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# LOWER FLATHEAD SYSTEM FISHERIES STUDY ANNUAL

Annual Report 1984

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# LOWER FLATHEAD SYSTEM FISHERIES STUDY

## ANNUAL REPORT 1984


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Research Conducted By

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Pablo, Montana

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### SOUTH BAY

# EXECUTIVE SUMMARY

This study was undertaken to assess the effects of Kerr Dam operations on the fisheries of the Lower Flathead System. Supported by Bonneville Power Administration funding, and conducted by the Confederated Salish and Kootenai Tribes, the study began in December of 1982 and is scheduled for completion in December of 1987. This report covers the 1983-84 field season and includes the status of target fish species populations in the Flathead River and tributaries, and initial work in South Bay of Flathead Lake. Additionally it addresses how Kerr operations may effect the reproduction of salmonids and northern pike.

Combined trout population estimates for rainbow, brown, brook, and bull trout, averaged 13 fish/km of the lower Flathead River. The number of bull trout and cutthroat trout captured was so low that estimation of their individual populations was not possible. An interim closure to trout harvest on the lower Flathead River was recommended and approved by the Tribal Council until study results can be further analyzed and management options reviewed.

Population estimates for northern pike ranged from six/kilometer in poorer habitat, to one hundred three/km in the best habitat in the main Flathead River. Seven pike were radio tagged and their movements monitored. Hovements of over 89 km were recorded. One fish left the Flathead River and moved down the Clark Fork to the Plains area.

Fish weirs were constructed on the Jocko River and Mission Creek to assess spawning runs of trout from the main river. Thirty-two adult rainbow passed the Jocko weir and twenty-eight passed the Mission weir during the spring spawning season. Twenty adult brown trout were captured at the Jocko weir and five at Mission weir in the fall. The Jocko weir suffered minor damage due to bed load movement during high flows of spring runoff.

The structure of trout populaticns in the lower Flathead River points to spawning and recruitment problems caused by hydroelectric operations and sedimentation. Among the consequences of the present operational regime are constant, rapid changes in river discharge during spawning and Incubation seasons of trout species present in the lower river. Hamilton and Buell (1976) reported that similar fluctuation might exceed tolerance limits of adults and inhibit spawning behavior, dewater redds, strand fry, and

displace juveniles to habitats less suitable for survival. Similar problems are felt to exist on the lower river.

Constant fluctuations over backwater vegetation have been linked to major problems in successful northern pike spawning and recruitment by preventing access to spawning sites, and dewatering eggs and attached fry.

Phase I of the South Bay investigation was completed this year resulting in a detailed study program for the next three years. Dominant habitat types were mapped, and physical habitat and biological monitoring methods were evaluated and selected. Permanent habitat transects, water quality stations, fish sampling, gillnetting, seining, and trapping sites were established.

# INTRODUCTION

The 1983 Annual Report of the Lower Flathead System Fisheries Study (DosSantos et al. 1983) discusses the importance of the Lower Flathead System to the Salish and Kootenai people. Closed in 1938, Kerr Dam controls Flathead Lake levels between 878.7 meters (m) (2883 ft) and 881.8 m (2893 ft) and discharges into the lower Flathead River. Kerr Dam is a 60.6 m high concrete arch structure located 7.2 kilometers (km) downstream from the outlet of Flathead Lake. The facility is used primarily as a peaking operation with some use for lower level base-load (prepared answering testimony of Don Gregg presented to the U.S. Federal Energy Regulatory Commission on April 23, 1984). Preliminary study observations in 1983 indicated water level fluctuations in the main river due to daily peaking operations may have a significant negative impact upon reproductive success and recruitment of important fish species utilized by the Tribes.

Funded by the Bonneville Power Administration, the Lower Flathead System Fisheries Study is being conducted by the Confederated Salish and Kootenai Tribes. The study began in December of 1982 with a pilot study which developed sampling methcds and established permanent study sections and a sampling schedule for the lower river and its tributaries (DosSantos et al. 1983). The study was expanded during 1984 to include the South Bay of Flathead Lake. The study, when finished, will fulfill program measure 804 (a) (3) and 804 (b) (6) of the Columbia Basin Fish and Wildlife Program.

While considerable effort by the State of Montana has been directed toward evaluating the impact of Kerr hydroelectric operations on the kokanee salmon (Oncorhynchus nerka) of Flathead Lake, (Leathe and Graham 1982, Decker-Hess and McMullin 1983), the Tribes have recognized a significant data gap of how lake level fluctuations affect other fish species important to the Tribes, notably yellow perch (Perca flavescens), lake whitefish (Coregonus clupeaformis), largemcuth bass (Micropterus salmoides) and northern pike (Esox lucius). The 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 of the fisheries resource.

The objectives of the Lower Flathead System 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 and hydroelectric generation capabilities would be modified.

Fiscal year 1984 was the beginning of Phase Two work on the main river and tributaries focusing on stock assessment and fish movement. Stock assessments were conducted at five permanent sites on the main river and 22 permanent sites on the tributaries. Fish weirs were constructed on the Jocko River and Mission Creek to assess salmonid spawning migrations from the main river into the tributaries. Seven northern pike were radio tagged to aid in identification of pike spawning habitat and movement in response to river discharge and reproductive condition.

The product of Phase One work on South Bay is a detailed study plan covering sampling, scheduling, funding estimates, and man-power needs for Phase Two. Permanent habitat study transects have been selected as have the biological and technical methodologies that best provide the required data to complete the objective of developing management alternatives. Phase Two of lake work will focus on extensive evaluation of habitat and the spatial and temporal distribution of fish species in response to lake level fluctuation.

