brown trout during the fall of 1985 were higher in all study sections except Perma, and found to be significantly ($p < .05$) higher than in 1984 in the Buffalo study section (3.44/hour, Table 7). Insufficient numbers of brown trout captured excluded population estimation for all but the Buffalo study section (50 fish/km ± 19). This was the highest estimate ever made for brown trout in the lower Flathead River. A total of 59 brown trout were tagged during 1985, averaging 286 mm TL (Appendix C).

Table 7. Catch-per-unit-effort for brown trout within the five permanent river study sections.

Year	Season	Buffalo	Sloan	Dixon	Weed	Perma
1983	Fall	1.21	0.29	0.57	0.53	0.65
1984	Spring	2.14	1.77	1.78	1.60	0.67
1984	Fall	***	0.82	1.67	0.47	0.07
1985	Fall	3.44	0.88	***	0.90	0.15
Mean CPUE		2.26	0.94	1.34	0.88	0.39

***not sampled

From 1 March 1983 through 30 September 1985, a total of 208 brown trout have been captured. Age 2 fish ranged from 200 to 279 mm, comprising 38% of the total catch. Age 3 brown trout ranged from approximately 280 to 389 mm and comprised 26% of the total catch. Age 4 and older brown trout accounted for 34% of the total catch. Only five Age 1 brown trout (< 3%) have been handled (Figure 11).

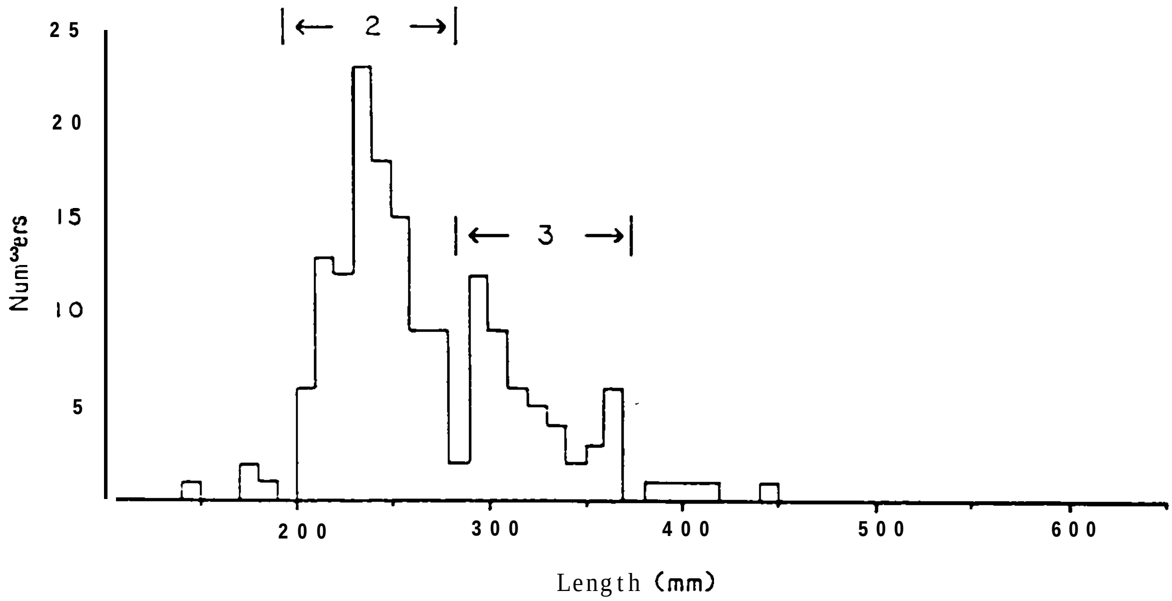

Figure 10. Length frequency distribution of 163 rainbow trout collected from the lower Flathead River 1 March 1983 through 30 September 1985 and their ages based on scale analysis.

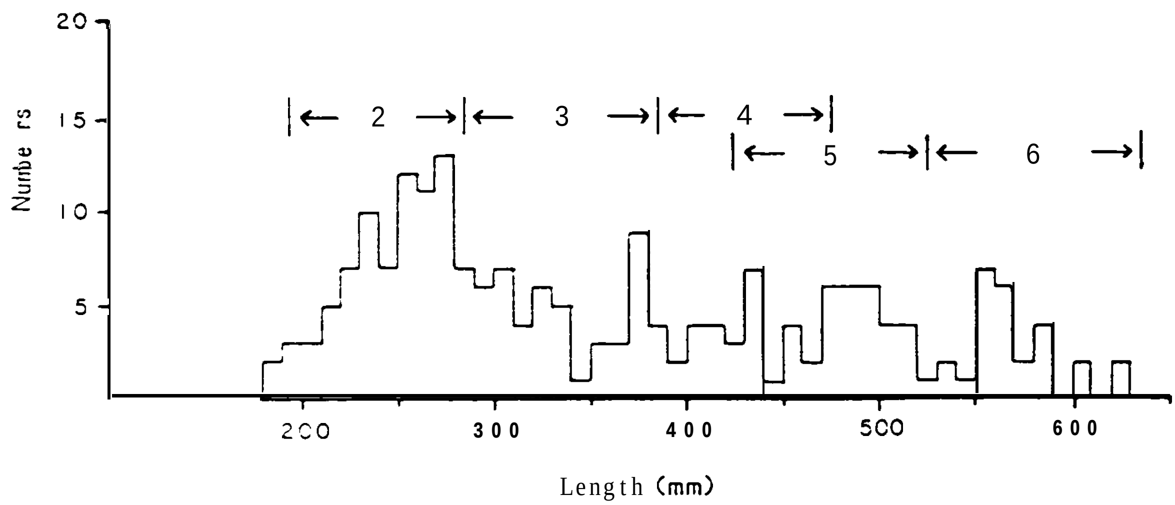

Figure 11. Length frequency distribution of 208 brown trout collected from the lower Flathead River 1 March 1983 through 30 September 1985 and their ages based on scale analysis.

Instream Flow Incremental Method

Study Sites

The results of--river segment evaluations for IFIM provided two study sections. IFIM River Segment I extends from RK 108.5 to RK 54 and is characterized as the single channel portion of the river. Repeating hydrological units are bordered by riffles and contain differing combinations of shallow runs, deep runs, and deep pools. Deep pools are associated with the outside of river bends.

The study section chosen to represent this single channel portion of the river extends from RK 75.5 to RK 73.4, and is within the Sloan habitat and stock assessment study section. The Sloan IFIM study section contains all the macrohabitat features found within River Segment I, which are described using a combination of 6 cross-sectional profiles (Figure 12).

IFIM River Segment II extends from RK 54 to RK 6 and can be characterized as the braided channel portion of the river. Repeating hydrological units within this section of the river are bordered by a single channel and contain differing combinations of braided shallow and deep runs, dewatered high-water channels, island sizes and association with backwaters.

The IFIM study section chosen to represent this braided channel portion of the river extends from RK 30.1 to RK 28.2

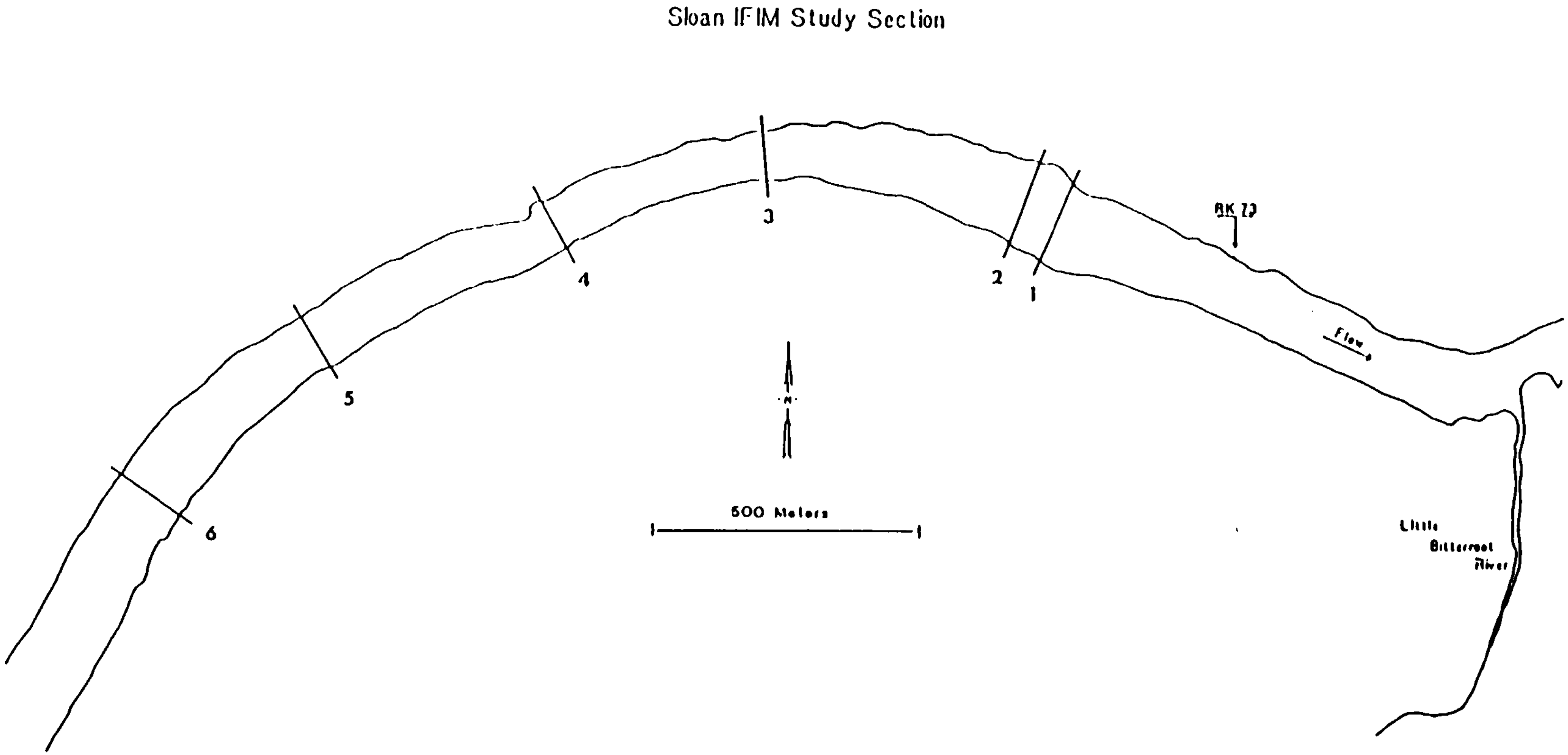

Figure 12. The Sloan IFIM study section showing transect locations and reference river kilometer (RK).

and is within the Weed habitat and stock assessment study section. The McDonald IFIM study section contains all the macrohabitat features found within River Segment II, which are described using a combination of 7 flowing and 2 standing water cross sectional profiles (Figure 13).

Complete transect descriptions for both the Sloan and McDonald IFIM study sections are presented in Appendix D.

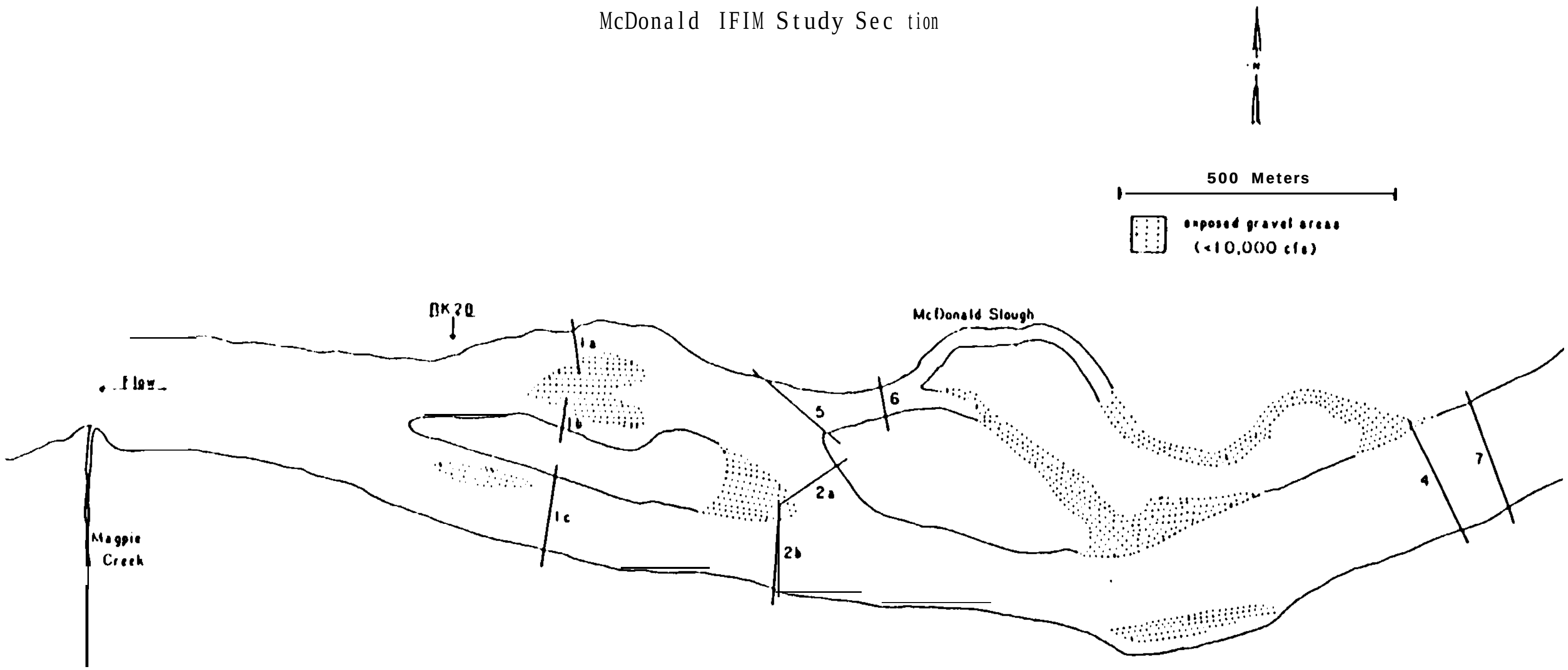

Figure 13. The McDonald IFIM study section showing transect locations and reference river kilometer (RK).

DISCUSSIONS AND CONCLUSIONS

Fish Populations

Largemouth Bass

No date of the introduction of largemouth bass into the lower Flathead River has been determined. Largemouth bass are primarily backwater residents of the lower Flathead and have been collected from all permanent backwater areas in river reaches III and IV. They are rarely found in main channel areas. The highest concentration of bass are found in the largest backwater areas.

Based on the reproductive condition of bass captured throughout this study, spawning begins in the later half of May and continues through June. Brown (1971) reported eggs and fry cannot tolerate temperatures below 10°C. Water temperatures within the lower Flathead warm to 10°C and above usually by the later part of April (Figure 3).

In the Flathead River, young-of-the-year largemouth bass grow to approximately 70 mm by the end of their. first year. By their second year they have reached 120 mm, and by age 4, the usual age of maturity, they have at least doubled in length (240 mm). Bass from the lower Flathead show a faster rate of growth than those reported by Brown (1971) for Montana largemouths, but grow somewhat slower through age 4 than growth rates reported by Scott and Crossman (1973) for bass from the Great Lakes area.

The oldest Flathead River largemouth bass aged to date was 10 years old and 527 mm long, considerably larger than the average length for similar aged bass reported by the above authors. The average length of all bass captured throughout this study is 307 mm (N = 188, Age 4). Catches of bass have been predominated by Age 4 and older fish (Figure 8).

Angler exploitation of largemouth bass appears minimal, with only two tags returned (1%) in three years. During the summer of 1983, river anglers caught bass at an average rate of 1 fish every 2.3 hours (DosSantos and Cross 1983). Largemouth bass are only found in a few areas in adequate numbers to support heavy fishing pressure. Low exploitation may be due to fishermen not knowing where to fish for bass.

Northern Pike

Northern pike are found throughout the length of the lower Flat-head River, occupying lentic habitats. Within the single channel portion of the river, reaches I and II, northern pike are found along deep, slow moving river bends, shoreline eddies, and slackwater shoreline areas. The upper reaches of the river provide limited habitat for pike as reflected in CPUE data (Table 2).

In river reach III, gradient and water velocities decrease, permanently wetted backwaters are common, and pike abundance, based on intensive sampling (CPUE) is twice that of reaches I or II. It is the combination of both riverine and lentic habitats which supports the largest northern pike concentrations within the lower Flathead. Cheney (1972), in his investigations of northern pike in the Tanana River, Alaska, found the blend between lotic and lentic habitats most preferred by pike.

Reach IV of the lower Flathead has the lowest gradient and the greatest abundance of main channel macrophytes of all river reaches, however abundance of pike within reach IV are comparable to reaches I and II. Deep water holding habitat, preferred by pike during the daylight hours, is not found in this reach. It would appear that increased macrophyte cover does not adequately replace deep water holding habitat. Reach IV and much of reach III have developed total ice cover during the past two winters. The lack of deep holding water in reach IV would afford no protective cover from ice scour during winter thaws and spring break up, and may explian why pike populations are lower in reach IV than observed in reach III.

Adult pike in the Flathead River prefer water depth in excess of 2 m and water velocities not exceeding 0.2 m/second (0.6) feet per second. Habitats utilized by pike are usually totally vegetated, providing excellent cover for these ambush predators. Chapman and Machey (1984) observed pike 81% of the time in totally vegetaed areas. Inskip (1982) reports that optimal water velocities for riverine pike should not exceed 0.06 m/second (0.2 ft/second). Limitations in metering gear did not allow for an accurate average water column velocity measurement in depths in excess of 2 meters. Measured velocities within deep water areas are probably higher than those actually experienced by the fish, assuming laminar flow at these sites.

At night, lower river pike have-been found in extremely shallow water near the river bank. Visual predators by day, they may use the shallow bench areas as resting areas, darkness protecting them from potential avian predation. Pike were rarely observed in these locations during daylight hours.

Northern pike spawn in spring. In the lower Flathead, males were sexually mature by the first week of April and females were sexually mature by 1 May. Pike begin movement to spawning grounds about the time they become ripe. Hales have shown maximum upstream movements of 17 km in 27 days and downstream movements of 45 km in 15 days during the spawning season.

Based on radio telemetry data, males will spend up to three months in and around spawning grounds, leaving during the later part of June or the middle of July. Females spend only about six weeks at spawning areas, usually centered around the month of June. It appears that peak spawning occured between the later part of May through the first half of June. One radio tagged female showed a downstream movement of 42 km in 15 days to reach a preferred spawning area she used in 1984, passing other areas where spawners were also found.

A total of 245 mature pike have been captured either entering spawning areas or in staging areas during this study, resulting in an overall male to female ratio of 3:l. Priegal and Krohn (1975) reported a healthy sex ratio of 2:1 fcr some pike populations in Wisconsin. Disproportionate angler harvest of larger pike, almost all females, within the lower Flathead may explain the observed higher number of males within the spawning population. Harrison and Hadley (1983), studying the Niagra River, give insight to another possible explanation. They reported a sex ratio of 4:1, and postulated a bias toward males because of the longer time during which males are sexable by the extrusion method. This is also true for northern pike from the lower Flathead and may explain the unusually high sex ratio (5:1) observed in 198s.

Spawning occurs during daylight hours, and has been observed in two backwater areas. Spawning groups-, consisting of a female plus one or two males, move in short rapid bursts after which the fish are stationary, presumably at rest. Eggs adhere to vegetation and at water temperatures above 10°C hatch in 12 days or less. After hatching fry also adhere to vegetation and remain attached from 10 to 24 days (Inskip 1982), Species of emergent and submergent aquatic vegetation found within backwater areas of the lower Flathead

River is presented in Appendix E.

It is this approximately 30 day period, from egg laying to mobile fry movement, when northern pike year class strength is directly influenced by Kerr Dam operations. Water level fluctuations at spawning sites can aggravate suspended sediments and contribute to egg suffocation. Hassler (1970) attributed 97% egg mortality to silt deposition caused by fluctuating water levels in two main-stem Missour River impoundments. Fry that successfully hatch attach to vegetation and are subject to desication due to dewatering as the river discharge varies. A change of only 3 cm in water surface elevations can change inflow to outflow in some spawning areas (DosSantos et al. 1983).

Average size of Flathead River male and female pike spawners was 688 and 699 mm, respectively. These lengths correspond to age 4 fish for the lower Flathead, the usual age of maturity for northern pike (Scott and Crossman 1973). Spawning males range in size from 428 to 975 mm (Age 2 and older) whereas female spawners range from 540 to 996 mm (Age 3 and older). Because of the highly aggressive nature observed in males, it is doubtful whether young males contribute significantly to spawning success.

Growth of male and female northern pike in the Flathead River was similar through age 3 (Darling et al. 1984). Fish older than age 4 show differential growth between the sexes, with females exhibiting faster growth. Similar observations have been noted in other studies (Anderson and Weithman 1978, Komyshnayo and Tsepkin 1973, and Philips 1980), Flathead River young-of-the-year pike grow to approximately 250 mm by the end of their first year. By their third year they have doubled their length. By their fifth year male northern pike range from 700 to 800 mm TL, and female pike may reach 920 mm TL. Seventy percent of all northern pike handled were age 3 or younger.

Northern pike are the most highly sought after fish species by fishermen in the lower Flathead River (DosSantos and Cross 1984). The present exploitation rate of 12% for Flathead River pike based on tag returns, is low compared to exploitation rates of 31% reported by Williams and Jacob (1971) and over 50% reported by Beyerle and Williams (1972). High annual natural mortality rates reported by some authors (Anderson and Weithman 1978) and non-returned tags could contribute to a higher than observed exploitation rate.

Salmonids

Population levels and structure of trout species studied in the Lower Flathead River from 1983 through 1985 reflects a lack of successful recruitment. Cutthroat and bull trout, although collected throughout the length of the river, are rare. Only twenty eight cutthroat and 12 bull trout have been captured and tagged during 3 years of study. The most probable origin of these cutthroat and bull trout is the upper reaches of the river’s tributaries, upstream migrants from the Clark Fork River, or from successful passage through Kerr Dam.

Rainbow trout are found along the entire length of the river, but are most abundant within river reach III (Table 7). Population estimates for this reach have ranged from 14 to 29 fish/km. Relative to other Montana rivers such as the Kootenai (May and Huston 1983) and the Missouri (Berg 1983), the lower Flathead River rainbow trout population and age class structure reflect serious recruitment problems. Catches of rainbow trout in the Flathead are dominated by age 2 and 3 fish, with age 1 fish only comprising 2.51 of the catch. In the Kootenai River, using similar capture methods, age 1 rainbow trout comprise 77.6% of the catch (May and Huston 1983). While the sample size of rainbow trout from the lower Flathead is small (N = 129) the lack of age 1 fish is obvious (Darling et al. 1984).

Brown trout are found along the entire length of the river, and are most abundant in river reach I (Table 8). Population estimates for this reach have averaged 31 brown trout/km. On the upper Missouri River, the lowest brown trout estimate was 74 fish/km (Berg 1983). As with rainbow trout, a lack of younger aged fish in brown trout catches from the river was observed. Age 1 brown trout comprise less than 2% of the total catch (N = 208).

The observed structure of brown trout populations in the lower river suggest similar limiting factors affect both rainbow and brown trout recruitment. Few age 3 or older rainbow or brown trout were captured in the lower reaches of Mission Creek or the Jocko River, while these older age classes predominate in the main river. In contrast, age 1 and 2 rainbow and brown trout predominate samples in the tributaries, but are rarely captured within the main river. In the Buffalo study section, brown trout have averaged 292 mm (Age 3) during fall sampling, but average 425 mm (Age 4) during spring sampling. Age class differences between river and tributary rainbow and brown trout suggest that recruitment to main river stocks is presently being supported primarily by tributary spawning.

Few trout redds have been found in the main river, and then only at its confluence with the Clark Fork River. Although areas of suitable spawning gravel exist thrgughout the river, they are apparently not being selected by spawning salmonids in the spring or fall. However, in many large western rivers, the percentage of adult trout spawning occuring in the mainstem may be insignificant compared with the number spawning in the tributaries. Within the Kootenai River it is estimated that less than five percent of the total rainbow trout spawning, based on redd counts, occurs in the mainstem (Bruce May, MDFWP, personal communication). This appears to also be the case for spawning salmonids within the lower Flathead.

Gravel sampling conducted on the main river during 1985 was limited. Eighteen samples were collected from approximately 654 hectares of potentially suitable spawning gravel (Darling et al. 1984). Comparing our substrate field data with the Idaho laboratory studies of sediment and embryo survival conducted by Irving and Bjorn (1984), rainbow trout embryo survival in the main Flathead River would average 42X combining the 0.85 and 9.5 mm substrate fractions. Gravel showing the highest predicted embryo survival was from the Weed study section. This area also shows the highest density (fish/km) of rainbow trout.

Survival rates reported here for lower Flathead salmonids based on the above comparisons should be viewed cautiously and is only used here to indicate a potentially significant problem that will have to be considered in developing future management alternatives. Results from these comparisons, however, have supported preliminary observations about gravel quality.

Seasonal and daily variability in discharge from Kerr Dam, highest in the spring and fall, are also suspected of having serious impacts upon spawning success of lower Flathead River trout. Water depths and velocities over potentially suitable spawning areas greatly affects its overall suitability. Hamilton and Buell (1976) concluded that the abrupt changes associated with fluctuating flows due to hydro-peaking operations caused serious recruitment problems for salmonids in the Campbell River system, British Columbia. Future IFIM analysis will directly address this problem occurring in the lower Flathead.

Stock assessment investigation in 1983 and 1984 showed population levels of mountain whitefish to be comparable to other western Montana rivers of similar size (Darling et al. 1984). Broadcast spawners, whitefish spawning requirements (water depth, velocity and substrate composition) are not as specific (Bovee 19781, as those for trout. The variability of discharges from Kerr, highest in spring and fall,has not affected recruitment of mountain whitefish within the lower Flathead.

-The question of competitive interactions between mountain whitefish and other salmonids, namely rainbow trout, has troubled many western fisheries managers for nearly half a century. Early studies (McHugh 1940, Sigler 1951 and Laakso 1951) concluded that mountain whitefish were serious competitor; for food and space with rainbow trout. Recent investigations (Pontius and Parker 1973, Thompsqn 1974, Kiefling 1978 and DosSantos 1985), however, have questioned this theory of competition between these two salmonids.

One of the common side effects in regulated rivers is a shift in the benthic insect community (Baxter 1977), with Chlronomidae being one of the insect families flourishing in regulated rivers (Appert-Perry and Huston 1983). The potential for competition for a specific food item

(Chironomidae) does exist between small rainbow trout and small whitefish (<200 mm) and habitats occupied by these smaller fish are similar (DosSantos and Huston 1983 and DosSantos 1985). Odum (1971) defines interspecific competition as “any interaction between two or more species populations which adversely affects their growth and survival”. This definition may apply to present-day rainbow trout populations within the lower Flathead River.

Recently several authors have concluded that mountain whitefish and trout in other western rivers (Kiefling 1978 and DosSantos 1985) do not actively compete for resources. In these studies, trout populations were several hundred fish per kilometer. In the lower Flathead, due to the ratio of whitefish to trout it may not be a question of interspecific competition, but actual species suppression.

The combined impact of constantly changing river discharge on the actual spawning act, poor survival of eggs due to sediment and changes in river discharge, and the possibility of suppression of trout by whitefish have combined to produce trout populations far below the potential of the lower Flathead River. These factors will have to be integrated into management alternatives for the lower river.

TRIBUTARIES

BY

James E. Darling

TRIBUTARIES

DESCRIPTION OF STUDY AREA

Glacial till and lake bottom sediments from prehistoric Lake Missoula underlie the tributary study area. Much of the runoff from the Mission Mountains descends through po.ous till at their base into the groundwater, resurfacing in springs found throughout the valley (Morrison-Maierle and Montgomery 1977).

Most of the surface water used on the Reservation is diverted, impounded, and distributed by the Flathead Indian Irrigation Project (FIIP). In total, the FIIP system includes 108 miles of main supply canals, approximately 1077 miles of distribution canals, and 10,000 irrigation structures (U.S. Department of Interior 1985). FIIP primarily serves three irrigation districts formed under Montana law,, serving Tribal and non-Tribal lands within the service area, as well as a few properties that are non-district. In order to supply these irrigation concerns, the major tributaries are impounded at their headwaters or mid-valley and are intersected throughout by canal diversions and irrigation returns. Consequently, the Flathead River tributaries, for the most part, have fair to poor water quality (Nunnallee and Botz 19761, caused primarily by irrigation return flows, agricultural dewatering, and erosion of fragile soils as a result of livestock overgrazing.

The tributary portion of the study is confined to the main stems of five major tributaries: the Jocko River, Mission Creek, Post Creek, Crow Creek, and the Little Bitterroot River.

Jocko River

The Jocko River flows westerly from the Mission Mountains and enters the Flathead River near Dixon. It drains an area of 67,747 hectares, with approximately 12 percent of the drainage under irrigation (Morrison-Maierle and Montgomery 1977). Silviculture and logging activities, road construction and maintenance, along with some residential development, influence the upper drainage water quality. Most years, segments of the river are totally dewatered below Big Knife Creek due to irrigation diversion. Downstream from the town of Arlee, Finley Creek and Valley Creek enter the Jocko, introducing considerable sediment. The lower river flows through hay and pasture lands and is channelized and heavily rip-rapped along the National Bison Range. Average annual discharge has been estimated as 10.4 m^3/second (Montana State Study Team 1975) and 5.2 m^3/second (Morrison-Maierle and Montgomery 1977).

Post Creek

Post Creek headwaters are impounded by the McDonald Lake dam. From the outlet the creek flows westerly, picking up irrigation return flows from Pablo Feeder canal and Mission

"B" and "C" canals, and continues through agricultural land in the Mission Valley before flowing into Mission Creek just east of the National Bison Range. Post Creek's average annual flow of about 2.5 m^3/second (Montana State Study Team 1975) is subject to direct regulation for use in irrigation. Much of Post Creek is turbid year-round due to irrigation returns.

Mission Creek

Mission Creek headwaters are impounded by Mission Dam. From Mission Reservoir the creek flows westerly through St. Ignatius; three canals (Pablo feeder canal and Mission "B" and "C" canals) intercept its flow. Between St. Ignatius and its confluence with Post Creek, the stream receives sewage-lagoon and irrigation returns, and travels through marshy and agricultural lands. Downstream along the Bison Range, Mission Creek receives agricultural return, feedlot runoff, and intermittent discharges from Charlo sewage lagoons via Dublin Coulee. Hillside Reservoir overflow, composed entirely of irrigation return flow and agricultural runoff, enters the creek just below the Bison Range. The stream then winds through an erosive clay-bank canyon and receives Moiese Valley irrigation return before reaching the Flathead River. Flows near the mouth may average about 2.04 m^3/second (Montana State Study Team 1975) or 4.7 m^3/second (Morrison-Maierle and Montgomery 1977) and are subject to year-round regulation by the FIIP.

Crow Creek

North and South Crow Creeks flow west from the Mission Mountains converging to form the main stem of Crow Creek approximately one mile east of Highway 93. Above Lower Crow Reservoir two major tributaries, Ronan Spring Creek and Mud Creek, bring urban stormwater runoff and irrigation runoff and returns to Crow Creek. Lower Crow Reservoir is used to store irrigation water for the Moiese area. Only the 6 km stream section below Lower Crow Dam is being surveyed for this study. Flows below the dam are regulated by Lower Crow Dam and a major irrigation diversion approximately 12 km below the dam. Historically, the creek flow would be withheld completely during a normal irrigation year (Morrison-Maierle and Montgomery 1977); however, some stream flows are now being maintained year-round. High spring runoff occasionally prompts large releases from the reservoir, causing mass wasting, scour, and debris movement in Crow Creek. Average annual flows are 2.4 m^3/second (Montana State Study Team 1975).

Little Bitterroot River

The Little Bitterroot emerges from Hubbart Reservoir north of the Reservation boundary and flows south through a narrow wooded canyon. Most of the flows are intercepted and diverted into Camas "A" canal at the canyon mouth. The remaining flow continues south through the arid Camas Prairie and Little Bitterroot Valley, cutting through generally, heavy, poorly-drained, erosive, alkaline soils. Sullivan Creek contributes hard-rock mine runoff and sediment to the upper river; Hot Springs Creek is a major sediment source further downstream. Lou rainfall and overgrazing have limited vegetation cover and aggravated seriouis erosion problems throughout the drainage. Consequently, the Little Bitterroot is turbid year-round and contributes considerable sediment to the lower Flathead River. Average annual flows have not been reported; however, the river is dewatered in several areas by summer irrigation withdrawals.

Northern pike, the primary target fish species in the Little Bitterroot River, was first collected from this stream during 1961 (Hanzel 1976). Pike probably were first introduced into Lonepine Reservoir in this drainage from Sherburne Lake in Glacier National Park during fall 1953.

Twenty-two reaches were selected in 1983 to characterize the five major tributaries: seven on the Jocko River, five on Mission Creek, four on Post Creek, one on Crow Creek, and five on the Little Bitterroot River (Figure 14). Stream reaches were established on the basis of marked changes in stream gradient, sinuosity, bank slope, land use, and water flow. Detailed descriptions of tributary reaches and permanent fish and habitat sampling stations established within these reaches are provided in Appendix F.

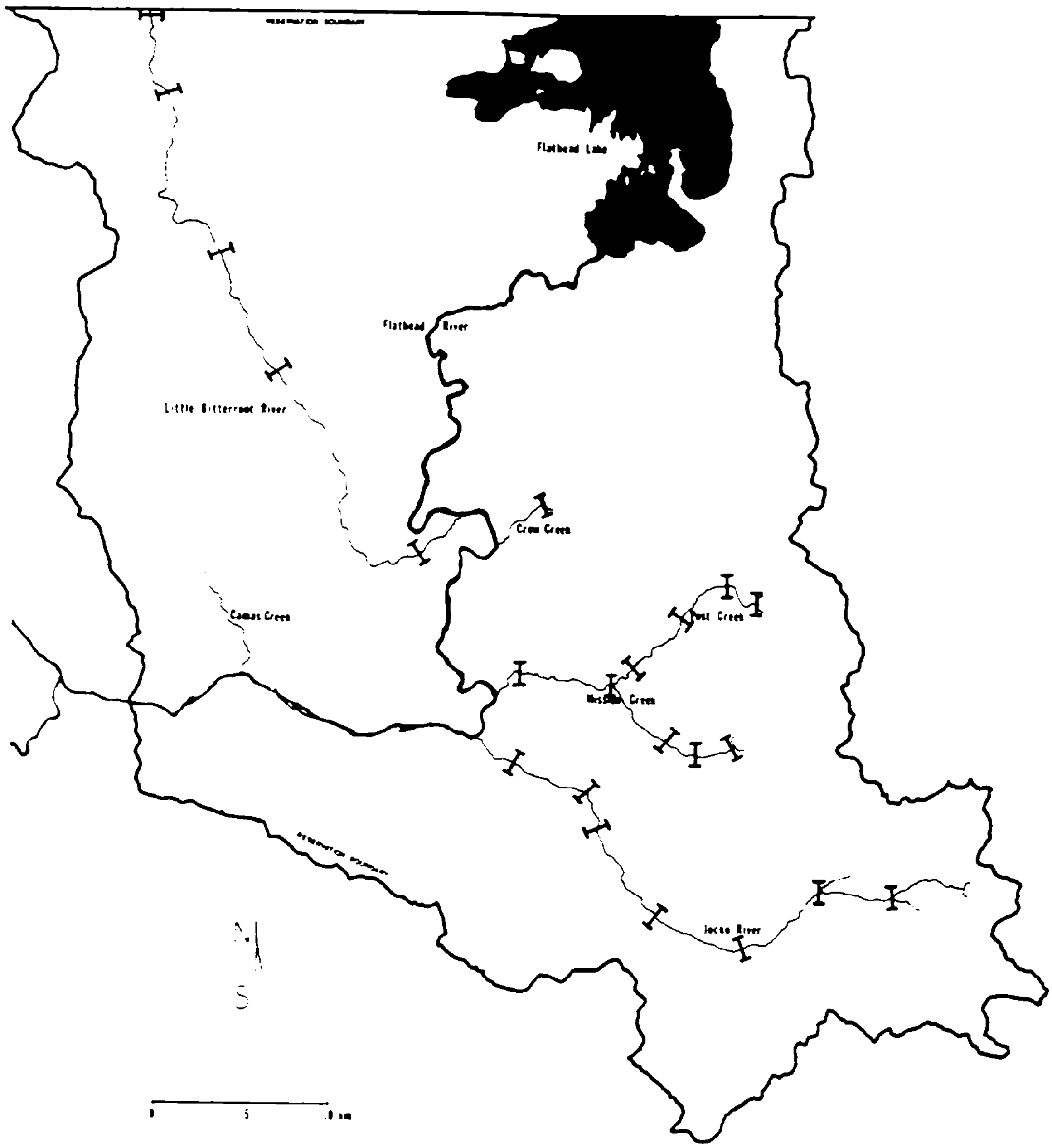

Figure 14. Reachboundaries established on five major tributaries to the lower Flathead River.

TRIBUTARIES

METHODS

Stock Assessment

During fall 1984, fish abundance was estimated using mark-recapture efforts at 22 stations (Figure 15) within five major tributaries to the lower Flathead River: the Jocko River, Mission Creek, Post Creek, Crow Creek, and the Little Bitterroot River. Intervals between marking and recapture were approximately one week.

Each 150 m-long station was electrofished during daylight using a bank or backpack shocker. Most stations were sampled as open sections by three persons, one operator and two netters, making one pass upstream. Target fish species were measured (total length - TL), weighed, and fin-clipped or tagged with floy anchor or fingerling tags, then released.

During fall 1985, ten stations were retained (Figure 15) to concentrate on those portions of the Jocko River, Mission Creek, Post Creek, and Crow Creek used by main-river salmonids. Each station was lengthened to 300 m to increase fish sample sizes for population estimates. After each station was electrofished, discharge was measured.

To better describe fish distribution in the Little Bitterroot River, three 150 m-long stations were established

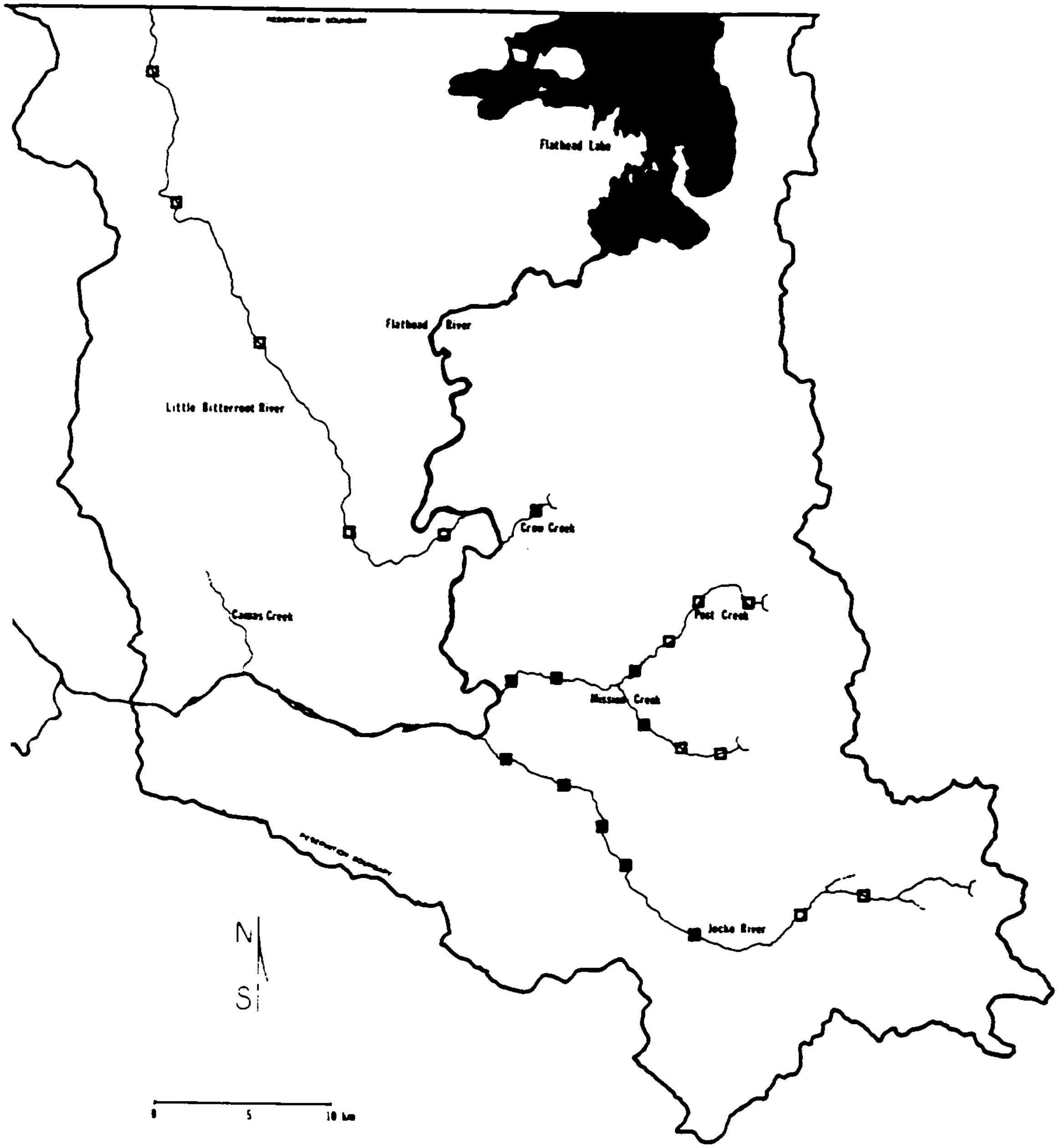

Figure 15 Stock assessment stations sampled during fall 1983 and 1984 (all squares) and fall 1985 (darkened squares) on five major tributaries to the lower Flathead River.

randomly within each of 5 reaches. Using a Coffelt BP-1C backpack electroshocker, one pass was made 150 m upstream to a block net at each site. The 15 sites were electrofished from 11 October through 22 October 1985. Gastric lavage (Light, et al. 1983) was used to remove the stomach contents of captured northern pike. Stomach samples were sorted and contents identified using a binocular microscope. Water samples were collected from all sites on 24 October 1985 and delivered to the University of Montana's Biological Station at Yellow Bay for turbidity analysis. Water samples were analyzed using a Hach Model 2100 A Turbidmeter.

