August 1986

LOWER FLATHEAD SYSTEM-FISHERIES STUDY INTERIM

Final Report 1986

DOE/BP-39830-2

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views of this report are the author's and do r necessarily represent the views of BPA.

This document should be cited as follows:

Bradshaw,William H., Joseph M. DosSantos, James M. Darling, Ian R. Waite, P. David Cross, Confederated Salish and Kootenai Tribes of the Flathead Indian Reservation, Thomas Vogel,Project Manager, Bonneville Power Administration, Division of Fish and Wildlife, U. S. Department of Energy, Contract DE-AI79-1983BP39830, Project No. 1983-l, 104 electronic pages (BPA Report DOE/BP-39830-2)

This report and other BPA Fish and Wildlife Publications are available on the Internet at:

http://www.efw.bpa.gov/cgi-bin/efw/FW/publications.cgi

For other information on electronic documents or other printed media, contact or write to:

Bonneville Power Administration
Environment, Fish and Wildlife Division
P.O. Box 3621
905 N.E. 11th Avenue
Portland, OR 97208-3621

Please include title, author, and DOE/BP number in the request.

LOWER FLATHEAD SYSTEM-FISHERIES STUDY

INTERIM REPORT 1986

Prepared by Project Biologists

William H. Bradshaw
Joseph M. DosSantos
James M. Darling
Ian R. Waite

Principle Investigator

P. David Cross

Research Conducted By

Confederated Salish and Kootenai Tribes

of the

Flathead Indian Reservation

Pablo, Montana

Prepared For

Thomas Vogel, Project Manager
U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
Contract DE-AI79-83BP39830
Project No. 83-l

August 1986

EXECUTIVE SUMMARY

From 1 December 1985 through 31 May 1986 the aquatic environment of the Lower Flathead System study area was in deep winter. Minus twenty degree temperatures were recorded in November 1985. Winter conditions resulted in limited ability to make field observations through much of the period covered by this interim report.

During the winter months Study activities were directed toward planning the up-coming field season, equipment repair and maintenance, data entry and analysis, winter ice fishing survey, limited pike radio tracking, and annual budget development.

Early spring activities included monitoring of rainbow trout (Salmo gairdneri) runs on the Jocko River and Mission Creek. High water and undercutting at the Jocko weir resulted in only 5 fish being captured. Thirty-six rainbow; trout were passed through the Mission weir. Both weirs were permanently removed in the month of May prior to spring run-off.

In May 1986 low flow measurements (3,200 cfs) for the IFIM portion of the study were completed at the Sloans and McDonald sites. A second flow of approximately 10,000 cfs was scheduled fcr July. Upon completion of all flow measurements, data entry for computer modeling will be initiated.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

SOUTH BAY

TABLE OF CONTENTS (CONT.)

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

This interim 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 from 1 December 1985 through 31 May 1986. The study began in December of 1982 and when completed in December 1987 will fulfill program measures 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 Flahead System Fisheries Study (DosSantos et al. 1983). Closed in 1938, Kerr Dan controls Flathead Lake levels between 878.7 meters (m) (2888 ft.) and 881.8 m (2893 ft.) and discharges into the lower Flathead River. Kerr Dam is a 60.6 m high concrete arch SOructure located 7.2 kilometers (km) downstream from the outlet of Flathead Lake. The facility is used primarily as a peaking operation with sore use for lower level base-load (prepared answering testimony of Don Gregg presented to the U.S. Federal Energy Regulatory Commimmission 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 (*Oncrhynchus nerka*) cf Flathead Lake, (Leathe and Graham 1982, Decker-Fess 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 culpeafornis), largemouth bass (Micropterus samonides) 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 resources 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.

MAIN RIVER

By

Joseph M. 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 100 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 moraine 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 cf 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. Eased on general valley characteristics, gradient, and channel morphology, the lower Flathead can be divided into four distinct river reaches (Figure 1).

Reach I of the lower Flathead extends from Kerr Dam (River

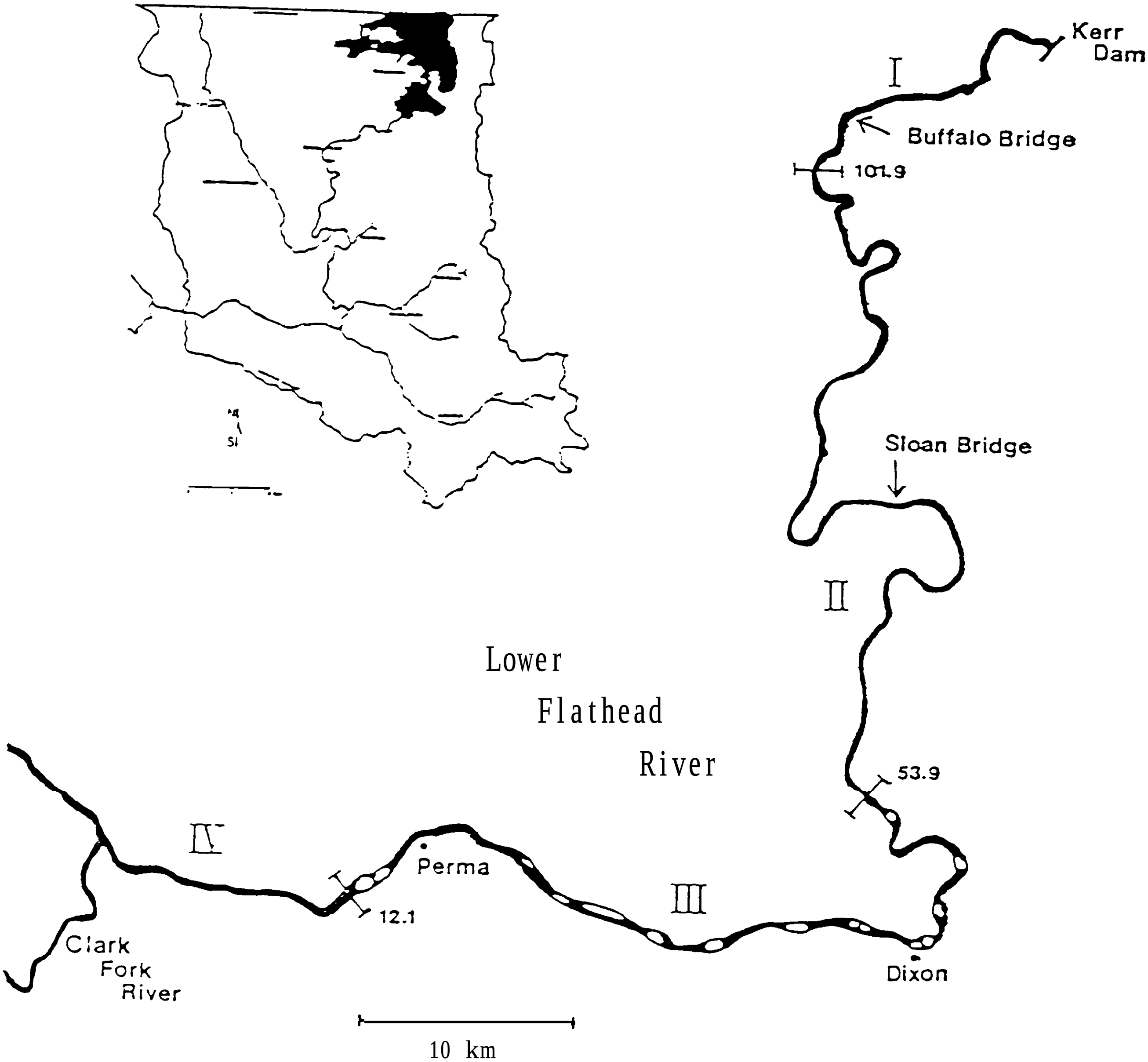

Figure 1. Reach breaks of the lower Flathead River.

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 secticn, 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 misture 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 (RX 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 Eitterroct River enters this study section at RK 72; its delta constricts the main river channel tc approximately one half its average width, forming a fast turbulent chute. Pablo A

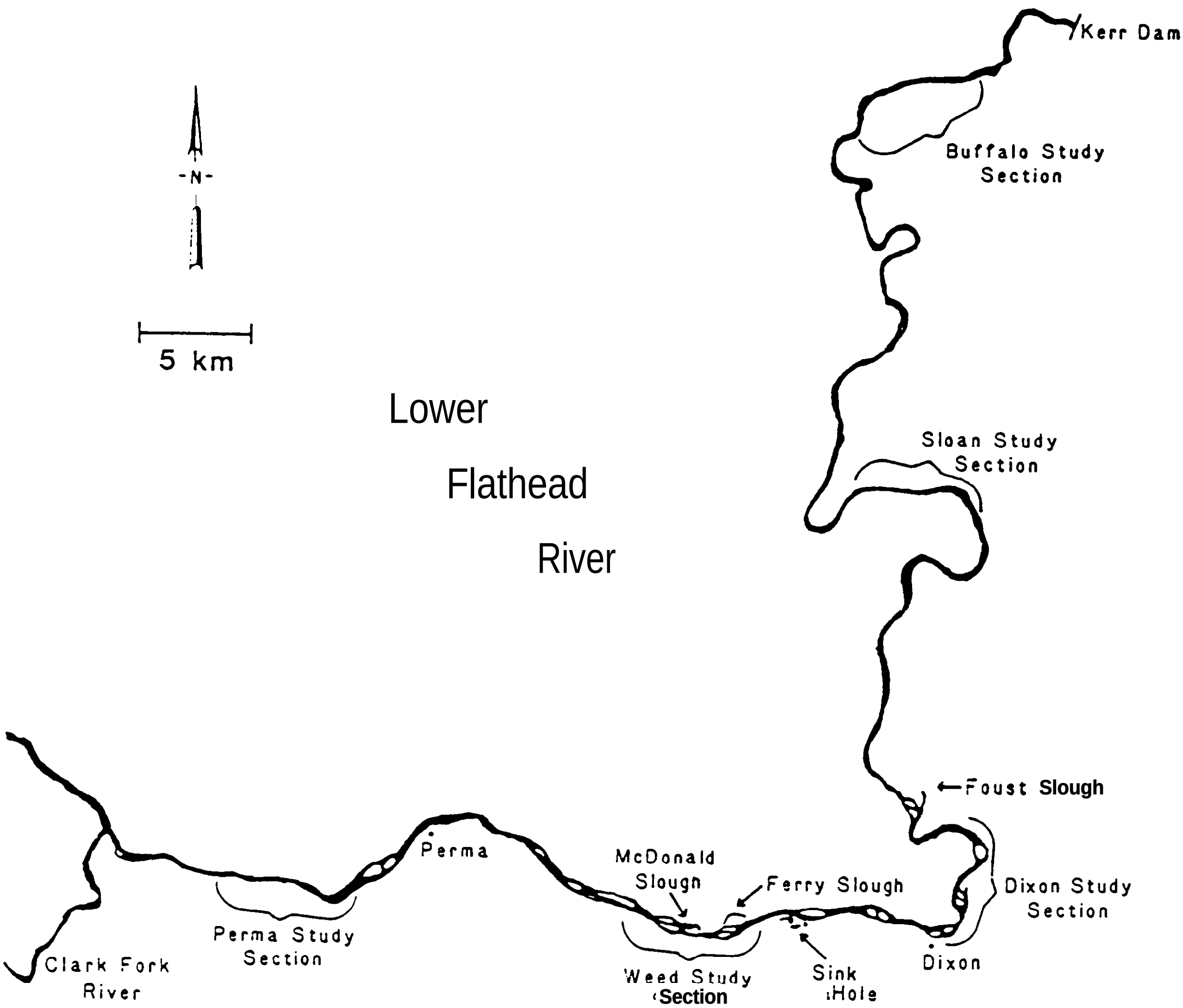

Figure 2. Permanent study sections and important backwater areas of the lower Flathead River.

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).

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 C.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 twc 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 5.5 and represents 53.3% 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 accesspoint is Robertson Creek (RK 6.4) (Figure 2).

METHODS

Physical Habitat Evaluation

Kerr Dam Flow Releases

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. Daily water level fluctuations at specific spawning areas were calculated as described by DosSantos et al. (1983).

Water Temperatures

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.

Movement of Radioed Northern Pike

Radio-tagged northern pike were tracked using a hand-held directional loop antenna and a programable scanning receiver (Darling et 2.1. 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. Radioed fish were sighted on many occasions. Pike locations were pinpointed by gradually reducing the receiver's gain. Total water depth and predominate substrate type were recorded at each location. Water velocities were also measured at the identified holding sites using a Marsh McBirney Model 201 electronic current meter. Using a 1.2 m top-setting wading rod, the probe was lowered 1.2 m into the water and turned to record the maximum water velocity.

Spawning Surveys

The inlets of three suspected northern pike spawning areas were trapped from 21 April to 2 Kay 1986, using 1.2 m diameter double-throated fyke nets. One off-channel, shallow bench of the main river was trapped using similar equipment. Experimental gill nets were used from 25 March to 18 April 1986 in deep water holding areas to capture pre-spawning pike. Captured pike were weighed, measured, sexed, tagged and released.

The main river was floated in the spring and likely locations surveyed to identify use by spawning salmcnids.

Instream Flow Incremental Method

The Water Surface Profile model (Bovee 1982) was selected to evaluate instream flow needs in the lower Fiathead River because of channel configuration and low gradient. It had earlier been determined that field measurements taken at two study sites at flows of 91 and 283 m^3/second (3,200 and 10,000 cfs) would enable the model to predict effects on weighted useable area (WUA) from 36 to 708 m^3/second (1,280 to 25,000 cfs).