PART I

MAIN RIVER AND TRIBUTARIES

DESCRIPTION OF STUDY AREA

The lower Flathead River is one of Montana's largest rivers, with an annual average discharge of 340 ($m^3$)/second (11,700 cfs). Today the lower river begins at Kerr Dam, located 7 kilometers (km) southwest of Polson, Montana. Flowing south and west for 115 km, the river flows into the Clark Fork River near Paradise, Montana (Figure 1). Approximately 110 km of the river are within the boundaries of the Flathead Indian Reservation, the second largest Indian Reservation within the State of Montana.

Based on general valley characteristics, gradient, and channel morphology, the lower Flathead was divided into four distinct river reaches (Figure 1). Complete reach descriptions are given in the 1983 Annual Report of the Lower Flathead River Study. Five permanent study sections were established in the four river reaches to assess both physical habitat and present target fish stock levels.

The Buffalo study section, extends from river kilometer (RK) 109.4 to RK 102.9, representing 46 percent (%) of Reach I in the lower Flathead River. The study section has an average width of 114 m and a gradient of 1.5 m/km. The channel substrate is composed of a large boulder-rubble mixture blending into a cobble-gravel mixture toward the end

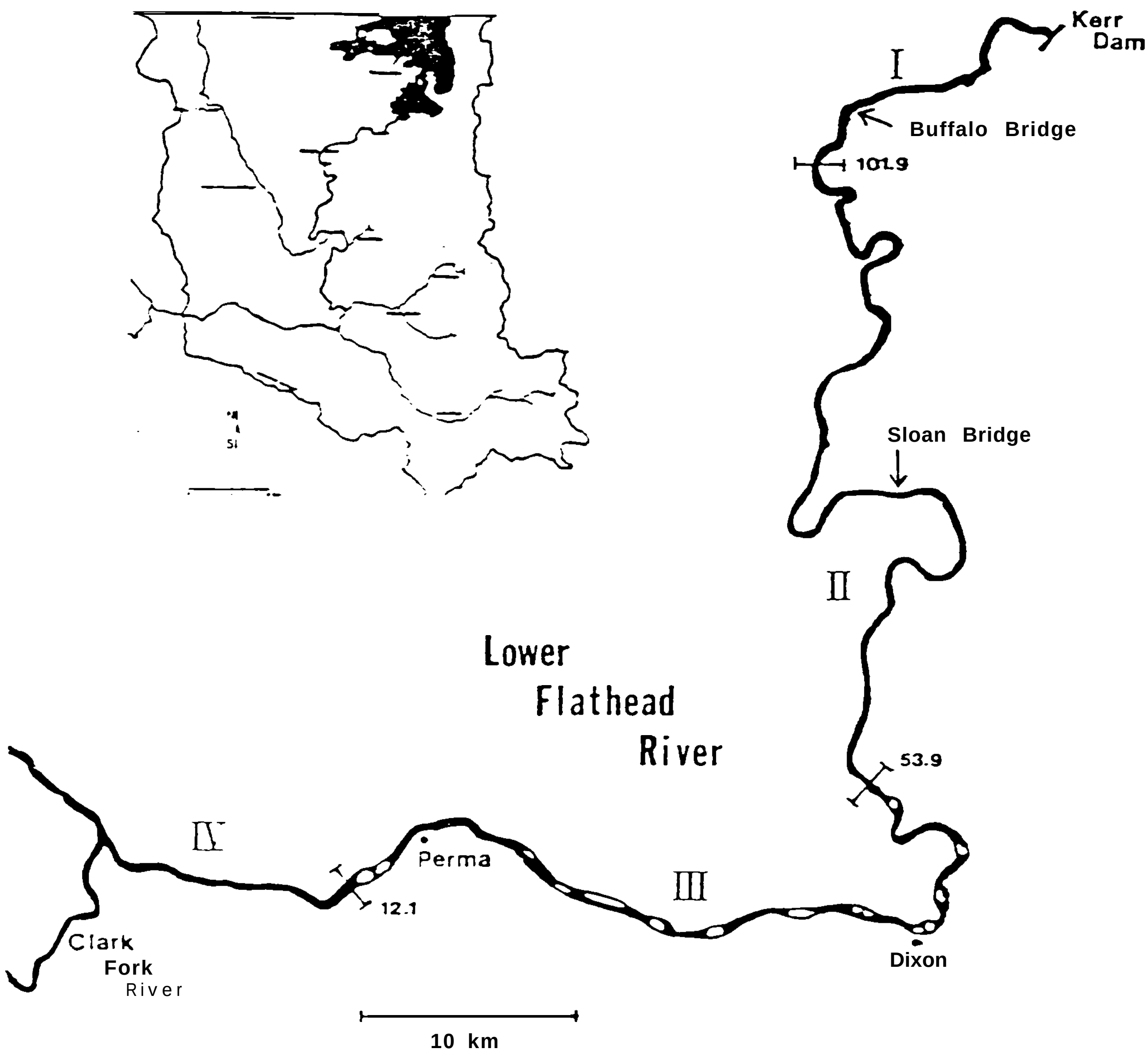



Figure 1. Reach breaks of the lower Flathead River.

of the section. The section is a single channel, fast flowing glide containing two riffle areas. The study section is subject to rapid water level fluctuation up to 2.4 m due to the hydropower peaking operations at Kerr Dam. No tributaries enter this study section, and the only boat access is Buffalo Bridge (RK 104.7) (Figure 2).