Spawning and Migration

Weirs

Trapping continued at the modular fish weirs installed in the Jocko River 2 km above its mouth and in Mission Creek 6 km above its mouth (Darling, et al. 1984). The traps were opened in late February, as soon as the attached ice could be broken free. The Jocko weir was closed on 12 April, and eleven modules were removed in anticipation of high water; trapping recommenced on 31 July 1985. Mission weir continued fishing until 29 May and was closed 6 days, reopening on 4 June 1985. Both weirs were closed for the winter on 22 November 1985.

Redd Surveys

Surveys were conducted during November/December 1984 and

1985 for brown trout redds and June/July 1985 for rainbow trout redds on the Jocko River (mouth to km 31), Mission Creek (mouth to km 17), and Post Creek (mouth to km 7). To establish redd locations, starting time for each survey was noted, and time elapsed to each identified redd was recorded. Each redd observation was ranked as definite, probable, or possible based on Montana Department of Fish, Wildlife, and Parks' criteria (Shepard, et al. 1982). For the final counts, only definite and probable redd observations were used.

Crow Creek Spawner Survey

The 5.6 km of Crow Creek below Lower Crow Reservoir were electrofished for spawning rainbow trout during April and brown trout during November 1985. Two days were required using a Coffelt BP-1C backpack electroshocker. Redds were counted during these surveys.

Little Bitterroot River Trapping

To capture spawning northern pike (*Esox lucius*) a fyke net 1.2 m in diameter was set on 19 March near the mouth of Hot Springs Creek, which enters the Little Bitterroot River at km 44. It was removed on 24 April. Water levels had dropped enough by 27 March for setting fyke nets in the Little Bitterroot below Lonepine marsh (km 60), immediately upstream from Hot Springs Creek (km 44), and near the mouth (km 2). On 13 May the trap at km 2 was moved to km 5 and all nets were reversed on 13 May to fish downstream-migrating northern pike. On 22 May, the nylon net at km 5 was replaced by a 150 x 120 x 90 cm box trap made of hardware cloth to better withstand shredding by beavers. High water ended trapping on 30 May 1985.

At all traps, captured target fish species were measured (TL), weighed, and fin-clipped or tagged with floy anchor or fingerling tags. Scales were removed and later impressed into cellulose acetate for age analysis.

Movement

Recapture of tagged fish during stock assessment and trapping, and the return of tags by fishermen, provided data on the movement of target fish species.

Substrate Analysis

Substrate samples were taken from known brown trout and rainbow trout spawning areas on the Jocko River, Mission Creek, Post Creek, and Crow Creek (Figure 16). samples were collected in mid-April and the first of May 1985 (before high water) when substrates were most embedded. A total of 16 samples were collected from eight areas. Samples were collected and analyzed using procedures described in Main River section of this report, under Wethods: Substrate Analysis.

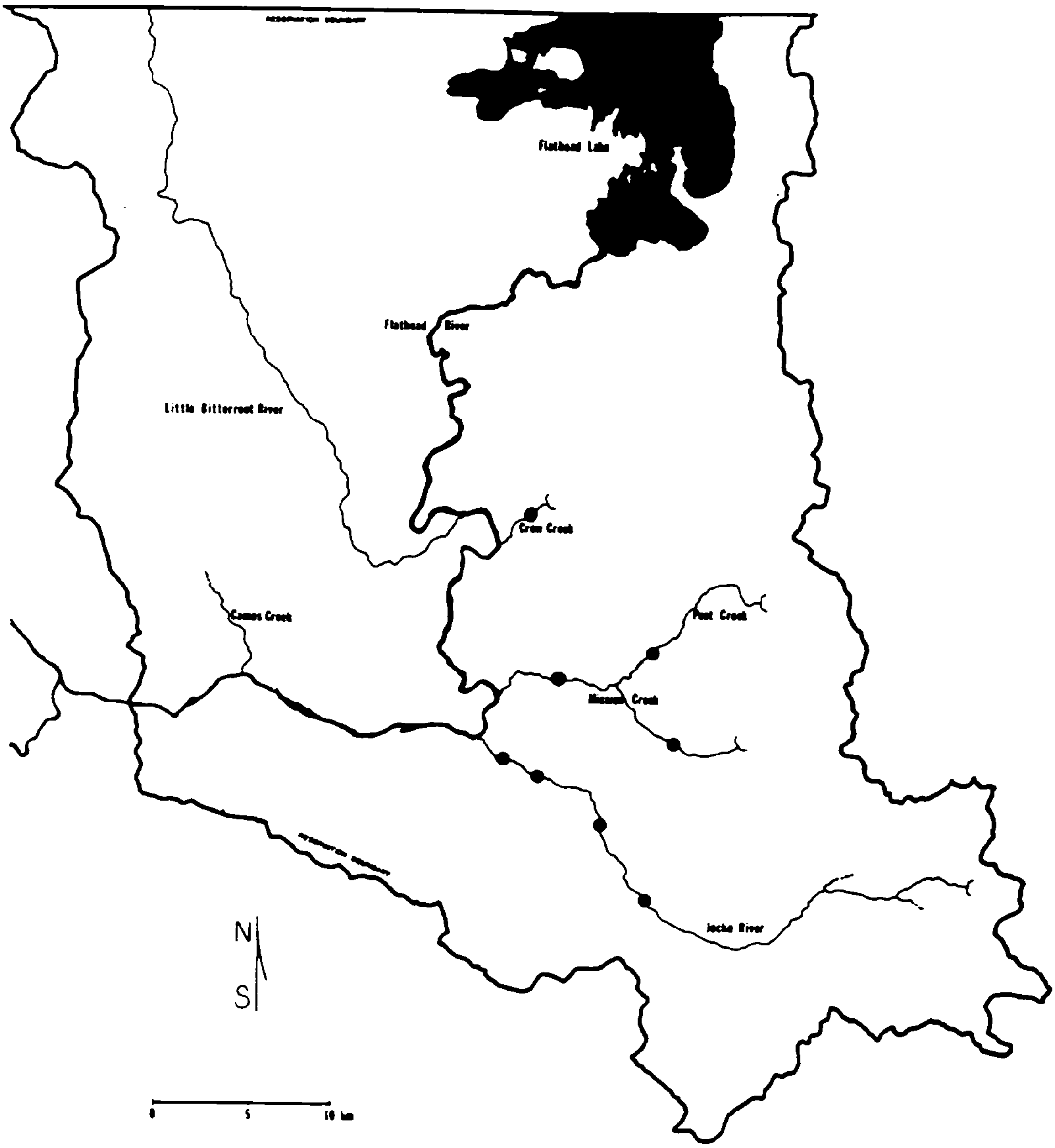

Figure 16. Substrate sampling sites on four tributaries to the lower Flathead River.

Water Temperatures

Continuously recording, 90-day thermographs were installed near the mouths of four tributaries: the Jocko River, Mission Creek, Crow Creek, and the Little Bitterroot River.

TRIBUTARIES

RESULTS

Stock Assessment

For the Jocko River, Mission Creek, and Post Creek, longitudinal changes in fish species composition and relative abundance, identified in earlier sampling (Darling, et al. 1984), were corroborated by fall sampling during 1984 and 1985 (Appendix G). Mean length of trout in Crow Creek was 150 mm in 1983, 191 mm in 1984, and 171 mm in 1985 at CPUE's of 9.5, 9.2, and 7.0, respectively; rainbow trout predominated.

In reach 5 of the Little Bitterroot River, which is above the Camas A Canal diversion, brook trout (*Salvelinus fontinalis* are more common than cutthroat trout. Coolwater species occupy the 76 km below the diversion with northern pike at the top of the food chain. Sampling at 15 stations distributed randomly throughout the drainage revealed that approximately 100 brook trout exist 3 km below the diversion, and northern pike are scattered the entire 76 km. Water turbidity measured at the 15 sampling stations ranged from 1.2 to 40 ntu's, generally increasing downstream (Figure 17). Stomach analysis indicated that pike smaller than 300 mm concentrated on aquatic insects and crustaceans. Larger pike (> 300 mm) examined had eaten crayfish (*Orconectes* sp.), yellow perch, and northern squawfish (*Ptychocheilus oregonensis*).

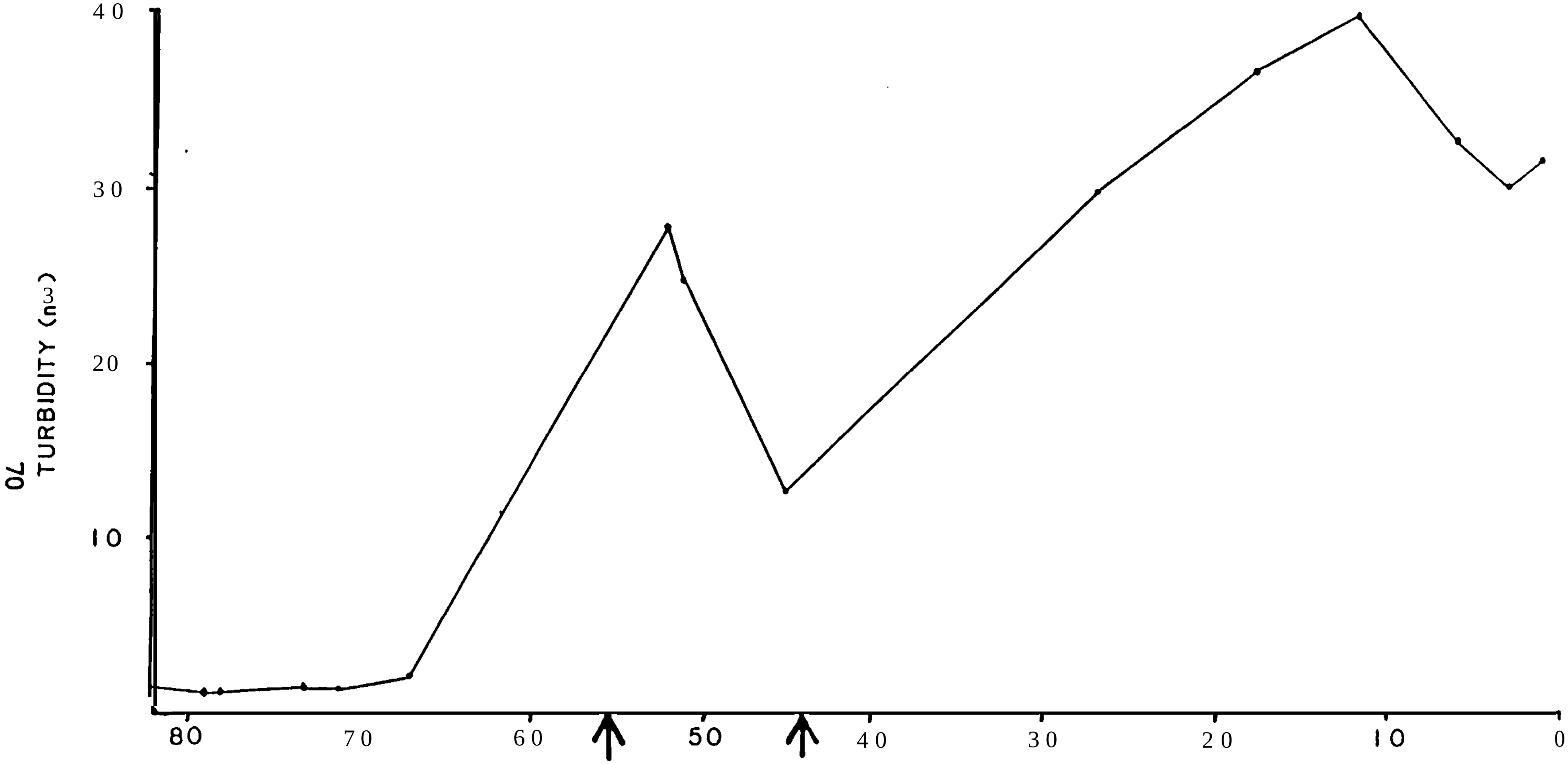

Figure 17. Longitudinal changes in turbidity in the Little Bltterroot River. Samples were collected 24 October 1984. Arrows represent known point sources of turbid water, i.e. Sullivan Creek (km 56) and Hot Springs Creek (km 44).

Spawning and Migration

Weirs

The weir 2 km above the mouth of the Jocko River began fishing on 29 February 1984. From 29 February to 15 May 1984, when high water forced trap closure, 32 rainbow trout and two brown trout were captured and released upstream (Figure 18). Trapping resumed on 18 July and continued until 3 December 1984 when ice formation forced closure. Twenty brown trout and three rainbow trout were captured during this interval. Six of the 20 brown trout entering the weir had been tagged in the Flathead River as early as 432 days before capture and up to 35 km from the trap site.

The Jocko weir was cleared of ice and resumed operating on 28 February 1985. Eighteen rainbows and one cutthroat trout entered the weir before 12 April when the modules were removed in anticipation of early runoff. From resumption on 31 July through 22 November 1985, 27 brown trout were captured; two had been tagged in the Flathead River, and one had been tagged at Jocko weir during fall of 1984.

The weir 6 km above the mouth of Mission Creek began fishing on 9 March 1984. Twenty-seven rainbow trout, six brown trout, and one bull trout were captured before high water forced closure on 16 May 1984 (Figure 19). One rainbow had moved 38 km upstream from the Flathead River (RK 13) and one had been tagged 144 days earlier at km 1 of the Jocko River.

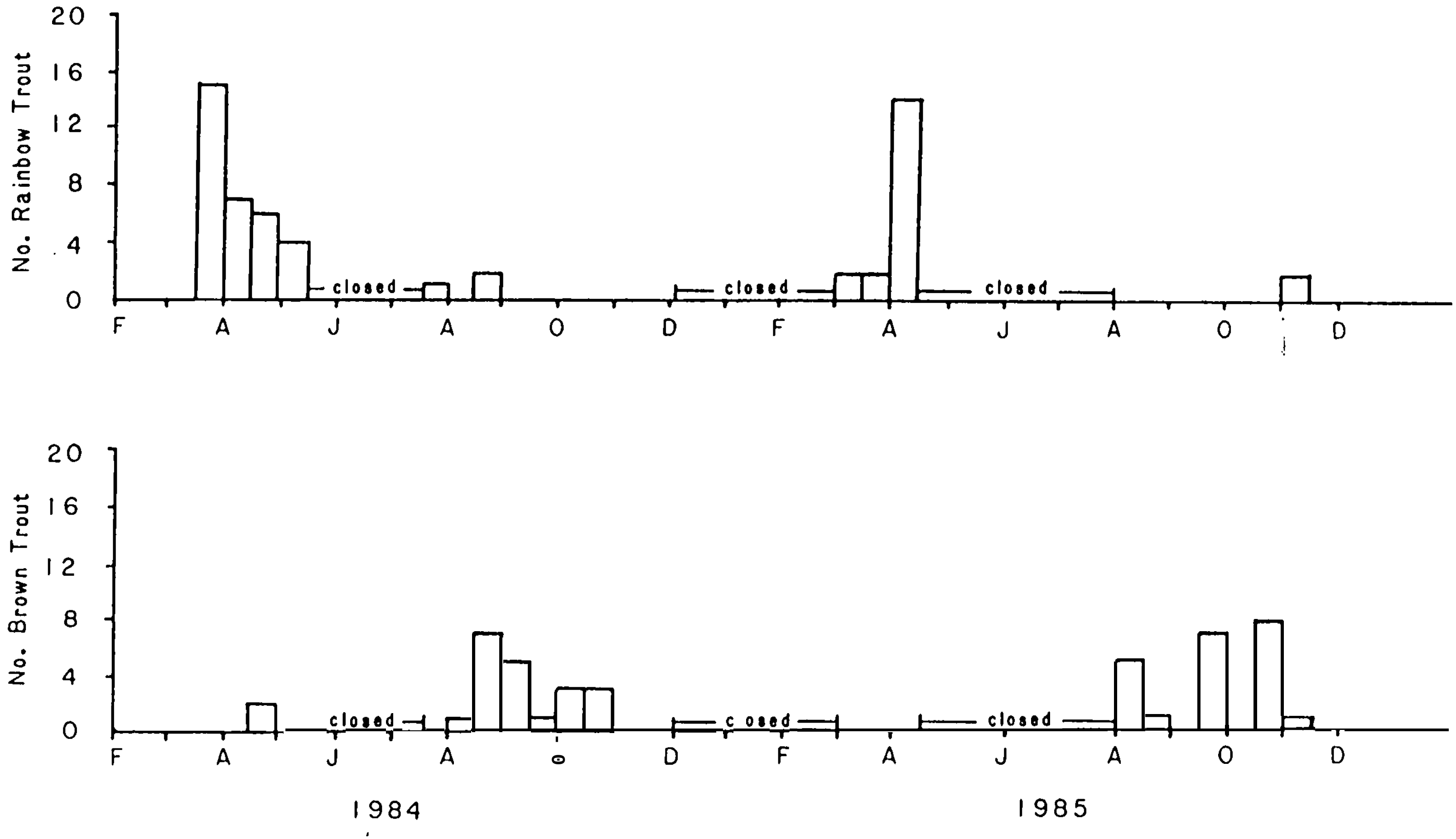

Figure 18. Timing of trout captures at Jocko weir from 9 March 1984 through 22 November 1985.

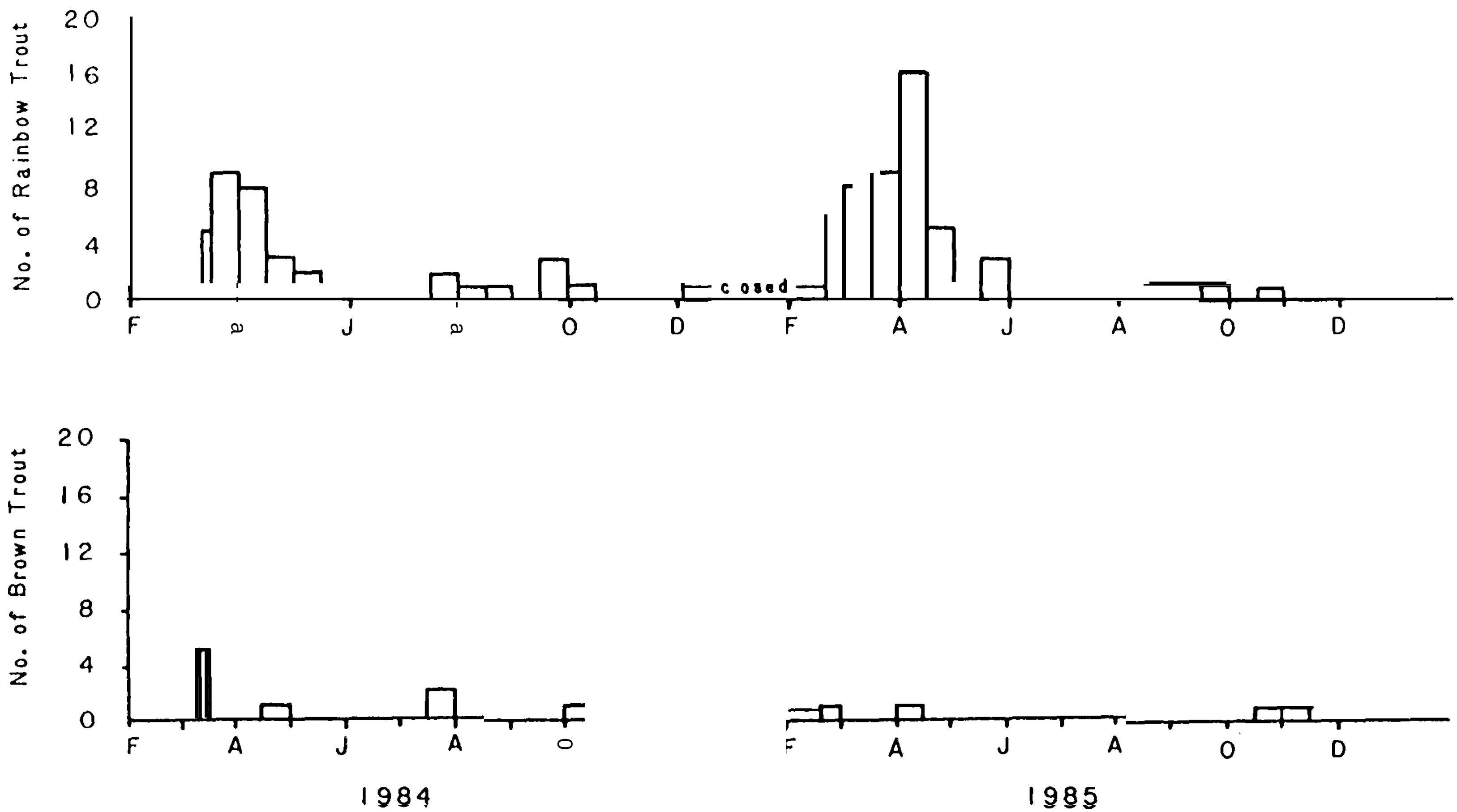

Figure 9. Timing of trout captures at Mission weir from 29 February 1984 through 22 November 1985.

Receding flows allowed trap operation to resume on 10 July, Eight rainbows, five browns, one brook trout, and one bull trout entered the Mission weir trap before ice forced closure on 3 December 1984.

The Mission weir began fishing again on 21 February 1985. Of 47 rainbow trout captured from February through May, four were recaptures from spring 1984, and one had been tagged at Jocko River km 3 144 days earlier. Four rainbow and three brown trout entered the weir from August through 22 November 1985.

Since trapping began at both weirs, a total of 141 rainbow trout (mean TL = 412 mm) and 59 brown trout (mean TL = 470 mm) have been captured and released. Approximately 36% of the rainbow trout spawners were age 3, and 57% were age 4. Approximately 41% of the brown trout spawners were age 3, and 39% age 4 and 5 (lengths overlapping). No spawning checks were observed on scales of 4 or 5 year old fish.

Redd Surveys

Forty-eight brown trout redds were found during fall 1984 surveys on the Jocko River between the mouth and Valley Creek (km 19), and 660 redds between Valley Creek and Finley Creek (km 31) (Figure 20). During fall 1985 surveys of these same sections, we found 72 brown trout redds below Valley Creek and 229 above (Figure 20), a 54% reduction from the previous year's count. We found 39 rainbow trout redds below

Figure 20. Redds counted on the Jocko River, Mission, Post, and Crow Creeks during (fall 1984, fall 1985.

Valley Creek and 17 above during spring 1985.

During fall 1984, 10 brown trout redds were found from the mouth of Mission Creek to its confluence with Post Creek (Figure 20). Seventy-one brook trout redds were found in Mission Creek above the confluence and twenty-seven in Post Creek. These redds were smaller than brown trout redds observed below the confluence, and brook trout were seen over several redds. Turbidity prevented a spring redd survey in Post Creek and in Mission Creek below the confluence. No redds were seen in the 4 km of Mission Creek above the confluence.

For the 4.8 km of Crow Creek surveyed below Moiese A Canal diversion, no redds were found during fall and two were found during spring.

Crow Creek Spawner Survey

A total of 67 adult rainbow trout (24 males and 43 females! mean TL = 362 mm) and six brown trout (mean TL = 406) were captured in the 5.6 km of Crow Creek below Lower Crow Reservoir during a two-day electrofishing effort in April 1985. During a similar effort conducted in November 1985, we collected 84 rainbow trout (mean TL = 372 mm; 19 recaptures) and 23 brown trout (mean TL = 312 mm; 3 recaptures). All recaptures had been tagged during the previous survey in April.

The day after fall shocking, the water temperatures in the

Flathead River near the mouth of Crow Creek was 0° C, in Crow Creek near its mouth water temperatures was 2 °C and near Lower Crow Dam 3.5°C. Seventy (65%) the 107 trout captured were within 0.8 km of the dam.

Little Bitterroot River Trapping

During spring 1985 a total of 11 northern pike were trapped in the Little Bitterroot River near Lonepine marsh (km 60); 35 were trapped in the Little Bitterroot upstream from Hot Springs Creek (km 44) and seven in Hot Springs Creek, and three were trapped moving downstream near the mouth of the Little Bitterroot (km 5). Eight of the pike captured above Hot Springs Creek were recaptures of pike tagged during previous electrofishing efforts in the same area of the Little Bitterroot River. No pike were recaptured in the other trapping areas.

Movement

Tag returns recorded since this study began in 1983 have shown that brown and rainbow trout move between the tributaries draining the east side of the Reservation and-the lower Flathead River. Northern pike move between the Little Bitterroot River and main river.

Since 1983, fourteen trout tagged in the lower Flathead River have been recaptured in its tributaries (Appendix H). Of these, 13 were brown trout recaptured in the Jocko River; one was rainbow trout that entered Mission Creek.

Since 1983, twelve trout originally tagged in the Jocko River have been recaptured; half of these showed no evidence of movement. Of those that showed movement, one brown trout moved upstream 21 km in 25 days from the Jocko weir where it was tagged, and one brown trout spawner tagged at the weir in fall 1984 was recaptured at the weir in fall 1985. One rainbow trout moved 36 km upstream within 67 days, and two rainbow trout tagged in the Jocko were recaptured in Mission Creek. One rainbow was caught in the Clark Fork River east of Paradise, 88 km from the Jocko weir, where it was originally tagged.

Sixty-seven percent (16 of 24) of trout recaptured from Mission Creek showed no movement. These trout were located in the upper reaches of Mission Creek, at least 11 km upstream from the mouth. The only brown trout captured at the Mission weir was caught within one week by an angler, as was one rainbow trout from the weir. Four spawning rainbow trout from 1984 returned to Mission weir in spring 1985. Two rainbows tagged at the weir were recaptured in the lower Flathead River; one had moved 92 km to the Clark Fork River east of Paradise.

One rainbow trout tagged in Post Creek above the Pablo Feeder Canal moved into the canal and northward 7 km before being caught near the South Fork of Crow Creek. The remaining 31,trout (97%) recaptured in Post Creek had not moved since being tagged; all but one resided in Post Creek's upper reaches.

Twenty-two of 29 northern pike recaptured in the Little Bitterroot River were found at their tagging location. Only one pike exhibited substantial movement within the Little Bitterroot, swimming the 34 km from above Hot Springs Creek (km 46) downstream to km 12. Five pike moved 5 km upstream from Hot Springs Creek in early spring 1983. One 3500 g northern pike moved 5 km out of the Little Bitterroot River downstream to Sloan Bridge on the lower Flathead River.

Substrate Analysis

The fraction from 16 to 63 mm predominated (by weight) most gravel samples from tributary spawning areas (Figures 21 and 22) particularly in samples from the Jocko River. The remaining fractions were relatively equal, each generally representing 20% or less of the total sample.

Comparing Idaho laboratory studies on embryo survival and fine sediment by Irving and Bjorn (1984) to our substrate data lead us to estimate potential rainbow trout embryo survival at an average of 36% for Jocko River spawning areas using substrate combinations smaller than 0.85 mm and 9.5 mm (Figure 23, Appendix I). Spawning areas in reaches 3 and 4 would be expected to have 34% embryo survival based on 0.85-9.5 mm fractions.

The combination of 0.85 and 9.5 mm fractions predicts 24% embryo survival in Mission Creek above its confluence

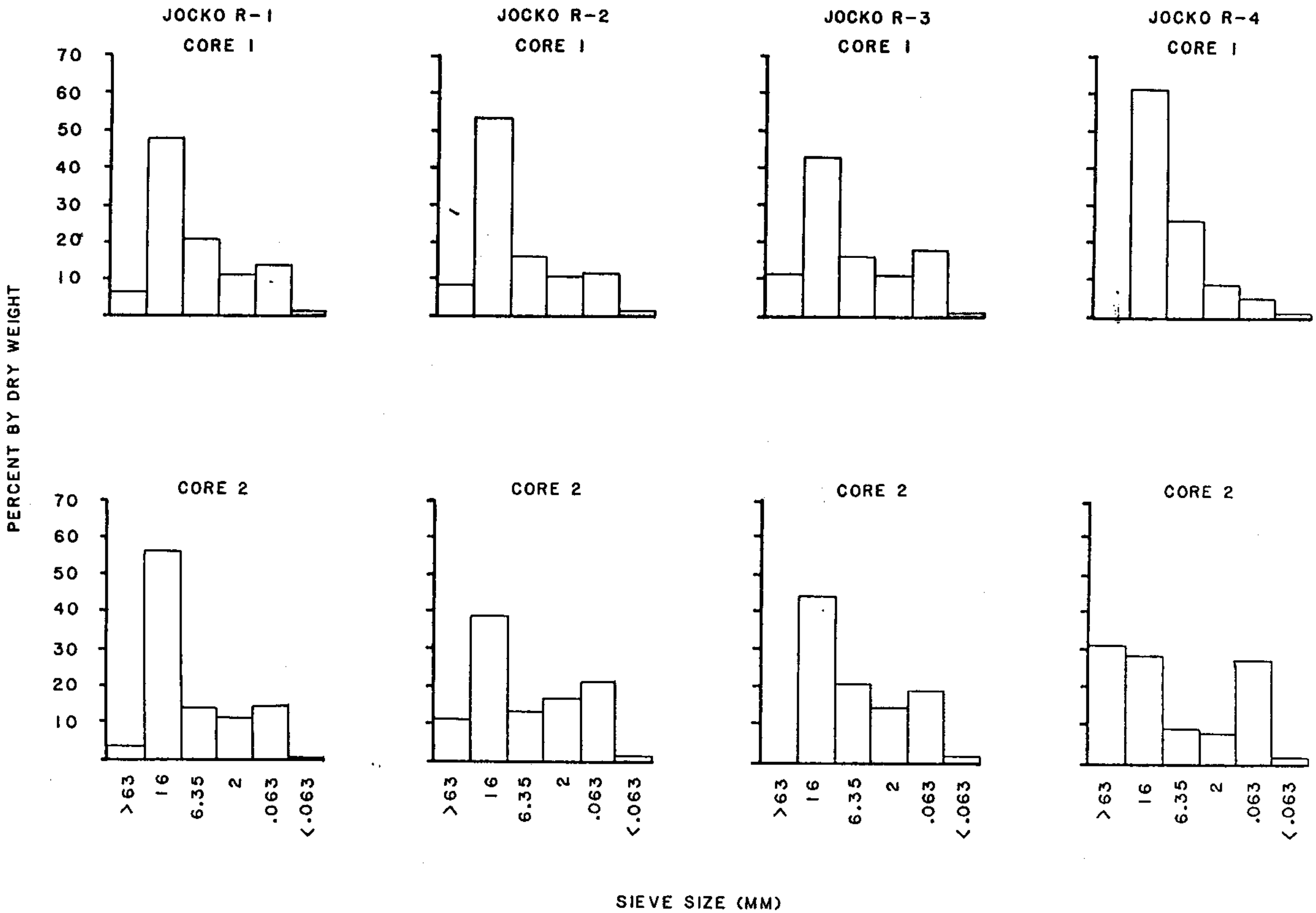

Figure 21. Substrate composition of gravels collected from brown and rainbow trout spawning areas in the Jocko River during spring 1985.

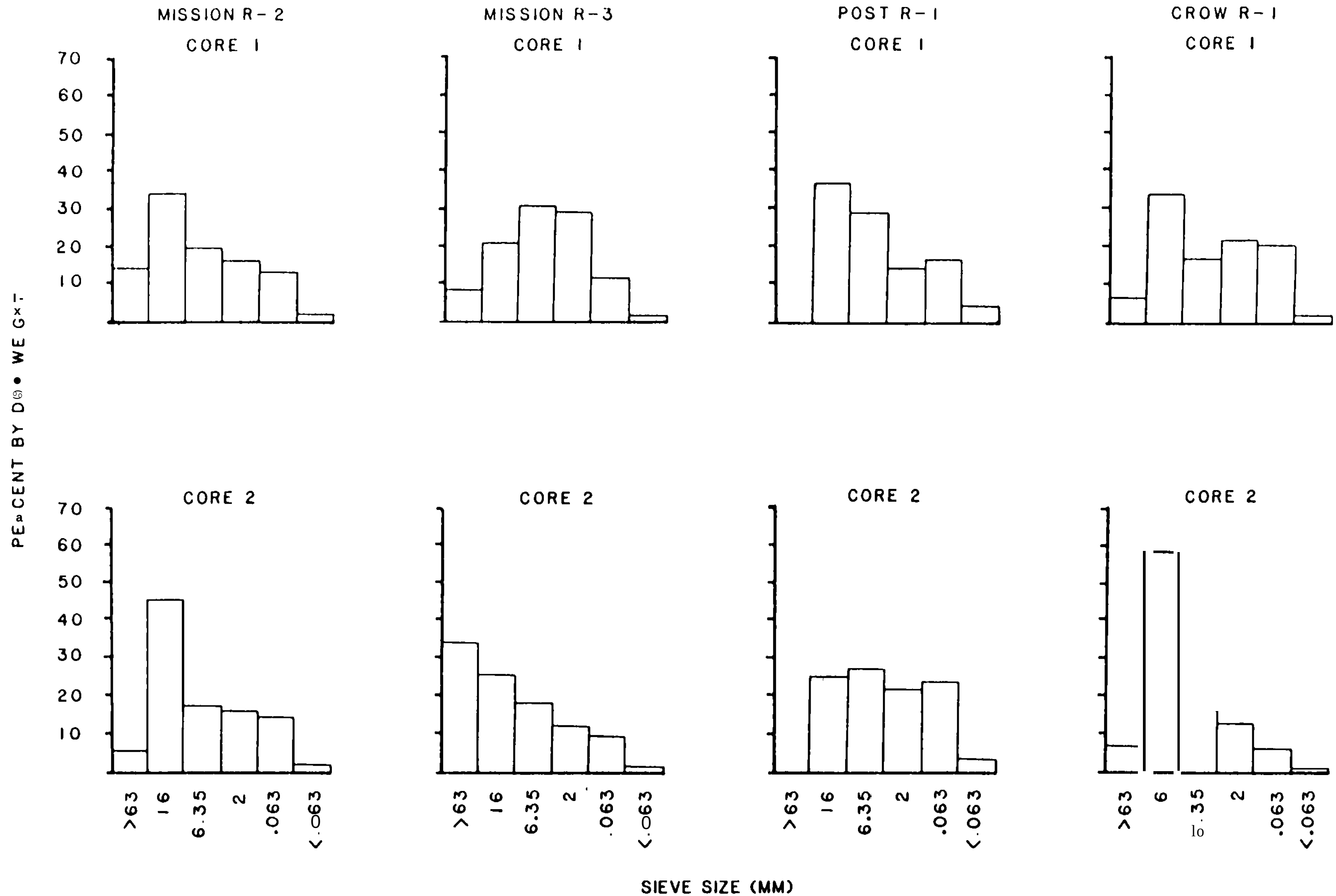

Figure 22. Substrate composition of gravels collected from brown and rainbow trout spawning areas in Mission, Post, and Crow Creeks during spring 1985.

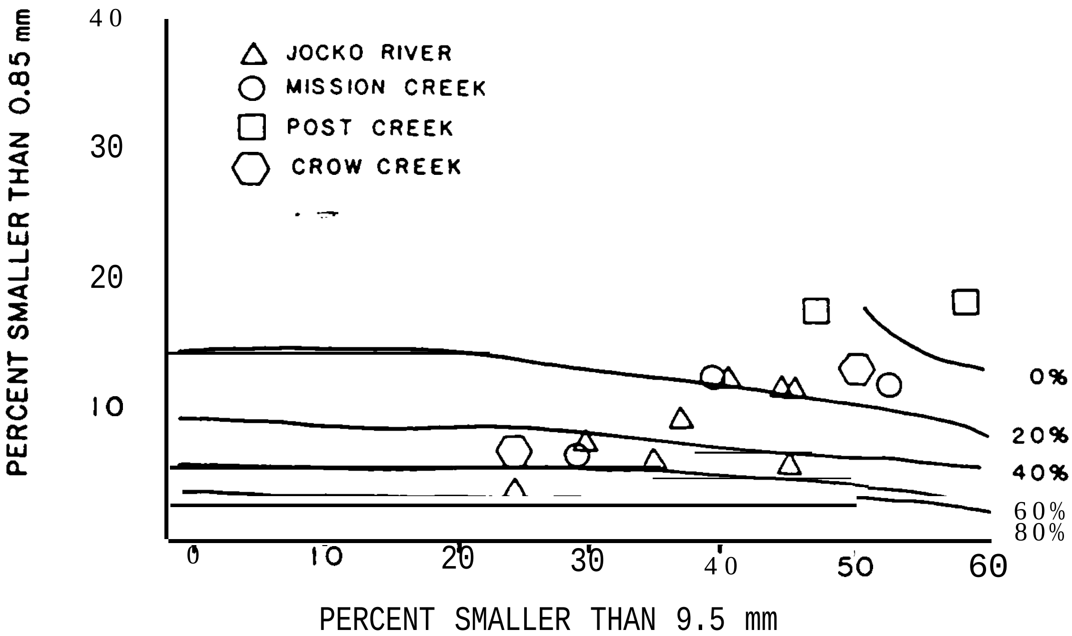

Figure 23. Predicted rainbow trout embryo survival in lower Flathead River tributaries related to various combinations of natural spawning gravel. (Adapted from Irving and Bjorn 1984.)

Table 8. Mean water temperatures (°C) recorded during August 1983, 1984, and July 1985 near the mouths of four tributaries and the lower Flathead River at Perma.

Stream	August 1983	August 1984	July 1985
Jocko River	16	15	17
Mission Creek	17	16	19
Crow Creek	19	18	19
Little Bitterroot	22	20	22*
Flathead River	21	22	23*

* Based on limited data due to thermograph malfunction.

with Post Creek and 18% survival below. In the Post Creek spawning area sampled, 1% survival would be expected. Embryo survival in Crow Creek is estimated at 28% based on 0.85 and 9.5 mm fractions.

Water Temperatures

Water temperatures near the mouth of the four major tributaries entering the lower Flathead River were highest during August 1983 and 1984, and during July 1985 (Table 8). Expecting the Little Bitterroot River, the tributaries were cooler than the main river during these hottest months.

DISCUSSION AND CONCLUSIONS

Movement of fish between the lower Flathead River and its major tributaries--has been well documented by recaptures of tagged study fish. Brown and rainbow trout move to and from the main river and the Jocko River, Mission and Post Creeks, and Crow Creek. Northern pike enter the Little Bitterroot River, but low flows near the mouth severely restrict movement.

Trout moving from the main river into the Jocko River apparently move no farther upstream than reach 5 (km 42) in the Jocko. Trout tagged in the lower Flathead have been recovered as far up the Jocko River as km 38, 5 km above the town of Arlee. Immediately above km 38 a section of the river is dewatered seasonally to supply irrigators, and a major irrigation diversion (K Canal) acts as a barrier at km 42. In reaches 6 and 7, resident fish populations differ from those in the lower five reaches in species composition, mean length, and total number of fish.