Frequent communication between the Instream Flow Group in Fort Collins, Colorado was maintained during study plan develcpment. On 29 January 1986 an interagency coordination meeting was held to present, discuss and review the study plan. Ferscnnel from the U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey, University of Montana Eiclogical Station, Bureau of Indian Affairs and Montana Power Company attended.

Details on the instream flow study plan development, river segmentation, study site selection and transect placement are reported in the Lower Flathead System Fisheries Study 1985 annual report (Pajak et al. 1986).

RESULTS

Physical Habitat Evaluation

Kerr Dam Flow Releases

Monthly low, mean, and high river discharges recorded by the USGS at RK 115 from 1 December 1985 through 31 May 1986 are presented in Table 1. Mean daily discharges from Kerr Dam were in excess of 204 m^3/second (7,000 cfs) during April and May of 1986. From 18 May to 22 May 1986, discharges from Kerr Dam averaged 91 m^3/second (3,200 cfs) as requested by this study for IFIM purposes. From 23 May to 31 May 1986, flows averaged 601 m^3/second (21,211 cfs).

Table 1. Monthly low, mean and high average daily discharges from Kerr Dam recorded by USGS at RK 115 from 1 December 1985 through 31 May 1986.

	Discharge (cfs) minimum	mean	maximum
Dec.	1,850	10,068	13,600
Jan.	3,850	11,313	13,700
Feb.	2,490	10,943	13,600
Mar.	2,240	9,226	14,000
Apr.	3,330	11,540	13,700
May	2,920	12,685	38,000

Temperature Monitoring

Monthly low, mean, and high river water temperatures recorded at Sloan (RK 71.4) and Ferma (RK 17.6) from 1 December 1985 through 31 May 1986 are presented in Table 2. Thermograph malfunction resulted in a loss of data for May 1986 at the Sloan site. The USGS discontinued all temperature monitoring at their gage house (RK 115) directly below Kerr Dam as of 1 October 1983.

Table 2. Monthly low, mean, and high river water temperature (°C) recorded at Sloan (RK 71.4) and Ferma (RK 17.6) from 1 December 1985 to 31 May 1986.

		Sloan	Perma
Dec.	max	3.1	2.1
	mean	2.5	1.3
	min	1.6	0.6
Jan.	max	3.6	2.9
	mean	2.7	2.1
	min	2.0	0.8
Feb.	max	3.7*	3.6*
	mean	2.3	2.c
	min	1.8	0.8
Mar	max	7.1	7.3
	mean	4.7	4.7
	min	2.8	2.8
Apr.	max	9.8	9.6
	mean	7.3	7.2
	min	5.0	5.4
May	max		11.6
	mean		10.9
	min		10.2

*indicates incomplete daily recordings for that month and station.

Spawning Surveys

Twenty three northern pike were captured and tagged from 25 March to 18 April 1986 (Table 3). Four of these fish (17%) were recaptures from previous sampling periods. Of the mature spawners captured and sexed, 39% were males and 17% were females, resulting in male-female sex ration of 2.2 to 1.0. Fish averaged 607 mm TL.

Table 3. Gill net catches of target fish species captured during the spring of 1986.

Location	Date	Species	No. Captured	Range in Size (mm)
Goose Bend	03-25-86	NP	1	834
RK 70.5	03-28-86	NP	3	506-795
Pike Hole	03-31-86	NP	9	403-936
Sink Hole	04-07-86	NP	5	370-630
Sloan #l	04-11-86	NP	2	653-762
		DV	1	379
Goose Bend	04-15-86	LL	1	606
Agency 1	04-18-86	NP	3	414-720

Northern Pike Movement

Two additional northern pike were radio tagged in March 1986: a 795 mm TL male and a 936 mm TL female. Increasing the total number of radioed pike to 11. From 1 December 1985 through 31 May 1986, seven fish were still transmitting, with four remaining in essentially fixed locations (#020, 223, 293, 553). Pike #653, a male, maintained position at RK 30.6 until 20 March 1986 and by 3 April 1986 had moved upstream to RK 48.9, a known spawning area. Pike 8163, a male, moved downstream from his usual holding area (RK 74.3) to the mouth of the Little Bitterroot River by 28 May 1986. Pike #392, a female, moved upstream from her usual holding area (RK 70.5) to the mouth of the Little Bitterroot River (RK 72.4) also by 28 May 1986. This male-female pair were initially radio tagged at RK 72.1 on 11 April 1984.

Instream Flow Incremental Method

Several changes in transect placement were made at the McDonald study site to better reflect habitat types. Two transects were added, two were dropped and one moved (Figure 3:. The revised transect arrangement allows fcr better overall habitat representation and quantification of flcws through the site. The Sloan study section remains as previously described (Pajak et al. 1986).

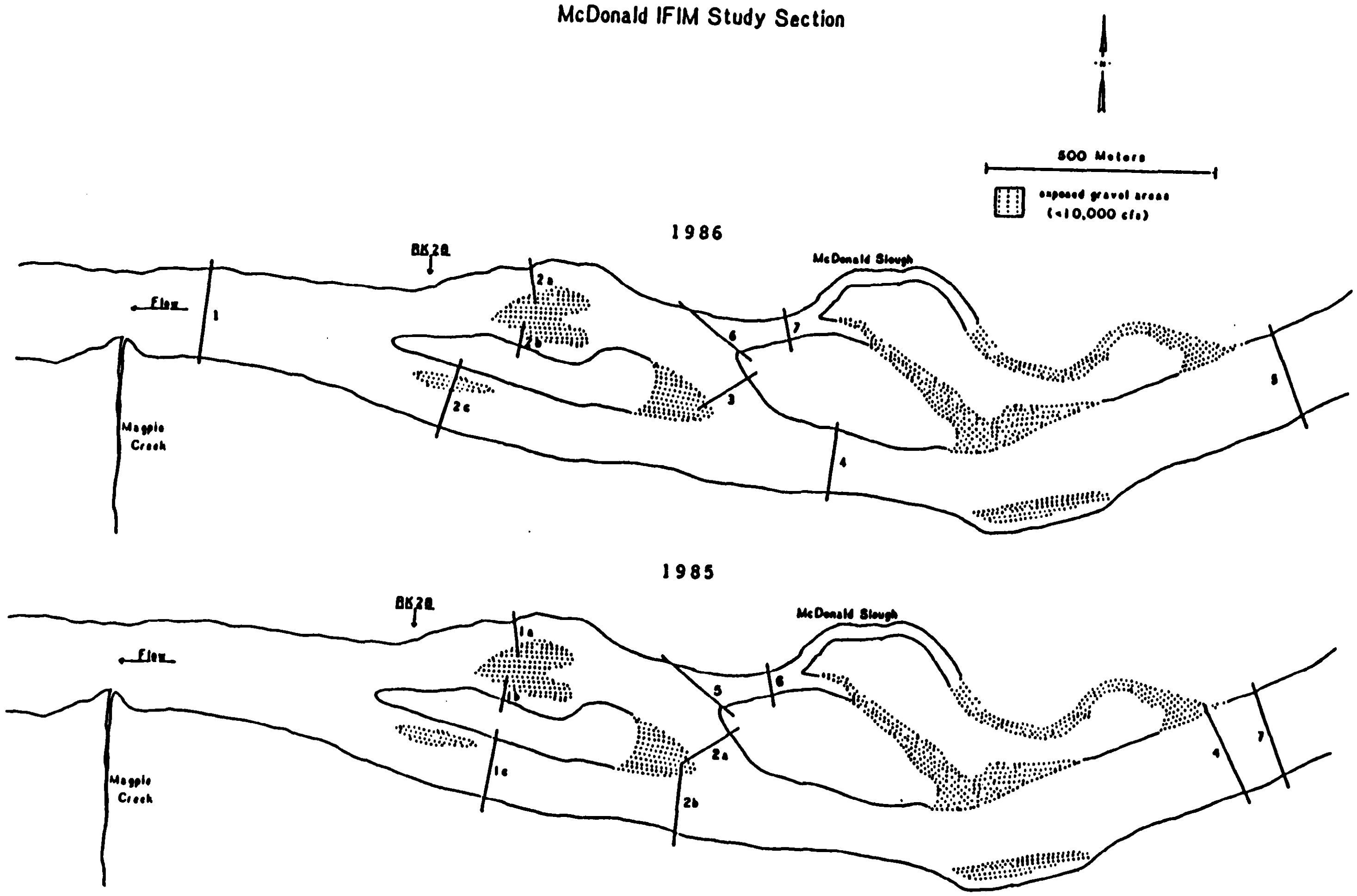

Figure 3. The McDonald IFIM study section showing original transect locations (1985) and revised 1986 transects.

A requested flow of 91 m^3/second (3,200 cfs) was provided by Montana Power Company beginning 19 May 1986, field measurements began on 20 May 1986. Twenty four hours were allowed for stabilization of flows at the study sites. Using two field crews, three working days were required to evaluate the Sloan and McDonald sites.

Measured river discharges varied by 22.8 m^3/second (807 cfs) at the Sloan study site and 17.4 m^3/second (616 cfs) at the McDonald site. A total of 180 and 261 observations were made to evaluate instream cover types and substrate composition at the Sloan and McDonald sites, respectively. A summarization of physical measurements obtained during this low flow are presented in Table 4.

Table 4. Summary of physical measurements taken for IFIM analysis.

	Transect	Transect length(ft)	Estimated Discharge(cfs)	Maximum Depth(ft)	Maximum Average Water Velocity(ft/sec)	Number of Verticles
Sloan	1	641.4	3,386	4.7	5.65	30
	2	5a.4	3,193	4.6	3.98	28
	3	457.5	2,899	19.4	1.42	27
	4	472.1	3,539	17.3	2.21	29
	5	557.3	3,520	8.9	3.98	28
	6	648	3,706	7.6	5.65	38
						180
McDonald	1	784	4,558	5.6	2.15	31
	2a	m . 5	3,373	11.5	3.62	29
	a	166	94	1.3	1.2	35
	2c	541.8	903	4.4	1.88	29
	3	493.6	3,131	5.2	4.2	31
	4	526.9	4,433	13.8	1.75	30
	5	813.9	4,650	6.9	2.81	27
backwater transects	6	666.3	*	2.55	*	24
	7	328.4	*	9.6	*	25
						261

DISCUSSION

Average discharges for April and May 1986 provided ample habitat for nothern pike spawning. Run-off increased discharge in the last week of May through the month of June and may have influenced the quality of known spawning areas by increasing water velocities through them.

River water temperatures recorded during the above mentioned time period were consistent with previous years data, however, winter water temperatures were slightly higher (<1.0°C).

Trapping and netting operations for northern pike were abbreviated this year due to instream flow work. Catches of adult fish were therefore less than in previous years. New areas were trapped, and population levels are no doubt less than found in the central areas of pike activity.

Movements of radio tagged pike were consistent with previous years data. Fish already in the vicinity of known spawning areas before April 1 showed no movement. Fish #163, 392 and 653 exhibited movements to known spawning areas. A complete evaluation of northern pike habitat and movement data will be presented in this study's final report.

All data collected at the requested 91 m^3/second (3,20C cfs) discharge for IFIM analysis have been proofed and transferred to ccnputer entry forms. Evaluation of various flow regimes will be reviewed by the final report of this study.

TRIBUTARIES

By

James E. Darling

TRIBUTARIES

DESCRIPTION OF STUDY AREA

Glacial till and lake bottom sediments from prehistoric Lake Hissoula underlie the tributary study area. Much of the runoff from the Mission Mountains descends through porous 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 tc 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 1976), 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 cf 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 ccntinues 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 Eison Range. The stream then winds through an erosive clay-bank canyon and receives Moiese Valley irrigation return before reaching the ilathead 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 regu lation by the FIIP.

Crow Creek

North and South Crow Creeks flow west from the Mission Mountains converging to form the main stem cf Crow Creek approxima tely cne 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 cf 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 ELtterroot 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. Low rainfall and overgrazing have limited vegetation cover and aggravated serious erosion problems throughout the drainage.

Consequently, the Little Bitterroot is turbid year-round and contributes considerable sediment to the lower ilathead River. Average annual flows have not been reported; however, the river is dewstered in several areas by summer irrigation withdrawals.

Nor thern pike, the promary 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 cn the Jocko River, five on Mission Creek, four on Post Creek, one on Crow Creek, and five on the Little Bitterroot River (Figure 4). 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 A.

Figure 4. Reach boundaries established on five major tributaries to the lower Flathead River.

TRIBUTARIES

METHODS

Spawning and Migration

Weirs

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), were closed for the winter on 23 November 1985. They resumed operation on 10 February 1986. Jocko weir was permanently removed 15 May, and Mission weir on 29 May 1986.

Redd Surveys

During December, the Jocko River was surveyed for brown trout (*Salmo trutta*) redds from Finley Creek (km 30.7) to the mouth. 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 Surveys

The 5.6 km of Crow Creek below Lower Crow Reservoir were electrofished for spawning rainbow trout (*Salmo gairdneri* during April 1986. Two days were required using a Coffelt BP-1C backpack electroshocker. Redds were counted during these surveys.

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.

Water Temperatures

Continuously recording, 90-day thermographs continued operating near the mouths of four tributaries: the Jocko River, Mission Creek, Crow Creek, and the Little Eitterroot River.

Instream Flow Incremental Methodology (IFIM)

A Statement of Work for applying the IFIM to the main stems of the Jocko River, Mission Creek, and Post Creek was prepared and submitted as a request for proposals from consulting firms.

TRIBUTARIES

RESULTS

Spawning and Migration

Weirs

Weir traps on the Jocko River (km 2) and Mission Creek (km 6) were both closed on 22 November 1985, and both resumed operation on 10 February 1986. High water from early run-off forced closure of Jocko weir from 21 February to 18 March and all but a few days during April. Mission weir was closed from 24 February to 3 March. Both weirs were removed during May 1986.