The Sloan study section extends from RK 75.6 to RK 69.2, representing 13.4% of Reach II. The study section has an average width of 128 m and a gradient of 0.6 m/km. Channel substrate is composed of primarily a cobble-gravel mixture, interspersed with large boulders; silt deposition occurs along shoreline areas. This section is a single channel smooth glide. The Little Bitterroot River enters this study section at RK 72, and its delta constricts the main river channel to approximately one half its average width, forming a fast turbulent chute. Pablo A canal also empties into this section at RK 69.9. No other tributaries enter this study section. The boat access point is Sloan Bridge (RK 71.4) (Figure 2).

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 channel back waters are common. Two major tributaries enter this study section; Mission Creek at RK 45.2 and the Jocko River at RK 40.9 (Figure 2).

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

The Perma study section extends from RK 12.1 to RK 5.6 and represents 53.3% of Reach IV. Average gradient of this section, a slow moving glide, is 0.2 m/km. Average channel width is 198 m. With the exception of one bedrock intrusion, substrates are primarily gravel with sizeable areas of sand and silt deposition. One small, mid-channel island is also present. Three small intermitant tributaries; Seepay, Burgess and Robertson Creeks, also enter this study section. The boat access point is Robertson Creek (RK 6.4) (Figure 2).

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. Twenty-two reaches were selected that characterized these five tributaries: seven on the Jocko River, five on Mission Creek, four on Post Creek, one on

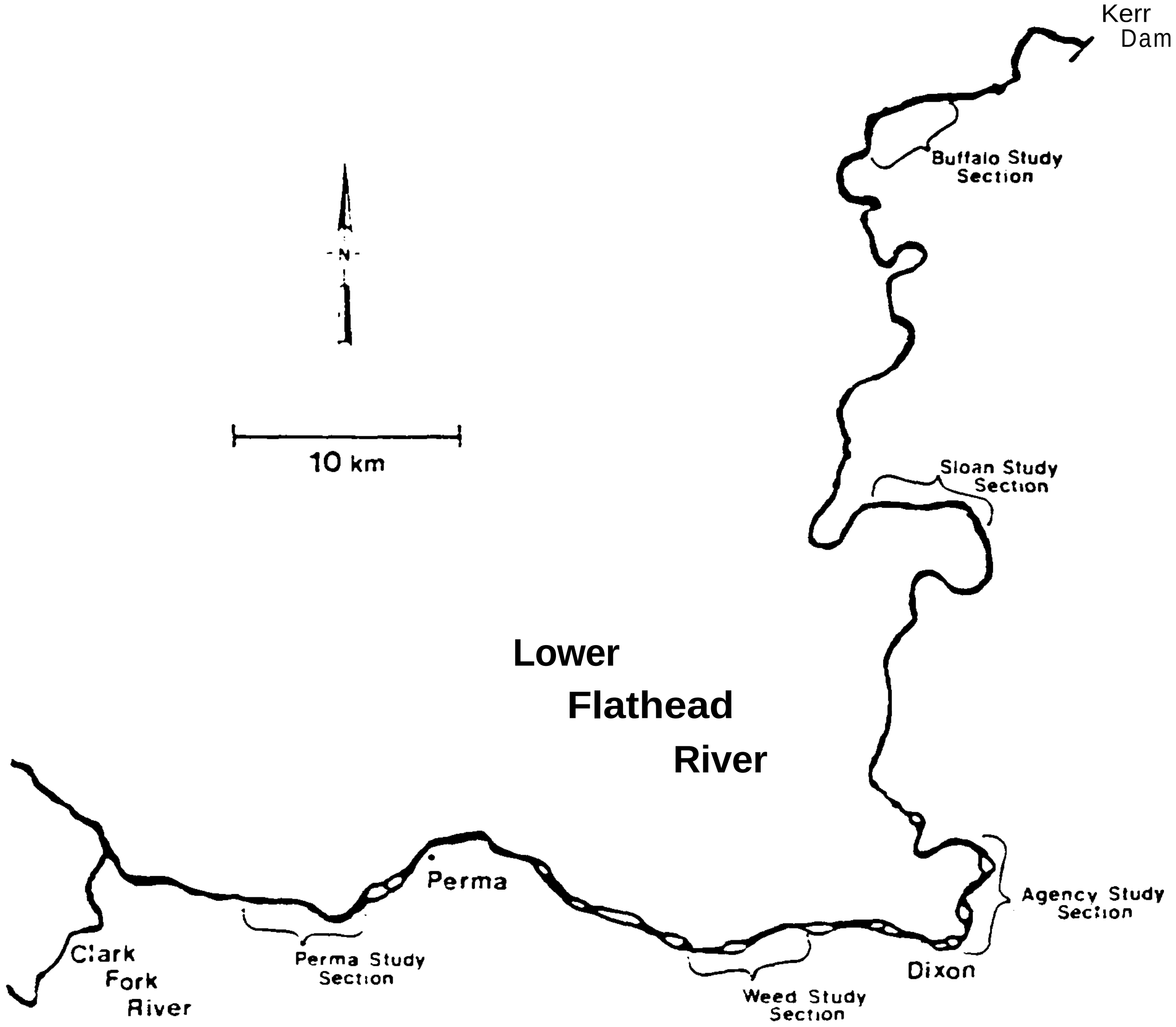
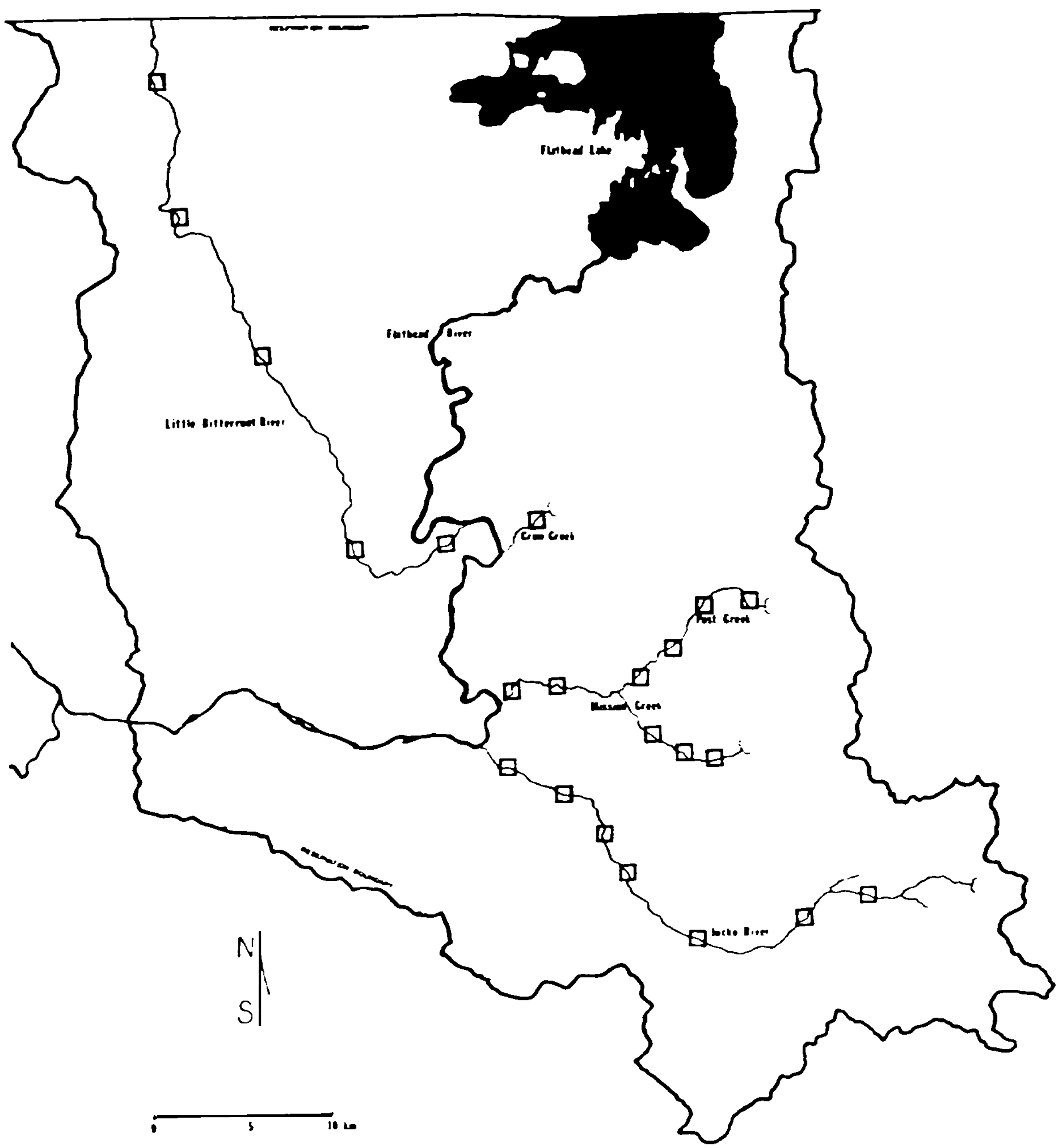