Although no barrier to exchange is apparent, changes in species composition (eastern brook trout appear and brown trout are not found) indicate that fish populations in Mission Creek above its confluence with Post Creek change from migratory to resident. Water in Post Creek above the Post/Mission confluence is turbid due to irrigation returns. This turbidity change may discourage upstream movement above km 3 in Post Creek. Movement of trout from the lower Flathead up Crow Creek is stopped at Lower Crow Dam (km 5.6).

Northern pike finding adequate flows to enter the Little Bitterroot River encounter other obstacles to movement. Rock outcrops, beaver dams, and flow deflectors for irrigation pumps obstruct passage in the lower 6 km of the Little Bitterroot, and water is withdrawn throughout the next 70 km dewatering sections of the river. High turbidity (30 to 40 ntu's) may also discourage movement within the lower 44 km of this river. Most of this turbidity is introduced by Sullivan Creek (km 56) and Hot Springs Creek (km 44). Nonpoint sources such as runoff and streambank sloughing in extensive areas with poor riparian management maintain the high turbidity levels to the river mouth.

Main-river trout enter the tributaries to spawn. Small but distinct spawning runs of rainbow and brown trout moving into the Jocko River have been documented at the weir. Mission weir results indicated that of the main-river trout, only rainbow trout use the Mission Creek drainage to spawn. Tag returns indicate that very few of either trout species spawn mere than once, ie: 6% of the rainbow trout and 3% of the brown trout spawners. A search for spawning checks on trout scales provided no confirmation. Migration may not be rlgorous enough to cause checks to form (Vincent, personal communication of 19 December 1985). In addition, trout may be using the tributaries as refuge from temperature extremes in the main river. The Jocko River, Mission and Crow Creeks are all cooler than the main river during the summer and warmer in the winter. For example, the majority (65%) of trout found during the November survey of Crow Creek were collected within 0.8 km of the dam, where water coming from the bottom of the reservoir was warmest. Rainbow trout have been shown to move in response to as little as a 1°C temperature change under laboratory conditions (Cherry et al. 1975).

No redds have been found in the main stem of the lower Flathead River, other than at its confluence with the Clark Fork River. Recruitment of trout to the lower river, therefore, depends heavily upon successful spawning within a few tributaries. Of these tributaries, only theJocko River has reliable flows (unlike the extreme and rapid fluctuations in lower Crow Creek) and good water quality year-round (unlike the turbid lower ends of Post and Mission Creeks).

Within the Jocko River, the 12 km between Valley Creek (km 19) and Finley Creek (km 31) are particularly critical to spawning trout, especially to brown trout. The 660 redds counted in this segment during fall 1984 and 229 redds during fall 1985 represent the majority of brown trout spawning in the lower river system, even after accounting for multiple redd-building and spawning by resident trout. Predicted embryo survival is 34% within this critical area based on substrate fractions smaller than 0.85 and 9.5 mm, assuming brown trout are at least as sensitive to substrate fines as rainbow trout. Laboratory studies in Idaho by Irving and Bjorn (1984) indicated that survival rates for rainbow trout were mainly related to the percentage of particles less than 0.85 mm in diameter. This high correlation ($r = 0.85$) is reflected in Figure 23, where the percent of substrate smaller than 9.5 mm has little effect on curves predicting trout survival. No laboratory studies have been conducted on brown trout survival to emergence. Trout embryo survival in the lower ends of Mission, Post, and Crow Creeks is predicted as even lower than in the Jocko River based upon preliminary sampling.

Results to date indicate that important trout spawning areas on the tributaries have been degraded by sedimentation. Irrigation returns and poor riparian management are the most apparent sources of this sediment. Expanded substrate sampling is planned for next year to test preliminary estimates for trout embryo survival. A more comprehensive study of embryo survival employing egg baskets, and measuring sub-gravel, dissolved oxygen concentration and water movement is beyond the scope of this project.

Northern pike spawning in the Little Bitterroot River appears to be concentrated in the 32 km between Hot Springs Creek (km 44) and the Camas A Canal diversion (km 76). The diversion is an absolute barrier to pike, while Hot Springs Creek changes habitat suitability by introducing very turbid water. Turbidity levels remain high in the Little Bitterroot from km 44 to the mouth, hampering the growth of aquatic vegetation critical to successful pike spawning.

In general, stock assessment was difficult in the lower reaches of the Jocko River and Mission Creek. Currents were too strong for block nets and some larger trout probably successfully avoided the electrical field around the bank-shocker probe. Doubling the station size from 150 to 300 m did not improve population estimates. To help determine whether these estimates were affected by sampling bias, we plan to shock at night using a drift boat system during spring and fall of 1986.

We propose application of the Instream Flow Incremental Methodolgy (IFIM) developed by the U.S. Fish and Wildlife Service in Fort Collins, Colorado, to selected segments of the Jocko River, Mission Creek, and Post Creek. This methodology will provide estimates of habitat available to several life stages of trout in this system under different flow regimes. Combined with the fish population,. spawning, and habitat information gathered to date, the IFIM results will allow us to present various management scenerios to Tribal decision-makers and identify resource impacts with each alternative.

SOUTH BAY

BY

Paul Pajak

and

William H. Bradshaw

DESCRIPTION OF STUDY AREA

Field investigation for the lake portion of this study is centered in SouthBay of Flathead Lake. The northern boundary of the study area extends west from Finley Point, through the Narrows, to the west shore just north of Lansing Point. The highway 93 bridge at Polson delineates the southern boundary of the study area. Total surface area at maximum elevations is approximately 5,336 ha.

South Bay is comparitively unique within Flathead Lake in its habitat characteristics and associated fish fauna. A mean depth of 4.62 m results in a disproportionate loss of habitat during the 3.1 m winter drawdown, approximately 46% (700 ha) of East Bay alone (Darling et al. 1984). The latter area is also notable in that it supports a remnant population of largemouth bass and a major ice and spring fishery for yellow perch. Both of these species are year-round residents in South Bay and have been targeted for impact assessment in this study. Other species, such as lake whitefish, bull trout, and cutthroat trout, utilize the bay on a more seasonal basis and are also being considered. A more thorough description of the geography, geology and limnology of South Bay is provided by Darling et al. (1984).

METHODS

Habitat Assessment

Habitat assessment activities in FY85 included final map revision, continued monitoring of water quality, and measurement of available physical cover. Refined sampling methods were implemented during the three lake elevation periods established as the result of FY84 surveys.

Habitat Evaluation Areas

Habitat types reported in Darling et al. (1984) were reclassified using the substrate sizeclasses and nomenclature of Stuber et al. (1982) (Figure 24). These revisions were designed to make future sampling and analyses more ecologically based rather than retain the original geologic classifications of Lorang (1982).

The depth intervals for habitat types established in FY84 were also revised. Both substrate and water quality data indicated relative homogeneity between mid-depth (3-6 m) and deep (6-10 m) water habitats of South Bay and thus these two intervals were combined into a single "permanently inundated" zone. The shallow (< 3 m) depth interval was simply renamed the "seasonally inundated" zone for purposes of this study. Evaluation areas for sampling purposes were then redefined. The fourteen areas include all unique combinations of substrate type and depth zone (Figure 25).

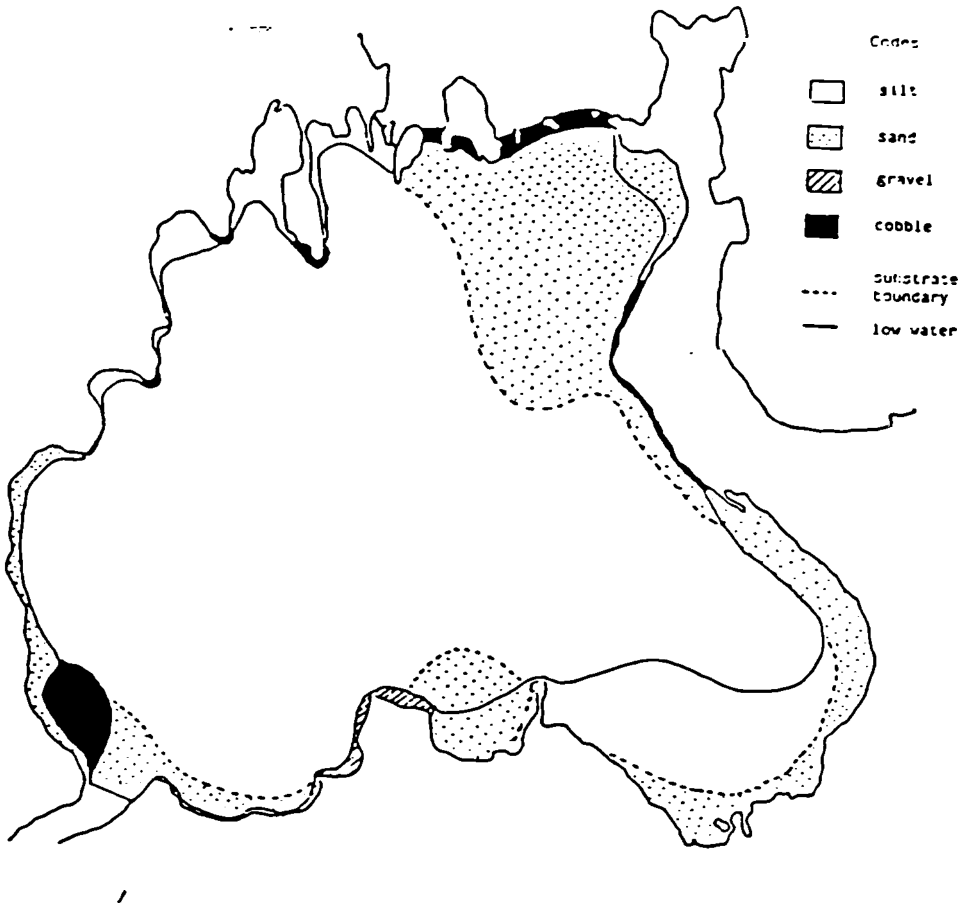

Figure 24. Dominant substrate types in South Bay of Flathead Lake.

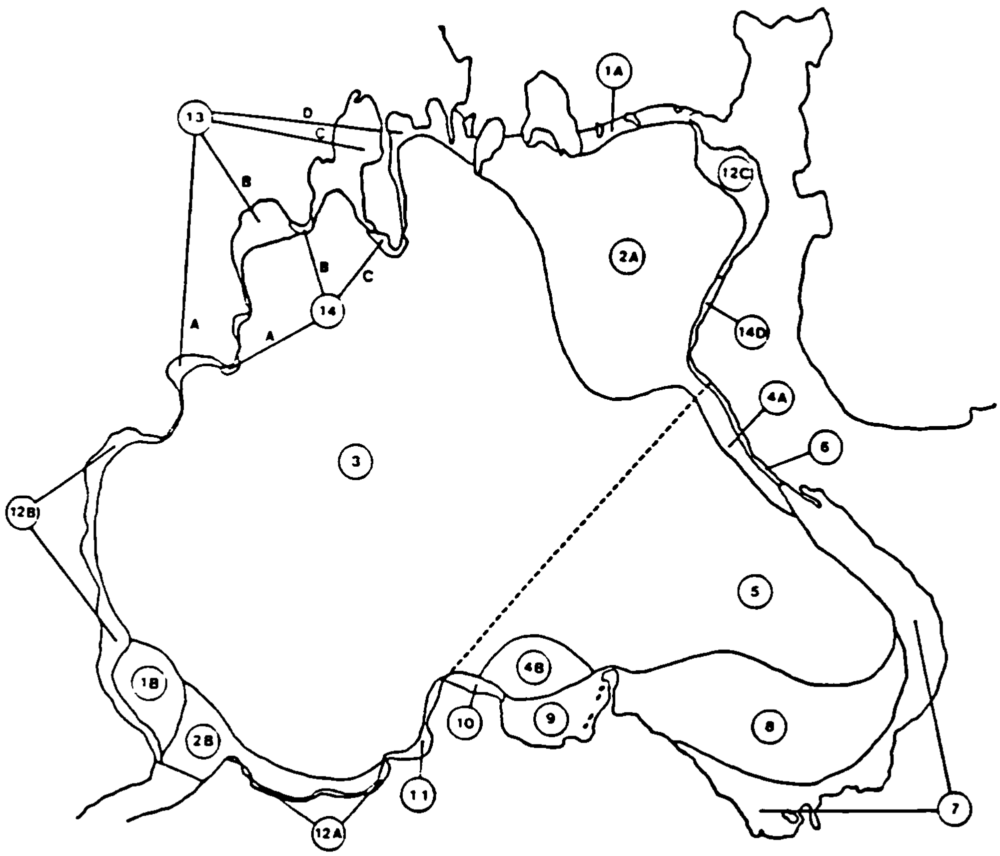

Figure 25. Evaluation areas based on depth and substrate characteristics in South Bay.

Non continguous areas with similar substrate and depth characteristics were considered collectively as a single evaluation area and are designated by upper case letters (eg. 14A).

Photo stations, established at sixteen permanent sites in FY84, continued to be visited. Monthly photos at each site were used to document and assess changes in the availability and suitability of physical habitat within the drawdown zone. Photo stations encompass all evaluation areas.

Vegetative Cover

Hydroacoustic surveys were conducted in early June, and again in October, to estimate minimum and maximum percentages of vegetation respectively. Vegetation was defined as any submerged macrophyte at least 30 cm (approximately 12 inches) in height. This minimum height was chosen as the direct result of observed utilization patterns for yellow perch, the dominant target species in South Bay. These latter observations were restricted to the ice-free months and were made by SCUBA divers at both minimum and maximum lake elevations. A Lowrance model X-15 depth finder was used to conduct the vegetation surveys along each of the fifteen permanent transects established in FY84 (Figure 26).

Percent vegetation was computed from the proportion of each sonar transect which intersected vegetation 30 cm or greater in height. To do this, dividers were set to the

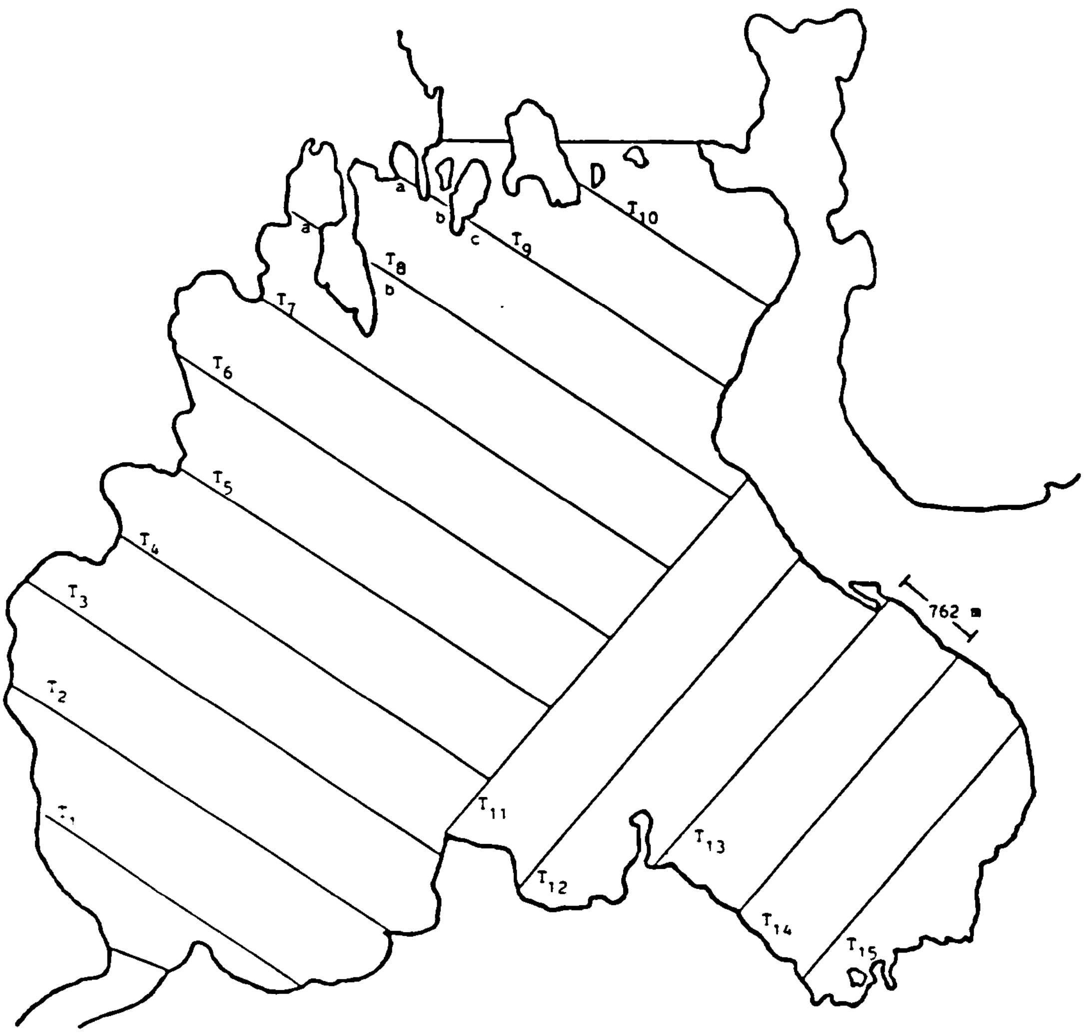

Figure 26. Permanent habitat evaluation transects in South Bay, Flathead Lake.

equivalent of 30 cm (on sonar tapes) and drawn along the "lake bottom" of each tape to mark all vegtation which exceeded this minimum height. The portions of each transect which intersected vegetation, as defined, were then summed by evaluation area (Figure 25). This number was then divided by the total of sample transects in the same area to obtain percent vegetation. This procedure was repeated for all fifteen surveys and tabulated by evaluation area.

Aerial photos were taken in April and October to facilitate the interpretation of hydroacoustic data and to assess the statistical validity of the transect method used. In addition, they document the general presence and location of aquatic macrophytes within the South Bay study area.

<u>Structural Cover</u>

Records from the Salish and Kootenai Tribal Office of Shoreline Protection were'used to determine the area of structural cover available in the South Bay study area. Structural cover was defined as any man-made structure extending below the high water mark. To determine the total area of structural cover, the number of docks in each evaluation area was multiplied by the mean surface area per dock. Mean dock area was determined from a systematic subsample (n = 49) of the 402 structures on record.

Aerial photos of the study area shoreline were also examined to evaluate the potential error inherent in this method of measuring available structural cover. The number of visible structures in each evaluation area was counted from color slides and then compared with corresponding totals obtained from the aforementioned records.

Water Quality

Bimonthly measurements of temperature, dissolved oxygen, pH, and conductivity were continued at twenty-five permanent sites located within each of the fourteen evaluation areas (Figure 25). All water quality measurements were taken at 1.0 m depth intervals as recommended in Darling et al. (1984). Prevailing weather conditions and secchi visibility were also recorded at each station.

Four Ryan model-J thermographs (90-day) were also utilized to record continuous temperature measurements. The thermographs were placed in each of the two major subareas within South Bay (Figure 27). These instruments were anchored on the bottom in at least 1 m of water in an attempt to minimize temperature variability, and to better reflect actual temperatures within the occupied habitat of target species.

Fish Distribution

A variety of methods were used to determine fish distribution patterns by species, life stage, habitat type, and elevation period. Data from this sampling will be used

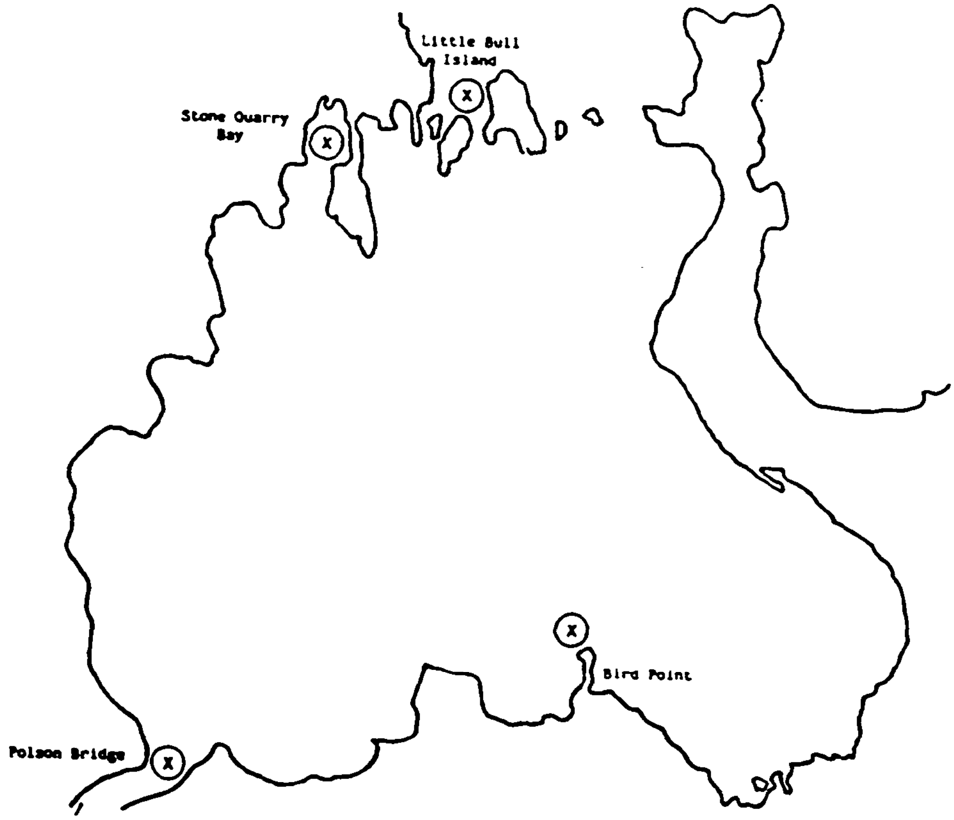

Figure 27. Sampling locations for continuous monitoring of water temperature in South Bay of Flathead Lake, 1985.

to assess the relative importance of available habitat types and their relationship to changing lake elevations.

Gill Netting

Experimental gill nets were the primary method used to determine the relative distribution of adult target species in South Bay. Sampling was conducted during each of the three elevation periods and included both spatial and temporal components. Supplemental samples were taken in vegetation to examine specifically the utilization of this dominant cover component.

In an effort to minimize sampling variability, all nets were fished simultaneously, were placed perpendicular to prevailing bottom contours, and were fished for equal duration. All data were converted to catch per unit effort (CPUE) statistics for analysis.

Individual nets were nylon and of the sinking type. Each net was 1.8 m deep, 38.1 m long, and ranged in square mesh sizes from 1.9 cm to 5.1 cm.

Spatial Distribution. Sampling for this study component was conducted within each of the fourteen evaluation areas during the three lake elevation periods (Figure 28). Five gill net sets were completed within each evaluation area. Nets were set after sunset and allowed to fish for approximately one hour. Upon hauling nets, the total catch was recorded by species. Horphometric data and scale samples

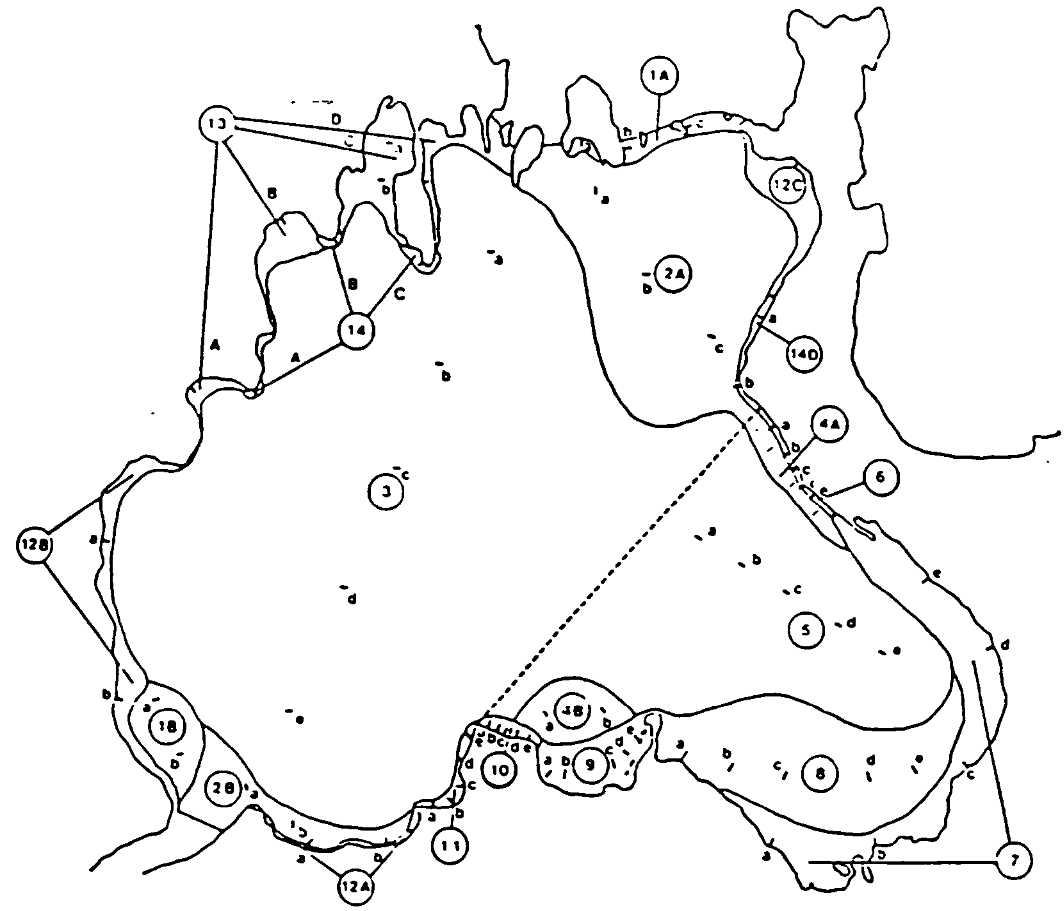

Figure 28. Gill net sample locations in South Bay of Flathead Lake, 1985.

were collected as needed for target species and salmonids only. All of the latter fish were tagged prior to their release.

Diel Use Patterns. A twenty four-hour period was sampled in each of the three elevation periods to determine the diel habitat utilization patterns of target fish species. One evaluation area was selected in each of the Polson (I) and East Bay (II) subareas for this purpose. Gill net stations 3c and 5c (Figure 28) were sampled at four-hour intervals beginning at 0800. Fishing effort was approximately one hour for all sets and catches were recorded as described previously.

Utilization of Vegetation. Six paired gill nets sets were completed in East Bay to determine if utilization by target fish species was significantly higher in vegetated versus non-vegetated areas. Although several evaluation areas were sampled, individual paired samples were taken within the same evaluation area. All sets were made in August when aquatic vegetation was near its maximum annual density.

Hydroacoustic recordings, to detect the presence or absence of vegetation, were also made during the more extensive night sampling of all evaluation areas. These records will be used to assess further the use of vegetation by target fish species in other habitat types and seasons.

Fyke Net Trapping

To collect length distribution information about target species, and to capture fish for tagging studies, fyke traps were fished at five shoreline locations (Figure 29) from 3 April through 18 June of 1985. Fyke trapping equipment and techniques were identical to those used in 1984 by Darling et al. (1984). All fish were measured for total length to the nearest millimeter (TL) and tagged. Floy tags were used on fish 150 mm TL and larger, while fish less than 150 mm TL were marked with fingerling tags.

Tagged Fish

Data from recaptured tagged fish were collected to determine the extent and seasonal patterns of movement for fish species under investigation. Tag returns were recorded by date, gear type, and location of recapture. This data will be used to determine habitat type utilization and the minimum annual home range of target fish species in South Bay.

Creel Survey

A creel survey, patterned after discussions of survey methodologies by Neuhold and Lu (1957), was conducted on the East Bay ice fishery from 12 January through 31 March 1985. Total angler estimates were derived daily from five instantaneous angler counts made from shoreline vantage points (Figure 30). The times of daily instantaneous angler

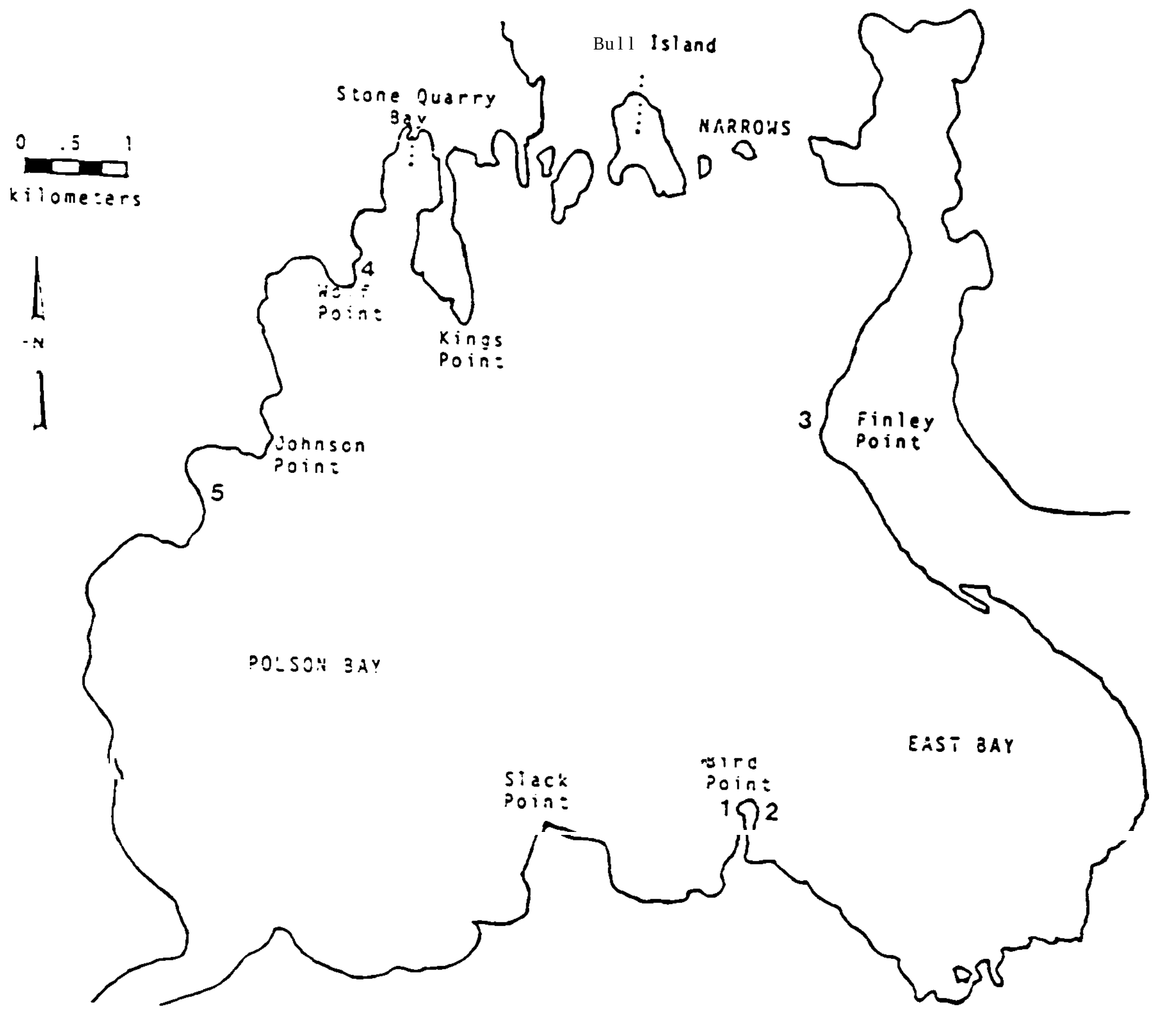

Figure 29. Fyke trap stations for the period April 3 through June 18, 1985, Flathead Lake, Montana.

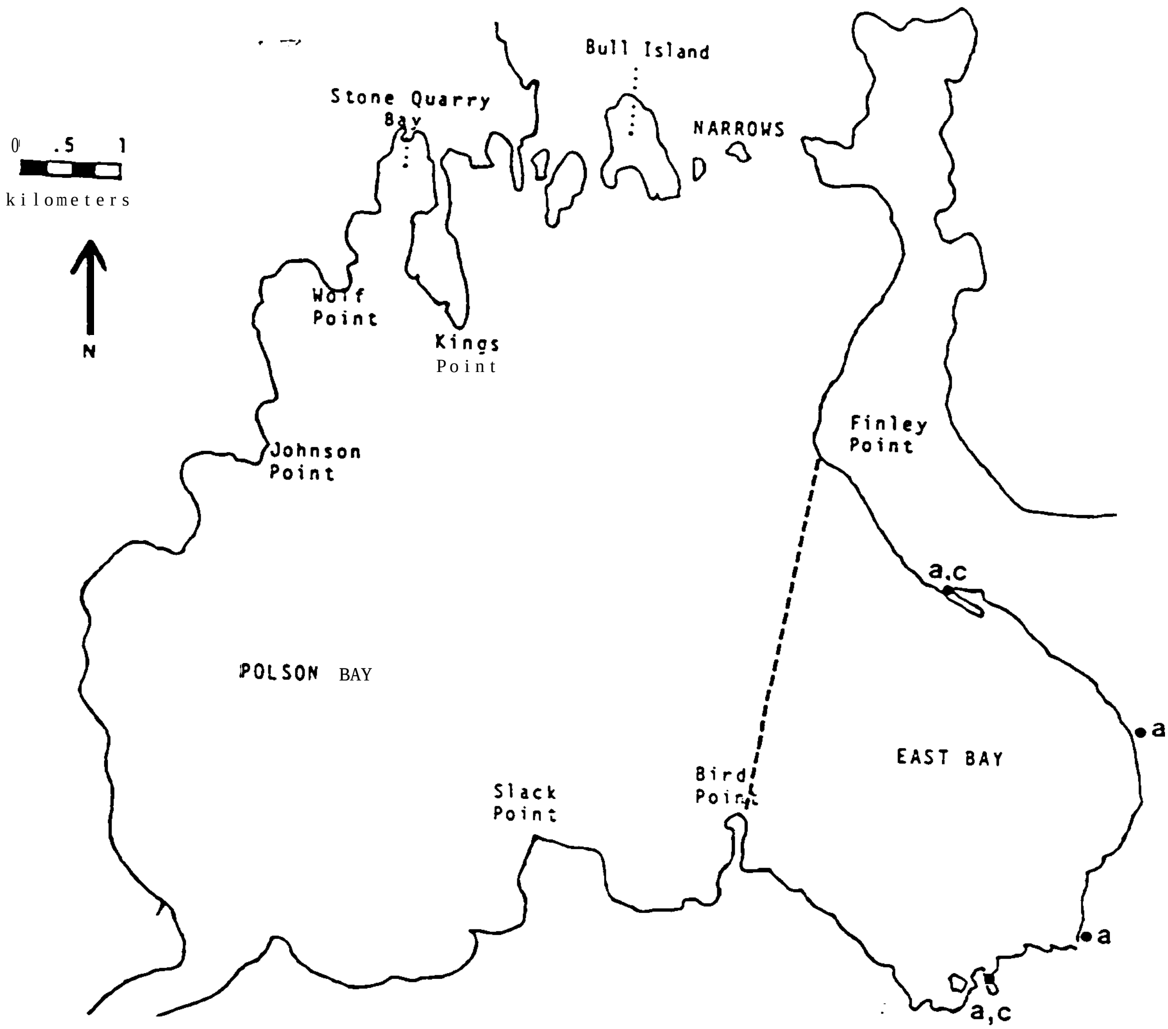

Figure 30. Angler access points (a) and locations for instantaneous angler counts (c) for the 1985 ice fishery at East Bay, Flathead Lake, Montana. Dashed line indicates approximate boundary of ice fishing area.

counts varied over the survey period as daylight hours increased.

Completed trip angler surveys were conducted at departure points (Figure 30) to obtain catch and creel data, and information about fishing time, catch composition, and catch size distribution.

Information was analyzed through Computing Services of Montana State University using a program developed by the Montana Department of Fish, Wildlife, and Parks (Robert McFarland, MDFWP, Helena, Montana).

Beach Seining

Exploratory beach seining in 1984 (Darling et al. 1984) provided the basis for selecting the 24 permanent seining stations (Figure 31) sampled in 1985. Major substrate types present in South Bay were sampled in both seasonally and permanently inundated shorelines in 1985 during three distinct sampling periods.

A 103.24 m by 2.36 m beach seine with 6.35 mm square mesh and a 2.36 m^2 bunt was used for all collections, When seine catches were small, (e.g.N < 100) all fish were measured to the nearest millimeter (TL). If catches were large (e.g.N > 100) subsampling methods were used. All fish which appeared larger or smaller than the majority of fish in the net, or species represented by few individuals were removed, measured (TL), and Floy tagged if greater than 150 mm long. To

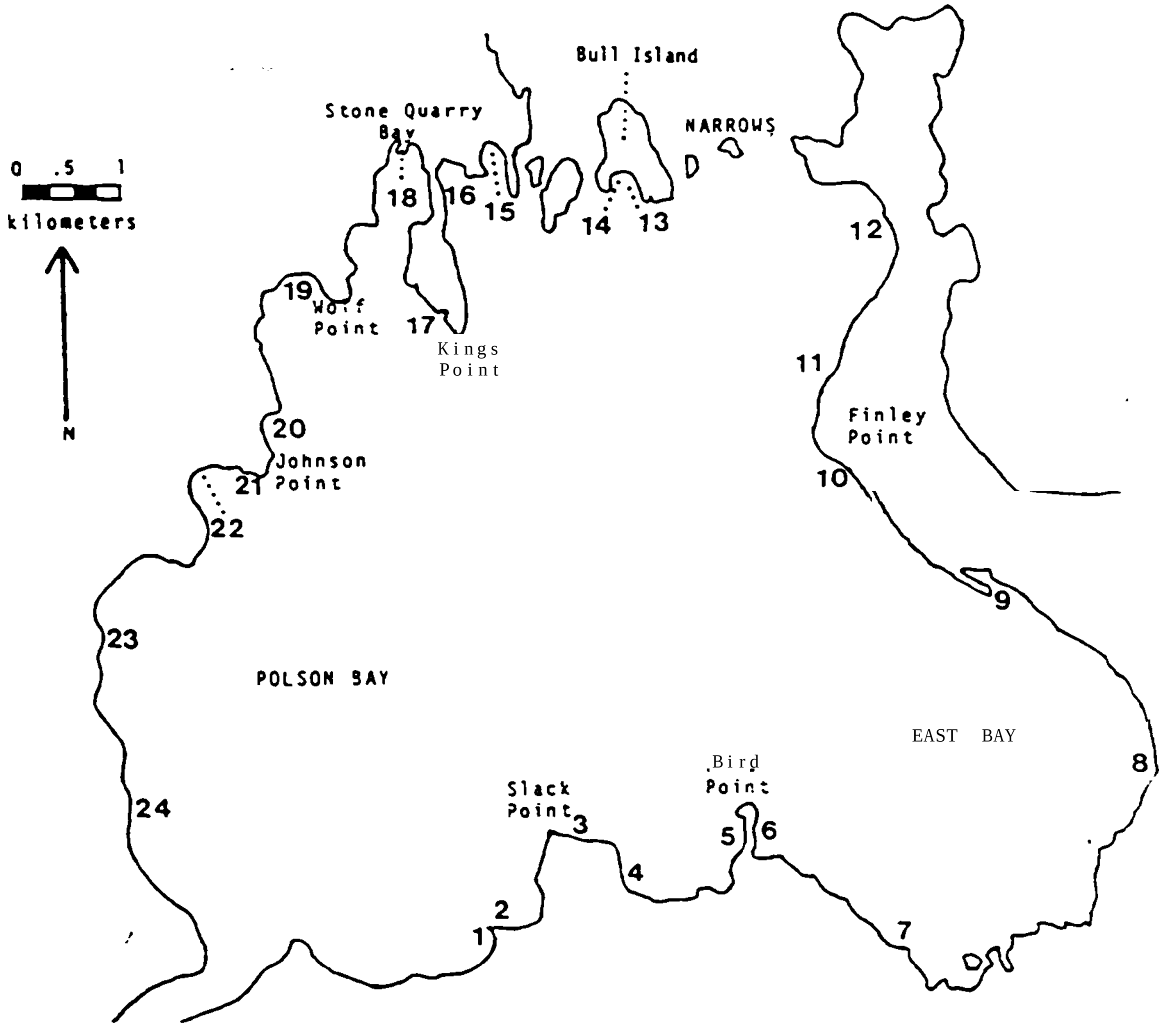

Figure 31. South Bay beach seine stations for the period 2 May through 26 September, 1985, Flathead Lake, Montana.

provide size distribution data on fish still in the net, a sample of the remaining fish was removed, placed in a plastic bag on ice, and returned to the lab where they were measured (TL). An abundance estimate of fish remaining after size class subsampling was obtained by calculating the average number of fish contained in small dipnet (N = 6 to 16) and multiplying this value by the total number of dipnets of fish in the seine. The number of fish subsampled for length distribution data was then added to the abundance estimate. Finally, size class data from the subsample was applied to the abundance estimate on a proportional basis.