At Jocko weir, five rainbow trout, one brown trout, and 21 mountain whitefish (*Prosopium williamsoni*) were captured this spring (Appendix B). Thirty-six rainbow trout, one brown trout, and 41 mountain whitefish passed the Mission weir this spring.

Redd Surveys

A total of 301 brown trout redds were counted during a December redd survey of the Jocko River from the confluence of Finley Creek (km 31) to the river's mouth. Two hundred twenty-nine (76 percent) were found in the 12 km between Valley Creek (km 19) and Finley Creek. Poor visibility due to turbid water and cloud cover, combined with the early onset of very cold temperatures, prevented redd surveys on Mission and Post Creeks. Five rainbow trout redds were counted during the April survey of lower Crow Creek.

Crow Creek Spawner Survey

On 16 and 17 April 1986, 41 spawning rainbow trout and 14 brown trout were captured and released in the 5.6 km of Crow Creek below Lower Crow Reservoir (Appendix B). Twenty rainbows and three browns were recaptures from earlier spawner surveys. Sixty-six percent (27) of the rainbows were found above the Moiese A Canal diversion (km 4.8).

Movement

Notable among the recaptures recorded between 1 December 1985 and 31 May 1986 (Appendix C) were: a northern pike (Esox lucius) that moved 27 km downstream from the Little Bitterroot River (km 3) to the Flathead River near Dixon (km 45); a brown trout that moved 11 km upstream from the Jocko weir to the Ravalli area; a rainbow trout that moved 29 km from the Flathead River near Sloan Eridge (km 74) to Mission Creek weir (km 6); and a rainbow that moved 37 km from Crow Creek into Mission Creek weir.

Water Temperatures

Mean water temperatures near the mouths of the four major tributaries were coldest during December 1985 and warmest during May 1986 for the period of this report (Table 5).

Table 5. Mean monthly water temperatures (°C) recorded from 1 December 1985 through 31 Kay 1986 near the mouths of four major tributaries to the lower Flathead River.

	Dee	Jan	Feb	Mar	Apr	May
Jocko River	2.6	3.8"	3.7*	6.7	8.0	10.4
Mission Creek	1.4	2.5*	2.2*	7.1	9.1	13.1
Crow Creek	1.0	0.8*	1.1*	4.2	7.2	8.8*
L. Bitterroot	0.7	0.8*	-	7.9*	9.6	15.5

“Daily readings incomplete.

Instream Flow Incremental Methodology (IFIM)

Because funding was withheld, the Statement of Work (Appendix D) for applying the IFIM to the Jocko River, Mission Creek, and Post Creek was withdrawn, and IFIM work was begun by Lower Flathead System Study personnel.

TRIBUTARIES

DISCUSSION AND CONCLUSIONS

Monitoring of rainbow trout spawning runs from the lower Flathead River into the Jocko River was hampered by high water, which forced trap closure and undermined several weir modules. Repairs were made as soon as the water dropped, but how many trout may have bypassed the trap is unknown. Comparing this spring's run in the Jocko with runs during 1984 (Table 6) indicates some trout were missed. The Mission Creek run of rainbows during 1986 was comparable to previous years.

Table 6. Summary of rainbow trout captures at Jocko River and Mission Creek weirs.

Year	Jocko weir	Mission weir
1984	32	27
1985	18	47
1986	5	36

Fifty-four percent fewer brown trout redds were counted in the Jocko River this December compared to fall 1984. This decline may reflect a natural variation in year-class strength of resident brown trout spawners, especially in the critical 12 km reach between Valley and Finley Creeks. Runs of migratory brown trout from the lower Flathead River did not show a similar variation. (Twenty brown trout were trapped at Jocko weir during fall 1984, 27 during fall 1985.)

Although 41 rainbow trout spawners were counted in Crow Creek during April 1986, only 5 redds were seen. Most of the spawners were found within one km of Crow Dam where the water released from the hypolimnion was probably warmer, but where channel substrate is larger and more armored, i.e. less suitable for redd construction.

Tag returns recorded from 1 December 1985 through 31 May 1986 further support the conclusions that exchange between the main river and major tributaries is common, and that more rainbow trout enter Mission Creek while more brown trout enter the Jocko River (Pajak et al. 1986). One rainbow trout's moving from Crow Creek into the lower Flathead River and then into Mission Creek confirms there is interchange between tributaries.

SOUTH BAY

By

William H. Bradshaw

and

Ian R. Waite

DESCRIPTION OF STUDY AREA

Field investigations for the lake portion of this study are centered in South Eay cf 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 Pclson delineates the southern boundary of the study area. Total surface area at maximum elevations is approximately 5,336 ha.

South Bay is comparatively 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 drawdcwn, 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 (Micropterus salmoides) and major ice and spring fisheries fcr yellow perch (Perca flavescens). 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 (Coregonus clupeaformis), bull trout (Salvelinus confluentus), and cutthroat trout (Salmo clarki), 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

Water Quality

Measurements of temperature, dissolved oxygen, pH and conductivity were continued at permanent sites located within south Bay. During January and February measurements were taken only from Pclson Bridge due to winter ice conditions. Eeginning in April water quality measurements were completed within the five permanently inundated evaluation areas (Figure 5). May allowed the start of bimonthly measurements within each cf the fourteen evaluation areas. All water quality measurements were taken at the surface and bottom in shallower areas, with the addition of mid-water column measurements at deeper areas. Weather conditions, time of day, and secchi visibility were also recorded at each station. One Ryan Mode 1-J thermograph (90-day) was utilized at the Polson Bridge to record continous temperature measurements.

Fish Distribution

A variety of methods were used to determine fish distribution patterns by species, life stage, habitat type, and evaluation period. Data from this sampling will be used tc assess the relative importance of available habitat types and their relationship tc changing lake elevaticns.

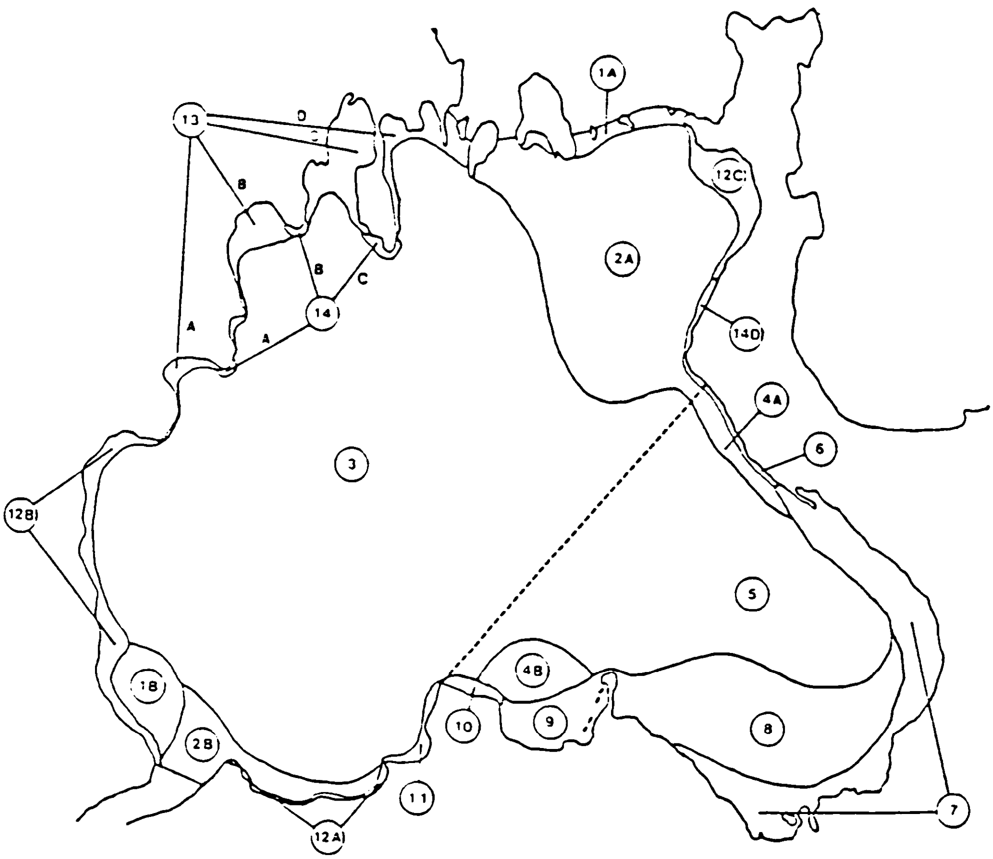

Figure 5. Evaluation areas based on depth and substrate characteristics in South Bay.

Gill Netting

Night gill net samples for period I began in April after ice-out. Samples were completed in April and May within the five permanently inundated evaluation areas (Evaluation Nos. 1-5, Figure 6). Five gill net sets per evaluation area were set after sunset and allowed to fish for approximately one hour. Upon hauling nets, the total catch was recorded by species. Morphometric data and scale samples were collected as needed for target species and salmonids only. All of the latter fish were tagged prior to their release.

In an effort to minimize sampling variability, all nets were fished simultaneously, were placed perpendicular to prevailing bottom contours, and were fished fcr a set 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 long, and ranged in square mesh sizes from 1.9 cm to 5.1 cm.

Beach Seining

From early tc mid-May beach seine samples were collected from 16 locations during evaluation period I (Figure 7). 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. Depending on the size and composition of individual catches, several procedures were used to obtain size class distribution data. When seine catches

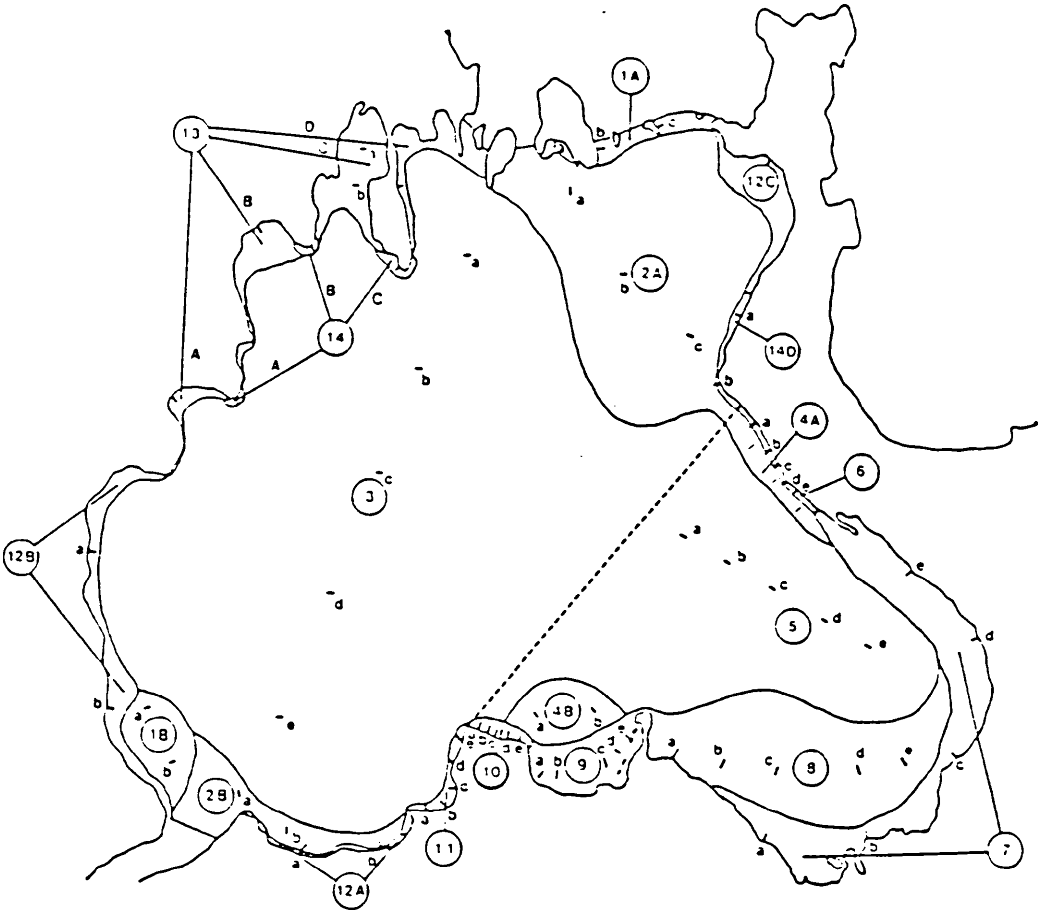

Figure 6. Gill net sample locations in South Bay.