Figure 2. Permanent stock assessment and habitat evaluation study sections of the lower Flathead River.

Crow Creek, and five on the Little Bitterroot River (Figure 3). 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 the 1983 annual report of the Lower Flathead River Study (DosSantos, et al. 1983).

**Figure 3. Stock assessment stations established on five major tributaries to the lower Flathead River.**



# MAIN RIVER

## METHODS

### Physical Habitat Evaluation

Staff gages were installed at RK 37 and 30.6 in 1983 to monitor water level fluctuations. In 1984, additional staff gages were installed along the banks of the main river near the old Dixon Bridge (RK 40.2) and just below the mouth of Magpie Creek (RK 27.2). Gages were usually read once a day during the northern pike spawning period.

Daily water level fluctuations at other specific spawning areas were calculated by:

1. taking daily minimum stage height readings, recorded directly below Kerr Dam (USGS unpublished data),

2. converting from stage heights to discharge (USGS unpublished data),

3. comparing discharge to cross-sectional data (USFWS, unpublished data), and

4. computing vertical changes in water surface at areas of interest.

Mapping of channel substrate within the five permanent study sections was completed using guidelines set forth by the Cooperative Instream Flow Service Group (Bovee 1978). Substrates classified by visual observations from boat or by snorkling were recorded on field maps. Areas with rooted aquatic macrophytes were also mapped. Areas too deep to evaluate substrate composition, greater than 3.1 m of water, were noted as such.

Field maps were transferred to aerial photos (scale 1 inch:10,050 feet). Substrate classes which were at or above the 80 percentile level for the habitat suitability curves of brown, rainbow and cutthroat trout were delineated on the photos. Total areas of the study sections, suitable spawning gravels, and aquatic vegetation were calculated using a digital planimeter.

Daily discharge records recorded at RK 115 for the lower Flathead river were provided by the USGS. Discharge recordings at the USGS station began in August of 1907.

## Water Temperatures

Water temperatures were recorded at three permanent sites along the lower Flathead River using continuously recording 90 day Ryan thermographs installed at Sloan (RK 72), Dixon (RK 40) and Perma (RK 18) bridges. On June 8, 1984 a Ryan thermograph was also installed at the "Sink Hole" (RK 33.9), the largest back-water found along the river. Daily water temperatures recorded at the USGS gage house directly below Kerr Dam (RK 115) were monitored, until September 30, 1983.