Larval Fish Sampling

To develop methodologies for assessing spatial and temporal distributions and relative year class strengths of larval fish in South Bay, preliminary sampling was conducted through the spring and summer of 1984 (Darling et al 1984). As a result, 32 locations (Figure 32) were selected as permanent sampling stations for 1985. Both seasonally and permanently inundated areas as well as the various substrate types found in South Bay are represented by these sampling locations.

Poor weather dictated an intermittent sampling schedule from late March through May, but as conditions improved, an essentially bi-weekly schedule became practical.

With one exception, icthyoplankton sampling gear was

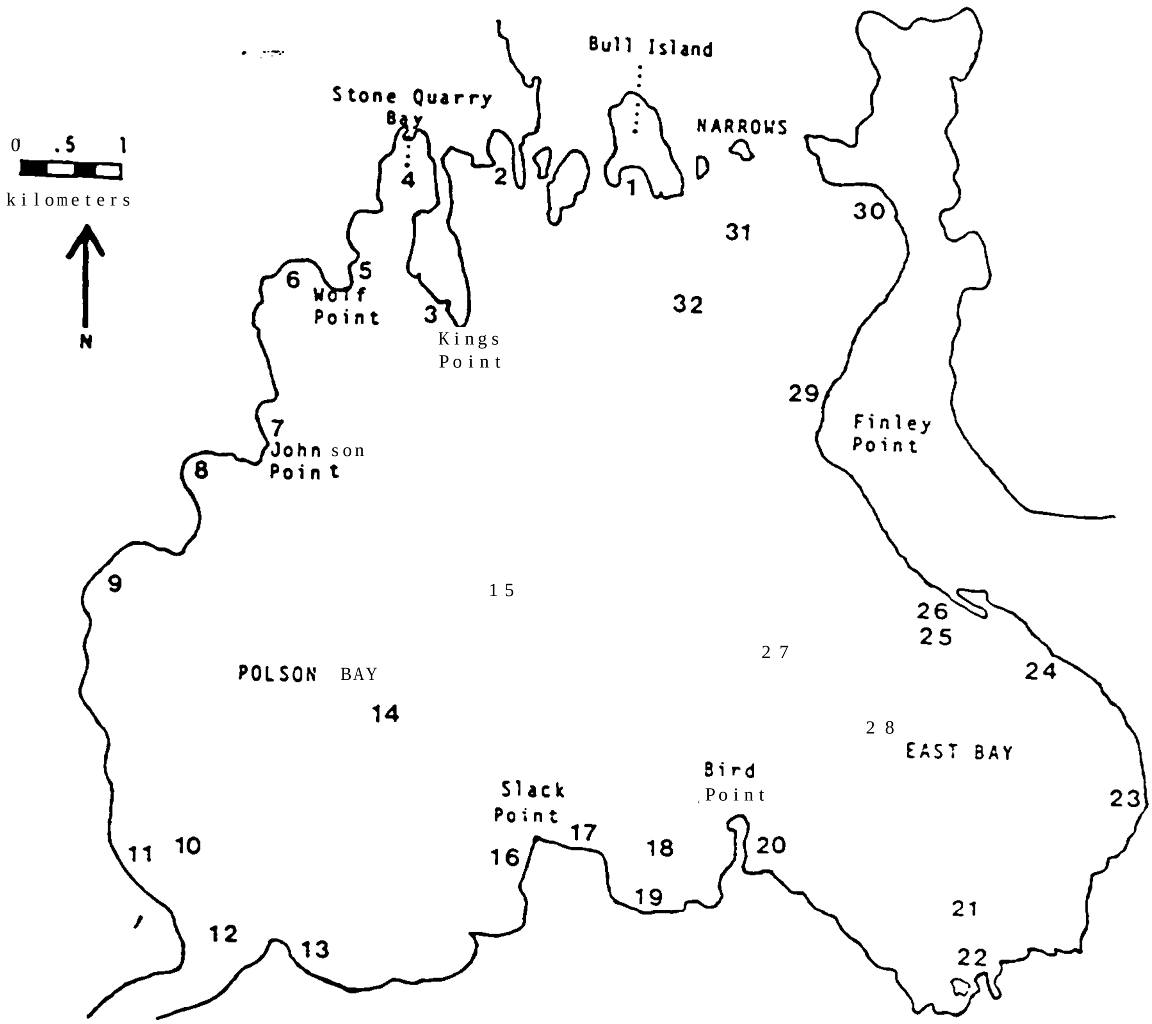

Figure 32. Larval fish sampling stations for the period 4 April through 22 August, 1985, Flathead Lake, Montana.

identical to that reported in Darling et al. (1984). In 1985 a second net was suspended from the port bow of the sampling boat to collect simultaneous sample replicates. At each station, nets were pushed for ten minutes at a tachometer reading of 1600 rpm. Samples were fixed in 5% formalin and preserved in a solution of 74% distilled water, 15% methyl alcohol, 10% formalin and 1% acetic acid.

Fish specimens were identified to the lowest practicable taxon using characteristics given by Auer (1982), Snyder (1981), and Mansuetti (1964). Following the criteria of Snyder (1976), fish were designated as larvae if the adult fin compliment was not fully developed or if median finfolds were present.

Spawning Surveys

Largemouth bass was the only target species for which spawning surveys were conducted. Relatively deep water spawning or apparent absence from the study area, combined with surface survey techniques, precluded effective surveys for lake whitefish, yellow perch and northern pike.

Two canoe surveys for nesting largemouth bass were conducted in near shore areas of East Bay during (Figure 33) the month of June, the expected spawning period. Both surveys were of equal effort and consisted of a single individual who counted all largemouth bass observed. For each sighting, the following data were recorded: 1)

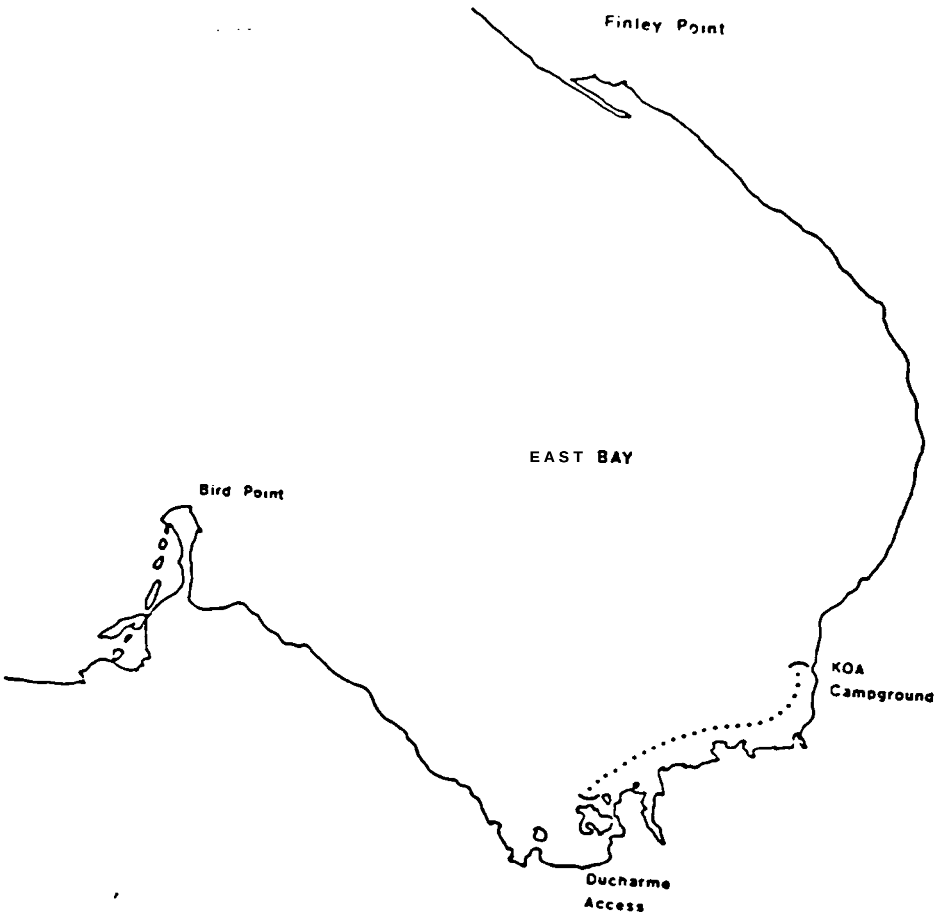

Figure 33. Location of spawning surveys for largemouth bass in East Bay of Flathead Lake, 1985.

approximate fish length, 2) nesting status, 3) approximate depth of water, 4) dominant substrate type, 4) surface water temperature, and 6) distance to cover.

Age Class Structure

Beach seining, fyke net trapping, and the 1985 ice fishery creel survey were provided scales used for age class analysis. Scales were taken from between the dorsal fin insertion (first dorsal fin for Percids) and the lateral line. Scale samples collected from the ice fishery were subsampled by 10 mm size classes. If there were more than 25 representatives of a given size class, 25% of the scale samples were selected at random from the group. This ensured that size classes with few individual samples were adequately represented. Acetate impressions were made from scales following methods reported by Darling et al. (1984). Distances from the focus to the outer edge of each annulus, and to the scale margin were measured on the anterio-dorsal axis at 48X for Percid species. Bagenal and Tesch (1978) provided the rationale for assigning a “birthday” to aid in age analysis. A birthday of May 1 was assigned to yellow perch based on the apparent peak of spawning activity in South Bay as reported in Darling et al. (1984).

RESULTS

Quality Water

Mean surface water temperature for all evaluation areas in South Bay ranged from 0.1°C in January to 23.3°C in July (Figure 34). The highest temperature observed in any area was 24.9°C in evaluation area 13D; the lowest was 0°C which was measured through the ice at several stations in East Bay.

In general, surface water temperatures tended to warm and cool more quickly in East Bay than in Polson Bay. However, differences between the means rarely exceeded 1°C (Appendix). This pattern of greater variability was also apparent in shallower, seasonally inundated areas versus permanently inundated areas. Again, differences in mean surface temperatures were generally less than 1°C. Sample sizes were too variable or incomplete to determine if important differences in temperature exist between individual evaluation areas.

Preliminary results from continuous monitoring of temperature from May to August indicate that bottom water temperatures (> 1 m deep) may drop as much as 5°C in 5 minutes (Appendix K). Fluctuations of 7°C in 18 minutes also occurred at Little Bull Island on three separate occasions (5/25, 7/23, and 8/8). Temperature fluctuations did not exceed 7°C in any other 24-hour period or at any of the other'monitoring locations. In general, bottom water

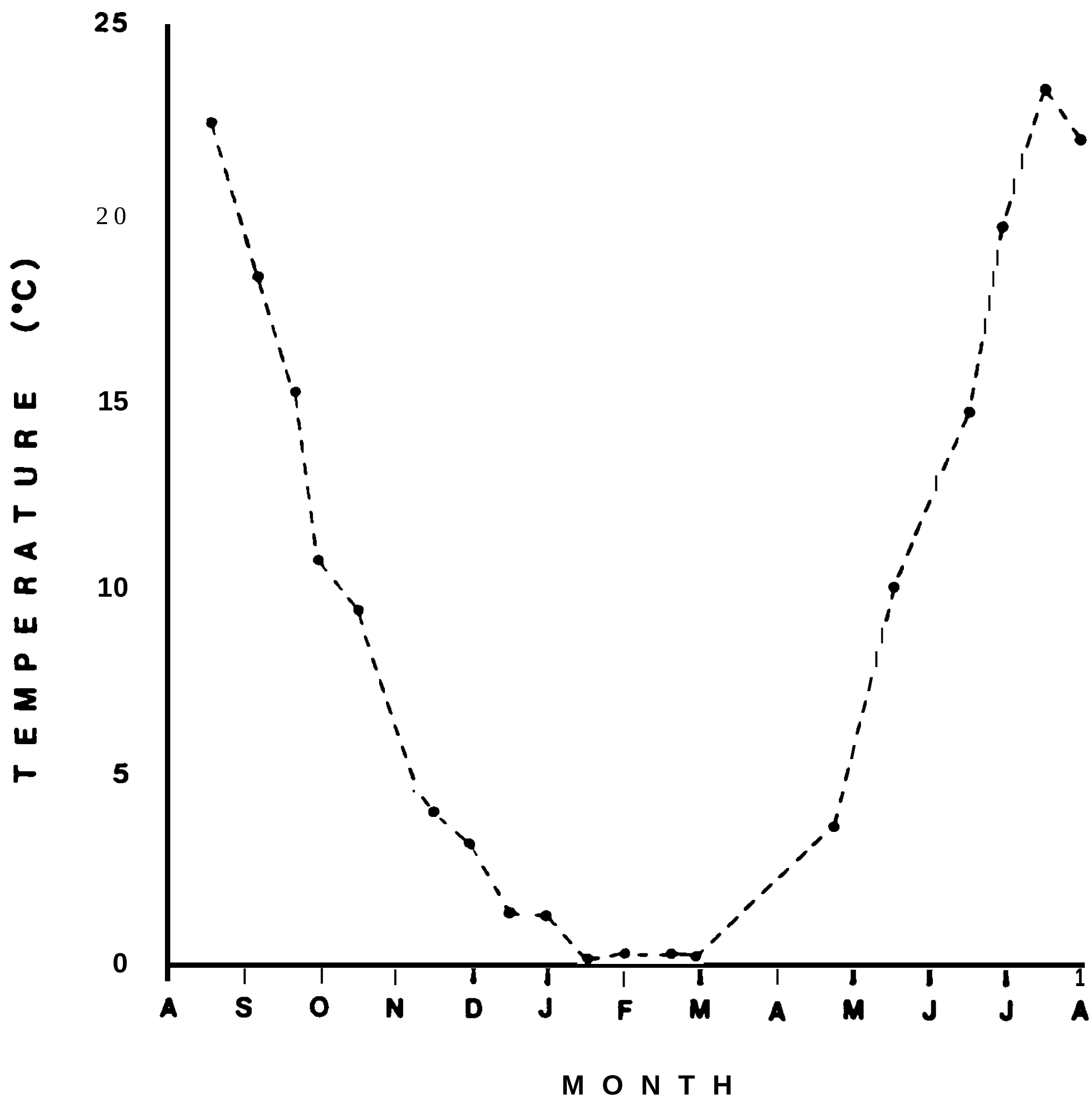

Figure 34. Mean surface water temperature for South Bay of Flathead Lake, 1984-85.

temperature was most stable at the Polson Bridge location and increased in variability at the Stone Quarry Bay, Bird Point and Little Bull Island locations respectively.

Inspection of other water quality measurements suggests an inverse relationship between temperature and dissolved oxygen, and relative spatial and temporal homogeneity of pH and conductivity parameters. Pre-dawn measurements of dissolved oxygen, taken through the ice in East Bay (2/6/85), were as low as 4 mg/l (@ 1.6 °C) on the bottom in shallow (1 m), vegetated areas. However, similar measurements taken in Stone Quarry Bay, and in deeper sections of East Bay, almost always exceeded 10 mg/l at comparable temperatures.

Vegetative Cover

Results from hydroacoustic surveys in June indicate that vegetation (> 30 cm) comprises approximately 5.4% or 270 ha, of the entire South Bay study area at maximum lake surface elevations., Most of this taller vegetation is *Potamogeton* or *Myriophyllum* and occurs primarily in silt substrates of East Bay. Although *Chara* is more -common, it rarely exceeds 30 cm in height and has been observed to have lower utilization rates by adult yellow perch. Percent vegetation in the East Bay and Polson Bay subareas in June was 17.6 and 0.1 respectively. When total surface area at maximum lake elevations is considered, less than one percent (0.1) of South Bay supports vegetation greater than 30 cm in height.

This vegetation is restricted to a single, permanent inundated evaluation area (5) in East Bay (Table 9). (Note: Vegetation still only comprises 0.7 percent by area of South Bay at minimum elevations).

Structural Cover

Cumulative observations from surface and SCUBA surveys indicate that both seasonally and permanently inundated areas are virtually devoid of woody debris or other natural, non-vegetative cover. Thus, man-made structures (eg. docks) provide the only other potentially significant source of structural cover in South Bay.

Records from the Confederated Salish and Kootenai Tribal Office of Shoreline Protection documented the presence of 402 structures extending below the high water mark within the study area. A comparable count made from aerial photos increased this total to approximately 518. When the latter count was multiplied by mean dock area (646 sq.ft.1, the resultant product was approximately 24,154 m, or ,044 percent of the total study area.

Estimates of percent structural cover by evaluation area ranged from 0 to 2.7 (Table 10). Evaluation area 6 contained the higher percentage of these two respectively. When duration and timing of lake drawdown are considered only evaluation area 1A contains structural cover available to fishes on a year round basis.

Table 9. Percent vegetation by evaluation area and month in South Bay of Flathead Lake, 1985.

Evaluation Area		% Vegetation	
Number	% of Study Area	June	October
1[b]	2.0	0	0
2	12.0	0	0
3	50.4	0	<l .0
4	1.8	0	24.4
5	17.8	3.7	16.9
6[c]	<l.0	0	0
7	3.2	23.9	16.8
8	6.6	59.4	34.9
9	<1.0	0	0
10	<l .0	0	0
11	<l.0	0	0
12	1.4	0	0
13	3.4	1.2	0
14	<l.0[a]	0	0

[a] no transect intersected subareas 14A, 14B, or 14C.

[b] areas 1 through 5 are permanently inundated.

[c] areas 6 through 14 are seasonally inundated.

Table 10. Percent structural cover by evaluation area in South Bay, Flathead Lake, 1985.

Evaluation Area	Substrate Type	Number of Docks	Dock Area (ha)	Total Area (ha)	% cover
1	cobble	16	0.096	119.6	0.001
2	sand	0	0.000	668.8	0.000
3	silt	0	0.000	2721.3	0.000
4	sand	0	0.000	85.2	0.000
5	silt	0	0.000	778.7	0.000
6	cobble	30	0.180	6.6	0.027
7	sand	22	0.132	234.4	0.001
8	silt	2	0.012	334.4	0.000
9	sand	0	0.000	59.0	0.000
10	gravel	10	0.060	6.6	0.009
11	gravel	20	0.120	18.0	0.007
12	sand	98	0.588	127.8	0.005
13	silt	168	1.008	152.4	0.007
14	cobble	36	0.216	22.9	0.009
Total		402	2.484	5335.7	

Fish Distribution

Gill Netting

A total of 2,572 fish were caught and released during 357 hours of gill net sampling in South Bay this year. Yellow perch dominated the catch in all gill net samples and comprised 46% of the total (Table 11). Other frequently 'sampled species, in descending order of abundance, were northern squawfish (Ptvchocheilus orgonensis) (28%), peamouth (Mylocheilus caurinus) (15%), and lake whitefish (6%). All other species combined accounted for less than 5% of all samples.

Mean catch per unit effort (CPUE) for all species combined was similar during all three elevation periods (Table 12). However, effort within evaluation areas varied considerably, from 4.15 to 25.21 hours. Additionally, gill net sampling for elevation period I was conducted during the day while that for periods II and III was completed at night. When individual species and elevation period are considered, yellow perch appear to dominate the catch in period I with an absolute and relative increase in CPUE for all other species in periods II and III (Table 13).

Spatial Distribution Yellow perch CPUE was highest in evaluation areas (5,6) located in East Bay (Table 14). Area 5 is permanently inundated, characterized by silt substrates,

Table 11. Total gill net catch data by species and sampling activity in South Bay, Flathead Lake (1985).

	Sampling Activity					
Species	Spatial	Diel	Vegetation	Combined Total	Percent of total	Cumulative Percent
yellow perch	647	335	189	1,171	46	46
northern squawfish	642	59	27	728	28	74
peamouth chub	320	78	0	398	15	89
lake whitefish	106	36	1	143	6	95
largescale sucker	70	8	3	81	3	98
longnose sucker	24	1	0	25	1	99
bull trout	7	2	0	9	-[a]	-
mountain whitefish	3	3	0	6	-[a]	-
cutthroat/ rainbow trout	5	0	0	5	-[a]	-
redside shiner	3	0	0	3	-[a]	-
pumkinseed	0	0	2	2	-[a]	-
kokanee	0	1	0	1	-[a]	-
total	1,827	523	222	2,572		100

[a]less than one percent

Table 12. Total gill net effort, total catch, and catch per unit effort (CPUE) by evaluation area and evaluation period for South Bay. (Spatial distribution samples only).

	Elevation Period								
	I			II			III		
Evaluation Area	Effort	Total Catch	CPUE	Effort	Total Catch	CPUE	Effort	Total Catch	CPUE
1	11.95	2	0.17	4.15	80	19.28	5.16	130	25.19
2	13.10	2	0.15	5.59	37	6.62	5.00	24	4.80
3	11.49	25	2.18	7.01	25	3.57	5.34	a	1.50
4	6.13	4	0.65	5.88	70	11.90	5.00	13	2.50
5	26.21	420	16.98	5.50	15	2.73	5.42	28	5.17
6	a-			4.60	62	13.48	b-		
7	a-			5.00	24	4.80	5.39	9	1.67
8	a-			5.00	22	4.40	5.87	13	2.21
9	a-			14.20	28	1.97	5.56	22	3.96
10	a-			8.29	51	6.15	5.00	65	13.00
11	a-			7.27	103	14.17	5.29	83	15.69
12	a-			4.52	63	13.94	5.00	108	21.60
13	a-			4.38	40	9.13	5.30	37	7.40
14	a-			10.64	200	18.80	b-	-	
Total	67.88	461	20.13	129.76	820	130.90	63.03	540	104.79
mean	13.58	92.2	4.03	6.57	58.57	9.35	5.25	45	8.73
Std. Dev.	7.04	107.97	7.29	2.84	48.00	5.89	0.28	41.64	8.19

[a]Dewatered during sampling Period I

[b]Not sampled due to inclement weather

Table 13. Mean gill net CPUE (std. dev.) by elevation period for dominant fish species in South Bay.

Species	Elevation Period		
	I[a]	II	III
yellow perch	3.89 (7.25)	2.33 (1 .46)	0.39 (0.44)
northern squawfish	0.03 (0.00)	4.41 (4.19)	4.20 (4.85)
peamouth chub	0.00 (0.00)	1.42 (1.32)	3.16 (4.52)
lake whitefish	0.09 (0.07)	3.44 (0.84)	0.74 (0.781
[a]other salmonids	0.03 (0.07)	0.04 (0.08)	0.38 (0.19)

[b]includes bull trout. mountain whitefish cutthroat/rainbow trout, and kokanee.

[a]sampled during daylight hours; periods II and III sampled at night

Table 14. Gill net CPUE (std. dev.) by' evaluation area for dominant fish species in South Bay.

	EVALUATION AREA													
	Permanently Inundated					Seasonally Inundated								
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14
yellow	0.80	0.60	0.76	1,29	6.20	4.70	0.89	1.52	0.57	1.32	2.44	1.77	0.00	1.50
perch	(1.53)	(0.88)	(1.08)	(1.71)	(9.17)	(---a)	(1.00)	(0.95)	(0.21)	(1.87)	(2.38)	(1.57)	(0.00)	(---a)
northern	7.91	0.65	0.63	1.94	0.86	5.43	0.88	0.30	0.27	4.44	8.96	0.52	6.22	11.56
squauflsh	(6.87)	(0.84)	(0.58)	(3.18)	(0.83)	(---a)	(0.45)	(0.42)	(0.38)	(3.90)	(6.04)	(0.46)	(3.15)	(---a)
peamouth	5.13	1.33	0.68	0.58	0.67	1.74	0.20	0.10	0.18	3.44	3.00	6.53	1.12	1.88
chub	(6.20)	(1.17)	(1.02)	(0.83)	(0.75)	(---a)	(0.28)	(0.14)	(0.25)	(3.34)	(2.38)	(8.30)	(1.25)	(---a)
lake	0.11	1.14	0.18	0.73	0.20	0.00	0.37	0.51	1.75	0.12	0.16	0.00	0.60	1.32
uhlteflsh	(0.12)	(1.50)	(0.18)	(1.27)	(0.31)	(---a)	(0.52)	(0.72)	(0.58)	(0.17)	(-.04)	(0.00)	(0.85)	(---a)
other	0.19	0.00	0.00	0.00	0.05	0.00	0.00	0.17	0.10	0.12	0.00	0.00	0.00	0.09
salmonids	(0.33)	(0.00)	(0.001	(0.00)	(0.09)	(---a)	(0.00)	(0.24)	(0.15)	(0.17)	(0.00)	(0.00)	(0.00)	(---a)

[a] n = 1, no sample standard deviation

and contiguous with area 6. The relatively high CPUE for yellow perch in this area was due primarily to large catches during the first elevation period (ie. April) at stations d and e.

Northern squawfish, the second most abundant species, were captured at the highest rates (CPUE) in seasonally inundated areas (11, 12, 1, 13) of Polson Bay. Similarly, CPUE was highest for peamouth chub in seasonally inundated areas (12, 10, 11) along the southern shores of Polson Bay. Lake whitefish catch rates were highest in a sandy area (9) in East Bay and along rocky shores (14, 1) in the vicinity of Kings Point and the Narrows.

Diel Sampling. A total of 68.6 hours of gill netting was completed in areas 1 through 5 during elevation periods I and II. Inclement weather precluded diel sampling for period III. In all, 523 fish were captured.

Mean CPUE by diel period was not significantly different ($P > .90$) when all species were considered. However, significant-differences ($P < .01$) in mean CPUE were observed between species, independent of the diel period sampled.

As with other gill net samples, mean CPUE was highest for yellow perch. Catch rates for this species were relatively constant from 0800 to 0000, but declined to their minimum during predawn samples (Table 15). CPUE for all other common species were substantially lower than that of yellow perch

Table 15. Mean gill net CPUE (std. dev.) by diel period for dominant fish species in South Bay

Species	0800-1200	1200-1600	1600-2000	2000-0000	0000-0400	0400-0800
yellow perch	10.2 (13.2)	11.2 (17.1)	11.4 (20.0)	12.0 (11.0)	2.7 (5.0)	1.5 (1.91
northern squawfish	0.1 (0.2)	0.5 (1.4)	0.7 (1.1)	1.1 (2.7)	2.1 (3.0)	1.4 (2.5)
peamouth chub	0.3 (0.7)	0.8 (2.1)	0.5 (1.2)	3.7 (1.1)	6.5 (14.3)	1.1 (2.5)
lake whitefish	0.1 (0.2)	0.1 (0.2)	0.3 (0.5)	0.5 (0.9)	0.8 (1.4)	0.7 (1.0)

and consistently reached their maximums during the 000-0400 period.

Utilization of Vegetation. Twelve gill net sets, paired in areas 5, 7, 8, 9, and 13 (two in this area), were completed to test for significant differences in CPUE in the presence and absence of vegetation. A total of 222 fish were captured in 28.2 hours of sampling effort.

As in other gill net sets, yellow perch dominated the catch. A pumkinseed (Lepomis gibbosus) was also captured in addition to the more common species reported in other gill net samples (Tables 11, 14).

Mean CPUE for all species combined was 2.64 in vegetated areas, and 0.83 in areas without vegetation. This difference was marginally significant (P< .15), but is difficult to interpret considering the small sample size (n=6), species composition of the catch, and possible differences in stem density within the vegetated areas sampled. However, it should be noted that mean CPUE for each species captured was consistently higher in vegetated areas versus non-vegetated areas with the exception of largescale sucker.

Fyke Net Trapping

Species composition of all fish captured (N = 4504) was dominated by yellow perch (98.9%) with lake whitefish (0.850, mountain whitefish (0.2%), a single cutthroat trout, and 2 individuals each of bull trout and kokanee also taken.

The number of yellow perch captured varied between trapping locations but the average size of fish captured was similar at each location (Table 16). Maximum yellow perch catch occured between 15 April and 23 May 1985 at all stations.

The size frequency distribution of all yellow perch trapped (N = 4455) is presented in Figure 35. Yellow perch total lengths ranged from 113 mm to 323 mm and averaged 213 mm.

Tag Returns

Total tag returns as of 1 August 1985 were 311 for yellow perch and 8 for bull trout. No tag returns have been recorded for lake whitefish or cutthroat/rainbow trout.

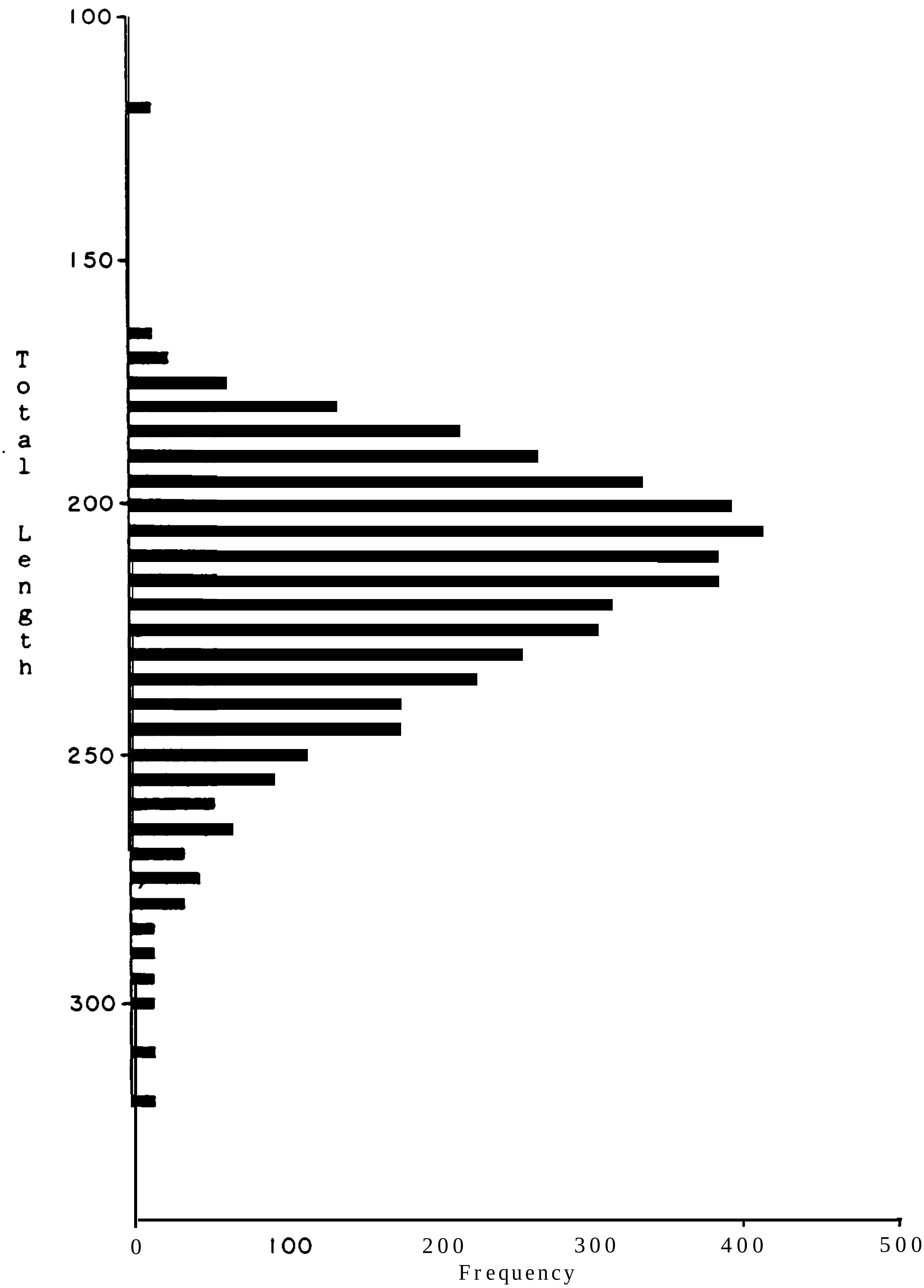

Figure 35. Length frequency distribution of yellow perch captured in 1985 by fyke net in South Bay, Flathead Lake, Montana.

Of the tagged yellow perch recaptured, nearly all were originally collected in fyke nets (95.3%) from evaluation area 5 (77.7%), also known as East Bay.

Table 16. Mean length, standard deviation, and total catch of yellow perch captured in 1985 at each fyke trap station in South Bay, Flathead Lake, Montana.

Location #	Mean length (mm)	Std. Dev. (mm)	N
1	215.8	22.5	1926
2	214.7	26.3	581
3	207.6	26.5	1030
4	219.8	23.3	460
5	205.7	24.6	458
	Mean 212.7		4455

Similarly, fyke nets accounted for the majority of tag returns (63.9%) with approximately 71X of these fish being recaptured in evaluation area 5. Fishermen accounted for 34.23 of all returns. In general, male yellow perch were recaptured three times more frequently than females. Floy and fingerling tags represented 71% and 29% of the tag returns respectively.

It should be noted that these data are relative and do not reflect absolute rates of return by time, location and gear type. Such data will be summarized in the final report.

Creel Survey

All results presented are summarizations of data collected over the entire survey period of 79 days with each day considered to be 9 hours long.

Data required for estimating fishing pressure was derived from instantaneous angler counts and angler interviews and is presented in Table 17. Estimated total fishing pressure for the entire survey expressed in angler-hours was 5165.4.

East Bay angler catch was composed almost exclusively of yellow perch (99%). Incidental catch was comprised of lake whitefish, mountain whitefish, largemouth bass, cutthroat trout, and bull trout.

The number of yellow perch caught by each party averaged approximately 49 (N = 409 completed trip interviews) but an average of 31 of those were returned. Therefore, the creel

Table 17. Angler pressure data for the 1985 East Bay ice fishery from January 12 through March 31, Flathead Lake, Montana.

	Mean	Std. Dev.	Range of Weekly Means	N
Angler Counts	7.32	.41	1.93-13.37	390
Party Size	1.96	.04	1.54-2.81	506
Hours Fished	3.95	.27	2.74-5.76	409

rate per party was approximately 37% of the catch rate, or 18.1 fish per party. The number of yellow perch creeled per angler-hour was 2.33.

By combining pressure data with creel data, total yellow perch harvest for the ice fishery was estimated at 12,049 fish, where: harvest estimate = fish creeled per angler * total angler hour estimate.

The length frequency distribution of 1430 yellow perch, subsampled from angler creels, is presented in Figure 36. Eighty percent of creeled fish were between 175 mm and 275 mm TL, with a mean of 227 mm.

Yellow perch recruit to the fishery at age 2 (see section on age class structure) but are not fully recruited to the fishery (i.e. creeled) until age 3 or 4.

Beach Seining

A total of 143,765 yellow perch were captured during the three evaluation periods. Most (85.6%) of the catch occured in evaluation period III with similar percentages captured in period I (8.4%) and II (6.0%). Respectively, average yellow perch catch per seine haul for all samples taken in evaluation periods I, II, and III was 673 (N = 18), 358 (N = 24), and 5,127 (N = 24).

High numbers of perch (>l,OOO) were collected from 2 to 10 locations in during each of the evaluation periods (Table 18). The two stations yielding high numbers in May (period

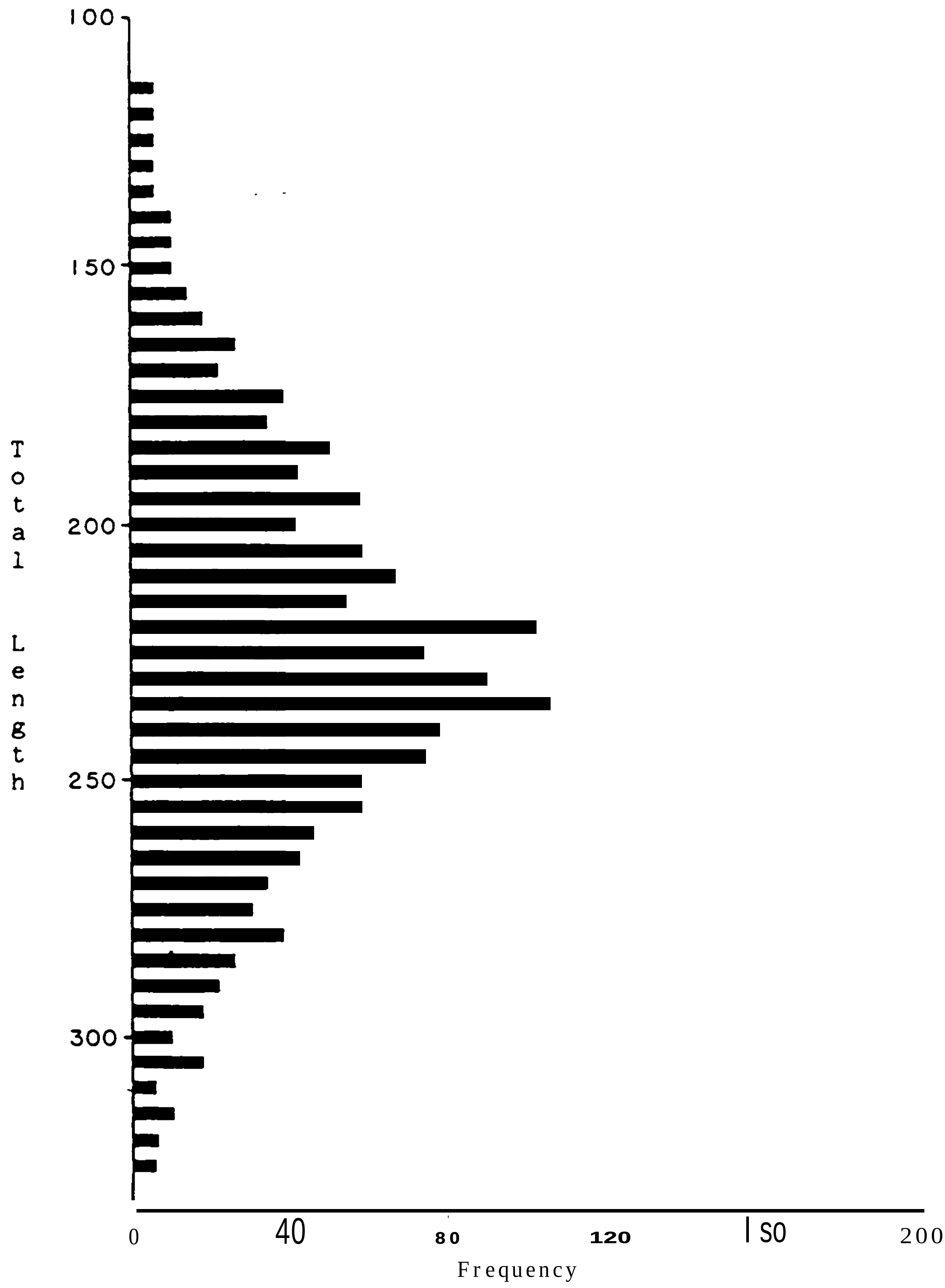

Figure 36. Creeled yellow perch length distribution from the 1985 ice fishery on East Bay, Flathead Lake, Montana. N = 1430

Table 18. Yellow perch catch from 1985 South Bay beach seine samples by evaluation period. Catch data are ranked in descending order, and corresponding substrate types and sample locations are given.

Evaluation Period								
I			II			III		
#	Substrate	Station[a]	#	Substrate	Station	#	Substrate	Station
5,329	silt	8	1,722	cobble	10	36,092	silt	22
3,459	silt	19	1,542	cobble	11	19,551	cobble	10
846	silt	2	1,337	sand	12	17,005	silt	18
573	cobble	24	1,332	cobble	14	12,836	silt	16
336	silt	22	447	silt	18	10,698	sand	9
252	silt	15	425	sand	7	9,118	sand	24
116	sand	3	396	sand	8	8,797	cobble	11
113	cobble	12	324	silt	6	3,335	silt	15
94	silt	16	189	gravel	2	2,169	sand	8
93	cobble	11	143	sand	9	1,132	sand	23
85	silt	21	129	silt	16	610	sand	7
81	sand	10	119	cobble	13	451	silt	21
76	sand	1	111	sand	1	365	cobble	17
44	silt	23	78	sand	3	338	cobble	5
7	cobble	5	77	cobble	4	210	gravel	2
5	sand	13	65	silt	15	188	sand	1
6	sand	14	57	sand	23	65	silt	19
0	silt	17	32	Sand	24	57	silt	6
			29	silt	22	26	sand	12
			26	silt	19	6	sand	3
			17	cobble	5	3	cobble	4
			0	cobble	17	0	cobble	13
			0	cobble	20	0	cobble	14
			0	silt	21	0	cobble	20

[a] refers to locations given in Figure 31.