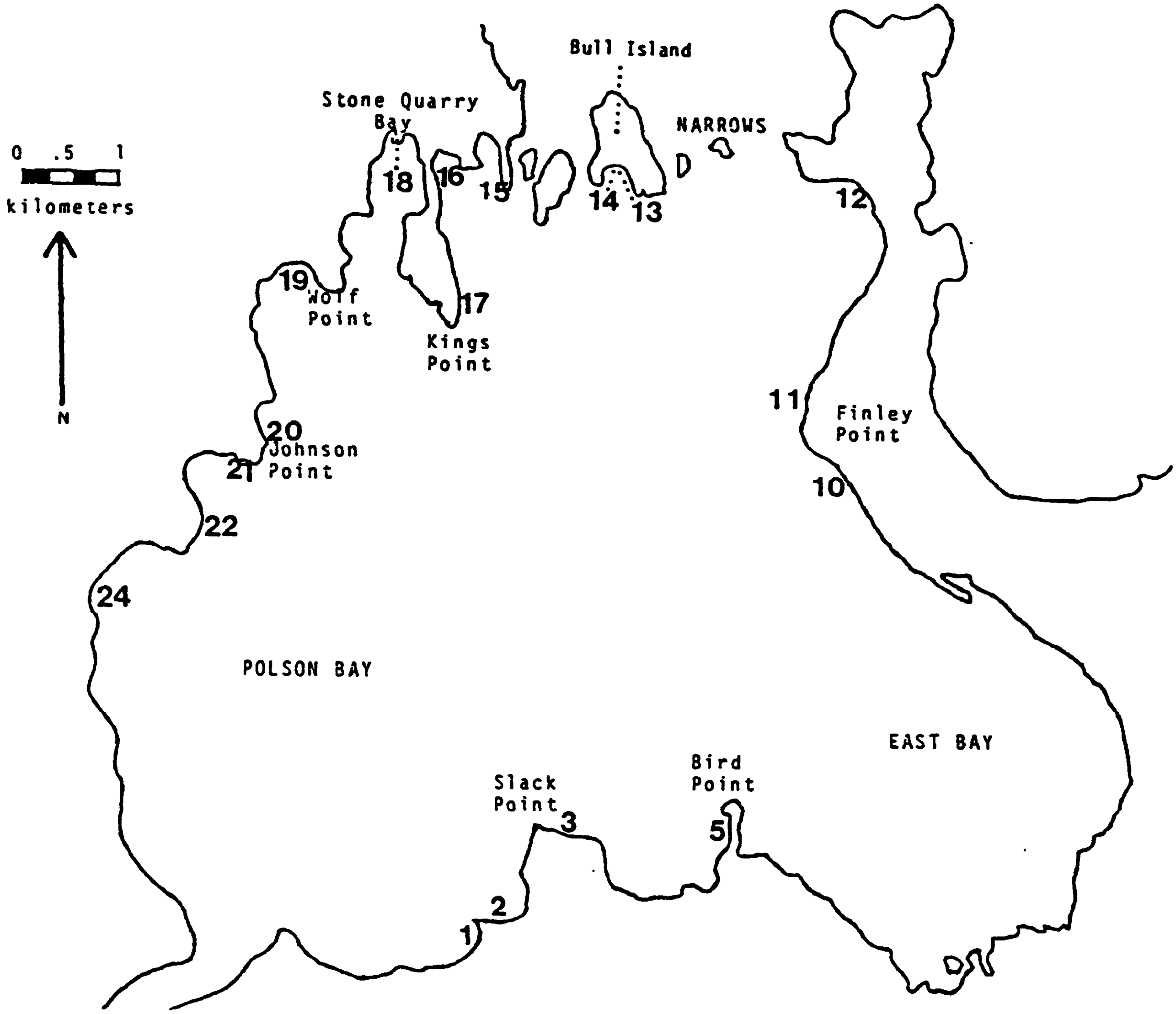

Figure 7. South Bay beach seine stations for the period 1 December 1985 through 31 May, 1986, Flathead Lake, Montana.

were small, the total length (TL) of all fish was measured to the nearest millimeter. If catches were larger (e.g. N > 50) and appeared homogenous with respect to size class distribution, a subsample was measured (N = 25-35), and the remainder of the catch simply counted. For very large catches (e.g. N > 1000) of homogenous size class distribution, a subsample of fish was measured (TL), and a numeric estimate of remaining fish was obtained by calculating the average number of fish/small dipnet multiplied by the total number of small dipnets of fish. For very large catches (e.g. N > 1000) with several size classes, fish which appeared larger or smaller than the majority of fish in the net, or species represented by few individuals were removed and measured (TL), and a sample of the remaining fish was removed and measured (TL). An abundance estimate of fish remaining after size class subsampling was obtained by calculating the average number of fish contained in a small dipnet and multiplying this value by the total number of dipnets of fish in the seine. In the latter two cases, the number of fish subsampled for length distribution data was added to the abundance estimates, and size class data from the subsample was applied to the abundance estimates on a proportional basis. Usually 15-20 weights (0.1 g) were obtained from fish at each seining location Prior to being weighed in the Laboratory, these fish had been placed on ice.

Larval Fish

During April and May of 1986, 21-32 larval fish sampling locations established for evaluation periods I and II were sampled nocturnally on approximately a bi-weekly basis (Figure 8;. During low pool conditions, larval fish samples were collected from 21 locations on the evening of 8 and 24 April, and on 5 May. For the period covered by this report, a fourth series cf samples (N = 32) were collected on the evenings of 28 and 29 May. Sample size increased in late May because increasing lake level allowed access to locations within the drawdown zone.

Two 0.5 m diameter, 153 mesh icthyoplankton nets were suspended from the bow of the sampling boat to collect simultaneous replicate samples. 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 (1984). 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.

Total length data (0.1 mm) was collected from larvae that were preserved in a non-flexed position.

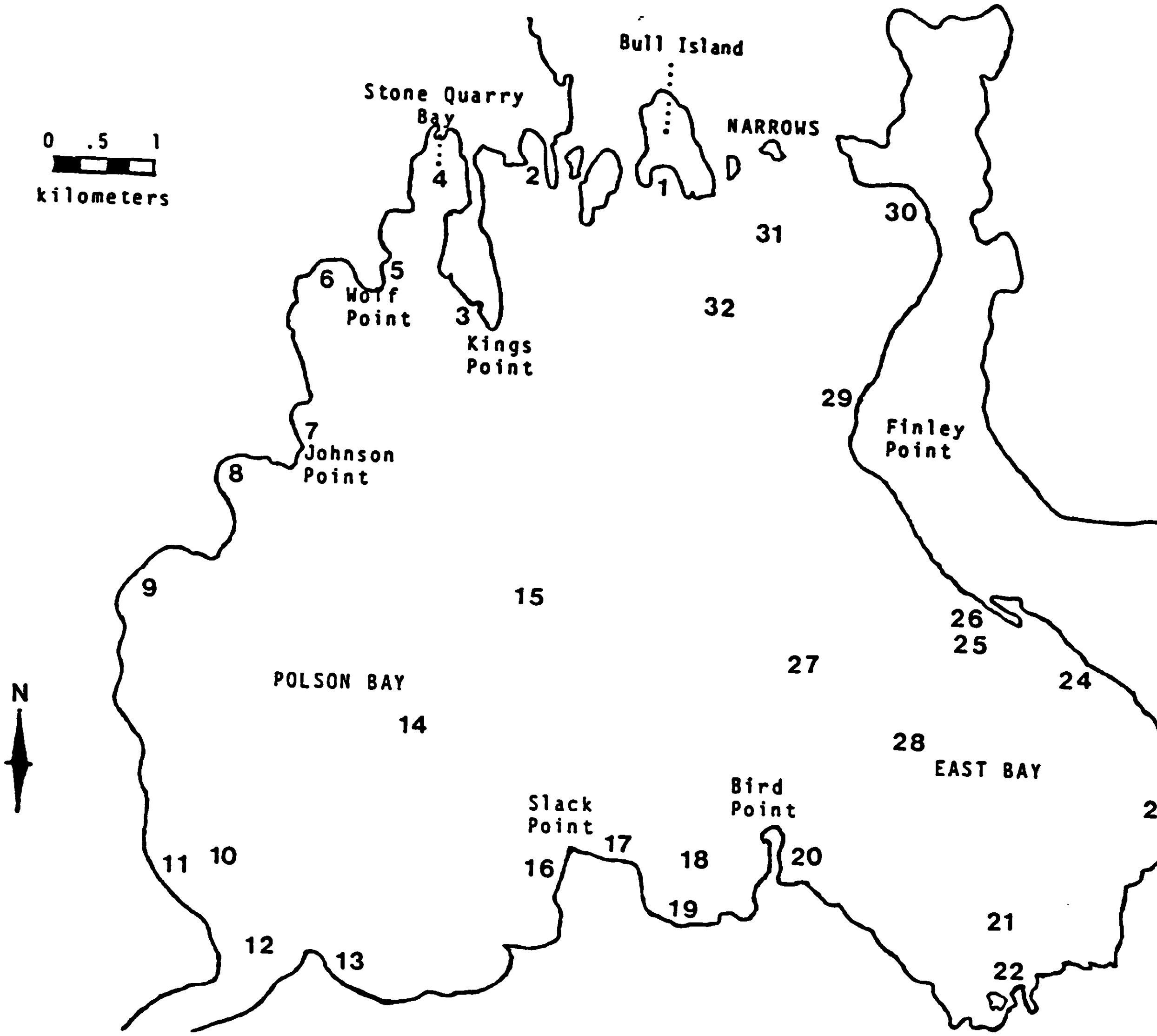

Figure 8. Larval fish sampling stations for the period 8 April through 29 May, 1986, Flathead Lake, Montana.

Creel Surveys

Two creel surveys were conducted on East Bay. The first covered the winter ice fishery from 21 December 1985 through 16 March 1986. The second creel survey, which began on 13 April 1986 and ended on 2 May 1986, was directed at a boat fishery that targets spawning concentrations of yellow perch in East Bay.

Although methodologies of both surveys were generally patterned after discussions by Meuhold and Lu (1957) and Malvestuto (1983), specific details of the two survey procedures were somewhat different.

For the ice fishery survey, total angler estimates were derived daily from five instantaneous angler counts made from shoreline vantage points (Figure 9). The times of daily instantaneous angler counts remained constant over the survey period and were obtained at 1030, 1200, 1330, 1500, and 1630.

Completed trip angler interviews were conducted at access points (Figure 9) to obtain catch and creel data, and information about fishing time, catch composition, and catch size distribution.

Results from the 1984-1985 ice fishery creel survey (Pajak et al.1985) revealed a low creel rate for yellow perch relative to the catch rate. It was apparent that this difference resulted from many small, immature fish being caught relative to each individual fish creeled. To determine the size distribution of yellow perch caught but not creeled, fish which had been discarded on the ice by anglers were measured on three dates.

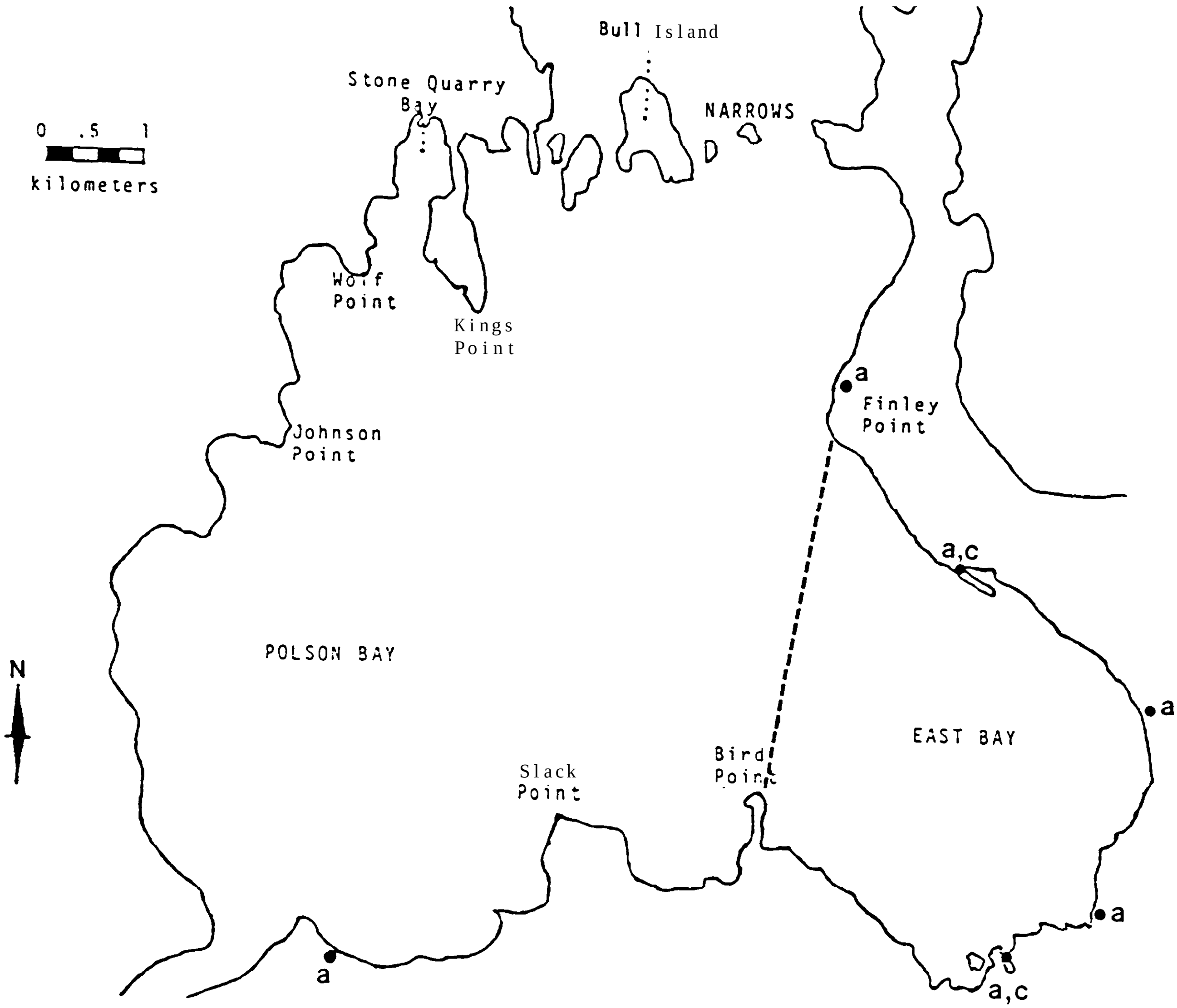

Figure 9. Angler access points (a) and locations for instantaneous angler counts (c) for the 1985-1986 winter and spring perch fishery surveys on East Bay, Flathead Lake, Montana. Fishing pressure occurred almost exclusively in the area East of the dashed line. Access points north or west of the dashed line were used during the spring fishery.