## Spawning Surveys

The inlets of six known and one suspected northern pike spawning areas were trapped from March 14 to June 28, 1984, using 1.2 m diameter double-throated hoop nets and 1.5 x 1.0 x 1.0 m box traps. Traps were set to allow both entering and exiting of the marshes by northern pike.

Two off channel shallow benches of the main river were also trapped using 1.2 m diameter double-throated hoop nets. One area, located at RK 99.9, was trapped during the month of March. The other area, located at RK 43.4, was trapped from May 7 to June 26, 1984.

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

## Angler Exploitation

The Lower Flathead River fishery was surveyed as part of a general creel census conducted on the Flathead Indian Reservation by the Tribes. This survey was adapted from procedures outlined by Neuhold and Lu (1957). One creel clerk began the survey on 1 April 1983, six clerks worked during the summer, and three continued through fall on a random schedule. Computer analysis of compiled data was done by Robert McFarland using a program developed by MDFWP.

## Stock Assessment

Stock assessment data were collected at five permanent study sections located in the four reaches of the main river during the fall of 1983 and spring 1984. Fish were collected at night using boat mounted electrofishing gear (Leob 1957), following guidelines presented by Vincent (1971 and 1983) and Peterman (1978).

Study sections are 6.4 km long. Two electrofishing passes were made along each bank for a total of 25.7 river km sampled within each study section. It required two days to make either a mark or recapture run at each study section. Recapture runs followed marking runs by seven days (Vincent 1971 and 1983).

During marking runs, target fish species captured were weighed to the nearest 0.01 kilogram (kg) if they weighed less than 5 kilograms (kg). Fish heavier than 5 kg were weighed to the nearest 0.1 kg. Total length (TL) was determined for all fish and scale samples were taken from select fish for age and growth analysis.

All target fish species, except mountain whitefish, greater than 250 millimeters (mm) TL were tagged with individually numbered Floy "T-tags" inserted just under the posterior margin of the dorsal fin. Fish between 100 and 200 mm TL were tagged with individual numbered fry tags inserted just anterior to the origin of the dorsal fin using a needle and thread. All mountain whitefish were marked with either a pelvic or caudal fin punch.

During recapture runs, all unmarked fish, except mountain whitefish, were processed as above. Only length and tag number were recorded from recaptured fish. Mountain whitefish were examined for marks, and lengths were taken on recaptured individuals. All unmarked mountain whitefish were counted.

Target fish species population estimates were made using an adjusted Peterson estimate. Formulae used are presented in Ricker (1975). Population estimates were determined as fish per kilometer (fish/km) ± the 80% confidence interval. Catch per unit effort for each target fish species was determined, and defined as one hour of actual fish sampling.

## Aging of Fish

Fish scales collected in the field were hand sorted under a disecting scope to eliminate regenerated scales. A maximum of five satisfactory scales from each fish were placed rough side down, on a 150 mm square of 0.02 cm clear acetate. The acetate sheet was pressed between two stainless steel plates at 200 degrees Farenheight (°F) and 20,000 pounds for one minute in a Carver hydraulic press, producing permanent scale impressions. Scale impressions were magnified 24X or 48X by a NMI90 micro-fiche reader for aging.

Age determinations of all target fish species, except northern pike, were determined by noting annuli and checked using length and age data presented in Carlander (1970) and Brown (1971) and histograms of captured fish.

The use of scales alone for agin northern pike is difficult and can be misleading (Williams 1955). Cleithra, the paired flat bones which are the major osseous component of the pectoral girdle, have been shown to be reliable in assessing the age of northern pike (Casselman 1973 and 1979). Age determination of northern pike using scale impressions was verified by Minnesota Department of Natural Resources fisheries personnel using cleithra and representative scale samples from Flathead River pike.

## Fish Movement

Recapture of fish tagged during stock assessment, spawning runs, and the return of tags by fishermen provided data on the movement of target fish species. Tag return requests were posted at public locations, circulated in local newspapers, and distributed to fishermen by creel census clerks.

Internal radio transmitters manufactured by Advanced Telemetry Systems of Bethel, Minnesota, powered by a TL200 Lithium battery having an expected life span of 785 days were surgically implanted in seven northern pike. Each tag measured 75 mm x 30 mm and weighed 97 grams (g), approximately two percent of the average weight of radio tagged fish (5,178 g). Radio signals are transmitted at 48 mHz through a 457 mm plastic coated stainless steel braided wire external antenna, chosen to prevent breakage due to body flexing by large fish. Tags were sealed in plastic bags and sterilized in a gas autoclave, thus remaining sterile until used.

Northern pike were anesthetized in water lightly treated with tricaine methanesulfonate prior to surgery. Fish remained in the initial bath until they were calm to the touch, without losing their vertical control. Fish were then placed upside down on an improvised operating table (Figure 4) and into a tub of lightly anesthetized fresh water that just covered the head and operculum. Respiration was checked throughout surgery, and periodically a current of water was manually forced over the gills. All surgical tools were disinfected immediately prior to surgery.

An incision was made with a scalpel approximately 60 mm anterior and medial to the origin of the right pelvic fin. The opening was lengthened by cutting with a scalpel between the arms of forceps used as spreaders and elevators of the body wall to prevent accidental injury to the viscera. The completed opening, usually 45 to 55 mm long, was only as large as was required to admit the transmitter.