I) were located on opposite sides of South Bay. In July (period II) the high catches were taken from the northeast and northern areas of the Bay while in September (period III) they were collected from the eastern shore, the northwestern shore, and the western shore. In general, the percentage of perch captured during the three evaluation periods from any substrate type was not proportional to the percentage of stations containing each substrate type (Table 19).

Table 19. Yellow perch catch and percent of total catch by substrate type for each evaluation period, and the percentage composition (by number) of each substrate type. N = 18 for period I, and 24 for periods II and III Data is derived from 1985 South Bay beach seine samples.

Substrate	% Occurrence of Substrate		Total Perch Catch					
	Evaluation Periods							
	I	I &	T		II		III	
	#	%	#	%	#	%	#	%
silt	50.0	29.2	11,045	91.2	1,020	11.9	69,841	56.8
cobble	22.2	33.3	786	6.5	4,809	55.9	29,045	23.6
sand	27.8	33.3	285	2.3	2,579	30.0	23,947	19.5
gravel	a	4.2	a	a	189	2.2	210	0.2
			13,116		8,597		123,052	

[a]substrate not sampled

Larvel Fish Sampling

Larvae of Coregonids and yellow perch were the only target species captured in quantities sufficient for analysis. Additionally captured taxa inlcuded Catastomidae, Cyprindidae, and pumpkinseed. Largemouth bass were rarely taken and no trout or salmon larvae were collected.

A total of 465 CoregonuS spp. larvae were captured from 1 April to 24 June 1385, but they were most commonly taken from mid-April to mid-May. The number of Coregonus spp. collected at any station (both nets combined) ranged from 0 to 98 with a mean of 2.1. Of all samples containing corognid larvae, 61.7% contained 3 or fewer individuals. Relatively high numbers of Coregonus spp. larvae were collected at stations 2 (55) and 3 (98) on 18 April, at station 4 (40) on 8 May, and again at stations 17 (50) and 19 (29) on 16 May. No Coregonus spp. larvae were collected from stations 5, 6, 8, 11, 13, 14 or 31.

Between 16 May and 26 June, 1985, 7469 yellow perch larvai were collected. Perch were collected from all stations but the highest numbers (both nets combined) occured at stations 3 (406), 8 (1396), 16 (467), and 23 (364) on 12 and 13 June. The average number of perch larvae captured at all stations was 33.7 and ranged from 0 to 1396.

Spawning Surveys

Few largemouth bass of any size class were observed during the two surveys conducted in East Bay on 11 and 28 June. All individuals observed on both dates were located between the mouth of Ducharme Creek and the KOA Campground facility to the east (Figure 33), No individuals were observed on nests during either survey. The good visibility, lack of extensive cover, and the territorial behavior of observed individuals suggested that sighting efficiency was relatively high.

Only four bass, ranging in approximate length from 100 mm to 600 mm, were observed during the first survey conducted on 11 June. These fish were all inhabiting relatively shallow water (< 1 m) areas characterized by silt substrates and mixed beds of *Chara* and *Patamogeton*. Mean surface water temperature on this date was 19.5 C. None of these fish were observed on or near nests, and no young-of-the-year specimens were sighted.

Similarly, only four individuals were observed during the second survey conducted on 28 June. All of these bass were estimated to be less than 175 mm in length and were found ‘in habitat similar to that previously described. Surface water temperatures were slightly higher and averaged 21.0 C. All individuals were closely associated with vegetative cover, the only type available. As before, no fish were observed on or near nests. In the absence of any data to the contrary, surveys were discontinued when inshore waters had reached 21 C, a temperature well above the expected range for spawning (16.7-18.3 C) reported for this species in northern latitudes (Scott and Crossman 1979).

Ancillary data, and observations by a knowledgeable fisherman, have subsequently suggested that spawning of the species in East Bay likely occurs in early July. Larval specimens of largemouth bass were collected on the north side of East Bay on 10 July. The length of these individuals combined with the average incubation period for the species suggest a spawning date near 1 July. A local fisherman also reported that inshore movement of adult bass peaked in early to mid July and that one individual with an eroded and bleeding tail was caught the weekend of 3 August 1985.

Age Class Structure

Catches by beach seine, fyke net and ice anglers were dominated by yellow perch and only results for this species are presented here. Based on age data from all three capture methods (Figure 37), it appears that essentially all age classes were sampled during 1985.

Most yellow perch (95.4%) collected for age analysis were 5 years old or less, and some age class selectivity is evident for each collection method (Table 20).

Beach seining provided samples of the younger year classes with 90.5% three years old or less. Perch caught by Fyke net were virtually all (97.4%) between 3 and 5 years old. Age compostion of yellow perch from the ice fishery was similar to that of the fyke net, but age 2 fish were more prevalent (20%) than in fyke net catches.

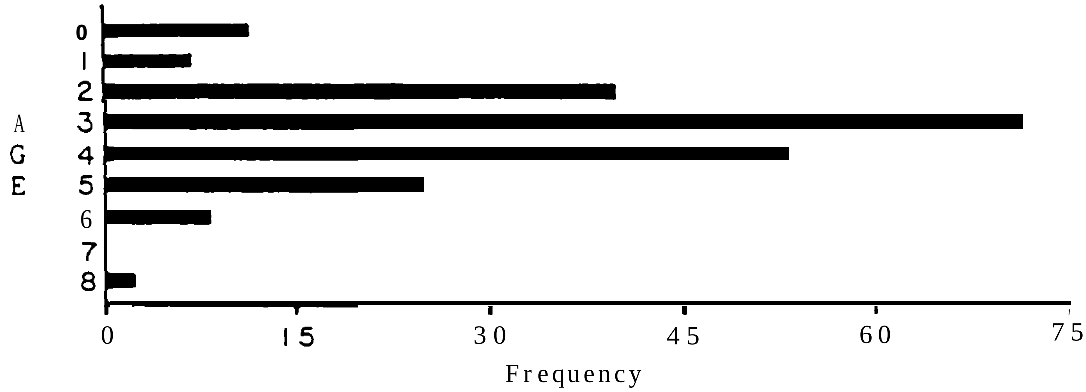

Figure 37. Age of yellow perch captured by beach seine, fyke net, and anglers in 1985 from South Bay, Flathead Lake, Montana. N = 210.

Table 20. 1985 yellow perch age class composition determined from samples collected in South Bay of Flathead Lake, Montana

		Age Class Percentage								
		Age								
		0	1	2	3	4	5	6	7	8
Gear	(N)									
Beach Seine	(42)	23.8	14.3	28.6	23.8	7.1	2.4	5.3		
Fyke Net	(38)			2.5	42.1	39.5	10.5			
Creel Survey	(130)			20.0	33.8	26.9	14.6	3.8		0.8

DISCUSSION

Gross trends in water quality data indicate relative spatial and temporal homogeneity for all parameters with the exception of water temperature. Observed ranges for dissolved oxygen, pH and conductivity were similar to those reported for 1984 (Darling et al. 1984) and probably do not play a decisive role in habitat utilization patterns for target fish species. Although pre-dawn levels of dissolved oxygen were below 5 mg/l in some inshore areas of East Bay (February), these readings were anomalous and could be avoided behaviorally by resident fish populations in those areas.

In contrast, water temperature was sufficiently variable by month and evaluation area to be a potentially important factor influencing fish distribution in South Bay. Seasonal trends in species composition generally followed annual temperature cycles (i.e. cold water species abundance increasing in fall) and tentatively support this hypothesis. Pending completion of fall gill net sampling, there are insufficient data to quantify any apparent relationships between temperature and fish distribution. However, temperatures within South Bay in May have been observed to drop as much as 5 C in 5 minutes, and may vary as much as 4.5 C between evaluation areas in June and November. Yellow perch and rainbow trout have both been reported to prefer temperatures within 1.4 C of an acclimation temperature (15 c) (Cherry et al. 1977) and would likely respond to the thermal gradients observed in South Bay.

Vegetative and structural cover are relatively limited in South Bay, a condition which could contribute to lower recruitment for some fish species. Preliminary data show that the study area contains only 0.04% structural and 5.4% vegetative cover respectively in June. Both of these figures are less than 1.0 percent during minimum lake elevations. Although such low percentages are generally deemed unsuitable for species such as largemouth bass (Stuber et al. 1982), incomplete data on seasonal fish distribution preclude comprehensive evaluation of the spatial and temporal importance of this habitat component to other, more abundant species such as yellow perch.

Gill net data suggest that yellow perch dominate the adult fish community in South Bay. This species was captured at nearly twice the rate as northern squawfish, the second most common species sampled. In general, yellow perch catch rates were highest in elevation period I (ie. April spawning period), during daylight hours, and in areas of permanent vegetation. These habitat characteristics and periods of activity are consistent with the known ecology of the species (Collette et al. 1977). However, variable effort and shift to nocturnal sampling after period I both confound reliable interpretation of apparent habitat utilization patterns at this time.

Lake whitefish was the only other target species sampled in gill nets. Comprising only 6% of all samples, this species constitutes a relatively small component of the South Bay fisheries. Whitefish catch rates were highest in the fall sampling period, a time when water temperatures may be more suitable for this coolwater species (Scott and Crossman 1979). Again, the shift from day to night sampling, variable effort by period, and the lack of comparable data ‘for other years (Darling et al. 1984) currently preclude a thorough understanding of the habitat needs and utilization patterns of adult target fish in the study area.

Species composition and relative proportions of each species captured by fyke net were similar in 1984 and 1985 except that a 90% reduction in bull trout catch was noted in 1985. Yellow perch was the predominant species and maximum numbers were captured at approximately the same time each year.

In 1984, most (80%) perch were sexually mature during the period of highest fyke net catches (Darling et al. 1984) and the maximum catches in 1985 can probably be attributed to perch spawning behavior which results in littoral concentrations of adults (Harrington 1947, Herman et al. 1959), (Scott and Crossman 1975).

As noted by. Bagenal (1972), variability of trapped Eurasian perch (Perca fluviatilis) catch may or may not reflect fish distribution and care should be exercised when interpreting catch distribution from passive gear types. Fyke net trapping in this study however, has been an effective means of collecting large numbers of perch, both for examining population structure and for tagging and recapture studies.

Robbins and Worlund (1966), reporting initial harvest rates for Flathead Lake fisheries, estimated that yellow perch was second only to kokanee salmon and comprised 17% of all fish harvested lakewide between May 1962 and April 1963. In a more recent lakewide census (Graham and Fredenberg 1982) a lakewide harvest composition comprised of 6% yellow perch was reported. When only shore and ice anglers were considered in the latter survey, the percentage of yellow perch increased to 33%. Because of differences in survey methodologies and objectives between reports, comparisons should be viewed cautiously, but it is nevertheless apparent that yellow perch have become an important component of Flathead Lake fisheries since their introduction in the early 1900's.

Anglers were not surveyed during approximately two weeks at the beginning of the 1985 ice fishery, during which time, anecdotal information suggests that catch rates and angler pressure were higher than later in the season. Therefore, the total harvest estimate derived from this study is conservative. A simple expansion assuming angler effort and creel rate values during these two weeks to be equal to those for the remainder of the survey period, results in a total harvest estimate of 12,343 fish. The 1985 harvest estimate is then similar (within 8%) to that reported for the 1982 ice fishery by Graham and Fredenberg (1982)

The average size of yellow perch creeled in the 1985 East Bay ice fishery (227 mm) was slightly larger than the average for yellow perch creeled lakewide (210 mm) during 1962 and 1963 (Robbins and Worlund 1961), and may reflect selectivity by either anglers or creel clerks, or the apparently optimal perch habitat of East Bay.

Graham and Fredenberg (1983) reported a yellow perch harvest from the 1982 ice fishery (South, Skidoo, and Somers Bays) that was 99% of the total catch, and a creel rate of 1.20 fish/angler-hour. This contrasts sharply with the 1985 ice fishery harvest estimate which was approximately 37% of the total catch, and a creel rate of 2.33 fish/angler-hour. Differences 6etween survey results may stem from differences in survey methodologies, or assuming that perch returned by anglers in 1985 were small, may be indicative o’f a large perch population in East Bay which is heavily skewed toward small fish.

Large catches of juvenile perch by beach seine was common although differences in perch catch between evaluation period III and periods I and II may result from gear selectivity. The minimum length of yellow perch collected by beach seine was approximately 35 mm (TL) and it was apparent from the numbers of small fish passing through the bunt mesh as the net was hauled to the beach that YOY perch were not fully recruited to this gear in May and July. By September when YOY were recruited to the seine, high numbers of juveniles were captured throughout South Bay along the east, northwest and west shorelines.

Although the relationship between perch abundance and habitat type remains obscure, the large catches of juveniles from littoral areas of South Bay are consistent with reports for other systems (e.g. Kelso and Ward 1977, Helfman 1979) in which migration by juveniles from epilimnetic regions resulted in an abundance of juveniles lottoraly.

Larval fish sampling yielded maximum catch of Coregonus spp. larvae approximately two weeks later in 1985 than was reported for 1984 (Darling et al. 1984). In 1985, low numbers were captured throughout South Bay with peak catches occuring at different times in both the northwestern and south-central portions of the bay.

Yellow perch larvae were initially collected in mid-May which was about two weeks later than in 1984 (Darling et al. 198), and catch was distributed fairly evenly throughout South Bay.

Annual variation in temperature may account for observed temporal differences in larval fish distribution. Ice covering Flathead Lake entirely for about 8 weeks during the winter of 1984 and 1985 but not in 1983 and 1984 resulted in cooler water temperatures in the spring of 1985 (Darling et al. 1983). This and the interrelationships between temperature and adul gonadal maturation, spawning, and larval ontogeny, may have caused the later appearance of perch and Goregonus spp. larvae during 1985.

Distributional variability was the apparent norm for Coregonus spp. and yellow perch larvae in 1985, and is consistent with other reports of seasonally and annually variable icthyoplankton distribution (Nelson 1980, Downey and Toetz 1983).

Based on maximum perch longevity reported in Scott and Crossman (1965), and Raher (1963), it appears that most perch age classes likely to be present have been sampled by the combination of gear types used in this study with some gear selectivity apparent.

Yellow perch ages 0 to 3 were effectively captured by beach signing. but fish 4 years and older had recruited past susceptibility. Both fyke nets and anglers effectively captured perch that were 4 years and older but ice fishery anglers captured a substantial percentage of age 2 fish which were not recruited to the fyke nets.

Yellow perch initially recruit to the East Bay fishery at a younger age (2) than in other Montana winter perch fisheries, for example, at Canyon Ferry where recruitment occurs at age' 4 (Bruce Rehwinkle, MDFWP, Townsend, Montana).

The occurence of very young perch in the East Bay ice fishery may simply be a consequence of the shallow water in East Bay which is the type of area favored by YOY and juvenile perch.

Based on preliminary analysis to date, several trends have become apparent. The unique physical characteristics of South Bay relative to the remainder of Flathead Lake appear to preclude Salmonids from using South Bay during late spring to early fall, while yellow perch tend to dominate samples from all gear types throughout the year. Anglers are obviously aware of this situation, as a popular and productive perch fishery occurs each winter in South Bay.

Although some statistically significant differences in fish distribution by evaluation area have been detected from gill net data, juvenile perch abundance from beach seine samples seems to vary by evaluation period, the data have not been sufficiently analyzed to ascribe cause and effect relationships. In the coming year, the multiplicity of factors potentially governing fish distribution and abundance will be further analyzed with regard to water level fluctuations and their relationship to the availability and suitability of habitat in South Bay.

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APPENDIX A

Intream flow strategies for the lower Flathead River 1985 - 1986.

TABLE OF CONTENTS

PROBLEM DEFINITION

The aquatic biota of Flathead River in northwestern Montana experience daily water level fluctuations dependent upon variable releases from Kerr Dam. The Kerr facility, a power peaking operation, is described in the following narrative from "Montana Recommendations for Fish and Wildlife Program" (Graham et al. 1981).

Kerr Project Desctiption

"Kerr Dam is a 200 foot high concrete arch structure across Flathead River and is located 4.5 miles downstream from the outlet of Flathead Lake. The dam is located on Confederated Salish and Kootenai Tribal lands. Kerr Dam, constructed primarily for hydropower, was closed in April of 1938. The license was amended and transferred from Rocky Mountain Power Company to the Montana Power Company in August 1938. Three generation units were installed; one in 1939, one in 1949 and the last in 1954. Each unit has a 56,000 kilowatt generating capacity for a total of 168,000 kilowatts. The Kerr project is currently operating under extension of a license which expired May 22, 1980. Montana Power Company and the Salish-Kootenai Tribes have filed for relicensing (Federal Energy Regulatory Commission 1980).

"Kerr Dam controls the water level of Flathead Lake between elevations 2883 and 2893 feet. This represents a storage capacity of 1,217,000 acre-feet. In most years, spring runoff produces a volume of water which not only refills the storage area,but also causes a continuous discharge over the dam for a month or more. The hydraulic capacity of the three generators is 14,346 cfs while the mean river discharge is 11,720 cfs. Lake elevations are also altered by Hungry Horse Dam upstream from the lake on the South Fork of the Flathead River. Hungry Horse Dam was closed in 1951 (Federal Energy Regulatory Commission 1980).

Project Operations

"Operation of Kerr Hydroelectric development is coordinated with that of other hydro resources of the Northwest Power Pool. Draft on storage usually begins in mid-September and reaches a maximum drawdown at the end of March or mid-April. In this period, use of storage releases from Hungry Horse Reservoir, together with those from Flathead Lake, makes generation possible at a plant factor of 75 to 80 percent. During remaining months of the year, generation depends on the volume of runoff available in excess of that required to refill reservoirs. In many years, the plant continues to operate at a high point factor through May and June (Federal Energy Regulatory Commission 1980).

"Because of the natural channel restrictions between Flathead Lake and Kerr Dam, the maximum rate of discharge through the outlet channel when Flathead Lake is at elevation 2892 feet is 55,000 cfs. The historic rate of inflow has been as high as 176,000 cfs on June 9, 1964.

"Because inflow, during periods of high runoff, can greatly exceed maximum outflow, drawdown on storage begins in mid-September to allow for flood control during spring. The maximum rate of outflow at drawdown (elevation 2883 feet) is 5,200 cfs because of natural channel restrictions-in the lake outlet. If the plant relays off when not spilling, no flows will be released through turbines for a short time.

"Montana Power Company relies on Kerr project for the bulk of its system's load frequency control. This often requires changing flows through Kerr very rapidly. This power peaking operating regime may involve going from full to minimum load or vice versa in an emergency situation. Other strategies to optimize power output from Kerr include filling the reservoir each summer and achieving maximum draft of the lake prior to spring runoff. Operational planning is based on a minimum daily average release of 1500 cfs (correspondence dated 9 September 1981 presented by the Montana Power Company at the MDFWP ad Hoc Committee meeting, Missoula, Montana), which is considerably below the USFWS proposed minimum instream flow of 3200 cfs (letter to the Federal Energy Regulatory Commission dated 10 March 1982 from John G. Woods, U.S. Fish and Wildlife Service).

"Kerr Dam is included in the Pacific Northwest Coordination Agreement. Stipulations in the agreement (Montana Power Company 1981) include:

1. Maintain Flathead Lake elevation in accordance with the. energy content curve determined under the agreement. This agreement provides for operation of all major facilities on the Columbia River. The use of the energy content curve provides for maximizing the amount of hydroelectric energy production under most prudent constraints.

2. Operate below the energy content curve only if all reservoirs are at or below their energy content curve.
3. Release stored water above their energy content curve at the request of downstream users or provide 'in-lieu' energy to replace the energy the water would have provided if it had been released.
4. Comply with numerous other conditions of the agreement.

"On May 31, 1962, the Montana Power Company and the Corps of Engineers negotiated a 'Memorandum of Understanding which set further principles and procedures for regulation of Flathead Lake in the interests of flood control. This agreement provides that, conditions permitting, the lake will be drawn down to elevation 2,883 feet, the minimum water level under the license, by April 15 and raised to a maximum level under license, by June 15. When the lake reaches elevation 2,886 feet in a moderate or major flood year, the licensee will gradually open spill gates and not close them until after the danger of exceeding elevation 2,893 feet has passed. This agreement has been endorsed by a group of local landowners and recreationists (Federal Energy Regulatory Commission 1980).

"The Montana Power Company currently has no definite plans for future development of the project and proposes to continue past operations. However, several options to increase energy output have been surveyed by government agencies and Montana Power Company. Options include: raising the dam and elevation of the reservoir, enlarging the lake outlet to increase maximum flow rate (at lake elevation 2,883 feet) from 5,200 to

30,000 cfs, rewinding the present generators, and installing an additional generator (Federal Energy Regulatory Commission 1980).

Primarv Agencies Involved

The lower Flathead River, from Flathead Lake to its confluence with the Clark Fork River, represents a major natural resource for the Indian people of the Flathead Reservation, today as well as historically. Subsistence hunting and fishing have been, and continue to be, culturally and economically important to the Salish and Kootenai people. Additionally, the benefits derived from hydroelectric power production, sports hunting, and fishing by non-Indians are recognized by the Tribes. Sound management of the fish and wildlife resources of the Lower Flathead River System, in conjunction with hydroelectric power production, is of vital interest to the Tribes.

In order to provide a more equitable balance for Tribal natural resources and protect and mitigate the Tribal fisheries, a study of the Lower Flathead System, funded by the Bonneville Power Administration, was begun in December, 1982.
The following study objectives pertain specifically to the lower river:

I. Assess existing aquatic habitat in the lower Flathead River and its tributaries and its relationship to the present size, distribution, and maintenance of all salmonid, northern pike, and largemouth bass populations.

II. Assess how and to what extent hydroelectric development and operation affect the quality and quantity of aquatic habitat in the lower Flathead River and its tributaries and life stages of existing trout, pike, and largemouth bass populations. Evaluate the potential for increasing quality habitat, and thus game fish production through mitigation.

III. Develop an array of fisheries management options to mitigate the impacts of present hydroelectric operations, demonstrating under each management option how fish populations and hydroelectric generation capabilities could be modified. Additionally, possible further hydroelectric development and operation and its impacts on target species would be considered.

An instream flow study is being conducted on the lower Flathead River to help identify the impacts of water level fluctuations on aquatic habitat, and to provide the Tribal Council and other Interested parties data needed to make sound fisheries management decisions.

BOUNDARIES OF THE PROBLEM

DExcription of Studv Area

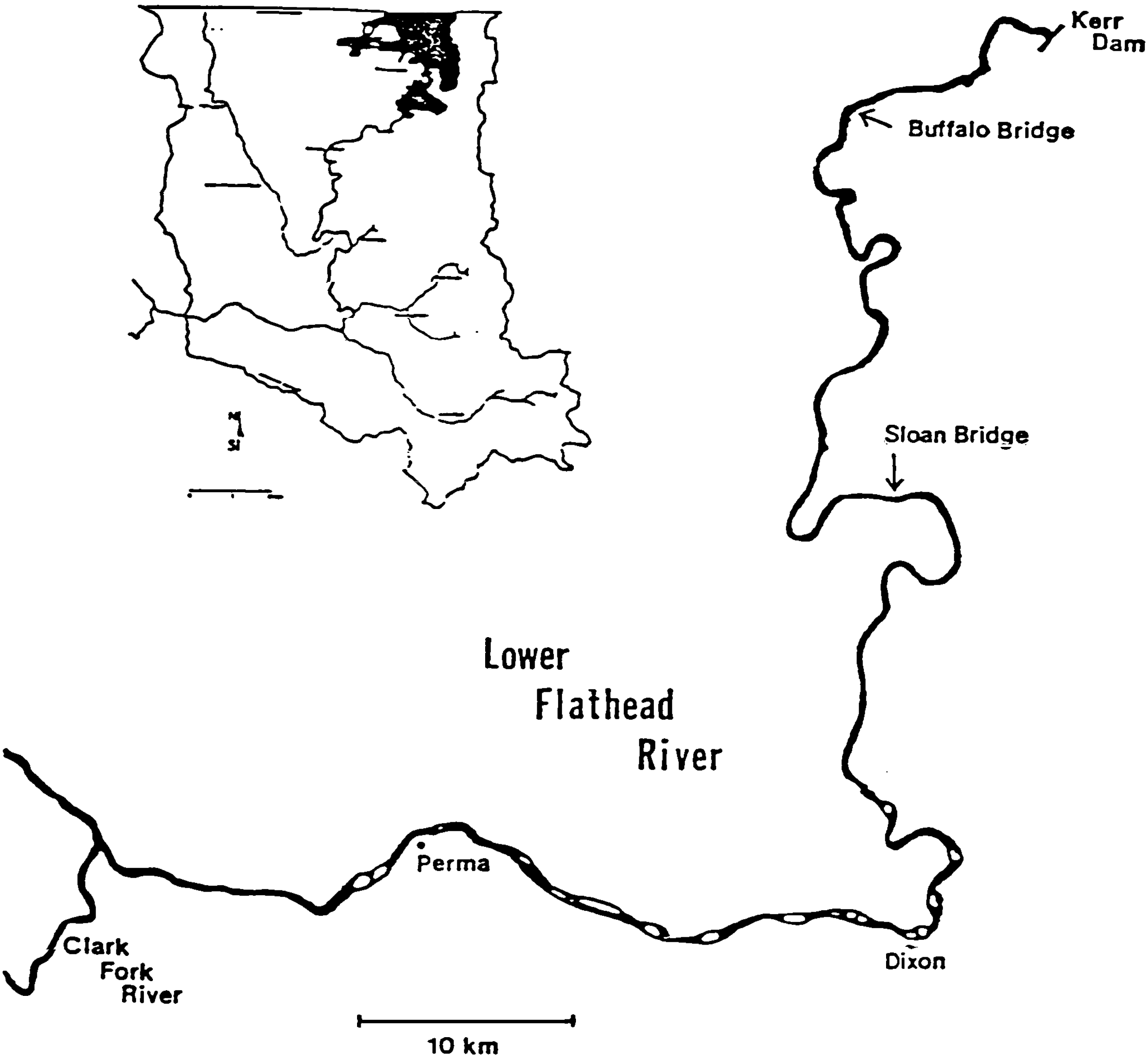
The lower Flathead River is one of Montana's largest rivers, with an annual average discharge of 340 m^3/second (11,720 cfs). Today the lower river begins at Kerr Dam, located 7 km (4 mi) southwest of Polson, Montana. Flowing south and west for 116 km (72 mi), the river flows into the Clark Fork River near Paradise, Montana (Figure 1). Approximately 110 km (68 mi) of the river are within the boundaries of the Flathead Indian Reservation within the State of Montana.

During the last of the ice advances approximately 25,000 years ago, a continuous ice sheet covered the Rocky Mountain Trench to the site of Flathead Lake. The Cordilleran Ice Sheet extended as far south as present day Buffalo Rapids, 7 km (4 mi) below the Kerr facility. For more than 10,000 years the remaining 68 mi of the lower Flathead lay quietly under the waters of Glacial Lake Missoula. Approximately 12,000 years ago, Glacial Lake Missoula began to drain, and once again the lower Flathead River began to form its channel.

The first 7 km (4 mi) of the lower Flathead cuts through a glacial morain forming a steep rocky canyon characterized by extensive white-water areas.

The lower river cuts through highly erosive lacustrine and alluvial sediments deposited during the life span of the glacial lake. These sediments have a high concentration of clay, sand, and silt, with small percentages of gravels (Montague et al. 1982). Bedrock formations are found in a few areas along the river. Irrigated croplands border the eastern and southern banks

Figure 1. Diagram of the lower Flathead River and Flathead Indian Reservation in northwestern Montana.



of the river; to the west and north is open rangeland.

The lower Flathead River drains 386,205 hectares (954,312 acres) and, with the exception of the first 4 mi, is a low gradient river. Riffle and pool areas blend forming a comparatively smooth flowing river. Average annual rainfall ranges from 40 to 50 cm (16 to 20 in).

Polson Bay, outlet for the river from Flathead Lake, has approximately 6,475 surface hectares (16,000 surface acres0 'and averages 4.9 m (16 ft0 in depth. During the summer, lower river water temperatures are slightly higher than those recorded in the upper river above Flathead Lake, due to the warming of shallow Polson Bay. The maximum water temperature in 1981, recorded directly below Kerr Dam on the lower river, was 23.5° C; at Columbia Falls on the upper river, the maximum water temperature recorded was 20.0% (Shields et al. 1982). Water temperatures in the lower river are higher than those of its tributaries. Water temperature recorded in early August at the mouth of the Jocko River was 11°C; water temperature in the main river, directly above the mouth cf the Jocko, was 22 °C on the same date. During 1982, summer water temperatures in the main river reached a high of 22° C and winter temperatures reached 0.0°C. Average annual water temperature was 9.0° C (Shields et al. 1983).

Kerr facility is a power peaking plant. Peaking operations are responsible fcr daily fluctuations of water levels in the lower Flathead River. The effects are most severe nearest the dam. At the U.S. Geological Survey gaging station immediately downstream from Kerr Dam, water levels have fluctuated from 0.6

to 2.4 m (2 to 8 ft) within 3 hours. These fluctuations are less pronounced near Dixon (RM 25) varying up to 0.3 m (1 ft) within 6 hours (USFWS unpublished data). The lower river channel is shallow with a relatively low longitudinal gradient, so that small vertical changes in water level have caused dramatic changes in wetted channel area. Consequently, off-channel spawning marshes important to northern pike (*Escox lucius*) are often dewatered.

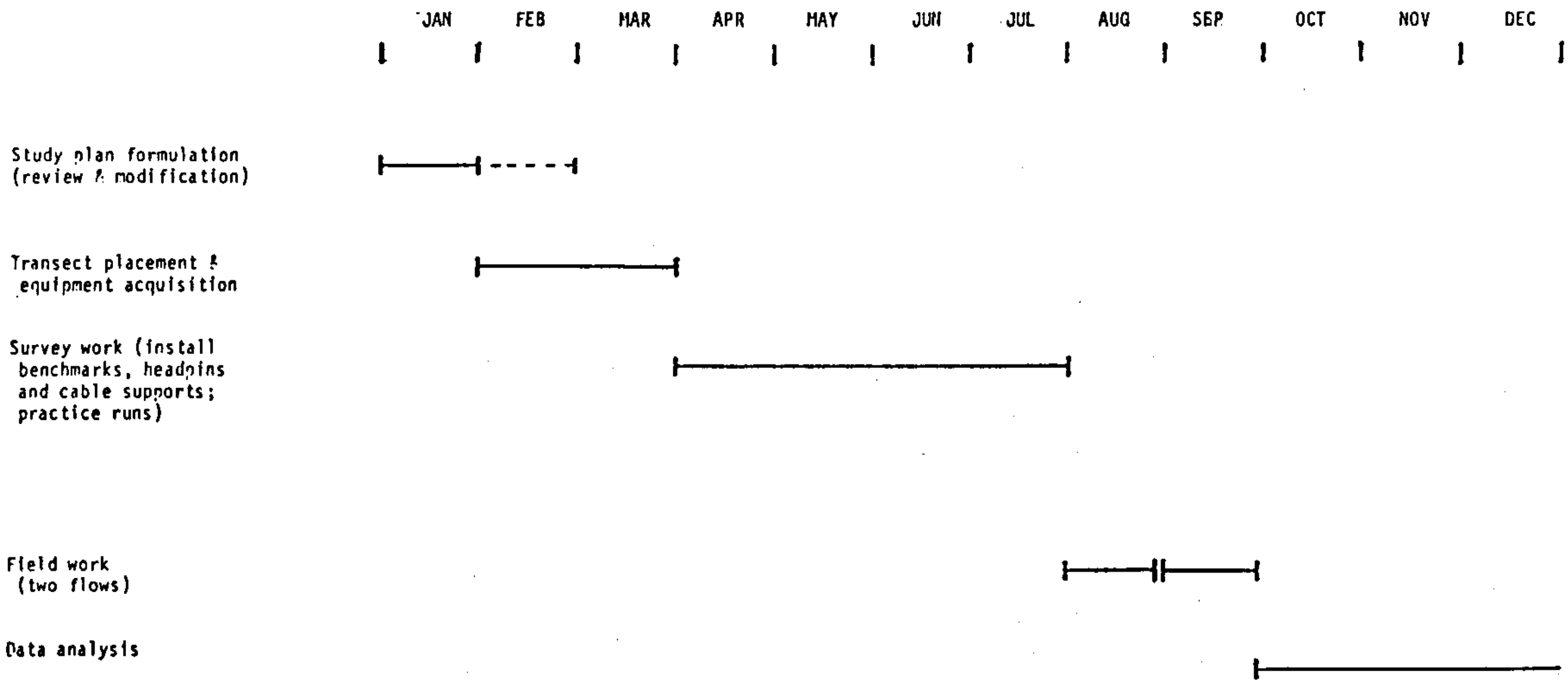
Time Constraints

Completion of the IFIM study is not constrained by the construction or implementation of a new project. It is constrained by the fisheries study time line and must be completed no later than December 1986.

Measurement of site-specific habitat parameters is to be completed during 1985 according to the schedule shown in Figure 2. The exact timing of the field studies is dependent upon the availability of flows from Kerr Dam as requested for one week during August and one week during September (letter to Montana Power/Company 26 December 1984 from David Cross, Confederated Salish and Kootenai Tribes).

Figure 2. LOWER FLATHEAD RIVER
IFIM ACTIVITY SCHEDUAL

1985



INSTREAM FLOW OBJECTIVES

The instream flow study for the lower Flathead River is designed to help evaluate the effects of seasonal releases and daily water level fluctuations on the aquatic habitat. Quantitative estimates of habitat lost or gained under various flow regimes will be integrated into fisheries management options developed in the study's final report. The final recommendations of the Lower Flathead System Fisheries Study will include options that consider the trade-offs between target species maintenance or mitigation and hydroelectric power production.

TARGET FISH SPECIES

The most sought-after sport fish in the lower river are northern pike, rainbow trout, and brown trout. Spawning activities and reproductive success of these three species are intimately related to river water-level fluctuations.

Flooded marsh areas along the river used by spawning northern pike are often completely dewatered within a 24-hour period. Gravel bars apparently suitable for spawning rainbow and brown trout are within the zone subject to daily fluctuation. Due to the constant water fluctuation over spawning gravels and because the narrow requirements of depth and velocity for trout are not maintained, these sites are usually unsuitable.

Mountain whitefish (Prosopoium willimasoni is the most abundant but least sought after sport fish species in the river. Because mountain whitefish are broadcast spawners, their reproductive success is not as severely affected as the other species which deposit their eggs in shallower sites more seriously affected by water-level fluctuations.

METHODS CONSIDERED

The wetted perimeter method, first developed in 1980 by the Montana Department of Fish, Wildlife and Parks, has been favored by local agencies for fixed flow recommendations. Wetted perimeter is the distance along the bottom and sides of a channel cross-section in contact with water. The method assumes that game fish carrying capacity is proportional to food production, which in turn is proportional to the wetter perimeter in riffle areas (Nelson 1983).

A graph of wetted perimeter versus flow for a stream riffle cross section will usually show two inflection or break points (Figure 3). Above the upper inflection point, the riffle generally remains wetted. At flows below the upper inflection point, the stream begins to pull away from the riffle bottom until, at the lower inflection point, the rate of loss of wetted perimeter accelerates rapidly.

The assumptions underlying this method are selectively related to salmonid production. Riffles are critical food production areas only to those fish for which aquatic invertebrates are the principal food item. And while riffles may also represent important spawning areas for trout, northern pike adults utilize backwaters with submerged vegetation, and their fry utilize similar areas as nurseries.

The wetter perimeter method has been employed to recommend a minimum instream flow at or near an inflection point. Factors considered in the final flow selection include the level of recreational use, existing level of environmental degradation,

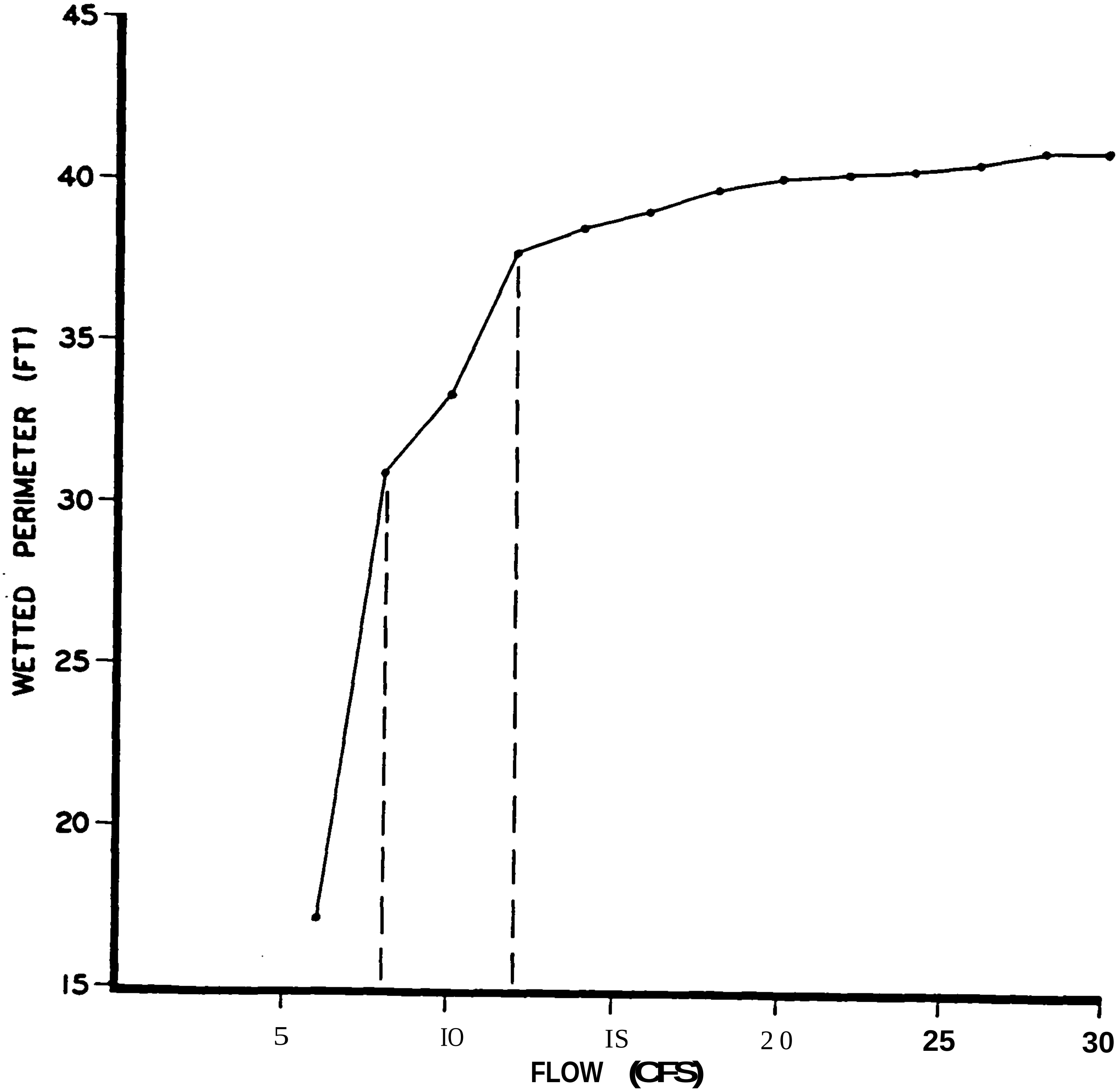


Figure 3. An example of a relationship between wetted perimeter and flow for a riffle cross-section (from Nelson 1983).

water availability, and the magnitude and composition of existing fish populations (*Nelson* 1983), The fisheries management alternatives, which are to integrate results from the instream flow study for the lower Flathead River, require a variable set of flow recommendations and project operating rules. A single minimum flow recommendation will not meet these needs.

The Instream Flow Incremental Methodology (IFIM) is specifically tailored to demonstrate the impact of alternative flow regimes upon fishery habitat potential (Stalnaker 1979). Two hydraulic models, the IFG-4 (Instream Flow Group - 4) and WSP (Water Surface Profile) models, are available for use in the Physical Habitat Simulation component of IFIM. The IFG-4 was developed to describe more complex aquatic environments and requires establishing an empirical stage-discharge relationship. This method would require at least three intensive field measurement trips at different flows. The WSP has proven most reliable for use in rather simple channels or where few rapidly vaired flow regions exist, and where simulation needn't cover a very broad range of flows (Trihey and Wegner 1981). This method may be used, cautiously, with only one set of field data.