Samples were collected on 29 and 30 December 1985, and again on 16 January 1986. It was assumed that yellow perch found on the ice were representative of non-creeled fish and that changes in total length caused by freezing and dessication were negligible.

A stratified two-stage sampling schedule was developed for the creel survey of the spring yellow perch fishery. Within each two week time period, four weekdays and two weekend days were randomly selected for survey activities. Five instantaneous boat and angler counts were made every two hours during the day, with the time of the initial count chosen randomly for either 0700, 0800, 0900, 1000, or 1100 hours. Boat and angler counts were obtained from vantage points (Figure 9) using binoculars or a spotting scope. Most harvest information was obtained from completed trip interviews conducted at boat access points (Figure 9), but several imcomplete trip interviews were also conducted from a small boat.

Catch and effort statistics used to derive total harvest estimates for the ice fishery were developed with SPSSPC+ software (SPSS Inc. 1984). Data entry and analysis fcr the spring fishery survey is progressing.

RESULTS

Habitat Assessment

Water Quality

Surface water temperatures ranged in period I from 1.1 °C in January to 23 °C in May Curing this same period dissolved oxygen remained equa1 to or above 10.0 mg/l. PH ranged from 6.9 to 9.0 and the range for conductivity was 0.163-0.184 uWcm. From May 15 to May 30, in the permanently inundated stations (nos. 1-5, Figure 5), surface water temperatures had an average increase of 12.4 °C, with a maximum increase of 15.5 °C. There has been no statistical analysis performed on water quality data to compare between periods or between years.

Fish Distribution

Gill Nettilzg

Preliminary results from night gill net data collected for 1985 indicated that yellow perch comprised the large majority of fish caught within all of South Bay (Pajak et al . 1985). Samples for period I were collected during the day, and samples for periods II and III collected at night, therefore statistical comparisons between these different sampling methods must be qualified.

Upon inspection, the original gill net data for 1985 in the form of CPUE did not meet necessary assumptions of homogeniety of variances and normality to allow an analysis of variance to be performed. Attempted transformations of the data still did not allow the assumptions to be met satisfactorily, therefore, nonparametric alternatives were conducted.

Distribution-free methods were used to compare between evaluaticn areas within periods and to compare between periods. A Kruskal-Wallis test completed using a SFSS statistical computer program revealed significant differences (P < 0.03) between evaluation areas within each period. Orthogonal comparisons between evaluaticn areas based on habitat characteristics and location (Darling et al. 1985) were completed with the Wilcoxon two-sample test according to Sokal and Rohlf (1981). Four a priori comparisons combining periods II and III (Evaluation areas 1-14) and two a priori comparisons with period I (Evaluations 1-5) were carried out (Figure 5). The four comparisons for periods II and III were:

1) permanently inundated areas (evaluaticn nos. l-5) versus seasonally inundated areas (evaluation nos. 6-14).

2) predominantly cobble substrate areas (evaluation nos. 1, 6, 12, 14) versus all other substrate areas (sand, mud/ooze; evaluation nos. 2-5, 7-11, 13).

3) Polson Bay areas (evaluation nos. l-3, 11-14) versus East Bay areas (evaluation nos. 4-10).

4) sand substrate areas (evaluation ncs. 2, 4, 7, 9, 11) versus all other substrate areas (evaluaticn ncs. 1, 3, 5, 6, 8, 10, 12-14).

comparisons for period I were the same as number two and three stated above; evaluation no. 1 versus nos. 2-5 and evaluation nos. l-3 versus nos. 4 and 5, respectively. All comparisons were carried out for CFUE for all species combined and for CPUE for yellow perch (YPCPUE) solely.

The only statistically significant ($P < 0.05$) comparisons of those made were comparisons numbers two and three for CPUE in the period II and III category. Evaluation areas with predominantly cobble substrate had higher CPUE than areas with other substrates ($P < 0.001$) Polson Bay evaluation areas also had higher CPUE than East Bay areas ($F < 0.0001$). Though not statistically significant, YPCPUE for these same two comparisons had the opposite pattern; YPCPUE was higher fcr East Bay and for the other substrate areas. Seasonally inundated areas for CPUE and YPCPUE were greater than permanently inundated areas (comparison no. 1, $P > C.11$). Sand substrate areas for both CPUE and YPCPUE had slightly higher values though the significance levels were very low (Comparison no. 4, $P > 0.40$).

Qualitative patterns from comparisons for period I emerged. East BAy had higher values than Polson Bay for CPUE and YPCPUE and cobble substrate areas had lower values than the other substrate areas. Neither comparisons were statistically significant.

Kruskal-Wallis tests comparing period II to period III were also completed using an SFSS computer program. Feriod II had a significantly higher ranking ($P < 0.04$) for both CPUE and YPCPUE.

The gill net samples collected in period I for 1986 followed a similar pattern in numbers and distribution of fish to those samples collected in 1985. Yellow perch again dominated the catch comprising 82% of the total (416 fish). Other sampled species in descending order of abundance were lake whitefish (7%), peamouth (MYlocheilus caurinus (6%), with all other species combined totaling 5% of the samples. Evaluation areas in East Eay had substantially higher numbers of fish than samples in Polson Bay. Ninety-one percent of all fish caught in period I were caught in East Bay, and ninety-eight percent of all yellow perch. However, the fact that the gill net samples for period I were collected at night in 1986 and during the day in 1985, hinders quantitative comparisons between years.

Beach Seining

In 1986, the total yellow perch catch during evaluation period I, for all size classes combined was 48,587. This represents an increase of four times the total perch catch during approximately the same time period in 1985.

Perch catch was highly variable between locations (Table 7), with an average catch per seine haul of 2,370 (N = 16). Five of the sampling locations on the western and northwestern shorelines yielded especially high catches in 1986, with an average catch per seine haul of 9,178 perch. Gut of these five stations, numbers 2, 19,22 and 24 (Figure 7), also produced the largest perch catches in evaluation period I of 1985.

Table 7. Yellow perch catch by beach seine, and percent of total catch for each location sampled during Evaluation Period I in 1986. Catch data are for all size classes combined. Location numbers refer to Figure 7.

Location #	Perch Caught	Percent of Total Perch
19	15,079	31.04
22	13,417	27.61
2	10,663	21.95
24	5,668	11.67
21	1,063	2.19
1	912	1.88
11	558	1.15
15	544	1.12
3	251	0.52
16	208	0.43
12	103	0.21
5	93	0.91
10	14	a
20	9	a
14	3	2
13	2	a
	48,587	100.0

[a]Less than 0.5%

Table 8. Total, and mean larval fish catch per location, during April and May of 1986. Total and mean values are based on combined contents of nets for each sample location.

Date	(N)	Total Whitefish Captured	Total Perch Captured	Mean Whitefish Per Location	Mean Perch Per Location
April 8	(21)	71.0	0.0	3.4	0.0
April 24	(21)	41.0	0.0	2.0	0.0
May 5	(21)	5G.0	212.0	2.4	10.1
May 28-29	(32)	85.0	1050.0	2.7	32.8

Larval fish

Values for total larval fish catch and the catch averaged over all sample locations are given in Table 8 for whitefish and yellow perch collected in Arpil and May of 1986.

The first larval fish to appear in samples were Table 8 whitefish. Primarily because cf the abundance of adult lake whitefish in Flathead Lake relative to mountain (Prosopium williamsoni) and pgmy (Prosopium coulteri) whitefish (Hanzel 1970, 1971), these larvae were assumed to be lake whitefish. The lack of dichotomous keys has made positive identification uncertain.

Total lenths of whitefish larvae ranged from 9.1 mm to 27.0 mm, and averaged 15.0 mm (N = 168). The average lengths of whitefish larvae increased about 1.0 mm over the period from early April (14.4 mm) to early May (15.2 mm).

Yellow perch were absent from samples until early May (Table 8). Total lengths of perch averaged 5.9 mm (n = 280) and ranged from 4.4 mm to 9.0 mm. Average perch lengths also increased about 1.0 mm during May (5.4 mm to 6.2 mm).

Larval whitefish catch averaged 3.3 over all sample locations combined (N = 95), but several stations produced substantially higher average catches. Individual sampling locations producing higher than average catches of whitefish or perch larvae are given in Table 9 for the period reported here. Overall yellow perch catch averaged somewhat higher (6.9) than for uhitefish, with different sample locations producing higher than average catches.

Table 9. Individual sample stations with an average larval whitefish or perch catch greater than the grand average. Values are for combined nets at each station. Location numbers refer to Figure 8.

Location	Average Whitefish Catch	Location	Average Perch Catch
4	20.4	17	41.0
3	11.0	25	19.7
10	4.7	28	18.3
1	4.4	13	15.0
9	4.0	29	12.3
		18	12.0

Creel Surveys

A non-stratified, total perch creel estimate (C), was calculated for the 1985-1986 East Bay ice fishery. The total creel estimate of 20,624 perch was derived from the following values:

Total hours in fishery	(T)	=	693.0
Mean fish creeled/angler	(C)	=	33.73
Wean party size	(P)	=	2.24
Mean hours fished	(H)	=	3.82
Mean anglers/hour	(E)	=	7.55

where C = (C/P/H) * (E * T). Substituting the mean number of perch returned by anglers (R = 51.26) for C, provided an estimate of the total number of perch returned during the fishery, which was equal to 31,343.

Over half (60.3%) of all fish caught during the fishery were returned. The average size (TL) of perch returned during the 1985-1986 ice fishery was 155.7 mm, or about 70 mm smaller than fish that were creeled.

Responses to inquiries regarding angler residence are compiled in Table 10 for the 1985-1986 ice fishery creel survey. The category "Other" includes a variety of Montana localities not otherwise listed, as well as cut-cf-state locations. The majority (83.6%) of the anglers participating in the ice fishery resided within approximately 96 km of East Bay, with about 35% residing within the boundaries of the Flathead Indian Reservation.

Of the 371 anglers who responded tc the question of Tribal membership vs. non-membership, less than 1.0% claimed Tribal affiliation.

Table 10. Origin of anglers interviewed during the 1985-1986 East Bay ice fishery creel survey.

Angler Residence	Number from Locality	Percent of Total
Kalispell	108	29.0
Folson	107	28.8
Missoula	69	18.5
Ronan	9	2.4
East Shore	8	2.2
Bigfork	5	1.3
Pablo	4	1.1
St. Ignatius	1	0
	61	16.4
	372	100.0

DISCUSSION

Water quality data for period I in 1986 followed similar trends as that measured in 1985 (Pajak et al. 1985). Dissolved oxygen, pH and conductivity are probably adequate for most species caught based on preliminary fish sampling data (Pajak et al. 1985), however, further comparison to other research needs to be completed. Temperature, therefore, seems to be the only water quality parameter studied that affects fish habitat utilization and fish distribution patterns to any large degree. East Bay and other shallow areas may become too warm for many species, particularly salmonids. This is supported by the high catches of warm water species and low numbers of cold water species (salmonids) in the spring/summer seasons within this area.

Water conditions seem to be close to optimal for yellow perch, the most abundant species. A review of habitat suitability information reported by Krieger et al. (1983) suggests that water conditions observed in South Bay are favorable for all life stages of yellow perch. Low winter temperatures (-C .4-5.8 °C) for gonadal development followed by the rapid increase in water temperatures from April through May for spawning (5.8-23 °C) are within the satisfactory ranges. In addition water temperatures during the summer are optimal for fry, juvenile, and adult growth (12.4-24.8 °C).

The lack of vegetative and structural cover in the littoral zone of South Bay may be one area that is suboptimal for yellow perch spawning. Preliminary results suggest that a high concentration of adult yellow perch may spawn in East Bay. In the summer months vegetative cover in this area is relatively abundant in the shallow areas (< 3 m). However, spawning occurs during the low water period which exposes the majority of vegetation. Further research needs to be conducted to determine if the permanently inundated area of East Bay provides vegetation which is considered important for yellow perch spawning (Krieger et al. 1983) and to document where spawning occurs.

The gill net data from 1985 and from period I in 1986 supports the conclusion that conditions in South Eay are highly favorable for yellow perch. Preliminary results indicate that fish distribution for individual species is positively correlated, at least in part, to season, (e.g. water temperature), and habitat location within South Bay.

During period I - colder water temperatures - there were more fish caught accounting for effort, for all species combined and for yellow perch in East Bay in 1985 - 1986, than in Polson Bay . After water temperatures become warmer, periods two and three, Polson Bay had higher CPUE for all species combined while East Bay had higher YPCPUE. This may be an indication that East Bay becomes tco warm for almost all the target species, except for yellow perch, a warm water species. Yellow perch may utilize East Bay for this reason, while other species may utilize the colder deeper areas of Polson Bay during periods II and III.

The CPUE and YPCPUE for period II was significantly greater than period III. The implications of this result with relationship to water quality, habitat utilization, and fish distribution patterns are not fully understood at the present time.

There can be no conclusive results from the statistical analysis performed on CPUE of evaluation areas based on substrate types. There seems to be no discernable difference in habitat utilization based on CPUE between sand evaluation areas and other substrate types. Initial results indicate that predominantly cobble areas may be utilized to a larger degree by all target species combined (CPUE) than other substrates. However, currently, these results can only serve as a basis for further research into these questions.

Depth and location within South Bay (i.e. East Bay versus Polson Bay) may be a better indicator of fish distribution. Further differences in fish distribution between periods (i.e. seasonally versus permanently inundated areas, etc.) and between years may become clear with further analysis of the 1986 data, still in collection, and 1985 data.