A 100 mm long, 10 gage Haupner Equine intravenous needle was inserted into the body cavity at a point just posterior to the pelvic girdle. The surgeon's finger was used to guide the point of the needle, preventing internal damage to viscera, to the posterior margin of the incision. The transmitter antenna was fed down the bore of the needle, and both needle and antenna were drawn out through the body wall from behind the pelvic girdle. The transmitter was then pushed through the body wall inicision and into the body

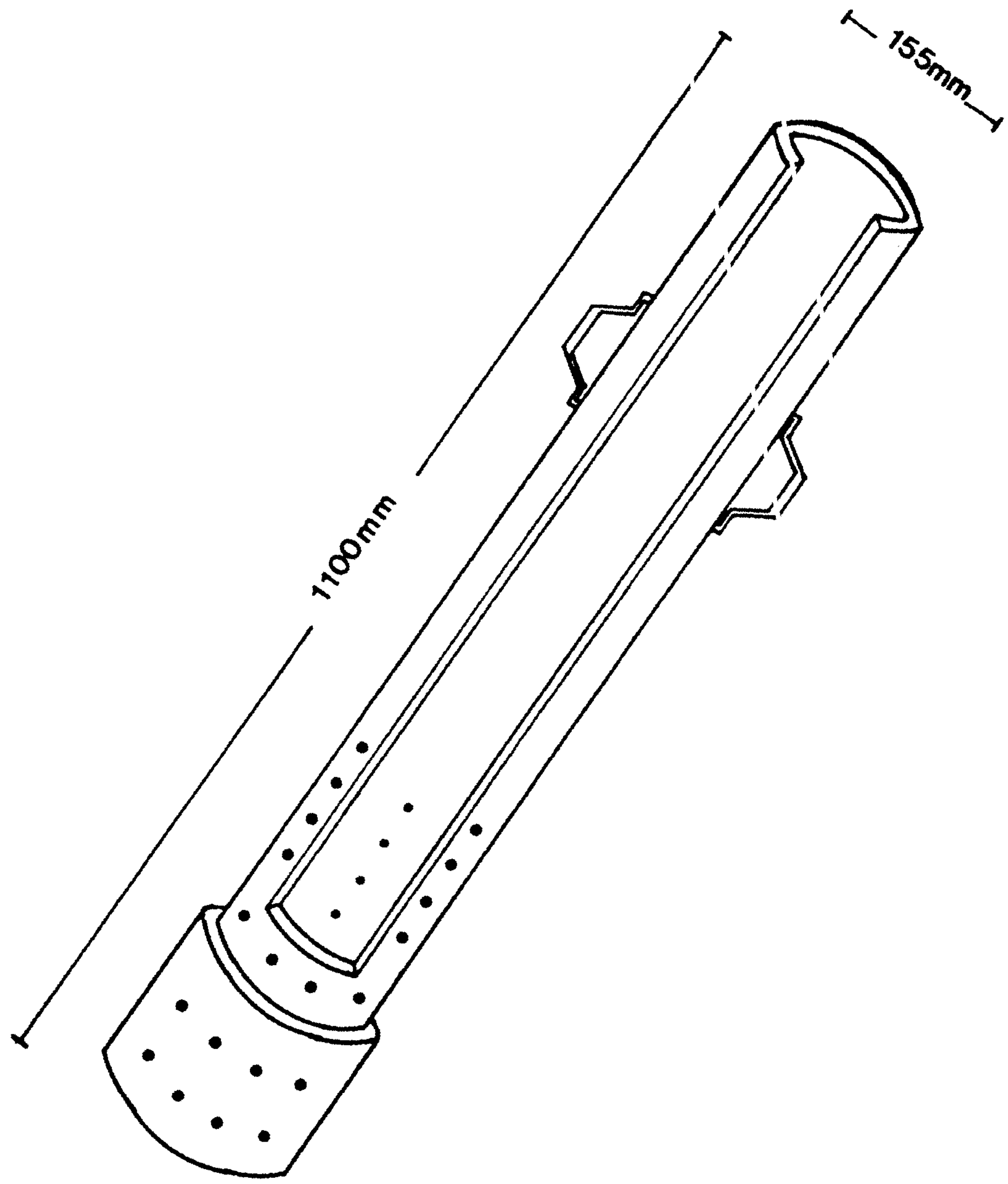



Figure 4. Northern pike PVC operating table.

cavity. By pulling on the antenna, the transmittef was held snuggly over the pelvic girdle. The incision was closed with sutures made at approximately 5 mm intervals with a 45 mm diameter half circle reverse cutting needle, using nylon suturing material (Braunamid, B. Braun Melsungen AG, West Germany). The individual nylon sutures were tied with a surgeon's knot topped with a tight double overhand knot.

Individual sutures were made by passing the needle through both the peritoneum and integument. Initially, we sutured the peritoneum with an absorbable polyglycolic acid suture then the integument with the nylon suture. We found, however, that a closer annealing of the tissues and less inflamation was caused when a single row of nylon sutures was used to close the incision.

Postoperative care consisted of approximately a -5 minute antiseptic bath in a 100:l dilution of the concentrated antiseptic solution; 500 milliliters (ml) of water, 1.25 ml of 10% formaldehyde and 0.5 gr of zinc-free Malachite green (personal communication, Bob Strand, Minnesota Department of Natural Resources, Fish Research, Bemidigi, Minnesota ). Fish were placed in a freshwater holding car until they regained almost total preoperative vigor. Signal transmission was checked and the fish re-leased. The entire process from initial anesthesis to final release took approximately 15 minutes.

Radio tagged fish were tracked weekly using a hand held loop antenna and a programable scanning receiver. Tracking operations were primarily conducted by floating mid-channel downstream in an open boat. The boat's motor was run as little as possible to prevent receiver interference. Tracking operations were also conducted by truck when possible. On several occasions, when individual fish were unable to be located, aerial surveys proved to be effective in locating fish. The hand held loop antenna was effective in radio locations up to approximately 400 m. Aerial flights conducted at an altitude of 30.5 m had a maximum signal reception range of 800 m.