The lower Flathead River below Kerr Dam has a rather simple channel with very few regions of rapidly varied flows. Therefore, the WPS model will be applicable to this sytem and reduce the need for steady discharges from Kerr Dam. Field measurements taken at two sites during two requested flows of 91 and 283 m^3/second (3,200 and 10,000 cfs) will enable the model to predict effects on weighted useable area (WUA) from 36.2 to 708 m^3/second (1,280 to 25,000 cfs).

HYDROLOGICAL BASELINE

The lower Flathead River has been gaged by the USGS since July 1907. Prior to Oct. 1, 1941, nonrecording gages or water-stage recorders were located at several sites near the highway bridge, today known as Buffalo Bridge, at the old site of Mitchell's ferry. A continuously recording USGS gage house was installed in 1941 0.8 km (0.5 mi) below Kerr Dam's powerhouse and is still in operation today. Water discharge records are excellent from this station. Average annual discharge for the period of records (1907-1983) is 331.9 m^3/second (11,720 cfs). Intermittent water quality records were also taken on the lower Flathead River by the USGS from June 1977 to September 1983.

Decker-Hess and Clancey (1984) demonstrated five distinct periods of operation for the Kerr facility. Eased on that analysis the seven-year period, 1977 to 1983, will be used as our "existing" or reference condition for this study.

The existing mean monthly flows from the Kerr facility are similar to the preimpoundment period. Peak run-off flows, however, have been diminished resulting in higher winter flows (Appendix A). Regulation of the river has resulted in a discharge of 212.4 m^3/second (7,500 cfs) to be equalled or exceeded 50% of the time, whereas pre-impoundment flows only equalled or exceeded 141.6 m^3/second (5,000 cfs) 50% of the time. Individual monthly flow durations are also presented in Appendix B.

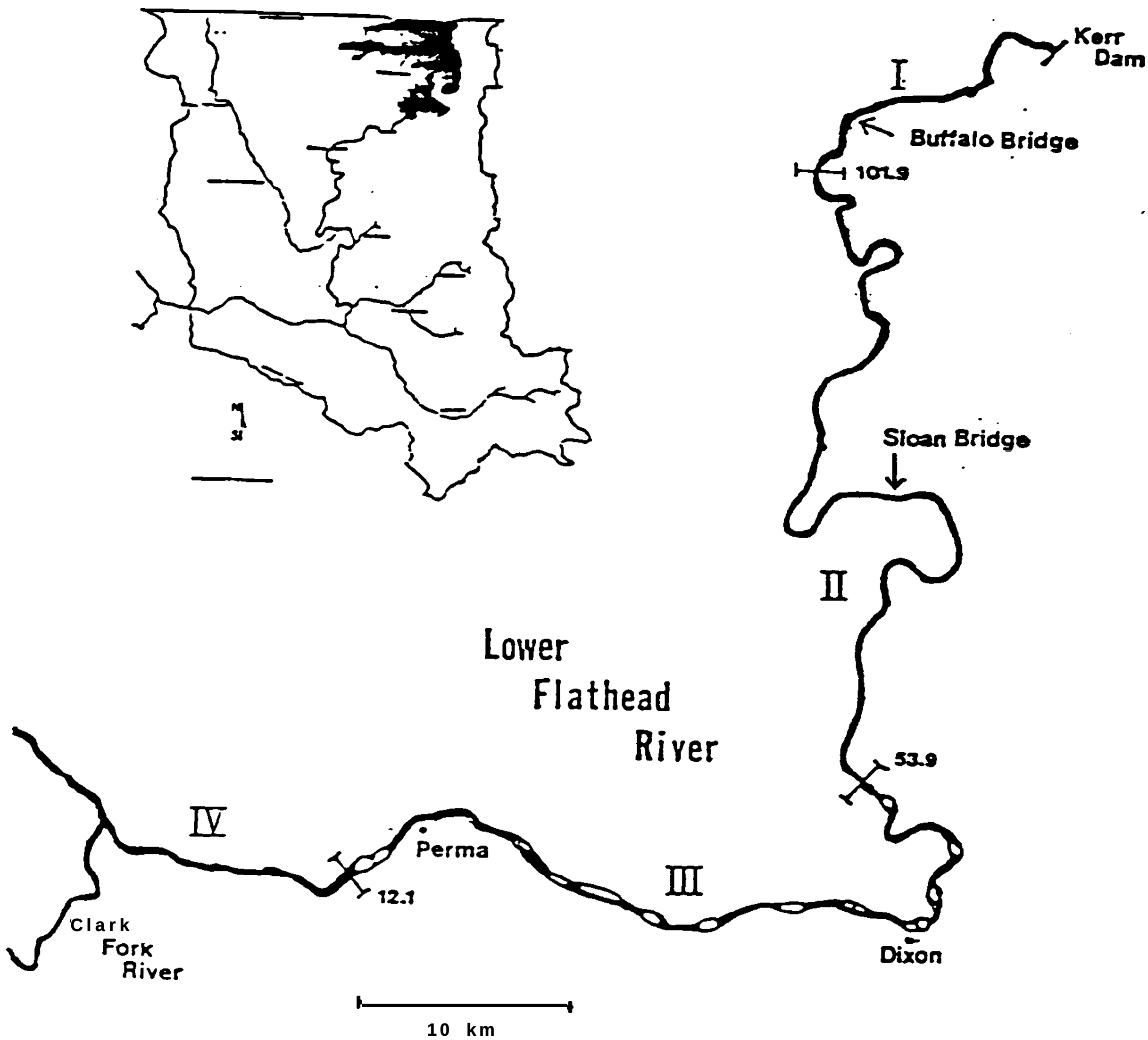
Water temperatures during the summer months vary no more than 2 °C along the entire length of the river, and are relatively uniform during the remainder of the year (Appendix C).

RIVER SEGMENTATION

Based on general valley characteristics, gradient (Appendix C), and channel morphology, the lower Flathead can be divided into four distinct river segments (Figure 4). Segment I of the lower Flathead extends from Kerr Dam (River Kilometer (RK) 116; River Mile (RM) 72) to the mouth of White Earth Creek (RK 102; RM 63.3). Gradient is 1.5 m/km (7.9 ft/mi), and the river has an average width of 114 m (374 ft). The river is confined in a steep rocky canyon for the first 6 km (3.7 mi) of this reach, after which the canyon widens. The channel bottom is composed of a large boulder-bedrock mixture blending into a cobble-gravel mixture toward the end of the segment. The canyon portion of this segment is primarily a whitewater area characterized by deep pools and several sets of rapids. The lower section of the segment RK 108.5-102; (RM 67.8-63.3) is a smooth, fast-flowing glide with two riffle areas. This river segment is subject to severe water-level fluctuations due to hydropower peaking operations at Kerr Dam. At the U.S. Geological Survey gaging station downstream from Kerr Dam, water levels have fluctuated from 0.6 to 2.4 m (2 to 8 ft) in 3 hours.

Segment II of the river extends from the mouth of White Earth Creek (RK 102; RM 63.3) to 2 km (1.2 mi) downstream of Moss's Ranch (RK 54; RM 33.4). Average gradient and average river width within this segment are 0.6 m/km (3.2 ft/mi) and 128 m (420 ft), respectively. Throughout this segment, the river gradually widens, but maintains a single channel. With the exception of a few small islands and constrictions of the river

Figure 4. Segment breaks of the lower Flathead River.



channel, the flow is a smooth glide. This segment is also typified by large meandering bends bordered by high, eroding, clay cliffs. River banks are generally steep with benchlands beyond ; the channel substrate ranges from solid bedrock tc size-able areas of silt deposition. Two tributaries enter this river segment: the Little Bitterroot River at RK 72 (RM 45) and Crew Creek at RK 67 (RM 41.5). These tributaries contribute less than 0.5% annually to the river's base flow.

Segment III of the river extends from RK 72 to RK 12 (RM 33.4 to RH 7.51. Average gradient and river width within this segment are 0.3 m/km (1.6 ft/mi) and 104 m (341 ft), respectively. Habitat is variable, and the river channel is braided. Major island complexes, gravel bars, and extensive backwater areas are common. Permanently wetted backwater areas are common. Permanently wetted backwaters range from 0.4 to over 12 hectares (1 to 30 acres). River banks are overgrazed and unstable within this segment. Water-level fluctuations are less pronounced than in Segment I or II, but may vary as much as 0.3 m (1 ft.) in 6hours at the bridge near Dixon, Montana (USFWS unpub-lished data). Two tributaries enter this river segement: Mission Creek at RK 45 (RM 28.1) and the Jocko River at RK 41 (RM 25.4). On an annual basis, these tributaries contribute less than 1% to the river's base flow.

The fourth river segment extends from RK 12 (RM 7.5) to the confluence with the Clark Fork River. The final 6 km (3.7 mi) of the lower Flathead River are outside the Flathead Indian Reservation boundary. Average gradient of this segment is 0.2 m/km (1 ft/mi). The valley walls rise steeply and force the river into a single channel. One small, mid-channel island and one usually dewatered channel are present. With the exception of one bedrock intrusion, substrates are primarily gravels with sizeable areas of sand and silt deposition.

Aside from a slight gradient difference, the lower section of river Segment I (RK 108.5-102; RM 67.8-63.3) has macrohabitat features very similar to river Segment II. Repeating hydrological features are similarly spaced, and river width is virtually the same. Therefore, for the purpose of IFIM segementation, one river segment will extend from RK 108.5 to RK 54 (RM 67.8 to RM 33.4) and can be generally characterized as the single-channel portion of the lower Flathead River. There are 17 candidate reaches within this river segment based on repeating hydrological features.

The upper half of river segment IV (RK 12-6; RM 7.5-4) has macrohabitat features similar to the single channel portion of river segment III. Gradient and channel width are virtually the same. Therefore, for the purposes of IFIM segmentation, a second river segment will extend from RK 72 to RK 6 (RM 33.4 to RM 4), and can be generally characterized as the braided channel portion of the lower Flathead River.- There are 15 candidate reaches within this river segment, based on repeating hydrological features.

SPECIES HABITAT SUITABILITY CRITERIA

Fish species habitat suitability criteria used in this study will be those compiled by the USFWS (Bovee and Cochnauer 1977, Bovee 1978, Inskip 1982, Raleigh et al. 1984a and Raleigh et al. 1984b). It is beyond the scope or objectives of this study to collect species site-specific microhabitat data. The majority of the habitat data compiled by the USFWS for the species of concern to this study has been gathered from northwestern waters, and has been found to be applicable to other waters within this region. These criteria represent the best species-specific reference data available. Suitability criteria for rainbow trout, brown trout, and northern pike will be used to determine weighted usable area available to each species at various flows.

Probability-of-use curves are based on the assumption that individuals of a species will tend to select the most favorable conditions in a stream, but will also use less favorable conditions within a defined range, with the probability of use decreasing as conditions approach the end point of the total range (Figure 5) Life stages to be reviewed in this study will be: spawning, fry, juvenile and adult. A PHABSIM curve set for each life stage consists of four curves; one each for velocity, depth, substrate, and cover. All curves are in English units, except the substrate curves. Depths are given in feet, velocities in feet per second, and temperature in degrees Farenheit. Substrates were categorized by a modified Wentworth particle-size scale. The presence and type of observable fish cover will also be assessed, based on objective professional opinion.

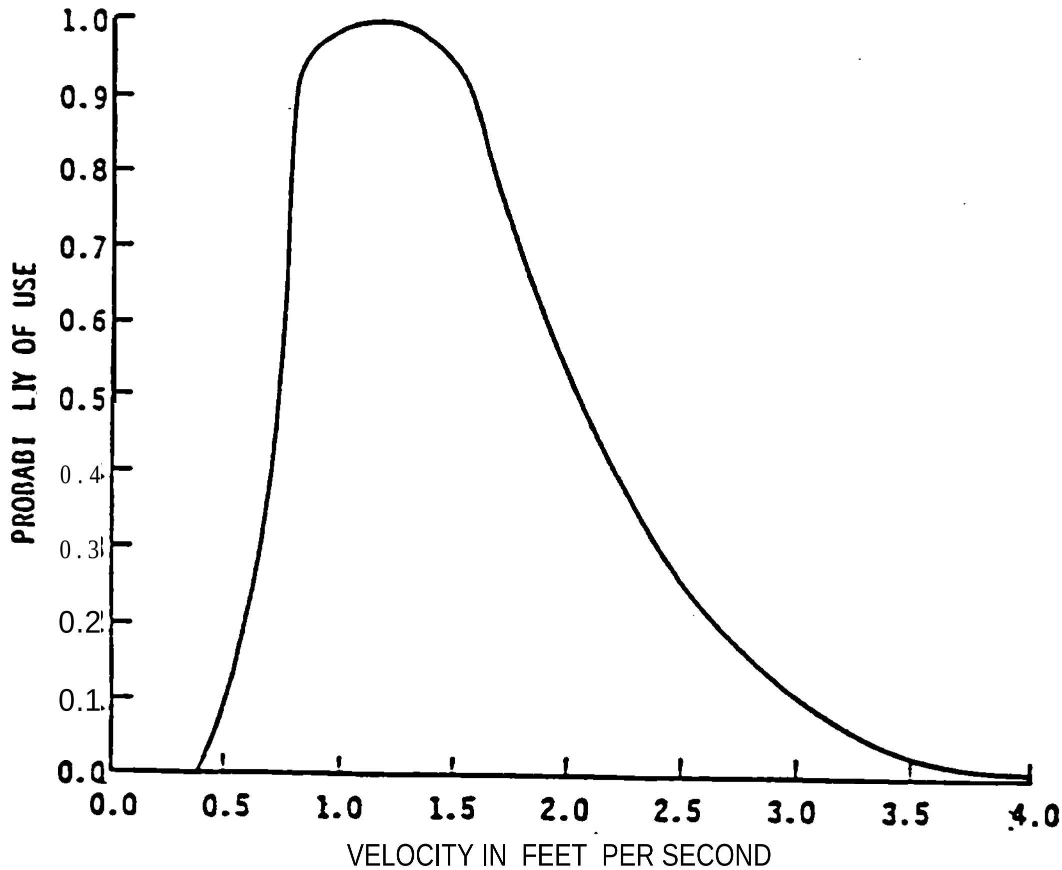


Figure 5. Example of probability criteria used in the IFG incremental method (from Bovee and Cochnauer 1977).

Curve Evaluation

All suitability index (SI) curves should be used judiciously. Existing curves will be carefully reviewed by our staff and modified, if necessary, before use. General consensuses as to SI curve applicability between our staff and other involved agencies is desireable.

Rainbow Trout

The SI curves for the habitat parameters velocity, depth, substrate and temperature were derived from data and information found in the literature (Raleigh et al. 1984a). Twenty four rainbow trout references were used in the development of the suitability curves used in the IFIM section of this model. Geographic origin of these data and information are: British Columbia, California, Idaho, Oregon and two general fisheries texts (Carlander 1969, Scott and Crossman 1973).

Brown Trout ,

All curves recommended for an IFIM analysis of brown trout habitat are category one curves (Raleigh et al. 1984b) and supersede curves for brown trout in Bovee (1978). Category one curves are intended to reflect general habitat suitability throughout the entire geographic range of the species throughout the year.

The SI curves for the habitat parameter velocity, depth, substrate and te,[eratire were derived from data nd information found in the literature (Raleigh et al. 1984b). Seventeen brown trout references were used in the development of the suitability curves used in this model. Geographic origin of these data are primarily from the Northwest and one general fisheries text (Carlander 1969).

Northern Pike

The habitat suitability model developed for northern pike (Inskip 1982) is primarily a macrohabitat model. Nine different variables are evaluated to project suitability for the species as a whole, and not individual life stages. IFG-2 will address three variables inherent to this model: 1) area less than 1 m (3.3 ft) deep, 2) drop in water level during embryo and fry stages, and 3) areas with water velocities less than 0.06 m/sec (0.2 ft/sec). The riverine model is applicable throughout North America and is based on range and optimum conditions measured in the field. A total of 168 northern pike references were used in the development of this model.

The Instream Flow Group also has a set of curves for northern pike spawning, fry, juvenile and adult depth, velocity and substrate suitability which can be used in the IFIM analysis. These SI curves will be evaluated as to their applicability to the lower Flathead.

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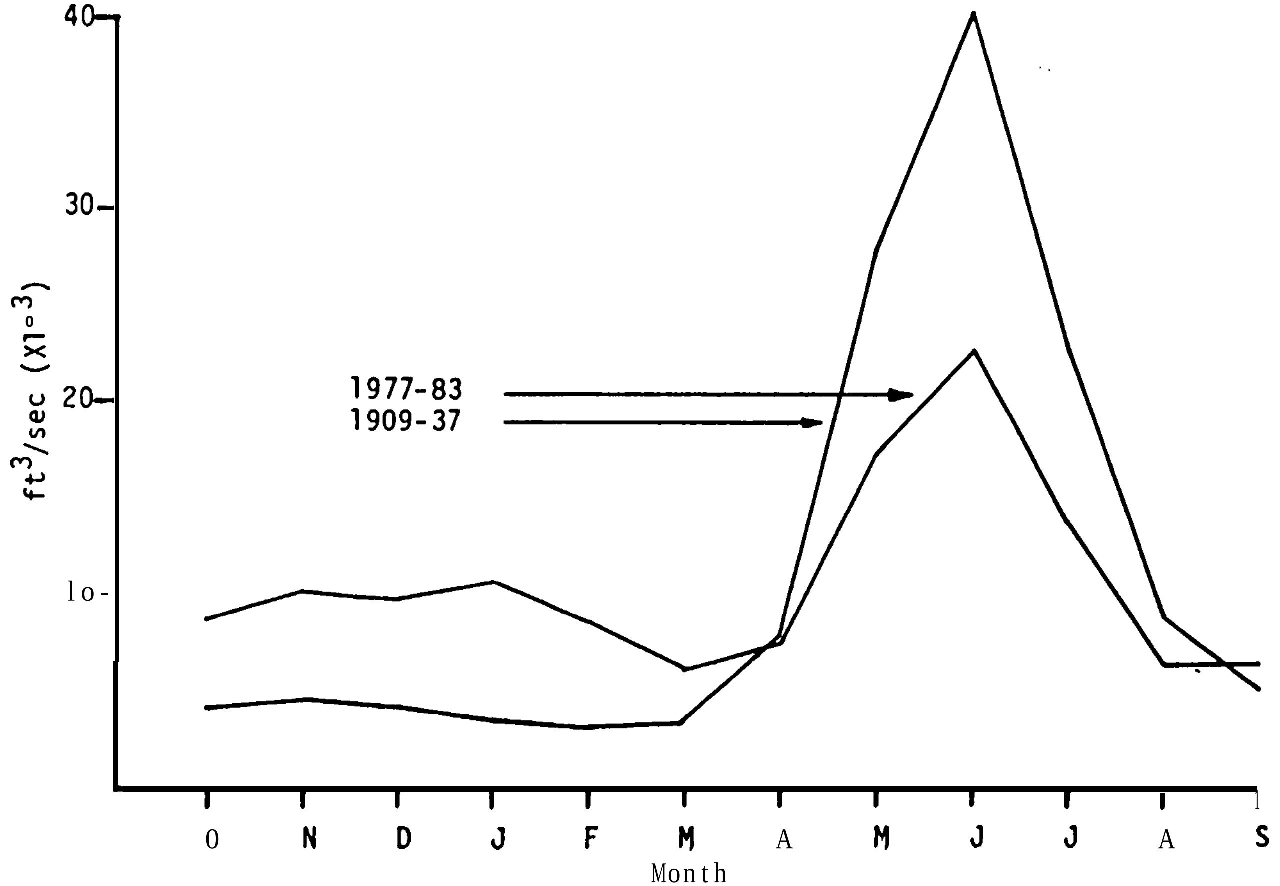
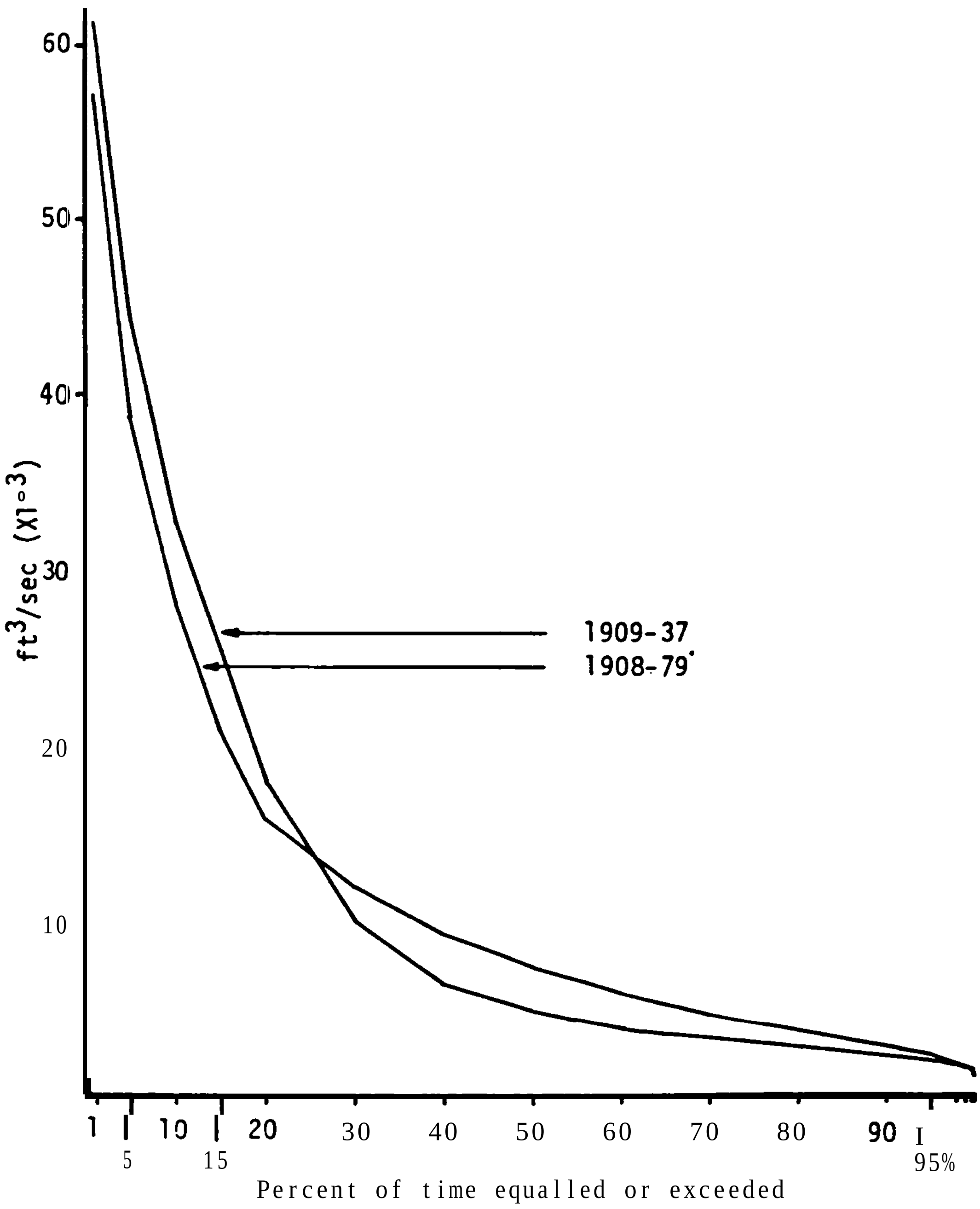
APPENDIX A1

General pre- and post- impoundment hydrological data for the lower Flathead River.



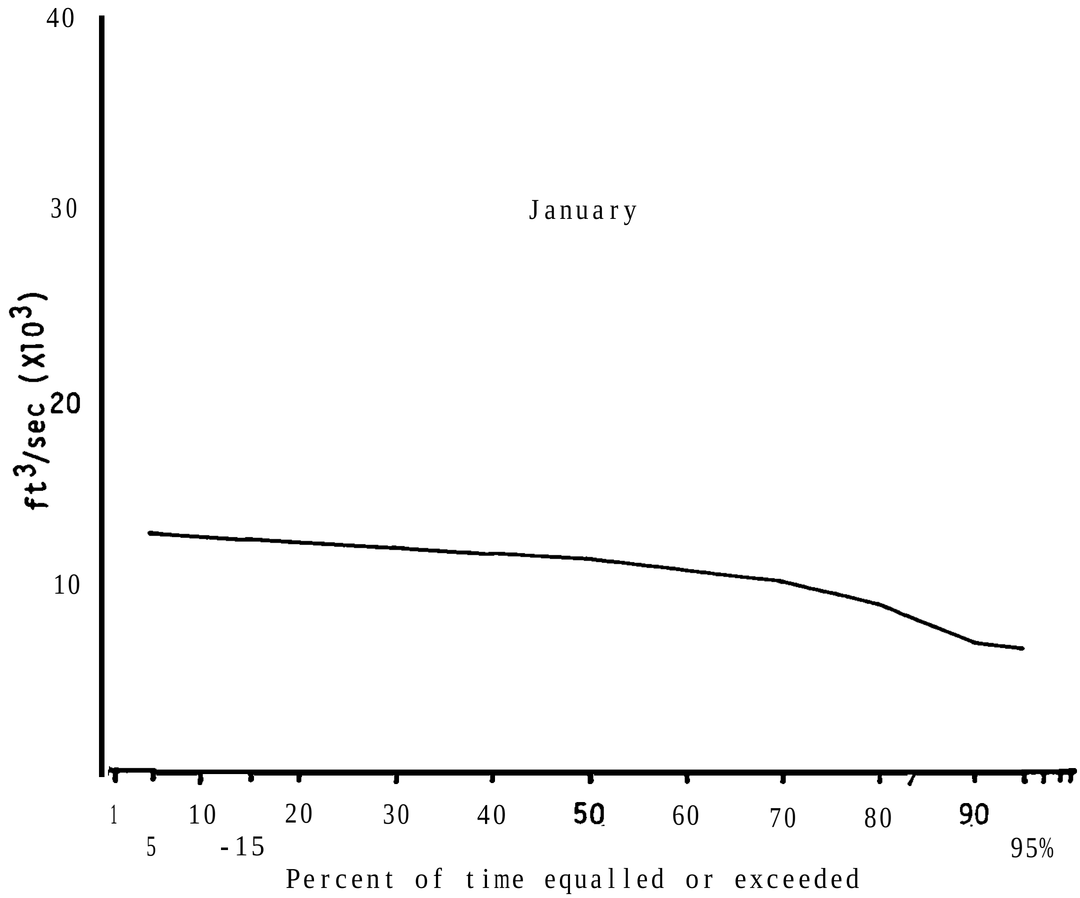
Mean monthly discharges in the lower Flathead River before Kerr Dam operation (1909-37) and under the present release schedule (1977-83).

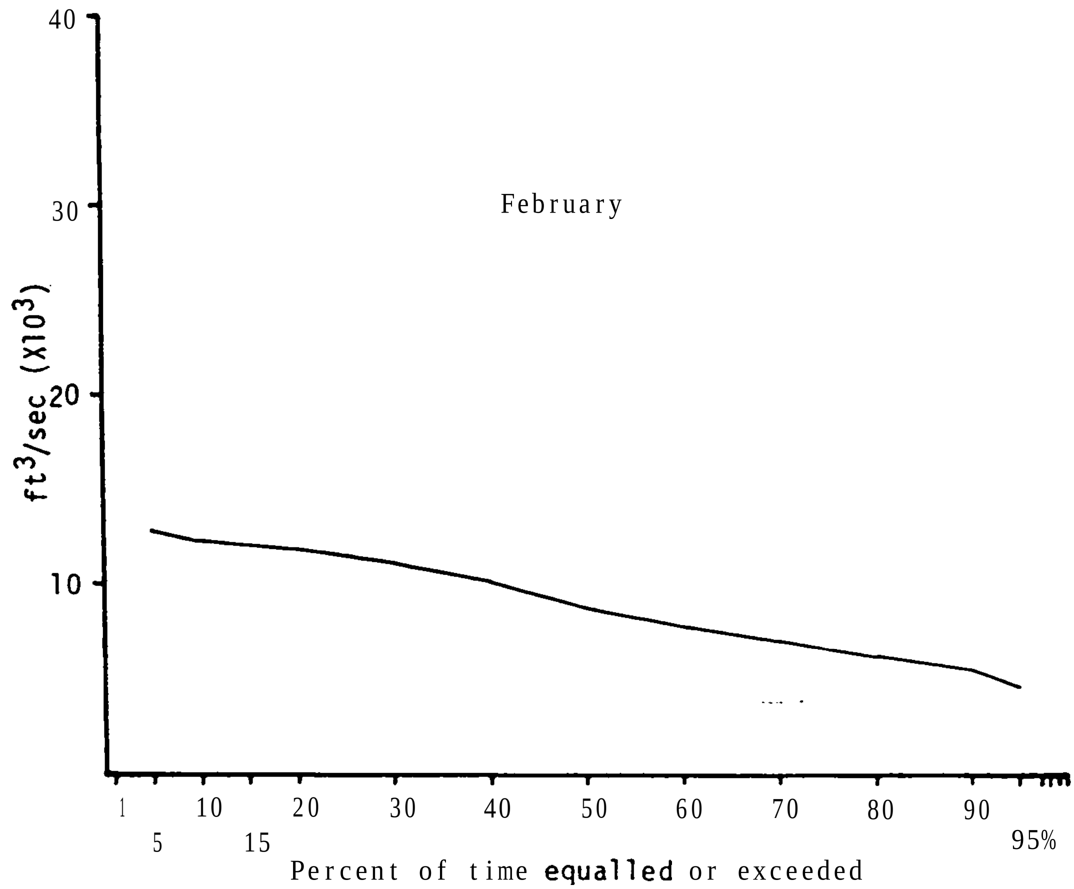


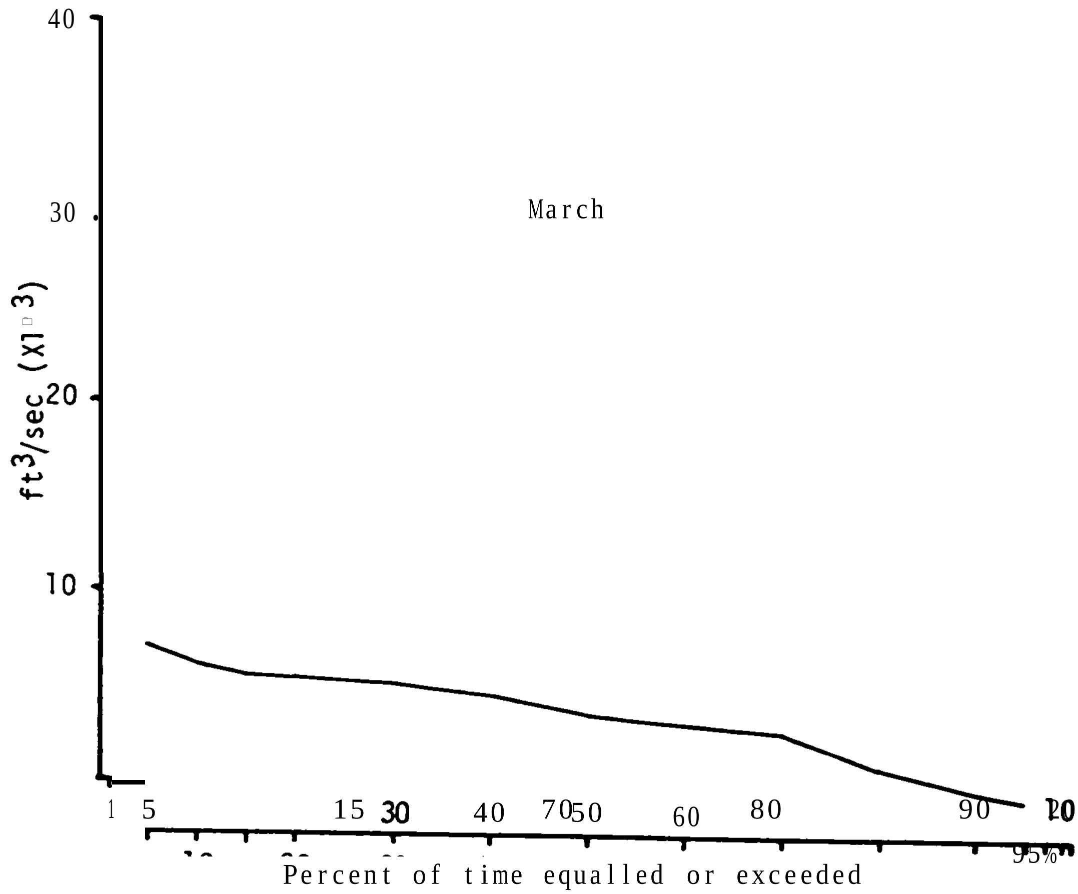
Flow duration curves of daily mean discharges in lower Flathead River before Kerr Dam operation (1909-37) and the entire period of record (1908-1979).

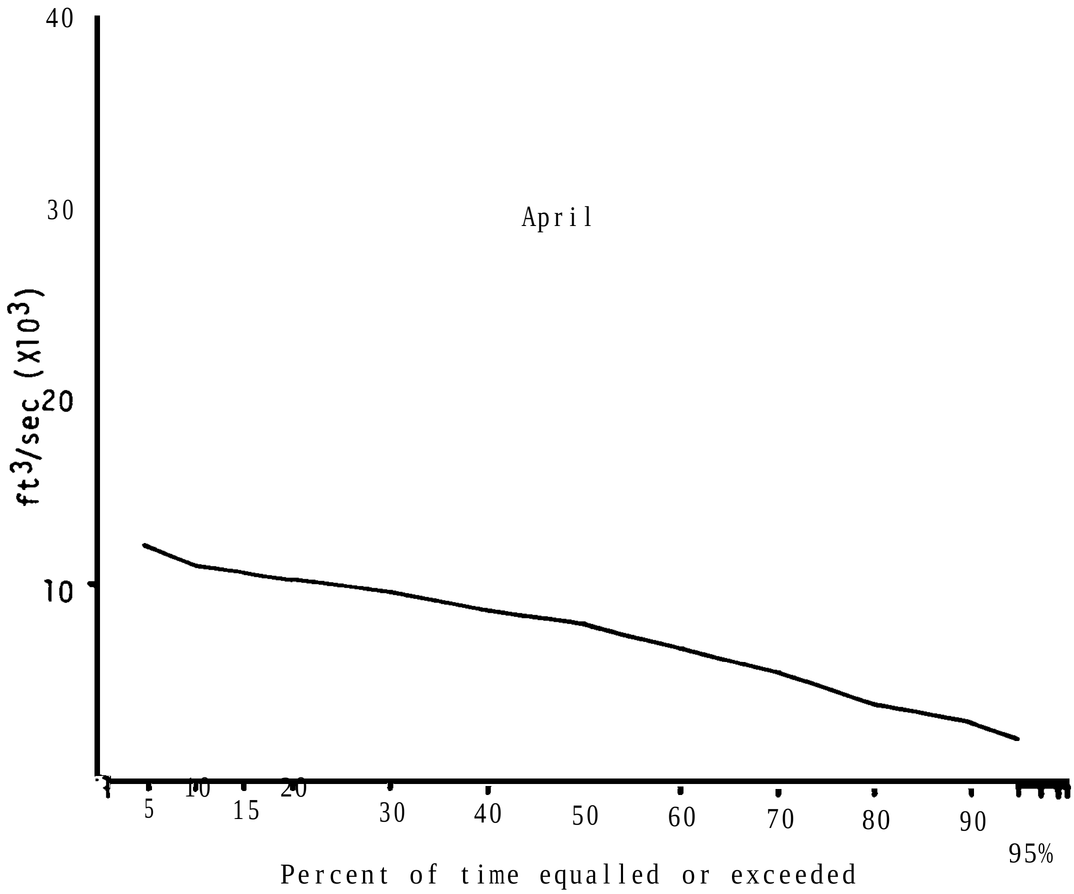
APPENDIX A2

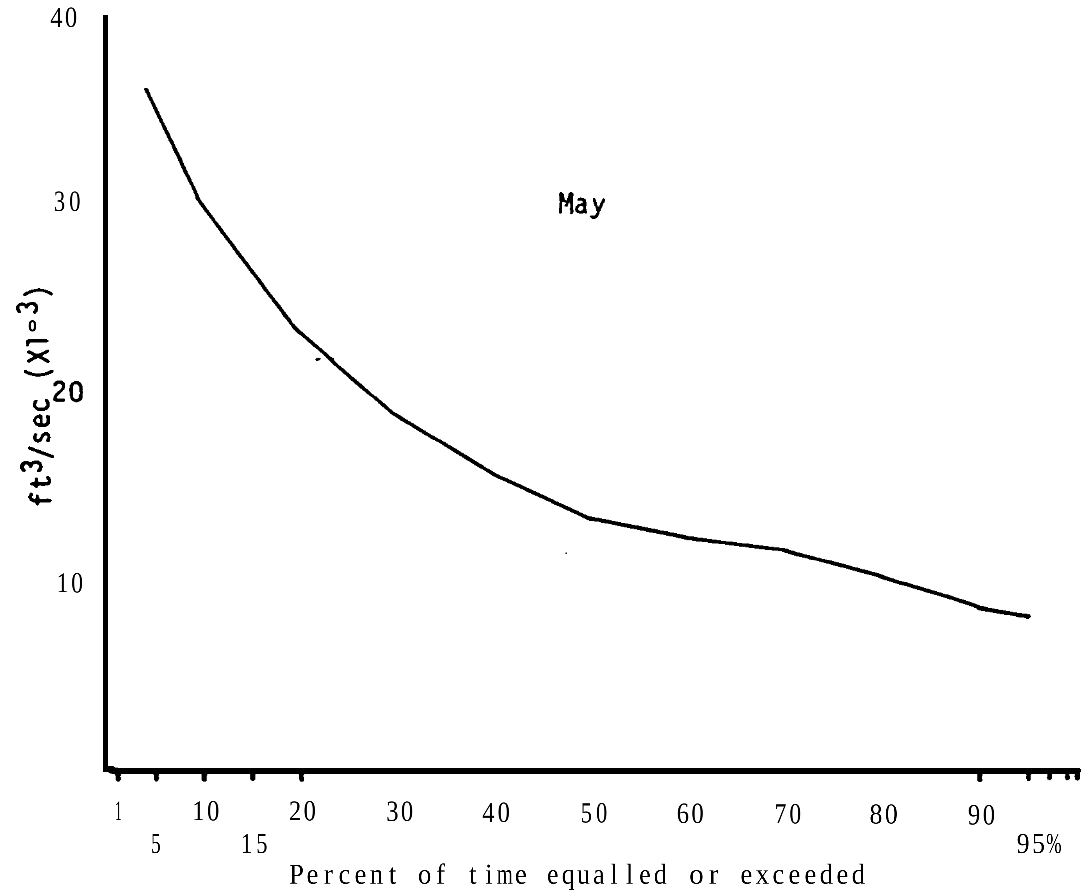
Monthly flow duration curves of daily mean discharges in the lower Flathead River under the present release schedule (1977-1983).