The total estimate for perch creeled in the 1985-1986 East Bay ice fishery is about 7,000 fish higher than reported in Pajak et al. (1985) for the 1984-1985 ice fishery. Whether the 1985-1986 creel estimate actually reflects an increase in harvest or is within the bounds cf normal sampling error is currently unknown, since the variance of the harvest estimates is unavailable for either year. Accepting for the moment, that the total perch harvest in 1986 was greater than in 1985, it appears that the cause lies with an increased creel rate in 1986. Because the average size of creeled perch remained fairly constant over both years, as did total angler hours and the creel to catch ratios, a recruitment of more harvestable sized perch to the fishery in 1986 is suggested.

In addition to the apparent increase in perch harvest during 1986, a substantial increase in juvenile perch also occured, as indicated by beach seine samples. Further analysis of age and size data will be required to determine if the trends are related, eg. if the high beach seine catches are comprised of cohorts produced by the year class or classes which caused the increased perch harvest during the 1985-1986 ice fishery.

To date, larval whitefish and perch catch rates in 1986 have remained nearly equivalent to those reported for 1985 in Pajak et al. (1985). This has occured in light of differences in the drawdown and refill schedule of Flathead Lake between the two years. In 1986, the lake was drawn down at a slower rate, reached minimum pool later, and was filled to full pool at a later date than in 1985. Therefore, although the long term schedule or lake level fluctuations may still in some general, perhaps subtle and indeterminable manner, govern or affect fish populations in South Bay, it appears that whitefish and perch recruitment to the larval stage occurs independently of annual variations in Kerr Dam operational schedules.

LITERATURE CITED

Auer, N.A. 1982. Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage. Great Lakes Fishery Commission, Publication 82-3, Ann Arbor, Michigan.

Bovee, K.D. 1982. A guide to stream habitat analysis using the Instream Flow Incremental Methodology. Instream Flow Information Paper 12. U.S. Fish and Wildlife Service, Fort Collins, Colorado.

Darling, J.E., P. Pajak, M.P. Wunderlich, and J.M. DosSantos. 1984. Lower Flathead System fisheries study: annual report 1984. Bonneville Power Administration Agreement DE-AI79-BT39830, Portland, Oregon.

DosSantos, J.M., J.E. Darling, and P.D. Cross. 1983. Lower Flathead River fisheries study annual report 1983. Bonneville Power Administration Agreement DE-AI75 83EP39830, Portland, Oregon.

Hanzel, D.A. 1976. History of northern pike in the Flathead River. Montana Department of Fish, Wildlife and Parks Memorandum, Kalispell.

Hanzel, D.A. 1971. The seasonal and depth distribution of the fish population in Flathead Lake. Montana Department of Fish, Wildlife and Parks, Project F-33-R-4, Job I-a, Kalispell.

Hanzel, D.A. 1970. Flathead Lake, investigation of its fish populations and its chemical and physical characteristics. Montana Department of Fish, and Wildlife and Parks, Final Report F-33-R-3, Job I, Kalispell

Krieger, D.A., J.W. Terrell, and P.C. Nelson. 1983. Habitat suitability information: Yellow perch. U.S. Fish and Wildlife Service, 83/10.5 .

Mansuetti, A.J., 1964. Early development of the yellow perch, Perca flavencens. Chesapeake Science 5:46:66.

Montogue, C., L.C. Munn G.A. Nielson, J.W. Rodger and H.E. Hunter. 1982. Soils of Montana. Montana Agricultural Experiment Station, Bulletin 744. Montana State University, Bozeman.

Montana State Study Team. 1975. The Flathead River Basin, a water and related land resources study, final draft report for agency review. Montana Department of Natural Resources and Conservation, Helena.

Morrison-Maierle, Inc., and James M. Montgomery, Consulting Engineers, Inc. 1977. Lakes and streams water quality study, Flathead drainage, Montana. Environmental Protccticn Agency, Flathead Drainage 208 Project, Denver, Coloradc,

Neuhold, J.M. , and K.H. Lu. 1957. Creel census method. Utah State Department of Fish and Game, Publication 8, Salt Lake City.

Nunnallee, D., and M.K. Botz. 1976. Water quality inventory and management plan, lower Clark Fork River basin, Montana. Department of Health and Environmental Sciences, Water Quality Bureau, Helena.

Pajak, P., W. H. Bradshaw, J.M. DosSantos, J.E. Darling, and P.D. Cross. 1986. Lower Flathead System fisheries study: annual report 1985. Bonneville Power Administration Agreement DE-AI79-83BP39830, Portland, Oregon,

Shepard, B.B., J.J. Fraley, T.M. Weaver, and P.J. Graham. 1982. Flathead River fisheries study - 1982. Montana Department of Fish, WIldlife and Parks, Kalispell.

Snyder, D.E. 1976. Terminologies for intervals of larval fish development. Pages 41-60 in J. Boreman, editor. Great Lakes Fish and Egg Larvae Identification; Proceedings of a Workshop. U.S. Fish and Wildlife Service, FWS/OBS-76/23, Ann Arbor, Michigan, USA.

Snyder, D.E. 1981. Contributions to a guide to the cypriniforn fish larvae of the upper Colorado River system in Colorado. U.S. Bureau of Land Management, Biological Sciences Series 3, Denver.

Sokal, P.R. and F.J. Rohlf. 1981. Biometry, W.H. Freeman and Company, New York .

SPSS Inc. 1984. SPSS/PC for the IBM PC/XT. Chicago.

U. S. Department of the Interior. 1985. Irrigation engineering report, Volume 3 in Comprehensive Review Report, Glathead Indian Irrigation Project, St. Ignatius, Montana.

APPENDIX A

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

JOCK0 RIVER

Reach 1	Stream km
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 l9/20 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 staticn (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 B

Summary of electrofishing and trapping data collected on five tributaries to the lower Flathead River during spring 1986.

Abbreviations:

LL = brown trout
MWF = mountain whitefish
Rb = rainbow trout

ELECTROFISHING

CROW CREEK (km 0.0-5.6)

Record#	DATE	SPECIES	LENGTH	TAG_NO	RECAP[1]
1	04/16/86	LL	486	2772	y
2	04/16/86	LL	248	4177	n
3	04/16/86	LL	245	4179	n
4	04/16/86	LL	435	4050	n
5	04/16/86	LL	330	4049	n
6	04/16/86	LL	295	4176	n
7	04/16/86	LL	517	2733	y
8	04/16/86	LL	293	4039	n
9	04/16/86	LL	385	4040	n
10	04/16/86	LL	310	4085	y
11	04/16/86	LL	261	4037	n
12	04/16/86	LL	368	4182	n
13	04/17/86	LL	362	4184	n
14	04/17/86	LL	342	4185	n
15	04/16/86	rb	375	4038	n
16	04/16/86	rb	370	4035	n
17	04/16/86	rb	328	4036	n
18	04/16/86	rb	378	4048	n
19	04/16/86	rb	380	4032	n
20	04/16/86	rb	376	4034	n
21	04/16/86	rb	410	4033	n
22	04/16/86	rb	371	4041	n
23	04/16/86	rb	483	4042	n
24	04/16/86	rb	456	4043	n
25	04/16/86	rb	245	4180	n
26	04/16/86	rb	400	4181	n
27	04/16/86	rb	329	4044	n
28	04/16/86	rb	235	0	n
29	04/16/86	rb	310	4045	n
30	04/16/86	rb	473	4046	n
31	04/16/86	rb	500	4055	y
32	04/16/86	rb	350	4109	y
33	04/16/86	rb	320	4047	n
34	04/16/86	rb	450	4090	y
35	04/16/86	rb	452	4178	n
36	04/16/86	rb	316	4106	y
37	04/16/86	rb	360	4087	y
38	04/16/86	rb	387	2739	y
39	04/16/86	rb	446	4097	y
40	04/16/86	rb	445	2738	y
41	04/16/86	rb	375	2745	y
42	04/16/86	rb	440	4099	y
43	04/16/86	rb	400	2743	y
44	04/16/86	rb	416	2751	y
45	04/16/86	rb	350	2752	y
46	04/16/86	rb	400	2769	y

CROW CREEK (continued)

47	04/17/86	rb	375	4183	n
48	04/16/86	rb	375	2776	y
49	04/16/86	rb	360	4078	y
50	04/16/86	rb	383	4123	y
51	04/16/86	rb	394	4129	y
52	04/16/86	rb	415	4121	y
53	04/16/86	rb	427	4124	y
54	04/17/86	rb	342	4060	y
55	04/17/86	rb	370	2745	y

[1] y = yes

n = no

TRAPPING

JOCKO RIVER WEIR (km 2)

Record#	DATE	SPECIES	LENGTH	WEIGHT	SEX	WATER_TEMP
1	04/11/86	LL	414	0	u	6.0
2	03/28/86	rb	449	990	f	8.0
3	03/28/86	rb	416	714	f	8.0
4	03/26/86	rb	429	764	f	5.0
5	03/21/86	rb	425	762	f	5.5
6	03/25/86	rb	353	396	m	5.0
7	03/25/86	mwf	379	0	u	5.0
8	03/25/86	mwf	312	0	u	5.0
9	03/25/86	mwf	335	0	u	5.0
10	03/26/86	mwf	352	0	u	5.0
11	03/28/86	mwf	344	0	u	8.0
12	03/28/86	mwf	366	0	u	8.0
13	03/28/86	mwf	348	0	u	8.0
14	03/21/86	mwf	345	0	u	5.5
15	03/21/86	mwf	343	0	u	5.5
16	04/11/86	mwf	326	0	u	6.0
17	04/11/86	mwf	335	0	u	6.0
18	04/11/86	mwf	352	0	u	6.0
19	04/11/86	mwf	346	0	u	6.0
20	04/11/86	mwf	322	0	u	6.0
21	04/11/86	mwf	320	0	u	6.0
22	04/11/86	mwf	340	0	u	6.0
23	04/11/86	mwf	362	0	u	6.0
24	04/11/86	mwf	329	0	u	6.0
25	04/11/86	mwf	342	0	u	6.0
26	04/11/86	mwf	363	0	u	6.0
27	03/21/86	mwf	308	0	u	5.5

MISSION CREEK WEIR (km 6)

Record#	DATE	SPECIES	LENGTH	WEIGHT	SEX	WATER_TEMP
1	03/04/86	rb	450	810	m	6.0
2	03/07/86	mwf	327	0	u	9.0
3	03/07/86	mwf	319	0	u	9.0
4	03/07/86	mwf	329	0	u	9.0
5	03/07/86	mwf	333	0	u	9.0
6	03/07/86	rb	400	602	f	9.0
7	03/07/86	rb	360	496	f	9.0
8	03/07/86	rb	359	420	m	9.0
9	03/07/86	rb	409	682	f	9.0
10	03/07/86	rb	427	870	f	9.0
11	03/11/86	rb	385	595	m	6.0

MISSION CREEK WEIR (continued)

12	03/11/86	LL	442	750	u	6.0
13	03/11/86	mwf	322	0	u	6.0
14	03/11/86	mwf	325	0	u	6.0
15	03/12/86	rb	443	876	f	9.0
16	03/12/86	rb	443	742	f	9.0
17	03/12/86	rb	390	612	m	9.0
18	03/12/86	rb	472	1020	f	9.0
19	03/12/86	rb	420	654	f	9.0
20	03/12/86	rb	428	738	f	9.0
21	03/12/86	rb	403	662	f	9.0
22	03/12/86	mwf	312	0	u	9.0
23	03/13/86	mwf	324	0	u	8.0
24	03/14/86	mwf	336	0	u	5.0
25	03/14/86	mwf	352	0	u	5.0
26	03/14/86	mwf	331	0	u	5.0
27	03/14/86	mwf	348	0	u	5.0
28	03/14/86	rb	453	690	u	5.0
29	03/18/86	rb	350	514	m	8.0
30	03/18/86	rb	400	682	m	8.0
31	03/19/86	mwf	326	0	u	8.0
32	03/19/86	mwf	334	0	u	8.0
33	03/19/86	rb	386	552	f	8.0
34	03/19/86	rb	361	437	m	8.0
35	03/20/86	rb	392	724	f	9.5
36	03/20/86	rb	330	376	f	9.5
37	03/20/86	rb	384	600	f	9.5
38	03/21/86	mwf	330	0	u	7.0
39	03/21/86	mwf	344	0	u	7.0
40	03/21/86	mwf	313	0	u	7.0
41	03/21/86	rb	382	518	m	7.0
42	03/25/86	mwf	346	0	u	7.0
43	03/25/86	mwf	322	0	u	7.0
44	03/25/86	mwf	336	0	u	7.0
45	03/25/86	rb	394	620	f	7.0
46	03/25/86	rb	367	484	m	7.0
47	03/25/86	rb	440	730	f	7.0
48	03/26/86	mwf	340	0	u	6.0
49	03/26/86	rb	410	720	m	6.0
50	03/27/86	rb	362	482	f	8.0
51	03/28/86	rb	447	772	m	10.0
52	03/28/86	rb	365	462	m	10.0
53	04/01/86	mwf	278	0	u	8.0
54	04/01/86	mwf	350	0	u	8.0
55	04/04/86	mwf	319	0	u	8.0

MISSION CREEK WEIR (continued)

56	04/04/86	mwf	331	0	u	8.0
57	04/08/86	mwf	307	0	u	9.0
58	04/11/86	mwf	293	0	u	8.5
59	04/15/86	mwf	310	0	u	10.0
60	04/17/86	mwf	335	0	u	0.0
61	04/17/86	mwf	312	0	u	0.0
62	04/17/86	mwf	322	0	u	0.0
63	04/18/86	mwf	327	0	u	0.0
64	04/22/86	mwf	324	0	u	0.0
65	04/23/86	mwf	339	0	u	11.0
66	04/23/86	mwf	342	0	u	11.0
67	04/25/86	mwf	360	0	u	0.0
68	04/25/86	mwf	325	0	u	0.0
69	04/30/86	rb	424	760	f	10.5
70	05/01/86	mwf	345	0	u	12.5
71	05/02/86	mwf	318	0	u	12.0
72	05/02/86	mwf	344	0	u	12.0
73	05/08/86	mwf	325	0	u	11.5
74	05/14/86	mwf	309	0	u	9.0
75	03/06/86	mwf	357	0	u	8.0
76	03/06/86	mwf	355	0	u	8.0
77	03/06/86	mwf	298	0	u	8.0
78	03/06/86	mwf	356	0	u	8.0
79	03/06/86	rb	385	498	m	8.0
80	03/06/86	rb	391	588	f	8.0
81	03/06/86	rb	368	490	m	8.0
82	03/06/86	rb	413	680	f	8.0
83	04/25/86	rb	425	730	f	0.0

APPENDIX C

Mark-recapture data showing movement of trout and northern pike to and from tributaries to the lower Flathead River from 1 December 1985 through 31 May 1986.