# TRIBUTARIES

## METHODS

### Stock Assessment

Mark-recapture efforts were conducted at 22 permanent stations (DosSantos, et al. 1983) within five major tributaries to the lower Flathead River: the Jocko River, Mission Creek, Post Creek, Crow Creek, and the Little Bitterroot River. Intervals between marking and recapturing were approximately two weeks during fall 1983 and one week during spring 1984.

Each 150 m-long station was electrofished during daylight using a bank or backpack shocker. Most stations were sampled as open sections by three persons, one operator and two netters, making one pass through. A block seine was installed at the upstream end of Station 2 and Station 3 on the Little Bitterroot River to improve capture efficiency in the turbid water.

Flow measurements were taken directly using a Marsh-McBirney electronic flow meter, or stage heights were read at established hydrologic stations and translated into flows using provisional rating curves developed by Tribal hydrologists. U.S. Geological Survey methods (Carter and Davidian 1968; Buchanan and Somers 1969) were followed in metering flows.

Captured target fish species were measured (TL), weighed, and fin-clipped or tagged with floy anchor or fingerling tags. Scales were removed and later impressed into cellulose acetate for age analysis as described in the methods section for the main river.

Population estimates were calculated using Chapman's modification of Petersen's formula (Ricker 1975). An 80 % confidence interval was computed for each estimate. Catch of target fish species per hour of electrofishing was also determined.

## Spawning Surveys

An ambitious stock assessment schedule and the early onset of high flows in spring 1984 limited redd surveys to the Jocko River for brown trout (*Salmo trutta*) during January, and lower Crow Creek during October and May for brown trout and rainbow trout (*Salmo gairdneri*), respectively. 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, and possible based on Montana Department of Fish, Wildlife and Parks' (Shepard et al. 1982) criteria:

A. Definite - the redd is located in an area that would not be cleaned due to stream hydraulics and contains a recognizable pit and tailspill area,

B. Probable - a definite cleaned area of streambed located in an area that would not normally be cleaned by stream hydraulics; the pit and tailspill areas are not easiiy discernible,

C. Possible - a clean area of streambed that could be attributed to stream hydraulics; no discernible pit or tailspill area, or an area which may have a pit and tailspill area is not "clean" due to sediment deposition or algal growth.

For the final counts, only definite and probable redd observations were used.

During February, three traps were set in the Little Bitterroot River 2 km, 60 km, and 61 km above its mouth to capture spawning northern pike. These 150 x 120 x 90 cm box traps were divided into two compartments, one with an upstream opening and one with a downstream opening. Wire mesh leads were attached.

To capture spawning adult salmonids, one box trap was installed in lower Crow Creek in mid-March approximately 2.5 km above its mouth. Modular fish weirs were installed in the Jocko River 2 km above its mouth and in Mission Creek 6 km above its mouth during late February and early March. The weir design was developed by Art Dobler, U.S. Forest Service engineer with the Shasta-Trinity National Forest, California, and described n the study's 1983 annual report (DosSantos et al. 1983).

A backhoe was used to dig a trench for installation of 23 gabions (3X1X1 m baskets) forming the base of each weir across each stream. The baskets were assembled and laced into pairs on shore, entrenched with long axis parallel to stream flow, and wired to adjacent pairs. Once in place, the gabion baskets were filled with 10 cm diameter and larger rock and laced shut. To form the weir, 17 trapezoid-shaped, angle-iron modules were bolted together and wired onto the gabion-basket base. Trapping facilities were provided by inserting a prefabricated trap into one of the modules. On the remaining modules rod panels were slid into channels to prevent upstream and downstream movement and funnel fish into the trap.

Rocks 15 cm and larger were placed around and downstream from the weir structure to add support and prevent scouring. The streambanks at either end of the weirs were carefully rip-rapped, and shoreline areas disturbed during construction were reseeded.

Salmonids trapped at the weirs were measured (TL), weighed, sexed, and tagged; scale samples were removed, and the fish were released upstream. Trap doors were closed, and several rod panels were removed near the banks during high water to facilitate fish passage.

## Fish Movement

Recapture of fish tagged during stock assessment, spawning runs, and the return of tags by fishermen provided data on the movement of target fish species. Tag return requests were posted at public locations, circulated in local newspapers, and distributed to fishermen by creel census clerks.

## Water Temperatures

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

## Angler Exploitation

The Jocko River, Mission Creek, Post Creek, and Crow Creek were surveyed as part of a general creel census conducted on streams and reservoirs on the Flathead Indian Reservation. This survey was adapted from procedures outlined by Neuhold and Lu (1957). One creel clerk began the survey on 1 April 1983, six clerks worked during the summer, and three continued through fall on a random schedule. Computer analysis of compiled data was done by Robert McFarland using a program developed by MDFWP.

MAIN RIVER

RESULTS

## Habitat Evaluation

The Buffalo study section encompasses approximately 208 hectares of wetted substrate at bank full discharge (approximately 708 $m^3$/second). Twenty-five percent of the area was too deep to adequately assess substrate composition. Nine hectares of gravel met size suitability standards for trout spawning (Bovee 1978 1) while only 0.5 hectares contained aquatic macrophytes (Figure 5). The Sloan study section encompasses approximately 292 hectares, 17% of this area was too deep to adequately assess substrate composition. None of the substrate size in this area met suitability standards for trout spawning, 2.5 hectares contain aquatic macrophytes (Figure 6). The Dixon study section encompasses approximately 488 hectares. One percent was too deep to assess substrate composition. Fifteen hectares of gravel met size suitability standards for trout spawning and 16 hectares contained aquatic macrophytes (Figure 7). The Weed study section encompasses approximately 532 hectares, 12% was too deep to assess substrate composition. Seventy-nine percent (421.5 hectares) met size suitability standards for trout spawning. Thirty nine hectares of rooted aquatic macrcphytes were found in the Weed study section with 7.5 hectares of macrophytes found in two backwater areas (Figure 8). The Perma study section encompasses approximately 484