January
ft³/sec (X10³)
40
30
20
10
1
5
10
15
20
30
40
50
60
70
80
90
95%
Percent of time equalled or exceeded

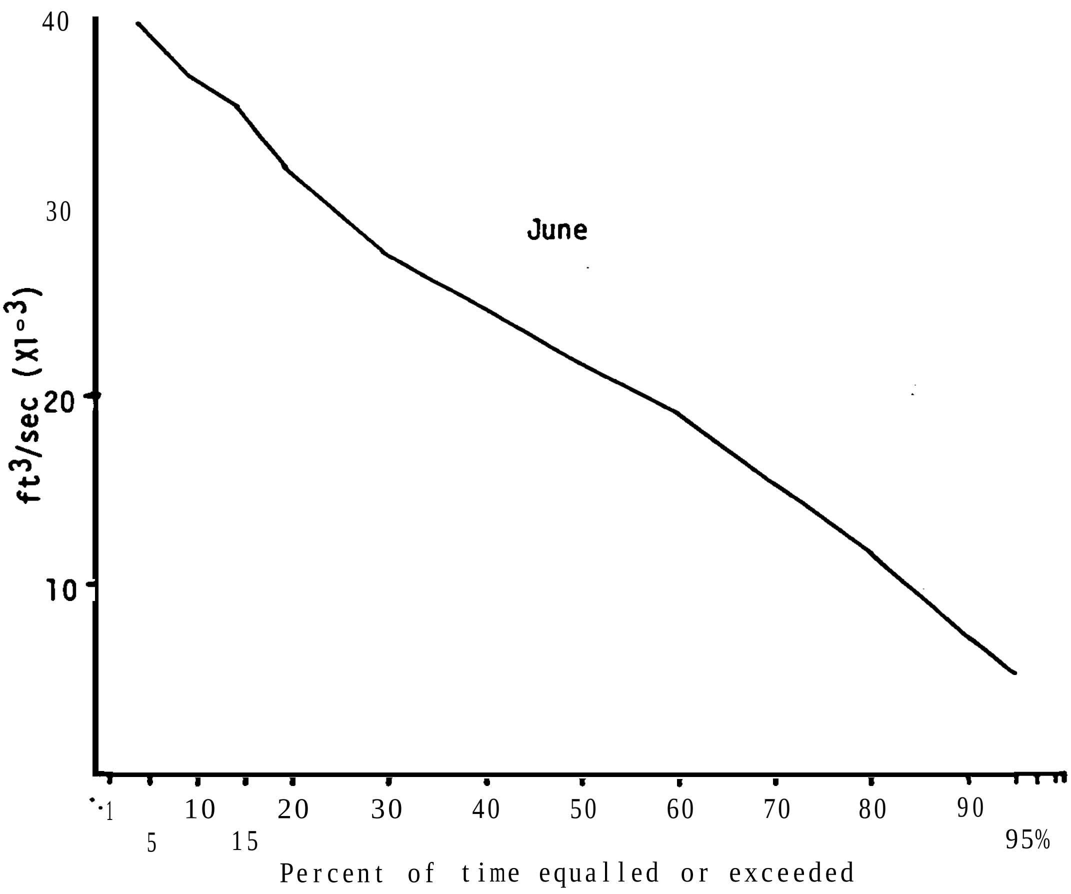

February
ft³/sec (X10³)
40
30
20
10
1
5
10
15
20
30
40
50
60
70
80
90
95%
Percent of time equalled or exceeded


March
ft³/sec (X10³)
40
30
20
10
1 5 15 30 40 50 60 70 80 90 95%
Percent of time equalled or exceeded

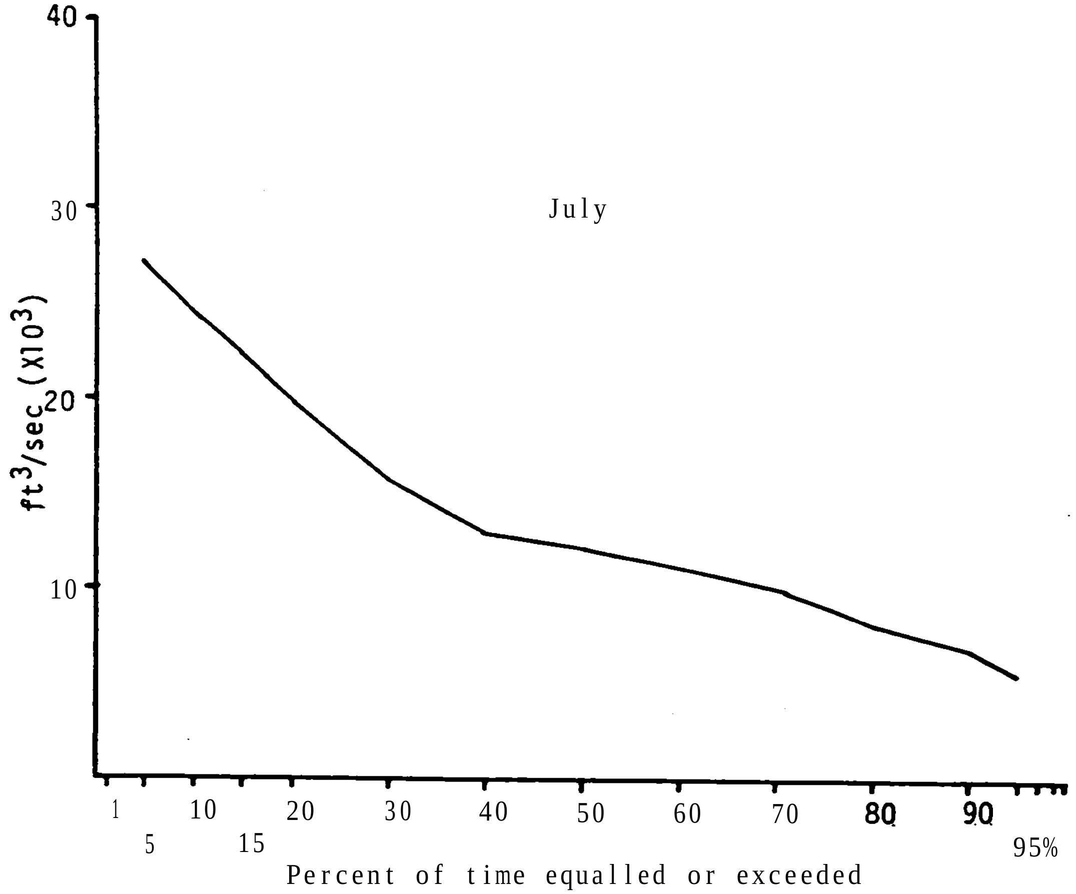

April
ft³/sec (X10³)
40
30
20
10
5 10 15 20 30 40 50 60 70 80 90 95%
Percent of time equalled or exceeded

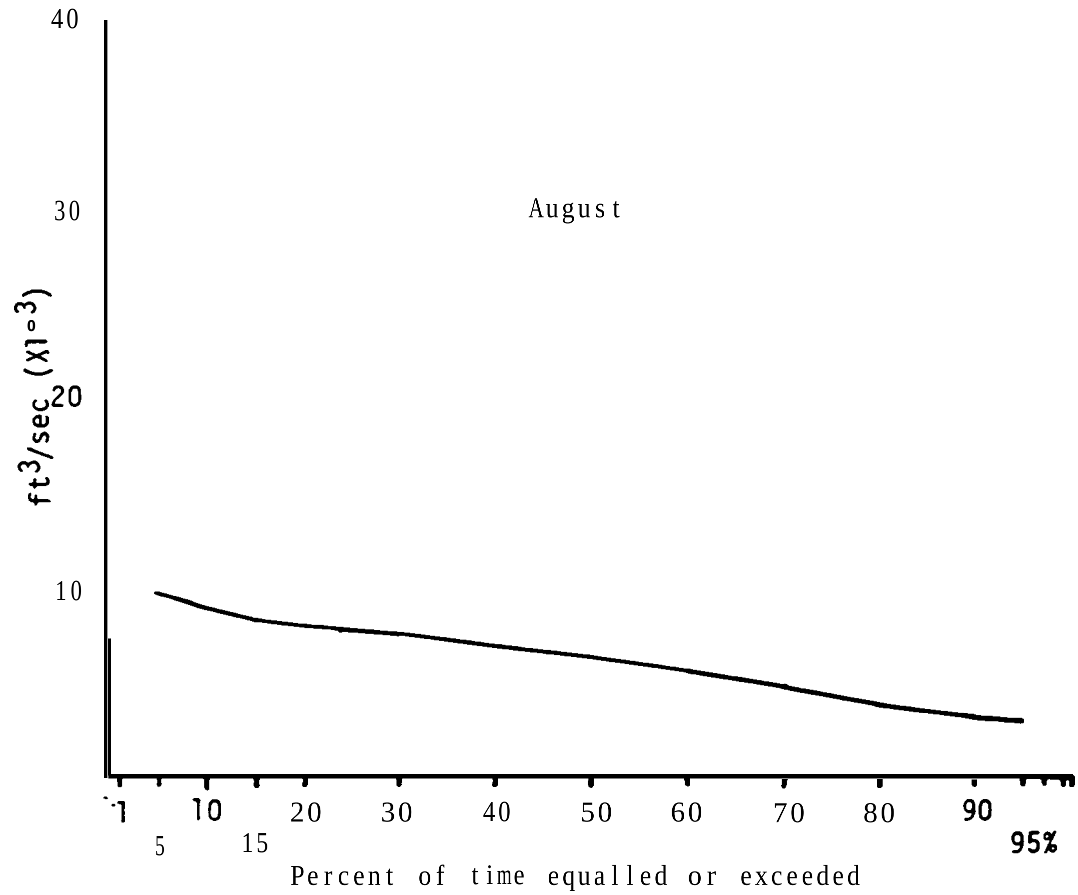


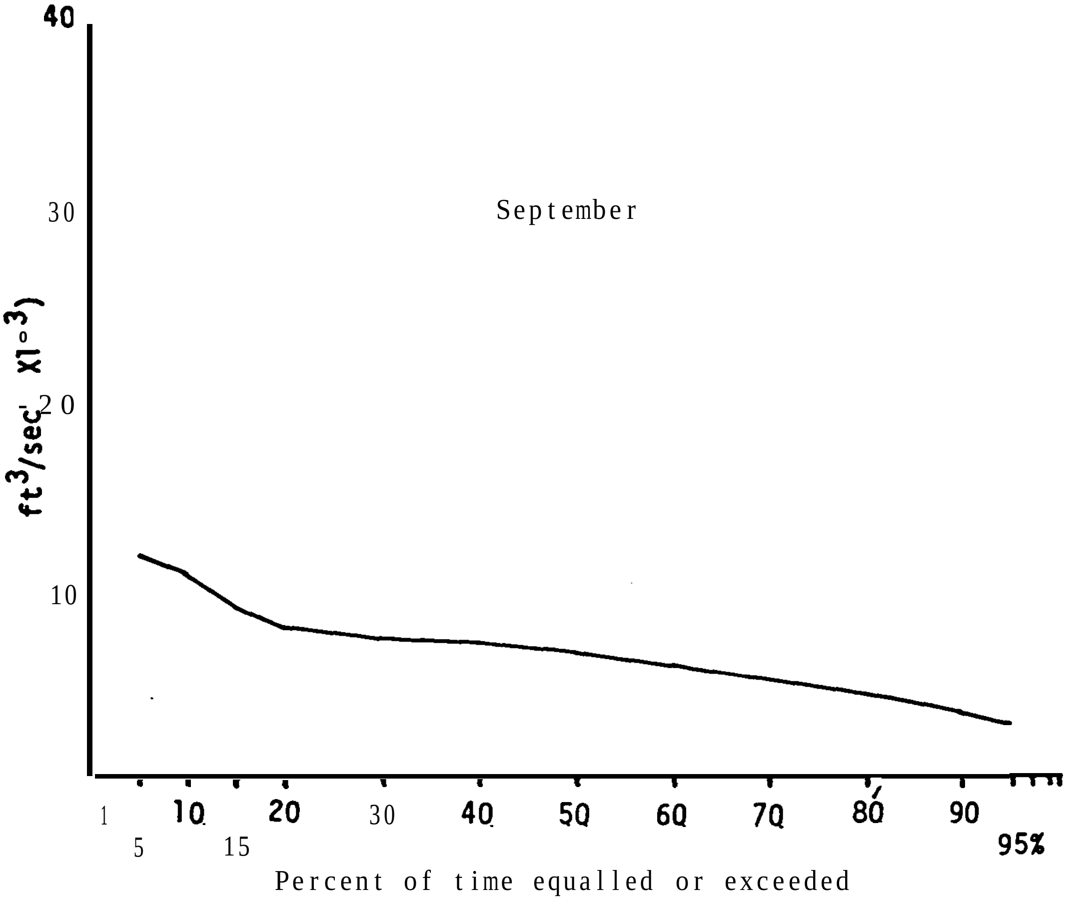
40
30
20
10
ft3/sec (X10-3)
May
1
5
10
15
20
30
40
50
60
70
80
90
95%
Percent of time equalled or exceeded

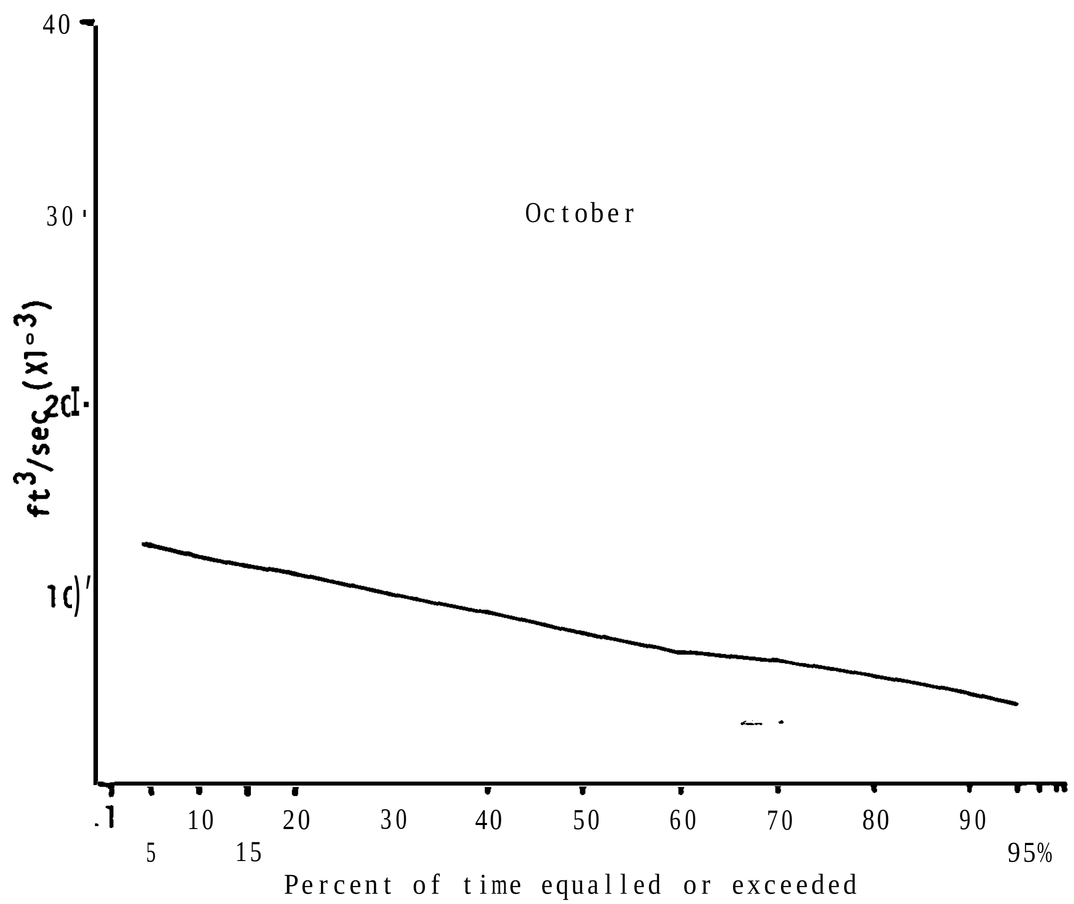


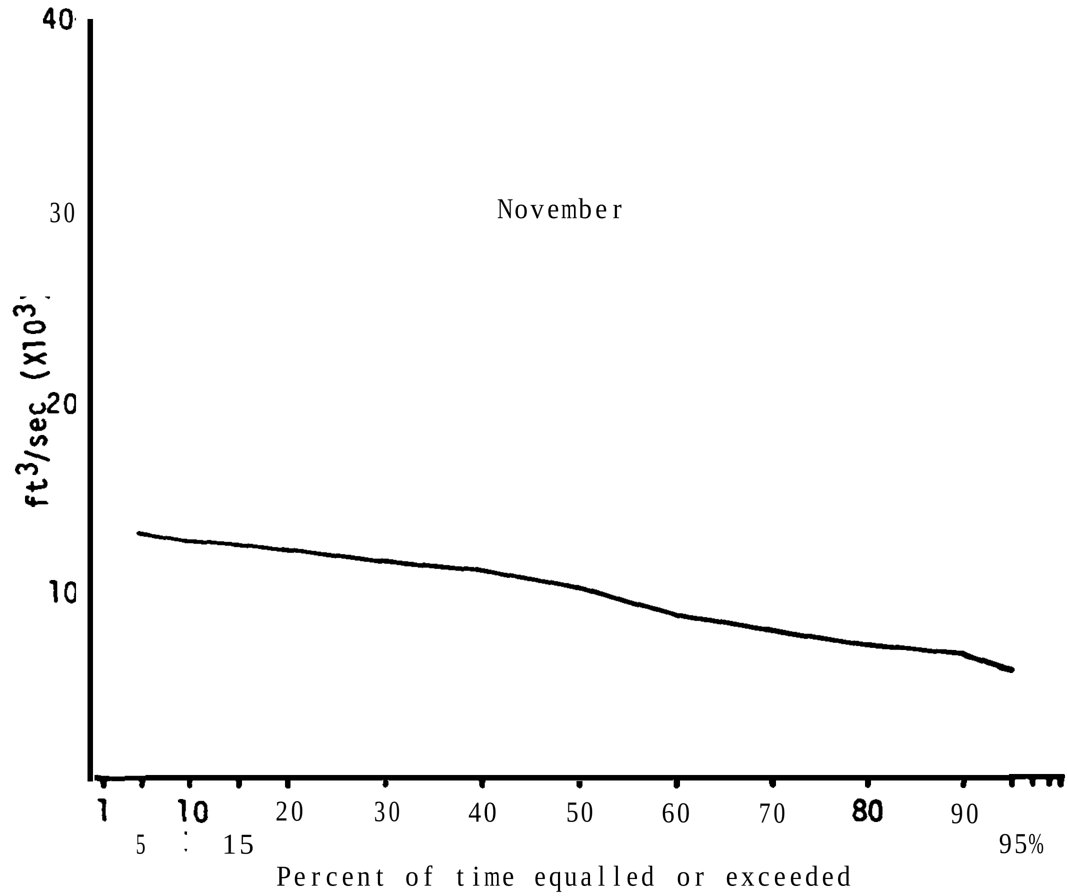
40
30
20
10
ft3/sec (X10-3)
June
1
5
10
15
20
30
40
50
60
70
80
90
95%
Percent of time equalled or exceeded

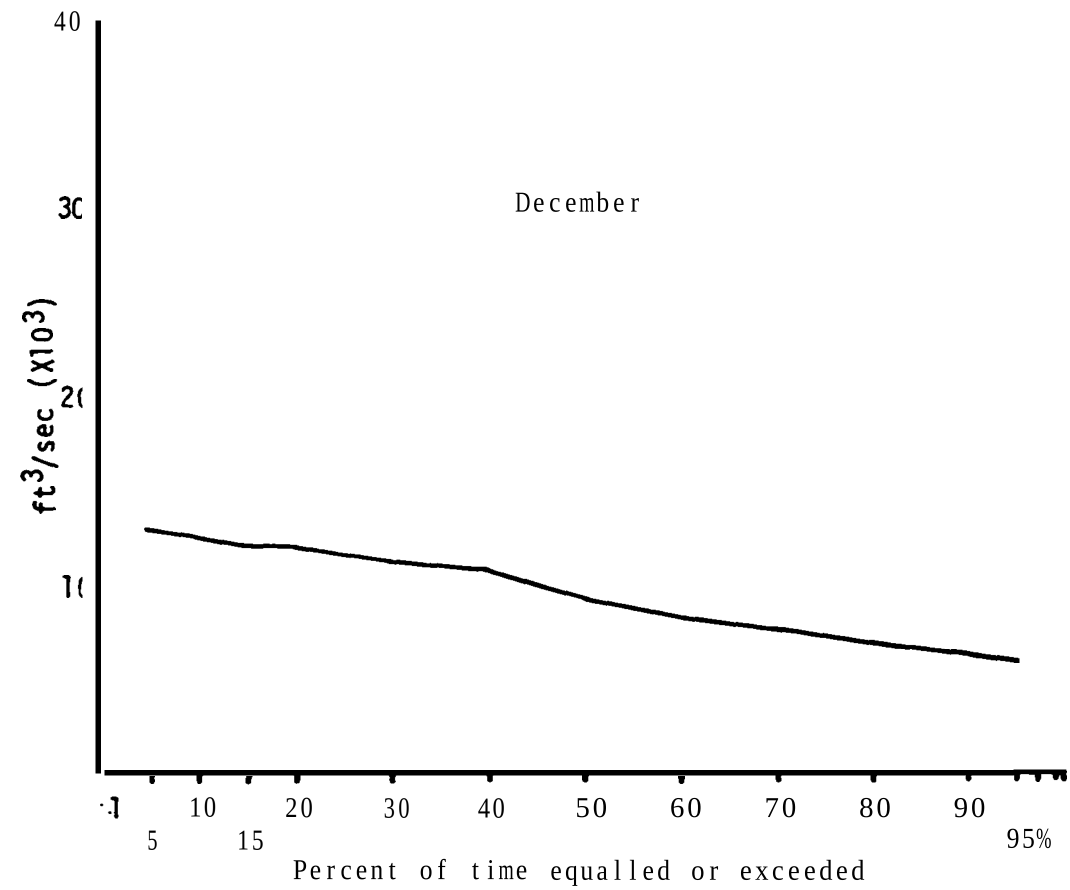

40
30
July
ft^3/sec (X10³)
20
10
1
5
10
15
20
30
40
50
60
70
80
90
95%
Percent of time equalled or exceeded


40
30
August
ft^3/sec (X1-3)
20
10
1
5
10
15
20
30
40
50
60
70
80
90
95%
Percent of time equalled or exceeded


September
ft3/sec (X10-3)
40
30
20
10
1
5
10
15
20
30
40
50
60
70
80
90
95%
Percent of time equalled or exceeded

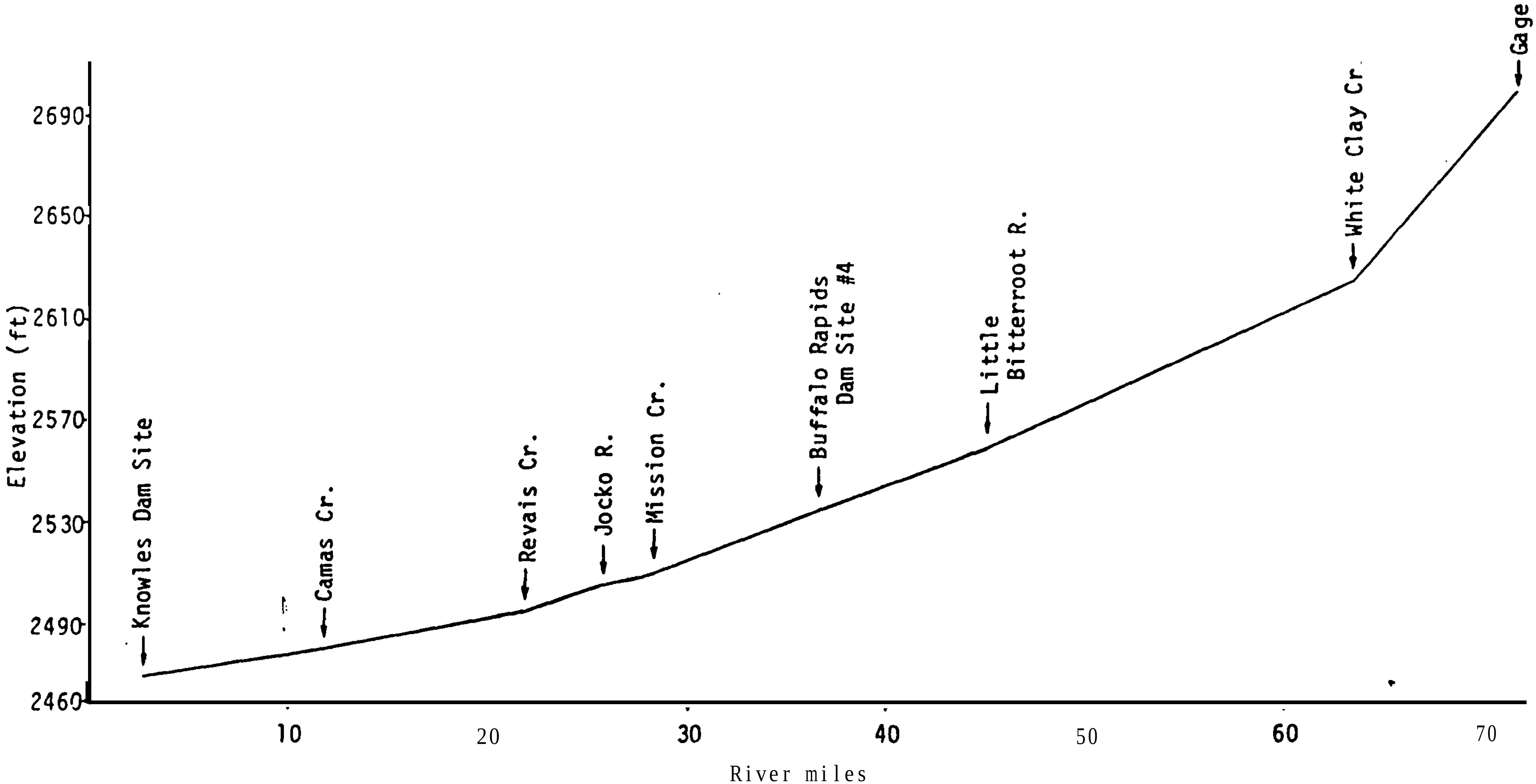

October
ft3/sec (X10-3)
40
30
20
10
.1
5
10
15
20
30
40
50
60
70
80
90
95%
Percent of time equalled or exceeded


November
ft³/sec (X10³)
40
30
20
10
1
5
10
15
20
30
40
50
60
70
80
90
95%
Percent of time equalled or exceeded

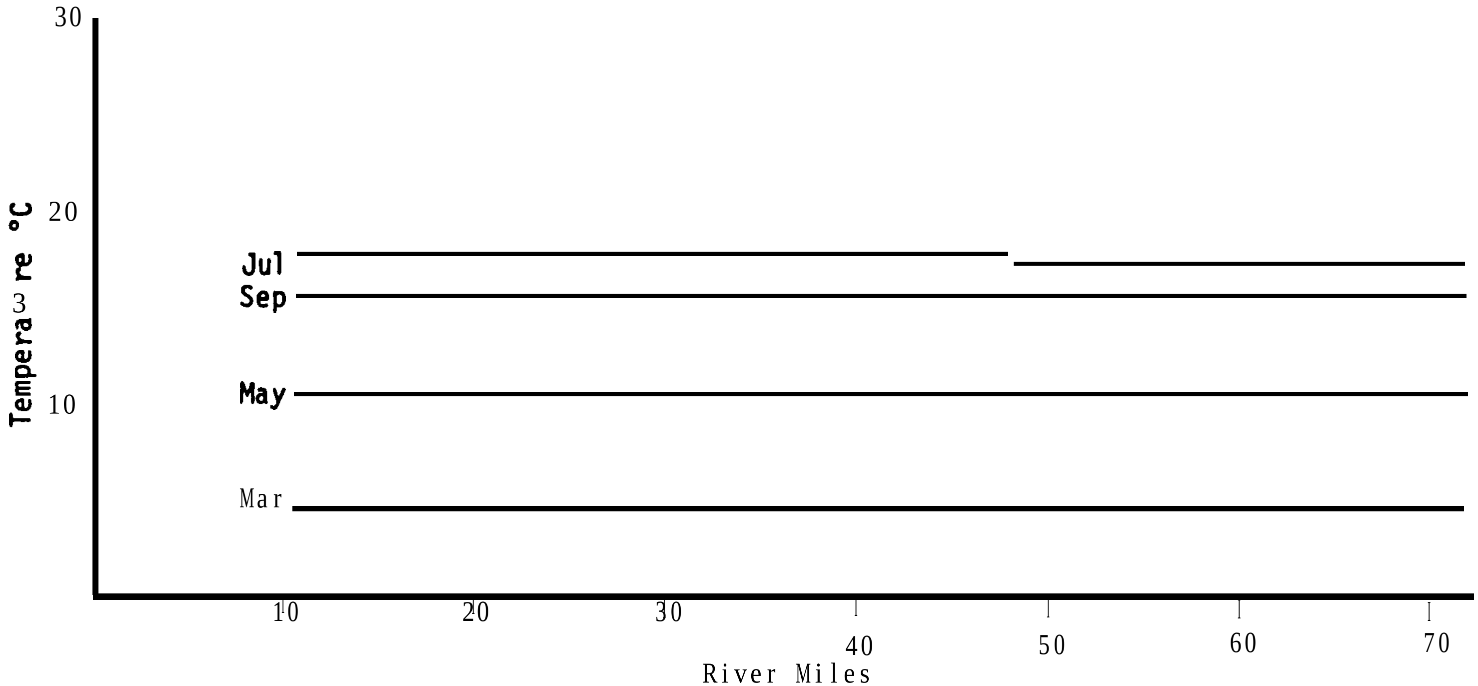

December
ft³/sec (X10³)
40
1
5
10
15
20
30
40
50
60
70
80
90
95%
Percent of time equalled or exceeded

APPENDIX A3

Elevation and temperature profiles for the lower Flathead River.



Longitudlnal profile of the lower Flathead River



Temperature profiles of the lower Flathead River during selected months of 1983.

APPENDIX A4

List of Attendants
February 6, 1985 Meeting

LIST OF ATTENDANTS

Interagency Meeting
February 6, 1985, Pablo, MT

Confederated Salish and Kootenai Tribes:

Jim Paro, Dave Cross, Jim Darling,
Paul Pajak, Bill Matthews,
Dennis Mackey, Foster DeReitzes

Bureau of Indian Affairs:

Jim Claar, Bob Klaver

Montana Power Company:

Tom O'Neil, Don Sprague,
Don Gregg, Larry Gruel

U.S. Fish and Wildlife Service:

Bruce Haines, Larry Lockard,
Carol Taylor, Ron Skates

U.S. Geological Survey:

Ron Shields

University of Montana Biological Station:

Jack Stanford

APPENDIX B

Predicted rainbow trout (Rb) embryo survival in spawning areas of the lower Flathead River related to combinations of substrates smaller than 0.85 and 9.5 mm based upon studies by Irving and Bjorn (1984).

Appendix B. Predicted rainbow trout (Rb) embryo survival in spawning areas of the lower Flathead River related to combinations of substrates smaller than 0.85 and 9.5 mm based upon studies by Irving and Bjorn (1984).

Area	River Kilometer	Percent Substrate Smaller Than 0.85 mm	Percent Substrate Smaller Than 9.5 mm	Percent Rb Survival
Buffalo #l	104.3	7	32	47
Buffalo #2	104.2	7	33	45
Buffalo #3	104.1	14	52	4
Buffalo #4	104.1	15	55	0
Buffalo #5	103.9	5	36	58
Buffalo #6	103.8	9	62	15
Foust #1	48.2	9	55	20
Foust #2	48.1	3	10	83
Dixon #I	42.6	14	81	20
Dixon #2	42.6	19	62	0
Dixon #3	44.8	6	44	43
Dixon #4	45.2	5	27	65
Ferry #1	31.8	4	29	69
Ferry #2	31.4	5	35	60
Ferry #3	31.5	1	2	100
Ferry #4,	31.5	5	40	56
McDonald # 1	28.3	8	42	37
McDonald #2	28.4	7	4 4	37

APPENDIX C

Summary of fisheries data collected from the lower Flathead River.

ELECTROFISHING SUMMARY

Location	Date	Species	No. Captured	Range in Size (mm)
Sink Hole (N)	-09-05-85	LMB	23	151-515
"	09-12-85	LMB	18	131-435
Pema #1	09-09-85	NP	1	588
"	"	LL	1	211
"	"	LMB	2	192-364
Pema X2	09-10-85	NP	7	303-799
"	"	LL	1	230
"	"	Rb	1	365
Perma #1	09-16-85	NP	4	314-791
"	"	Rb	1	305
"	"	LMB	5	293-418
Perma #2	09-17-85	NP	2	295-636
Sloans #1	09-18-85	DV	1	190
"	"	Ct	1	312
"	"	LL	3	228-423
Sloans #2	09-19-85	NP	3	331-896
Weeds #1	09-22-85	NP	12	305-958
"	"	Rb	8	220-293
"	"	LL	2	190-279
"	"	Ct	1	261
"	"	DV	1	574
Weeds #2	09-23-85	NP	2	580-615
"	"	LL	7	197-415
"	"	Rb	5	203-315
"	"	Ct	2	215-272
"	"	DV	1	466
Sloans #1	09-24-85	NP	1	785
"	"	LL	4	226-377
"	"	Rb	2	356-390
Sloans #2	09-25-85	NP	3	535-783
"	"	LL	2	200-272
"	"	Ct	1	389
Weeds #1	09-29-85	NP	8	322-838
"	"	Rb	4	237-271
"	"	LL	2	178-252
"	"	Ct	2	236-262
Weeds #2	09-30-85	Rb	8	222-305
"	"	LL	1	264
"	"	Ct	2	235-271
"	"	DV	1	296

TRAPPING SUMMARY

Location	Date	Species	No. Captured	Range in Size (mm)
Ferry #1	03-20-85	PS	2	?
"	03-22-85	PS	1	?
"	"	YP	3	?
"	03-27-85	NP	1	319
Beaver Lodge	04-04-85	NSQ	1	?
Agency	04-04-85	csu	1	?
"	04-05-85	NP	1	280
Beaver Lodge	04-12-85	YP	1	?
Pike Alley	04-13-85	BB	1	?
"	"	csu	1	?
Agency	04-17-85	BB	1	?
Beaver Lodge	04-20-85	NP	3	655-820
Ferry #1	04-20-85	NP	2	585,795
Beaver Lodge	04-28-85	NP	2	625,630
"	"	csu	1	?
"	"	BB	1	?
Agency	04-28-85	NP	1	905
Ferry #1	05-01-85	NP	3	680-772
Beaver Lodge	05-03-85	NP	2	633,755
"	"	csu	1	?
Ferry #1	05-03-85	NP	1	665
"	05-05-85	NP	2	748,780
"	05-07-85	NP	1	?
"	05-10-85	NP	6	540-794
"	05-14-85	NP	2	739,774
"	05-17-85	NP	2	593,640
Agency	05-19-85	NP	2	633
Ferry #l	05-21-85	NP	1	593
"	05-24-85	NP	5	615-795
Pike Alley	05-29-85	NP	1	626
Ferry #1	05-31-85	NP	2	682, ?
"	"	csu	8	?

GILL NETTING SUMMARY

Location	Date	Species	No. Captured	Range in Size (mm)
Beaver Lodge Sl.	-Q3-22-85	NP	1	631
Horseshoe Bend	"	NP	1	611
Goose Bend	03-26-85	NP	1	740
Pike Alley	03-27-85	NP	1	634
Sink Hole	04-03-85	LL	1	327
"	"	LMB	1	413
"	"	NP	1	576
"	"	NSQ	2	
Pike Hole	04-04-85	NP	1	558
Mac. SL.	04-10-85	NP	1	634
RK 52.6.	04- 12-85	MWF	3	
"	"	LSU	1	
"	"	SO	6	
Pike Hole	"	NP	3	513-631
"	04-26-85	NP	4	520-975
Mac. Sl.	05-01-85	NP	6	592-715
"	"	SQ	3	
Buffalo Br.	05-06-85	NP	1	633
Pike Hole	06-07-85	NP	1	739
Foust SL.	"	NP	1	454
"	"	LL	1	440

APPENDIX D

Transect descriptions for the Sloan and McDonald IFIM study sections.

Appendix D. Transect descriptions for the Sloan and McDonald IFIM study sections.

Sloan #1: the downstream-most transect within the Sloan IFIM study-area. This cross section transects a hydraulic control, defines the stage of zero flow, and sets the stage for the remaining upstream transects.

Sloan #2: a habitat-descriptive transect representing a deep, fast moving run. Substrates grade from gravel to cobble, with an interspersion of large-boulders. This type of habitat and substrate composition is common throughout River Segment I.

Sloan #3: a transitional habitat transect representing those areas which grade from deep-water, low velocity habitats into fast-moving runs. This transect shares some of the habitat features common to both transects #2 and #$.

Sloan #4: a habitat-descriptive transect representing a very deep, trench-shaped channel commonly found along the river bend/s. It also encompasses a fairly large and deep side eddy, previously identified as important habitat for northern pike. Substrates grade from large boulders and cobble on descending slopes to a flat fine-graveled bottom. A considerable amount of fine deposition has occurred within the eddy resulting in scattered growth of Chara sp. and Elodea sp.

Sloan #%: a transitional habitat transect representing those areas which grade from wide cobble-gravel riffles into deeper channeled runs. This transect shares some of the habitat features common to both transects #4 and #6.

Sloan #^: a habitat descriptive transect with one half representing a wide gravel-cobble riffle, the other half, a deep, fast moving, run with large substrate which carries the majority of the flow. This transect characterizes a large depositional point bar commonly associated with river bends. These areas are sometimes found to be important trout spawning areas.

McDonald #la, #lb, and #1c: the downstream most transect within the McDonald IFIM study area, transects three distinct channels. Cross section la transects a hydraulic control, lb a small, shallow secondary channel, and lc a wide, shallow run. This transect will be used primarily for hydraulic purposes.

McDonald #2a and #2b: a habitat descriptive transect representing both a deep and shallow run. Substrates are predominantly gravel and appear suitable for salmonid spawning. This type of habitat and substrate composition is common throughout River Segment II.

McDonald #4: a habitat descriptive transect representing a single-channel, wide, shallow run. Substrates are the same as transect #2. This transect crosses the inlet to a high water channel, and defines the stage at which inflow begins and the amount of water carried by this channel during high-water periods.

McDonald #7: the upstream-most transect within the McDonald IFIM study area. This is the only true single-channel transect and will be used to calculate the total discharge flowing through the study area, which will be used as a check for the multi-channel transects' discharge measurements.

McDonald #5: a non-flowing transect and crosses the mouth of McDonald Slough, one of the largest backwaters found in River Segment II. This transect will be used to determine water velocities through and accessability into this backwater area.

McDonald #6: a backwater cross section and transects the deepest part of McDonald Slough. This transect will be used to calculate the total area of the backwater at different stages.

APPENDIX E

Aquatic plant species found in backwater habitats of the lower Flathead River, Montana.

Appendix E. Aquatic plant species found in backwater habitats of the lower Flathead River, Montana.

PLANT TYPE	SPECIES	
Emergent Aquatic	common cat-tail*	*Typha latifolia*
	hardstem bulrush*	*Scirpus acutus*
	reed canary grass	*Phalaris arundinaceae*
	tussocks	*Carex*
	horsetail*	*Equisetum spp.*
	spike-rush*	*Eleocharus spp.*
	creeping spike rush	*Eleocharis palustris*
	needle rush	*Eleocharis acicularis*
Submerged Aquatic	stubby wapato	*Sagittaria cuneata*
	Canadian waterweed*	*Elodea muttallii*
	waterweed	*Elodea canadensis*
	water crowfoot*	*Ranunculus aquatilis*
	spiked water-milfoil	*Myriophyllum spicatum*
	clasping-leaf pondweed	*Potamogeton richardsonii*
	floating-leaf pondweed	*Potamogeton pectinatus*
	curled pondweed+	*Potamogeton crispus*
	slender leaved pondweed*	*Potamogeton filiformus*
	pondweed	*Potamogeton pusillus*
	chara*	*Chara vulgaris*

*dominant species

From Mackey et al. 1985 and Matthews et al. 1986 (inpress).

APPENDIX F

Locations of reach boundaries, habitat survey sections, and stock assessment stations on five major tributaries to the lower Flathead River.