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
2733	04/16/85	LL	467	C	5	04/16/86	517	C	5	365	0
2772	04/16/85	LL	460	C	5	04/16/86	486	C	5	365	0
2726	04/16/85	LL	347	C	5	11/20/85	415	C	5	218	0
4085	11/20/85	LL	301	C	5	04/16/86	310	C	5	146	0
2595	10/22/84	rb	376	C	5	11/20/85	410	C	2	394	3
2727	04/16/85	rb	367	C	5	11/20/85	381	C	5	218	0
2735	04/16/85	rb	427	C	5	11/20/85	428	C	5	218	0
2738	04/16/85	rb	403	C	5	04/16/86	445	C	5	365	0
2740	04/16/85	rb	320	C	5	11/20/85	344	C	5	218	0
2743	04/16/85	rb	405	C	5	04/16/86	400	C	5	365	0
2745	04/16/85	rb	373	C	5	04/17/86	370	C	5	366	0
2754	04/16/85	rb	320	C	5	11/20/85	384	C	5	218	0
2746	04/16/85	rb	333	C	5	11/20/85	375	C	5	218	0
2750	04/16/85	rb	399	C	5	11/20/85	407	C	5	218	0
2751	04/16/85	rb	391	C	5	04/16/86	416	C	5	365	0
2752	04/16/85	rb	274	C	5	04/16/86	350	C	5	365	0
2749	04/16/85	rb	375	C	5	11/20/85	387	C	5	218	0
2758	04/16/85	rb	297	C	5	11/20/85	361	C	5	218	0
2761	04/16/85	rb	239	C	5	11/20/85	380	C	5	218	0
2764	04/16/85	rb	490	C	5	11/20/85	508	C	5	218	0
2767	04/16/85	rb	332	C	5	11/20/85	405	C	5	218	0
2769	04/16/85	rb	385	C	5	04/16/86	400	C	5	365	0
2773	04/16/85	rb	481	C	5	11/20/85	495	C	5	218	0
4090	11/20/85	rb	449	C	5	04/16/86	450	C	5	146	0
4097	11/20/85	rb	455	C	5	04/16/86	446	C	5	146	0
2776	04/16/85	rb	347	C	5	04/16/86	375	C	5	365	0
4099	11/20/85	rb	444	C	5	04/16/86	440	C	5	146	0
2782	04/17/85	rb	393	C	5	11/21/85	419	C	5	218	0
4106	11/20/85	rb	316	C	5	04/16/86	316	C	5	146	0
4055	11/20/85	rb	495	C	5	04/16/86	500	C	5	147	0
4109	11/20/85	rb	358	C	5	04/16/86	350	C	5	146	0
4060	11/20/85	rb	355	C	5	04/17/86	342	C	5	147	0
4115	11/20/85	rb	396	C	5	03/20/86	392	M	6	120	37
4087	11/20/85	rb	283	C	5	04/16/86	360	C	5	146	0
2739	04/16/85	rb	360	C	5	04/16/86	387	C	5	365	0
4121	11/20/85	rb	420	C	5	04/16/86	415	C	5	146	0
2777	04/16/85	rb	370	C	5	11/21/85	383	C	5	219	0
4056	11/20/85	rb	481	C	5	12/02/85	483	C	5	12	0
4078	11/20/85	rb	363	C	5	04/16/86	360	C	5	146	0
4123	11/20/85	rb	387	C	5	04/16/86	383	C	5	146	0
4124	11/20/85	rb	435	C	5	04/16/86	427	C	5	146	0
4129	11/21/85	rb	399	C	5	04/16/86	394	C	5	146	0
4161	03/25/86	rb	367	C	6	05/23/86	356	M	7	59	1
4178	04/16/86	rb	452	C	5	07/16/86	452	C	5	91	0
3041	09/24/85	rb	390	F	74	03/06/86	385	M	45	163	29
2877	09/24/85	LL	416	J	2	10/26/85	0	J	13	31	11
2203	06/27/83	NP	418	L	72	02/28/86	0	F	45	976	27

[1] LL = brown trout; rb = rainbow 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 D

Lower Flathead System Fisheries Study
Tributary Instream Flow Study
Statement Of Work

BACKGROUND

The Lower Flathead System Fisheries Study represents research efforts funded by the Bonneville Power Administration and conducted by the Confederated Sálish & Kootenai Tribes of the Flathead Indian Reservation. The study began in Decemeber 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. Study results will provide a technical data base on the fisheries resources of the lower Flathead System from which management and mitigation alternatives will be developed concerning the present status of hydroelectric development and operation (Kerr Dam), and possible future development.

Among the objectives of the Study are assessment of existing aquatic habitat in the lower Flathead River tributaries, and evaluation of the potential for increasing quality habitat, and thus game fish production, through mitigation. Application of the Instream Flow Incremental Methodology (IFIM) developed by the U.S. Fish and Wildlife Service in Fort Collins, Colorado, combined with results from ongoing habitat surveys, stock assessments, and spawning surveys, will allow this evaluation.

IFIM studies will be conducted concurrently on smaller tributaries throughout the Reservation under separate contract by the Bureau of Indian Affairs (BIA). The BIA studies are intended to support federal water rights claims, but will also supplement our evaluation.

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 througn porous 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 midvalley 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 1976), 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 (Figure D-1: the Jocko River, Mission Creek, Post Creek, Crow Creek, and the Little Bitterroot River. The IFIM will be applied to two drainages, the Jocko River and Mission-Post Creek.

Jocko River

The Jocko River flows westerly from the Mission Mountains and enters the Flathead River near Dixon. It drains an area of

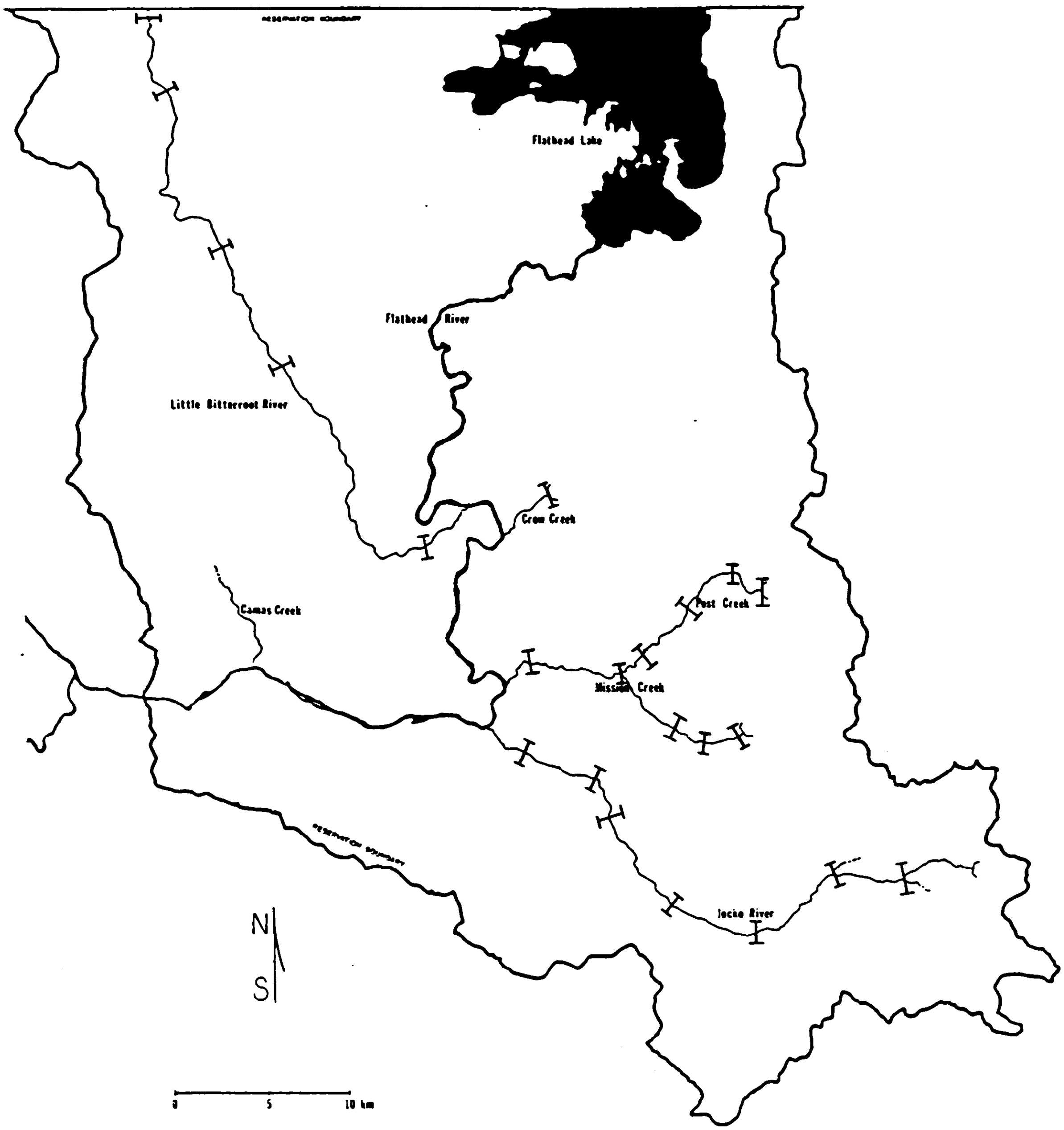

Figure D-1. Reach boundaries established for habitat surveys and stock assessment on five major tributaries to the lower Flathead River.

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).

Of the Study's target fish species rainbow trout (*Salmo gairdneri*), and brown trout (*Salmo trutta*) predominate in the lower reaches of the Jocko River, with cutthroat trout (*Salmo clarki*) and brook trout (*Salvelinus fontinalis*) replacing these species in the foothills (Table D-1).

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

Figure D-1. Abundance and age class distribution of trout captured in fall 1983 and spring 1984 for the Jocko River, Mission and Post Creeks.

Stream	Reach No.[1]	Species	No. (% of total) Trout Captured[2] F83	No. (% of total) Trout Captured[2] S84	% Age Class 1 F83	% Age Class 1 S84	% Age Class 2 F83	% Age Class 2 S84	% Age Class 3 & Older F83	% Age Class 3 & Older S84
Jocko River	1-4	Rb	38 (35)	5 (28)	97	20	0	20	3	60
		LL	69 (63)	12 (67)	86	50	3	17	11	33
		Eb	2 (2)	1 (5)	100	100	0	0	0	0
		Total	112	18						
	5-7	DV	8 (11)	2 (8)	38	100	50	0	12	0
		Ct	37 (51)	9 (38)	68	67	32	33	0	0
		Rb	0 (0)	1 (4)	0	100	0	0	0	0
		LL	3 (4)	4 (17)	33	75	67	0	0	25
		Eb	25 (34)	8 (33)	40	75	56	25	4	0
		Total	73	24						
Mission Creek	1-2	Ct	0 (0)	1 (7)	0	0	0	0	0	100
		Rb	15 (94)	12 (86)	80	25	7	25	13	50
		LL	1 (6)	1 (7)	100	100	0	0	0	0
		Total	16	14						
	3-5	Rb	298 (44)	267 (44)	47	52	46	42	7	6
		Eb	383 (56)	336 (56)	49	56	50	41	1	3
		Total	681	603						
Post Creek	1-3	Ct	0 (0)	1 (1)	0	0	0	0	0	100
		Rb	122 (56)	121 (44)	79	72	8	19	13	9
		LL	3 (1)	9 (3)	100	89	0	11	0	0
		Eb	93 (43)	142 (52)	68	54	28	42	4	4
		Total	218	273						
	4	Ct	1 (1)	1 (2)	0	0	100	0	0	100
		Rb	66 (72)	33 (65)	9	6	74	76	17	18
		Eb	25 (27)	17 (33)	24	24	68	53	8	23
		Total	92	51						

[1] See Figure

[2] Number captured from one run only in Post Creek fall 1983 and the Jocko River spring 1984.

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 1.04 m^3/second (Montana State Study Team 1975) or 4.7 m^3/second (Morrison-Maierle and Montgomery 1977) and are suject to year round regulation by the FIIP.

A few large rainbow trout inhabit Mission Creek below its confluence with Post Creek (Table D-1. Above the confluence, large resident populations of rainbow and brook trout are found.

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.

Rainbow trout predominate in the lower valley portion of Post Creek (Table D-1. Brook trout enter the fishery in the foothills of the Mission Mountains.

TASKS

Although every effort has been made to accurately reflect the scope of work, it is recognized that revisions may be required as the field work progresses, particularly with respect to the total number of study sites and transects. Consequently, your proposal should include a fixed price based on the described scope of work and, in addition, a schedule of rates applicable to a time and materials quotation to cover any additional work not included in the original scope of work.

The contractor will be responsible for the following tasks:

1) Transect placement

Streams chosen for IFIM application have been divided into 11 segments (Figure D-2)based on changes in stream gradient, sinuosity, bank slope, land use, and/or flow. Habitat surveys have been conducted on one 1.6 km representative reach within each of the 11 segments, except the upstream-most segment on the Jocko River. Thirty-one separate physical habitat parameters were measured in each reach according to Montana Department of Fish, Wildlife and Parks' modification (Fraley and Graham 1981) of the British Columbia method (Chamberlin 1980). In addition, the U.S. Forest Service (1978) Stream Reach Inventory and Channel Stability Evaluation was applied twice during each survey to further describe the habitat. Field forms used in these surveys are provided in Appendix D-A.

The contractor will ascertain whether information gathered during these habitat surveys is adequate for determining IFIM transect placement using a habitat mapping method, such as that described by Morhardt, et al. (1984), and applying the IFG4 hydraulic model. The contractor will submit estimates based on

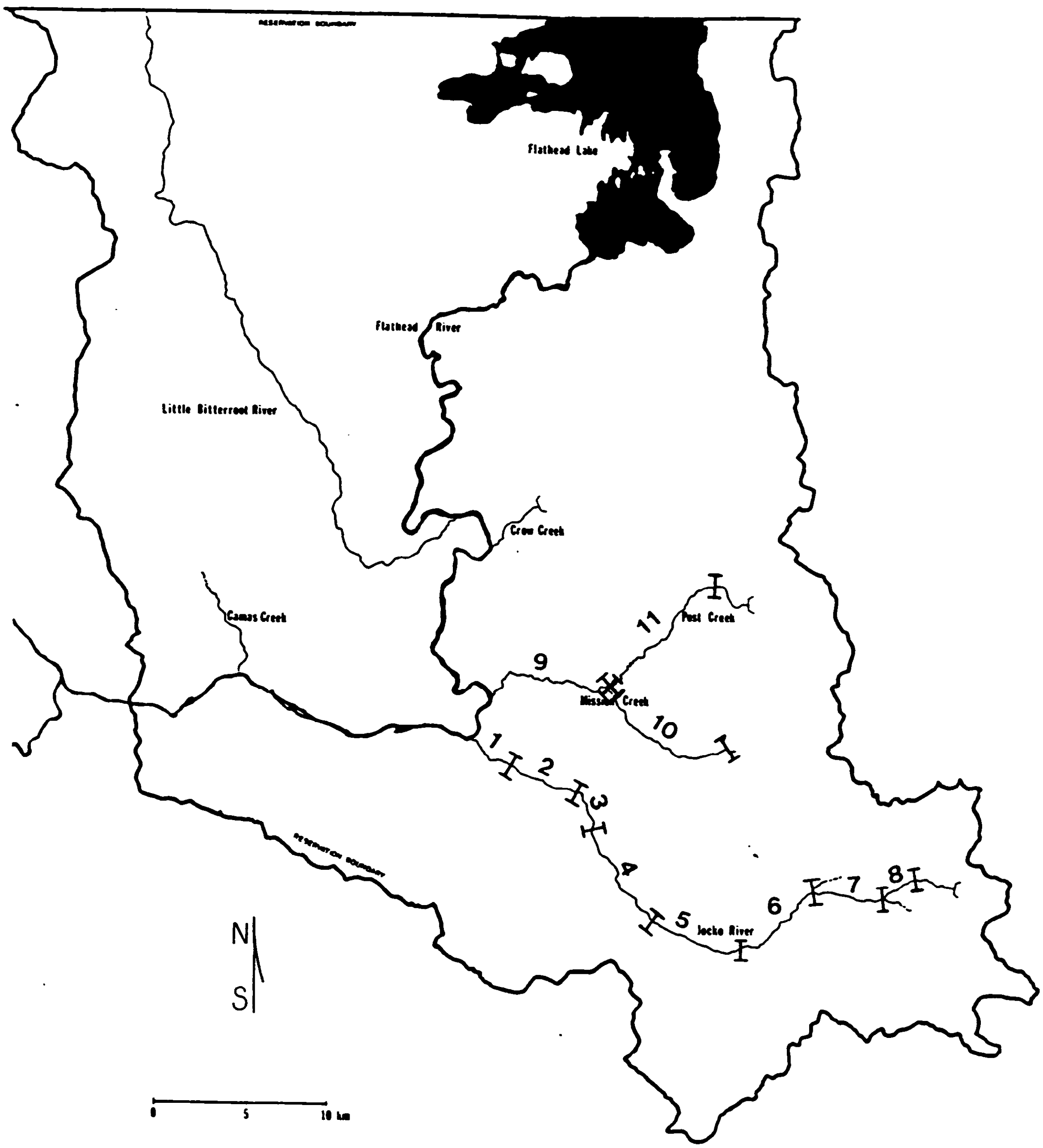

Figure D-2. Preliminary IFIM segmentation.

using a habitat-mapping method and the representative-reach method (Bovee and Milhous 1978). Estimates for the latter should be based on an average of 10 transects per reach. Final numbers and locations of transects will be determined in the field in consultation with project fisheries biologists and Study director. Photostations will be established at each transect site, one site shooting upstream from the bottom-most transect and one site shooting downstream from the upper-most transect. Photographs will be taken during each flow measurement outing.

2) Transect measurements

The contractor will use standard survey techniques to locate transects and to measure cross-sectional profiles. Depth, velocity (mean-column and nose), substrate and cover will be measured along each transect. Substrate and cover coding will be evaluated in discussions with Study staff and the U.S. Fish and Wildilfe Service Instream Flow Group.

Discharges in all of the study segments are controlled by the FIIP. The contractor will work with the Tribes to negotiate flow releases from the FIIP as needed for IFIM field work. Cost estimates should be based upon collecting three sets of flow measurements. Also indicate cost savings if project biologists measure discharges and stage heights at the intermediate flow. Boats and/or suspension systems will be needed to measure discharges in at most five segments.

The contractor will be responsible for contacting private landowners or lessees when necessary to gain access to study sites located on fee (private) and trust land. The contractor will have access to all Tribal lands, for the purposes of conducting IFIM field studies.

3) Report preparation

Monthly progress reports will be provided to the Lower Flathead Fisheries Study director during the field season, describing accomplishments for the reporting period and real or potential variations from schedule or budget. The contractor shall maintain frequent and informal communications with the Study office throughout the term of the contract.

The Tribes will proved suitability index curves to the contractor, who will then determine weighted useable area (WUA) for spawning, fry, juveniles, and adult life stages of the target fish species for each transect and each segment using an IFIM simulation. Study species will include rainbow, brown, cutthroat, and brook trout.

In addition, the contractor will provide:

1) A map of each study site showing transect stationing.
2) A graph showing the cross sectional profile of each transect.
3) Two sets of color 35 mm slides and one set of black and white prints plus negatives of each reach as described under Transect placement. Labelling will consist of photographer, date, transect, up-or downstream orientation, and stream discharge.
4) A printout of the depth, velocity, substrate, and cover data.
5) Graphs of WUA vs discnarge for spawning, fry, juvenile, adult life stages for the target fish species for each

transect and for the study segment.

6) Explanations of all corrections, alterations, or manipulations of data made in the course of simluation modeling.

EQUIPMENT

The contractor will be required to furnish all the equipment, vehicles, and personnel needed to complete this project.

SCHEDULE

The field work portion of this study will begin as soon as possible after spring runoff has begun subsiding (usually around 1 July), and will be completed by 1 November 1986. A draft report will be submitted to the Lower Flathead System Fisheries Study for review and comment by 1 January 1987. The final report shall be completed by 15 February 1987, or not later than two weeks after the draft report has been returned to the contractor with comments.

REQUIRED PROPOSAL FORMAT

The proposal shall be structured into two sections: one containing a technical description of how the work would be performed and the other describing the project budget. The following items should be included:

1) A Project Management Plan describing the manner in which the work identified in this RFP shall be carried out and how its quality will be controlled.
2) An estimated time schedule covering each task detailed in the scope of work.
3) A qualifications statement explaining the relevant

experience of the contractor including references which can be contacted regarding contractor's experience in performing comparable IFIM studies, and successful defense of IFIM data in court.

4) A proposed project organization including the names, title, and resume of the principal investigator and of key technical personnel.

5) A proposed fee structure for preparing and presenting testimony in court as an "expert witness".

6) Cost estimates with complete budget breakdown indicating costs by task, equipment rental, personnel hours, and charged rates.

Proposals postmarked later than 1 April 1986 will not be accepted.

LITERATURE CITED

Bovee, K.D., and R. Milhous. 1978. Hydraulic simulation in instream flow studies: Theory and techniques. Instream Flow Information Paper No. 5. Cooperative Instream Flow Service Group FWS/OBS-78/33, Fort Collins, Colorado, USA.

Chamberlin, T.W. 1980. Aquatic system inventory (biophysical stream surveys). British Columbia Ministry of Environment, Assessment and Planning Division Technical Paper 1, Victoria, British Columbia, Canada.

Fraley, J.J., and P.J. Graham. 1981. Physical habitat, geologic bedrock types and trout densities in tributaries of the Flathead River drainage, Montana. In Proceedings of a Symposium on Acquisition and Utilization of Aquatic Habitat Inventory Information. American Fisheries Society, Bethesda, Maryland, USA.

Montana State Study Team. 1975. The Flathead River Basin, a water and related land resources study, final draft report for agency review. Montana Department of Natural Resources and Conservation, Helena, Montana, USA.

Morhardt, J.E., D.F. Hanson, and P.J. Coulston. 1984. Instream flow analysis: increased accuracy using habit mapping. Ecological Analysts, Inc., Lafayette, California, USA.

Morrison - Maierle, Inc. and James M. Montgomery, Consulting Engineers, Inc. 1977. Lakes and streams water quality study, Flathead Drainage, Montana. Prepared for the Flathead Drainage 208 Project, Environmental Protection Agency, Denver, Colorado, USA.

Nunnallee, D., M.K. Botz, and D.G. Willems. 1976. Water quality inventory and management plan, Flathead Drainage Basin, Montana. Water Quality Bureau, Department of Health and Environmental Sciences, Helena, Montana, USA.

U.S. Department of the Interior. 1985. Irrigation engineering report. Volume 3 in Comprehensive Review Report, Flathead Indian Irrigation Project, St. Ignatius, Montana, USA.

U.S. Forest Service. 1978. Stream reach inventory and channel stability evaluation, a watershed management procedure. U.S. Forest Service, Northern Region, Missoula, Montana, USA.

APPENDIX D-A

Forms used for habitat surveys.

CHANNEL STABILITY EVALUATION

Item Rated	Stability Indicator Classes: A		B		C		D	
UPPER BANKS								
Landform Slope	Bank slope gradient <30%.	(2)	Bank slope gradient 30-40%.	(4)	Bank slope gradient 40-60%.	(6)	Bank slope gradient 60%+.	(8)
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	(12)
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.	(8)
Bank Protection from Vegetation	90%+ plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	(12)
LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio < 7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Ocassional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio > 25.	(4)
Bank Rock Content	65%+ with large, angular boulders 12"+ numerous.	(2)	40-65%, mostly small boulders to cobbles 6-12".	(4)	20-40%, with most in the 3-6" diameter class.	(6)	< 20% rock fragments of gravel sizes, 1-3" or less.	(8)
Obstructions Flow Deflectors	Rocks, old logs firmly embedded. Flow pattern of pools & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong.	(8)
Cutting	Little or none evident. Infrequent raw banks.	(4)	Some intermittently at outcurves and constrictions.	(8)	Significant. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts. Failure of overhangs frequent.	(16)
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increase in bar formation, mostly from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominantly fine particles. Accelerated bar development.	(16)
BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners and edges, surfaces smooth and flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	(4)
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull, but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15% i.e., 35-65%.	(3)	Predominantly bright, 65%+, exposed or scoured surfaces.	(4)
Consolidation or Particle Packing	Assorted sized tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.	(8)
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change is sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials < 20%.	(16)
Deposition	< 5% of the bottom affected by deposition.	(6)	5-30% affected. Some deposition in pools.	(12)	30-50% affected. Deposits at obstructions, constrictions, and bends. Some filling of pools.	(18)	> 50% of the bottom in a state of flux or change nearly yearlong.	(24)
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	(4)
	COLUMN TOTALS →		→		→		→	

Size Composition of Bottom Materials (Total to 100%)

1. Exposed bedrock............ %
2. Large boulders, 3'+ Dia.....____%
3. Small boulders, 1-3'.......____%
4. Large rubble, 6-12"........____%
5. Small rubble, 3-6".......____%
6. Coarse gravel, 1-3".....____%
7. Fine gravel, 0.1-1".....____%
8. Sand, silt, clay, muck..____%

TOTAL SCORE __________

1/ Modified from U. S. Department of Agriculture Forest Service/Northern Region.

STREAM: DATE: TIME: AIR: WATER: CREW:

Transect	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Wetted Width (m)																														
Feature: Pool =P Riffle=R Run =RN Pocket=PW																														
Additional Features																														
Compaction (N,L,M,H)																														
D90 (c m)																														
Imbeddedness (%) (<25m 25-50, 50-75, >75)																														
Channel Cover (%): Ot / Cwn / Instr																														
Debris: Channel / Flood Plain																														
Channel Width (m)																														
Aquatic Veg: Type (S,E) / N, L, M, H																														
Average Depth (c m)																														
Flood Signs: HT (m) / Type(D,E,P,M,H)																														
Bank Material (fines, gravel, cobble, voulder, bedrock)																														
Bed Material (f,g,c,b,b)																														

Stream Features On Back

Side Channel (m)
Vert. Stability
Turbidity
Stage
Stable Debris (%)
Bank Form

Pools
III
II
I

Valley Flat
Maximum Depth (c m)
Stream Pattern
Flow Character
Flood Signs (Type, Ht)

89