JOCKO RIVER

	Stream km
Reach 1	
Boundaries: mouth to Spring Canyon	0.0 to 5.8
Habitat survey: Dixon Bridge upstream	1.6 to 3.2
Fish sampling station (150 m): near Hwy 200, Sec 20/21	3.2
Comments: reach open and braided below Bison Range canyon	
Reach 2	
Boundaries: Spring Canyon to Hwy 200	5.8 to 13.8
Habitat survey: Section 25/26 boundary upstream	8.8 to 10.4
Fish sampling station (150 m): Sec 25/26 boundary	10.4
Comments: reach confined along Bison Range	
Reach 3	
Boundaries: Hwy 200 to Valley Creek	13.8 to 19.0
Habitat survey: North Valley Creek Road downstream	16.9 to 18.5
Fish sampling station (150 m): North Valley Creek road	18.5
Comments: reach still somewhat confined; Valley Creek influence	
Reach 4	
Boundaries: Valley Creek to Finley Creek	19.0 to 30.7
Habitat survey: South Valley Creek Road downstream	23.2 to 24.8
Fish sampling station (150 m): South Valley Creek road	23.2
Comments: reach unconfined; Finley Creek influence	
Reach 5	
Boundaries: Finley Creek to K canal	30.7 to 41.8
Habitat survey: Teresa Adams Road downstream	36.7 to 38.3
Fish sampling station (150 m): behind Clinkenbeard ranch, Sec 7	36.8
Comments: reach has hatchery influence and dewatered section	

Reach 6	Stream km
Boundaries: K Canal to North Fork Jocko River confluence	41.8 to 48.9
Habitat survey: Section 31/36 road crossing upstream	45.2 to 46.8
Fish sampling station (150 m): Sec 31/36 road crossing	45.2
Comments: reach with Pistol Creek and North Fork Jocko River	

Reach 7	
Boundaries: North Fork to Middle Fork Jocko River	48.9 to 55.3
Habitat survey: Section 27/28 road upstream	52.1 to 53.7
Fish sampling station (150 m): Section 27/28 road	52.1
Comments: South and Middle Fork converge at reach head	

MISSION CREEK

Reach 1	
Boundaries: mouth to Burlington Northern RR bridge	0.0 to 5.5
Habitat survey: 0.5 km below old bridge upstream	1.6 to 3.2
Fish sampling station (150 m): 0.5 km above old bridge	2.6
Comments: reach has clay banks at lower end; steeper above BN RR	

Reach 2	
Boundaries: BN RR bridge to Post Creek	5.5 to 13.4
Habitat survey: H Canal diversion downstream	9.7 to 11.3
Fish sampling station (150 m): 0.5 km below H Canal diversion	10.8
Comments: reach has 'Post Creek influence	

Reach 3	
Boundaries: Post Creek to Hwy 93 bridge	13.4 to 21.7
Habitat survey: Section 9/10 road upstream	17.4 to 19.2
Fish sampling station (150 m): Section 9/10 road	17.4
Comments: gradient steepens above St. Ignatius	

Reach 4	Stream km
Boundaries: Hwy 93 to Mission B Canal	21.7 to 25.1
Habitat survey: high school road upstream	22.9 to 24.5
Fish sampling station (150 m): Section 13/24 road	24.0
Comments: Mission "B" Canal influence	

Reach 5	
Boundaries: Mission B Canal to Mission Reservoir outlet	25.1 to 26.9
Habitat survey: Section 19/20 road upstream	25.3 to 26.9
Fish sampling station (150 m): Section 19/20 road	25.3
Comments: steepest reach	

POST CREEK

Reach 1	
Boundaries: mouth to narrowed area	0.0 to 2.3
Habitat survey: Section 33 road downstream	0.2 to 1.8
Fish sampling station (150 m): Section 33 road	1.8
Comments: reach broad and flat	

Reach 2	
Boundaries: narrowed area to McDonald Lake Road Section 13/24	2.3 to 11.1
Habitat survey: Section 22/27 road upstream	6.0 to 7.6
Fish sampling station (150 m): Section 23 road	6.8
Comments: reach sinuous with low gradient	

Reach 3	
Boundaries: McDonald Lake Road to Section 13/24	11.1 to 16.9
Habitat survey: Section 5/6 road upstream	13.7 to 15.3
Fish sampling station (150 m): Section 5/6 road	13.7
Comments: straighter, steeper reach; canal at head	

Reach 4 | | Stream km

Boundaries: Pablo Feeder Canal to McDonald Lake outlet	16.9 to 20.0
Habitat survey: footbridge above Pablo Feeder Canal upstream	16.9 to 18.5
Fish sampling station (150 m): footbridge above Pablo Feeder Canal	16.9
Comments: short, steep reach	

CROW CREEK

Reach 1

Boundaries: mouth to Lower Crow Reservoir outlet	0.0 to 5.6
Habitat survey: Moiese A Canal diversion downstream	3.2 to 4.8
Fish sampling station (150 m): Moiese A Canal diversion	4.8
Comments: reach has uniform gradient; reservoir is barrier	

LITTLE BITTERROOT RIVER

Reach 1

Boundaries: mouth through canyon	0.0 to 5.6
Habitat survey: mid-canyon near road in Section 24 upstream	1.6 to 3.2
Fish sampling station (150 m): near road in Section 24	2.1
Comments: reach has steeper canyon area with rocky bottom	

Reach 2

Boundaries: canyon to Hot Springs Creek	5.6 to 44.1
Habitat survey: hydrologic gaging site downstream	16.3 to 17.9
Fish sampling station (150 m): hydrologic gaging site	16.3
Comments: Hot Springs Creek introduces heavy sediment load	

Reach 3	Stream km
Boundaries: Hot Springs Creek to Sullivan Creek	44.1 to 55.7
Habitat survey: Section 29/20 road upstream	45.9 to 47.5
Fish sampling station (150 m): Section 29/30 road	45.9
Comments: Sullivan Creek is another sediment source	

Reach 4	
Boundaries: Sullivan Creek to Camas A Canal	55.7 to 76.0
Habitat survey: Section 22 crossroads upstream	61.3 to 62.9
Fish sampling station (150 m): Section 22 crossroads	61.3
Comments: large marsh in reach; canyon above Bassoo Creek	

Reach. 5	
Boundaries: Camas A Canal to Reservation boundary	76.0 to 82.1
Habitat survey: canyon area Section 9 upstream	77.2 to 78.8
Fish sampling station (150 m): canyon area Section 9	77.2
Comments: reach has trout-accommodating habitat	

APPENDIX C

Catch per unit effort (CPUE) and mean total length for trout in the Jocko River, Mission Creek, and Post Creek.

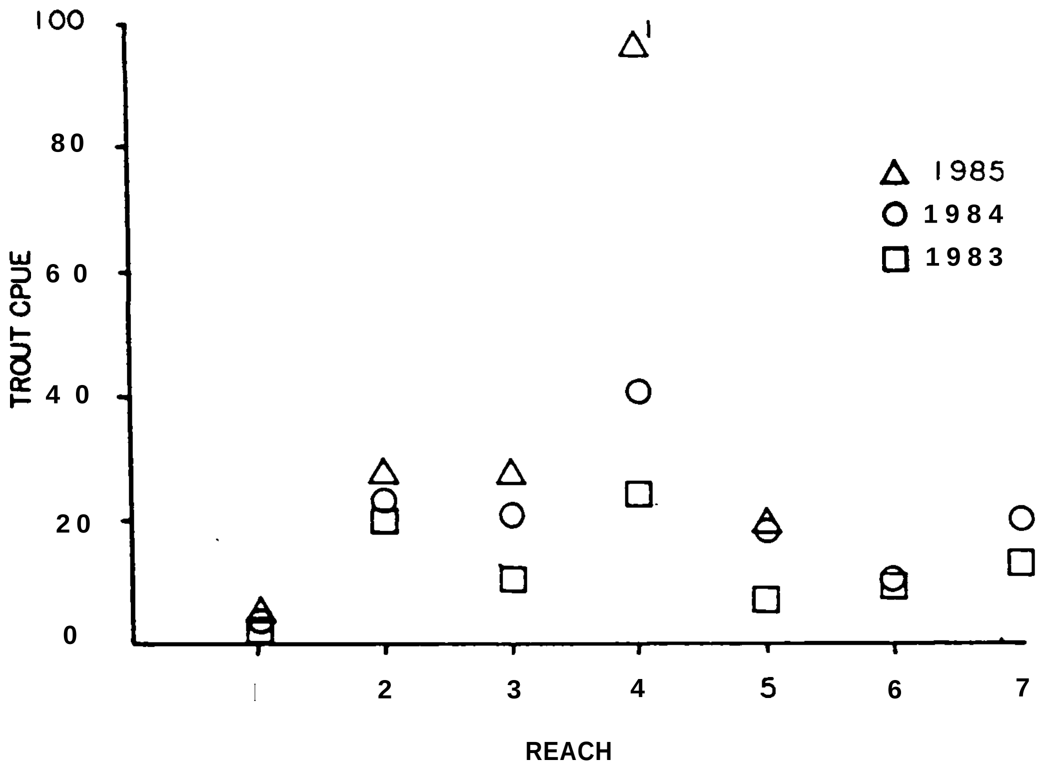


Figure H-l.. Catch per unit effort (CPUE) for trout in the Jocko River during fall 1983, 1984, and 1985.

'Station size was doubled to 300 m at all sites in 1985. The additional 150 m held many more fish at this station.

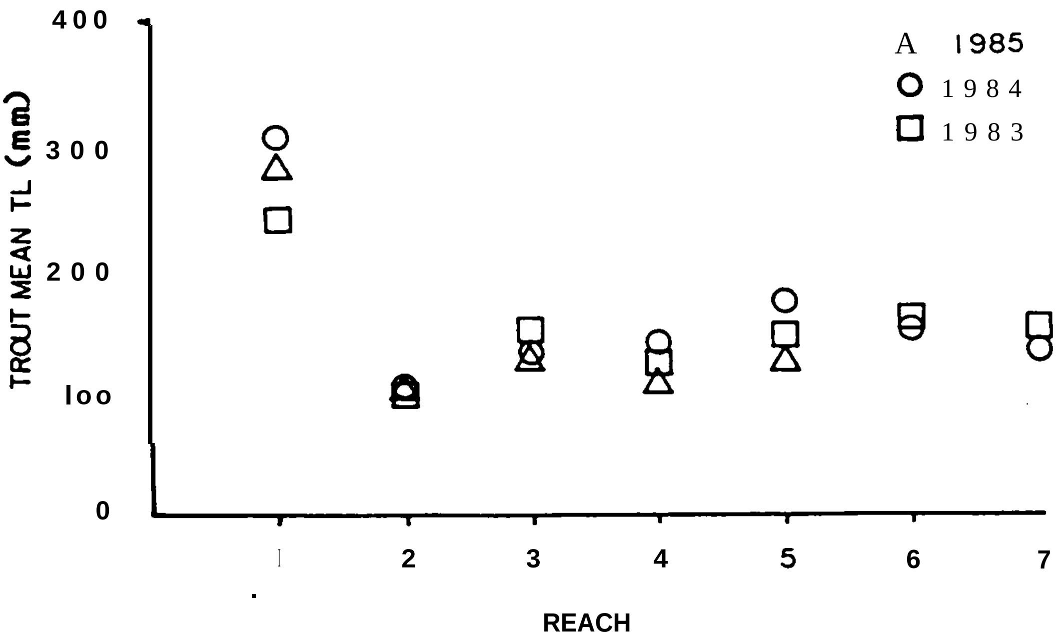


Figure H-2. Mean total length (TL) for trout in the Jocko River during fall 1983, 1984, and 1985.

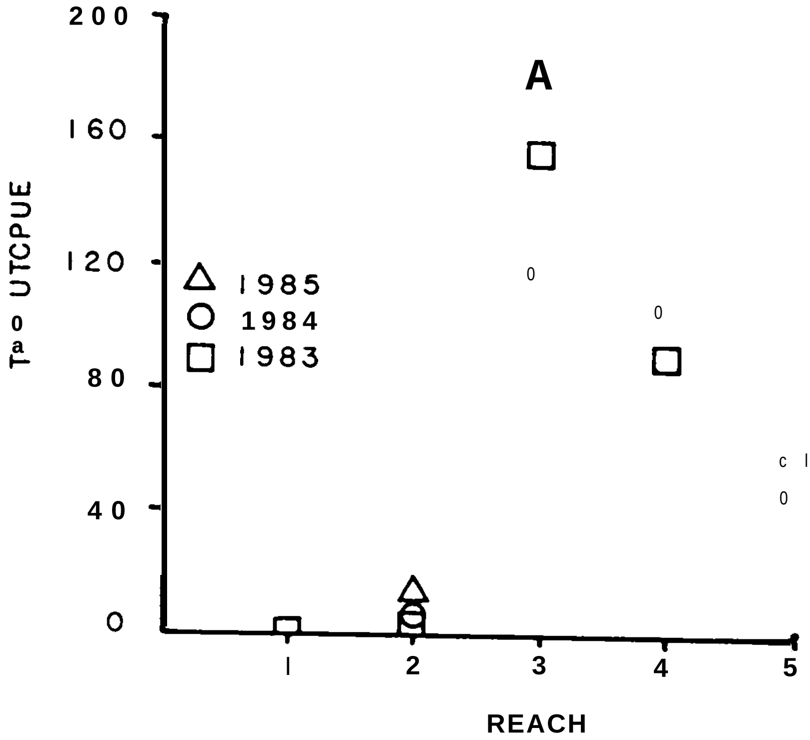


Figure H-3. Catch per unit effort (CPUE) for. trout in Mission Creek during fall 1983,1984, and 1985.

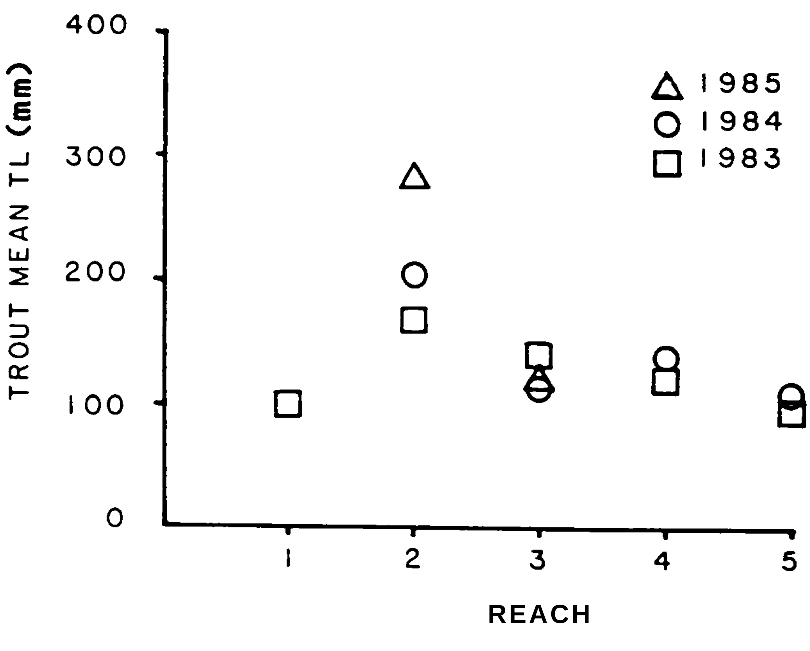


Figure H-4. Mean total length (TL) for trout in Mission Creek during fall 1983,1984, and 1985.

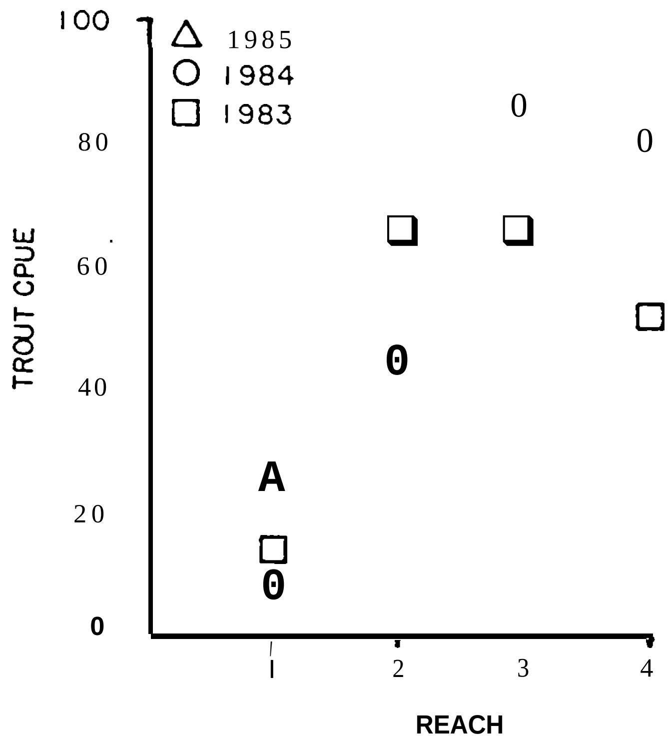


Figure H-5. Catch per unit effort (CPUE) for trout in Post Creek during fall 1983, 1984, and 1985.

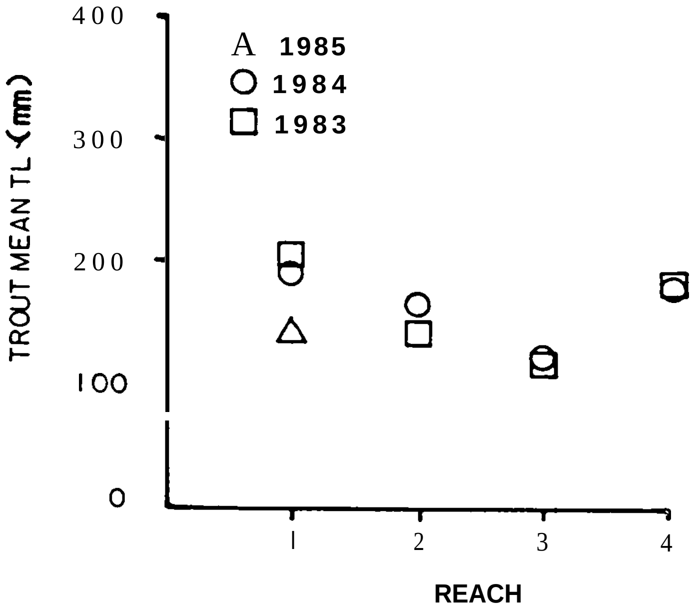


Figure H-6 Mean total length (TL) for trout in Post Creek during fall 1983, 1984, and 1985.

APPENDIX H

Mark-recapture data (1983-1985) showing movement of trout and northern pike to and from tributaries of the lower Flathead River.

TAG_NO	TAG_DATE	SPECIES [1]	TAG_LENGTH	TAG_STREAM [2]	TAG_KM	CAP_DATE	CAP_LENGTH	CAP_STREAM [2]	CAP_KM	TIME_INTER [3]	DISTANC_KM
2595	10/22/84	rb	376	C	5	04/17/85	382	C	2	177	3
1727	04/23/84	LL	383	F	42	04/29/84	386	J	2	6	3
1702	04/22/84	LL	553	F	45	08/02/85	565	J	2	467	6
1659	04/15/84	LL	621	F	45	08/13/84	620	J	2	120	6
1504	10/25/83	LL	470	F	45	10/24/84	523	J	2	365	6
1643	04/11/84	LL	289	F	71	10/11/85	353	J	2	549	32
1226	06/15/83	LL	567	F	10	08/20/84	575	J	2	432	33
1637	04/10/84	LL	444	F	74	08/26/84	449	J	2	138	35
1633	04/10/84	LL	497	F	74	08/20/84	508	J	2	132	35
1225	06/15/83	LL	403	F	10	08/27/83	999	J	14	73	45
1618	04/04/84	LL	271	F	71	09/05/85	412	J	19	519	49
1597	04/02/84	LL	430	F	105	08/08/84	0	J	14	128	78
1350	09/26/83	LL	336	F	105	08/08/84	381	J	14	317	78
1606	04/02/84	LL	474	F	105	09/09/85	559	J	20	525	84
1332	07/19/83	rb	360	F	13	03/22/84	372	M	6	247	38
2611	10/24/84	LL	440	J	2	11/18/84	447	J	23	25	21
2583	09/27/84	LL	315	J	3	09/04/85	368	J	3	342	
2590	10/04/84	rb	372	J	3	02/25/85	380	M	6	144	13
2218	09/07/83	rb	282	J	1	03/30/84	999	M	24	205	29
2378	03/21/84	rb	405	J	2	05/27/84	381	J	38	67	36
2469	04/17/84	rb	435	J	2	05/19/85	432	CF	45	397	88
2483	04/27/84	NP	538	L	46	04/02/85	568	L	45	340	1
2068	04/25/83	NP	542	L	60	06/11/83	999	L	55	47	5
2202	06/28/83	NP	764	L	4	07/27/83	999	F	71	34	5
2050	04/21/83	NP	467	L	60	06/11/83	999	L	55	51	5
2009	03/27/83	NP	522	L	60	06/11/83	999	L	55	76	5
2047	04/21/83	NP	622	L	60	06/11/83	710	L	55	51	5
2054	04/21/83	NP	554	L	60	06/11/83	999	L	55	51	5
2483	04/27/84	NP	538	L	46	10/19/84	571	L	12	175	34
2506	08/02/84	LL	505	M	6	08/09/84	999	M		7	
360	03/16/84	rb	410	M	6	07/01/85	999	M	7	472	1
2817	05/22/85	rb	392	M	6	06/16/85	392	M	9	25	3
2420	04/04/84	rb	371	M	6	07/04/84	999	CF	45	91	92
2360	03/16/84	rb	410	M	6	03/27/85	417	M	6	376	
2390	03/27/84	rb	499	M	6	03/28/85	504	M	6	366	
2362	03/18/84	rb	405	M	6	05/27/84	432	F		70	
2556	09/20/84	rb	449	M	6	03/21/85	452	M	6	182	
2304	11/16/83	rb	379	P	.7	03/13/84	356	P	8	118	1
B136	10/23/84	rb	225	P	17	05/18/85	229	PF	99	207	7

[1] rb = rainbow trout; LL = brown trout;
NP = northern pike.

[2] C = Crow Creek; F = lower Flathead River;
J = Jocko River; L = Little Bitterroot River;
M = Mission Creek; P = Post Creek.

[3] Time interval in days.

APPENDIX I

Predicted rainbow trout (Rb) embryo survival in spawning areas of the lower Flathead River tributaries related to combinations of substrates smaller than 0.85 and 9.5 mm based upon studies by Irving and Bjorn (1984).

Appendix I. Predicted rainbow trout (Rb) embryo survival in spawning areas of the lower Flathead River tributaries related to combinations of substrates smaller than 0.85 and 9.5 mm based upon studies by Irving and Bjorn (1984).

Stream	Reach	Core	Percent Substrate Smaller than 0.85 mm	Percent Substrate Smaller than 9.5 mm	Percent Rb Survival
Jocko River	1	1	6	45	46
		2	6	34	52
	2	1	8	29	43
		2	12	45	12
	3	1	10	37	28
		2	12	44	14
	4	1	4	24	76
		2	12	40	18
Mission Creek	2	1	12	39	18
		2	12	39	18
	3	1	14	52	4
		2	6	29	50
Post Creek	1	1	19	47	2
		2	20	60	0
Crow Creek	1	1	15	50	2
		2	6	24	54

APPENDIX J

Summary of electrofishing and trapping data collected on five tributaries to the lower Flathead River during FY85.

Abbreviations:

Ct = cutthroat trout
DV = bull trout
Eb = eastern brook trout
LL = brown trout
MWF = mountain whitefish
NP = northern pike
Rb = rainbow trout
Rb x Ct = rainbow-cutthroat hybrid

ELECTROFISHING

JOCKO RIVER

Location (stream km)	Date	Species	No.	Size Range (mm)
3.2	09-27-84	MWF	41	212-498
"	"	LL	1	315
"	"	Rb	2	206-220
"	10-04-84	MWF	54	100-491
"	"	Rb	4	237-470
10.4	09-27-84	LL	20	88-358
"	"	Rb	15	75-114
"	"	MWF	33	257-370
"	10-04-84	MWF	51	225-388
"	"	LL	10	80-123
18.5	09-28-84	MWF	45	193-397
"	"	LL	33	81-490
"	"	Rb	2	90-181
"	10-05-84	MWF	20	210-443
"	"	LL	25	81-463
"	"	Rb	3	85-93
23.2	09-25-84	MWF	25	226-401
"	"	LL	77	80-574
"	"	Eb	11	81-108
"	"	Rb	4	83-185
"	10-02-84	LL	46	81-461
"	"	Rb	7	68-326
"	"	Eb	3	80-108
"	"	MWF	23	260-388
36.8	09-25-84	Eb	12	85-210
"	"	Ct	1	125
"	"	Rb	1	176
"	"	LL	8	105-447
"	10-02-84	LL	3	84-215
"	"	Eb	16	81-202
"	"	DV	1	255
45.2	09-24-84	DV	6	84-277
"	"	Ct	4	107-185
"	"	Rb	1	150
"	10-01-84	Ct	11	86-287
"	"	DV	1	87
52.1	09-24-84	Ct	21	go-250
"	"	Eb	5	72-182
"	"	DV	2	172-181
"	10-01-84	Ct	19	91-188
3.2	09-04-85	LL	4	229-466
"	"	Rb	4	193-247

JOCKO RIVER (continued)

Location (stream km)	Date	Species	No.	Size Range (mm)
3.2	09-11-85	Rb	3	194-432
"	"	LL	7	227-390
10.4	09-04-85	LL	42	72-402
"	"	Rb	28	57-216
"	09-11-85	LL	19	84-284
"	"	Rb	17	53-230
18.5	09-05-85	LL	60	73-412
"	"	Rb	20	55-320
"	09-12-85	LL	29	68-566
"	"	Rb	8	57-254
23.2	09-05-85	LL	287	70-473
"	"	Rb	3	89-173
"	"	Eb	49	65-204
"	09-l 2-85	LL	57	69-450
"	"	Eb	11	67-104
"	09-19-85	LL	71	63-632
"	"	Eb	27	68-193
"	"	Rb	3	68-81
36.8	09-09-85	LL	16	71-394
"	"	Eb	19	72-242
"	"	Rb	1	306
"	09-16-85	LL	7	72-439
"	"	Eb	21	76-181
"	"	Rb	1	77

MISSION CREEK

2.6	09-13-84	MWF	4	124-136
10.8	"	MWF	7	116-300
"	"	Rb	3	196-357
"	09-20-84	MWF	12	114-298
"	"	Rb	4	83-223
17.4	09-14-84	Eb	102	65-219
"	"	MWF	4	119-123
"	"	Rb	142	61-252
"	09-21-84	Rb	106	59-254
"	"	Eb	89	70-230
24.0	09-11-84	Eb	104	63-269
"	"	Rb	74	60-273
"	09-18-84	Eb	112	66-270
"	"	Rb	69	74-280
25.3	09-11-84	Eb	68	52-215
"	"	Rb	19	58-241

MISSION CREEK (continued)

Location (stream km)	Date	Species	No.	Size Range (mm)
25.3	09-18-84	Eb	64	60-207
"	"	Rb	36	53-250
10.8	09-20-85	Rb	25	92-470
"	09-26-85	Rb	26	95-465
17.4	09-18-85	Rb	406	49-249
"	"	Eb	248	66-247
"	09-25-85	Rb	382	57-265
"	"	Eb	188	69-248

POST CREEK

Location (stream km)	Date	Species	No.	Size Range (mm)
1.8	09-12-84	MWF	14	110-387
"	"	Rb	5	166-203
"	09-19-84	Rb	12	83-343
"	"	MWF	15	97-406
6.8	"	Rb	34	65-398
"	"	LL	4	105-304
"	"	Eb	1	220
"	"	MWF	16	256-365
"	09-26-84	MWF	24	229-390
"	"	LL	6	112-280
"	"	Rb	57	67-368
13.7	09-10-84	Eb	118	60-232
"	"	Rb	19	76-264
"	09-17-84	Eb	109	65-202
"	"	Rb	15	69-262
16.9	10-23-84	Rb	142	66-374
"	"	Eb	47	81-230
"	"	RbxCt	3	139-225
"	"	DV	1	146
"	10-29-84	Rb	97	62-336
"	"	Eb	39	84-232
1.8	09-03-85	Rb	34	70-289
"	"	LL	2	246-255
"	"	Eb	1	196
"	09-10-85	Rb	40	63-416
"	"	Eb	1	194
"	"	LL	2	220-229

CROW CREEK

Location (stream km)	Date	Species	No.	Size Range (mm)
4.8	10-22-84	MWF	36	139-317
"	"	Rb	9	91-376
"	"	LL	1	122
"	10-29-84	MWF	8	144-258
"	"	Rb	3	117-458

LITTLE BITTERROOT RIVER

Location (stream km)	Date	Species	No.	Size Range (mm)
45.9	10-09-84	NP	1	175
77.2	10-08-84	Ct	39	67-207
"	"	Eb	210	68-240
"	10-15-84	Ct	29	108-204
"	"	Eb	87	70-225
12.0	10-19-84	NP	1	571
27.0	10-18-84	NP	6	211-366
45.0	10-11-84	NP	14	151-551
52.0	10-18-84	NP	7	176-223
73.0	10-17-84	Eb	68	89-267
"	"	NP	2	342-415
78.0	10-15-84	Ct	29	110-202
"	"	Eb	87	70-225
79.0	10-16-84	Eb	96	74-268
"	"	Ct	24	108-258
82.0	"	Eb	113	65-288
"	"	Ct	11	132-199

TRAPPING

JOCKO RIVER WEIR

Location (stream km)	Date	Species	No.	Size Range (mm)
2.0	10-09-84	LL	3	436-440
"	10-10-84	MWF	28	293-456
"	10-10-84	LL	3	441-542
"	10-23-84	MWF	1	380
"	10-24-84	LL	2	440-523
"	10-29-84	LL	1	379
"	11-25-84	MWF	4	330-405
"	11-28-84	MWF	3	342-410
"	11-30-84	MWF	3	333-454
"	03-01-85	MWF	4	330-389
"	03-05-85	MWF	3	340-384
"	03-08-85	MWF	1	382
"	03-12-85	MWF	2	316-322
"	03-13-85	MWF	2	324-346
"	03-14-85	MWF	2	335-357
"	03-14-85	Rb	1	430
"	03-15-85	MWF	1	310
"	03-15-85	Rb	1	415
"	03-19-85	MWF	1	331
"	03-19-85	Rb	2	383-500
"	03-21-85	MWF	2	337-370
"	03-22-85	MWF	1	325
"	03-27-85	MWF	2	336-342
"	04-01-85	MWF	1	350
"	04-02-85	MWF	4	320-365
"	04-02-85	Rb	2	423-435
"	04-03-85	MWF	2	333-385
"	04-04-85	Rb	3	419-445
"	04-09-85	MWF	3	327-347
"	04-10-85	Rb	3	358-508
"	04-11-85	MWF	3	290-349
"	04-11-85	Rb	2	431-467
"	04-12-85	MWF	6	313-338
"	04-12-85	Rb	4	357-455
"	08-01-85	LL	2	365-520
"	08-02-85	LL	1	565
"	08-06-85	LL	1	491
"	08-08-85	LL	1	505
"	08-21-85	MWF	1	285
"	08-27-85	LL	1	337
"	09-06-85	MWF	1	310
"	09-24-85	LL	3	416-533

JOCKO RIVER WEIR (continued)

Location (stream km)	Date	Species	No.	Size Range (mm)
2.0	09-25-85	LL	1	587
"	09-26-85	LL	1	530
"	09-27-85	LL	2	519-555

MISSION WEIR

Location (stream km)	Date	Species	No.	Size Range (mm)
6.0	10-01-84	MWF	2	343-366
"	10-02-84	MWF	7	311-386
"	10-03-84	MWF	19	311-374
"	10-03-84	LL	1	538
"	10-04-84	MWF	5	331-366
"	10-05-84	MWF	11	290-357
"	10-07-84	MWF	5	308-327
"	10-08-84	MWF	2	311-356
"	10-10-84	MWF	6	300-365
"	10-12-84	MWF	10	307-335
"	10-12-84	Rb	1	297
"	10-13-84	MWF	30	234-381
"	10-14-84	MWF	13	296-359
"	10-15-84	MWF	2	321-322
"	10-16-84	MWF	6	318-357
"	10-17-84	MWF	12	279-361
"	10-19-84	MWF	3	332-355
"	10-20-84	MWF	1	405
"	10-21-84	MWF	35	306-395
"	10-22-84	MWF	8	310-361
"	10-23-84	MWF	16	297-336
"	10-24-84	MWF	12	294-428
"	10-25-84	MWF	9	290-354
"	10-26-84	MWF	14	290-381
"	10-27-84	MWF	18	294-405
"	10-28-84	MWF	7	281-336
"	10-29-84	MWF	10	298-361
"	10-30-84	MWF	7	308-390
"	10-31-84	MWF	5	300-334
"	11-01-84	MWF	6	290-375
"	11-01-84	Eb	1	371
"	11-02-84	MWF	18	283-387
"	11-03-84	MWF	24	300-457
"	11-04-84	MWF	1	326
"	11-05-84	MWF	2	310-324
"	11-06-84	MWF	11	298-379
"	11-06-84	Rb	1	262

MISSION CREEK WEIR (continued)

Location (stream km)	Date	Species	No.	Size Range (mm)
6.0	11-07-84	MWF	2	298-311
"	11-08-84	MWF	5	291-409
"	11-10-84	MWF	7	297-362
"	11-11-84	MWF	2	335-385
"	11-12-84	MWF	11	314-411
"	11-13-84	MWF	5	324-432
"	11-13-84	LL	1	378
"	11-15-84	MWF	3	333-366
"	11-19-84	MWF	5	322-429
"	11-24-84	MWF	7	318-363
"	11-28-84	MWF	1	368
"	11-29-84	MWF	1	335
"	11--30-84	MWF	3	346-372
"	02-25-85	MWF	16	313-405
"	02-25-85	Rb	2	380-388
"	02-27-85	Rb	3	346-380
"	02-28-85	MWF	7	318-369
"	02-28-85	LL	1	501
"	02-28-84	Rb	1	412
"	03-01-85	MWF	9	294-380
"	03-01-85	Rb	2	346-361
"	03-05-85	Rb	1	414
"	03-05-85	MWF	5	320-383
"	03-06-85	MWF	5	299-371
"	03-06-85	Rb	1	427
"	03-07-85	MWF	5	316-375
"	03-07-85	Rb	1	413
"	03-08-85	MWF	4	318-355
. "	03-12-85	MWF	3	318-350
"	03-12-85	Rb	1	455
"	03-13-85	MWF	3	350-375
"	03-14-85	MWF	6	321-359
"	03-15-85	MWF	6	319-357
"	03-15-85	Rb	2	365
"	03-19-85	MWF	6	306-370
"	03-19-85	Rb	2	354-434
"	03-20-85	MWF	14	269-360
"	03-21-85	MWF	13	295-375
"	03-21-85	Rb	2	417-452
"	03-22-85	MWF	2	334-378
"	03-26-85	MWF	7	305-368
"	03-26-85	Rb	1	409
"	03-27-85	Rb	3	406-420
"	03-28-85	MWF	2	322-355
"	03-28-85	Rb	1	504

MISSION CREEK WEIR (continued)

Location (stream km)	Date	Species	No.	Size Range (mm)
6.0	03-29-85	MWF	4	337-350
"	04-02-85	MWF	16	299-363
"	04-02-85	Rb	3	376-410
"	04-03-85	MWF	2	346-360
"	04-03-85	Rb	3	393-445
"	04-04-85	MWF	3	312-325
"	04-04-85	Rb	2	338-365
"	04-05-85	MWF	1	330
"	04-09-85	MWF	10	325-396
"	04-09-85	Rb	3	415-462
"	04-10-85	MWF	5	303-346
"	04-10-85	Rb	2	370-448
"	04-11-85	MWF	3	290-365
"	04-11-85	Rb	1	471
"	04-11-85	LL	1	515
"	04-12-85	MWF	1	158
"	04-12-85	Rb	1	367
"	04-15-85	MWF	2	315-331
"	05-15-85	Rb	1	466
"	04-16-85	Rb	2	403-475
"	04-17-85	MWF	3	320-367
"	04-17-85	Rb	1	340
"	04-18-85	MWF	8	314-358
"	04-18-85	Rb	1	376
"	04-1 9-85	MWF	2	341-346
"	04-22-85	MWF	1	310
"	04-23-85	MWF	1	320
"	04-26-85	MWF	2	327-402
"	04-26-85	Rb	1	424
"	04-30-85	MWF	2	310-323
"	05-07-85	MWF	3	281-303
"	05-08-85	MWF	9	310-342
"	05-08-85	DV	1	350
"	05-09-85	MWF	3	326-297
"	05-10-85	MWF	8	300-360
"	05-14-85	MWF	6	301-354
"	05-17-85	Rb	1	384
"	05-22-85	Rb	2	387-392
"	05-24-85	MWF	3	333-343
"	05-29-85	MWF	2	287-311
"	06-05-85	MWF	1	292
"	06-06-85	MWF	1	293
"	06-07-85	MWF	9	280-403
"	06-11-85	MWF	7	303-380
"	06-12-85	MWF	3	350-361

MISSION CREEK WEIR (continued1

Location (stream km)	Date	Species	No.	Size Range (mm)
6.0	06-l 3-85	MWF	3	311-317
"	06-14-85	MWF	1	342
"	06118-85	MWF	3	319-361
"	06-19-85	MWF	3	305-326
"	06-20-85	MWF	1	245
"	06-21-85	MWF	2	304-349
"	08-02-85	MWF	2	335-338
"	08-07-85	MWF	1	391
"	08-08-85	MWF	1	325
"	08-13-85	MWF	3	311-365
"	08-14-85	MWF	1	356
"	08-15-85	MWF	2	308-351
"	08-16-85	MWF	1	317
"	08-19-85	MWF	5	295-341
"	08-21-85	MWF	3	318-372
"	08-22-85	MWF	2	299-318
"	08-23-85	MWF	6	312-380
"	08-27-85	MWF	2	304-375
"	08-28-85	MWF	2	303-312
"	08-28-85	Rb	1	421
"	08-30-85	MWF	3	320-344
"	09-06-85	MWF	4	331-412
"	09-11-85	MWF	5	294-345
"	09-11-85	Rb	1	420
"	09-12-85	MWF	1	305
"	09-13-85	MWF	14	296-390
"	09-17-85	MWF	6	270-330
"	09-18-85	MWF	10	302-360
"	09-19-85	MWF	1	293
"	09-20-85	MWF	1	335
"	09-20-85	Rb	1	382
"	09-24-85	MWF	12	295-344
"	09-25-85	MWF	10	310-355
"	09-27-85	MWF	15	292-336
"	10-02-85	MWF	3	296-331

APPENDIX K

Mean (x) range, and maximum change (DT) of bottom water temperatures in South Bay of Flathead Lake, May-August 1985.

Appendix K. Mean (x) range, and maximum change (DT) of bottom water temperatures in South Bay of Flathead Lake, May-August 1985.

Locatlon	Day	Hay				June				July				August			
		x	Min	Max	DT	ii	Min	Max	DT	x	Min	Max	DT	x	Min	Max	DT
Polson Bridge	5	-	-			12.3	11.5	13.0	1.5	19.5	19.0	20.0	1.0	21.3	21.0	61.5	0.5
	10	-	-			12.0	11.5	12.5	1.0	21.5	21.0	22.0	1.0	18.5	18.0	19.0	1.0
	15	-	-			12.3	12.0	12.5	0.5	21.8	21.0	22.5	1.5	16.8	16.5	17.0	0.5
	20	13.8	13.0	14.5	1.5	15.0	14.5	15.5	1.0	22.3	22.0	'22.5	0.5	17.5	17.5	17.5	0.0
	25	14.5	14.b	15.0	1.0	15.5	15.0	16.0	1.0	22.8	22.5	23.0	0.5	17.8	17.5	18.0	0.5
	30	13.5	13.0	14.0	1.0	18.0	1'1.5	18.5	1.0	22.3	22.0	22.5	0.5	18.5	18.5	18.5	0.0
Blrd Point	5					10.8	9.5	12.0	2.5	19.5	18.0	21.0	3.0	21.0	21.0	21.0	0.0
	10					11.5	10.5	12.5	2.0	21.0	19.5	22.5	3.0	17.8	17.5	10.0	0.5
	15					13.3	12.5	14.0	1.5	22.5	22.0	23.0	1.0	17.0	17.0	17.0	0.0
	20	12.5	10.0	15.0	5.0	15.0	14.0	16.0	2.0	21.8	21.5	22.0	0.5	17.3	17.0	17.5	0.5
	25	13.8	12.0	15.5	3.5	15.8	15.5	16.0	0.5	22.3	22.0	22.5	0.5	17.5	17.0	18.0	1.0
	30	13.3	13.0	13.5	0.5	17.5	17.0	18.0	1.0	22.3	22.0	22.5	0.5	19.0	18.5	19.5	1.0
Little Bull Island	5	-	-			10.0	9.0	11.0	2.0	17.5	16.0	19.0	3.0	19.8	19.5	20.0	0.5
	10					8.8	7.5	10.0	2.5	18.3	15.5	21.0	5.5	-	-	-	-
	15					8.3	6.5	11.0	4.5	20.5	20.0	21.0	1.0	-	-	-	-
	20	8.3	7.5	9.0	1.5	11.5	9.5	13.5	4.0	21.0	21.0	21.0	0.0	-	-	-	-
	25	11.0	8.0	14.0	6.0	13.5	13.5	13.5	0.0	20.5	20.0	21.0	1.0	-	-	-	-
	30	9.0	6.0	12.0	6.0	16.3	16.0	16.5	0.5	21.0	21.0	21.0	0.0	-	-	-	-
Stone Ouarry Bay	5	--								21.8	20.5	23.0	2.5	21.5	21.0	22.0	1.0
	10									24.0	23.0	25.0	2.0	18.0	17.5	18.5	1.0
	15					16.0	15.0	17.0	2.0	23.0	22.0	24.0	2.0	17.8	17.0	18.5	1.5
	20	-	-			18.0	17.0	19.0	2.0	23.0	22.0	24.0	2.0	18.8	18.5	19.0	0.5
	25	-',	-			15.5	15.0	16.0	1.0	23.8	23.0	24.5	1.5	18.8	18.0	19.5	1.5
	30	-	-			19.3	10.5	20.0	1.5	22.0	21.5	22.5	1.0	19.5	19.0	20.0	1.0