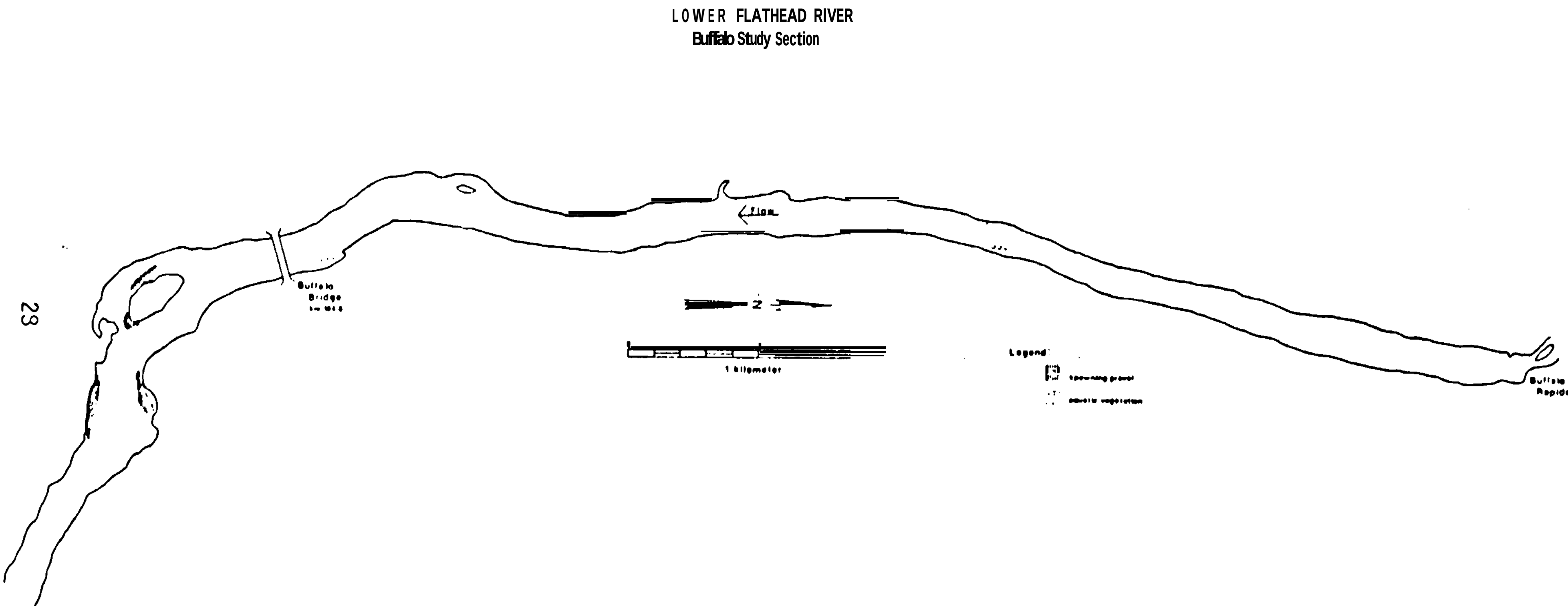



Figure 5. The Buffalo study section, potential salmonid and northern nike spawning substrates,

**LOWER FLATHEAD RIVER**
**Sloan Study Section**

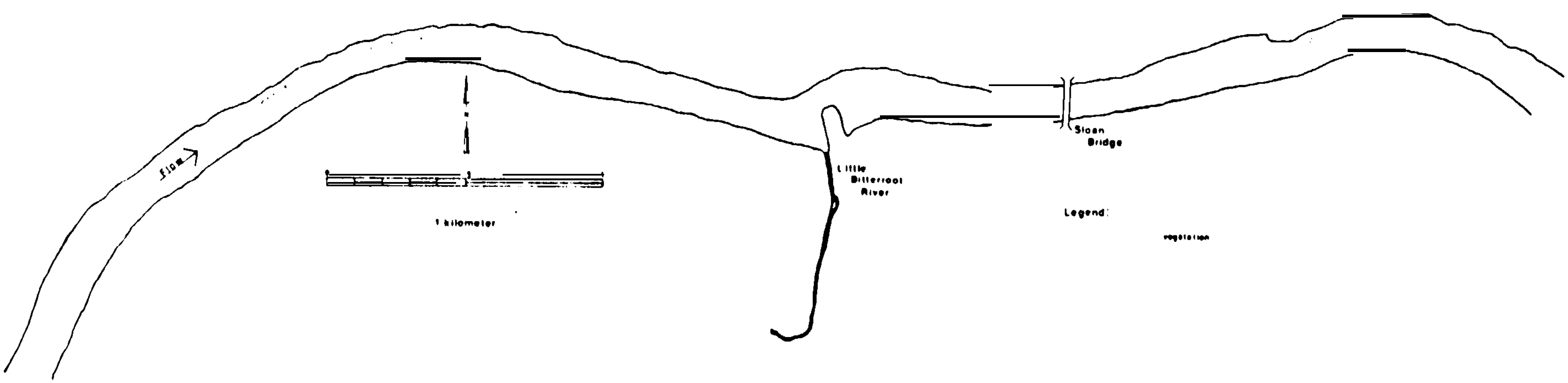



Figure 6. The Sloan study section, potential salmonid and northern pike spawning substrates.

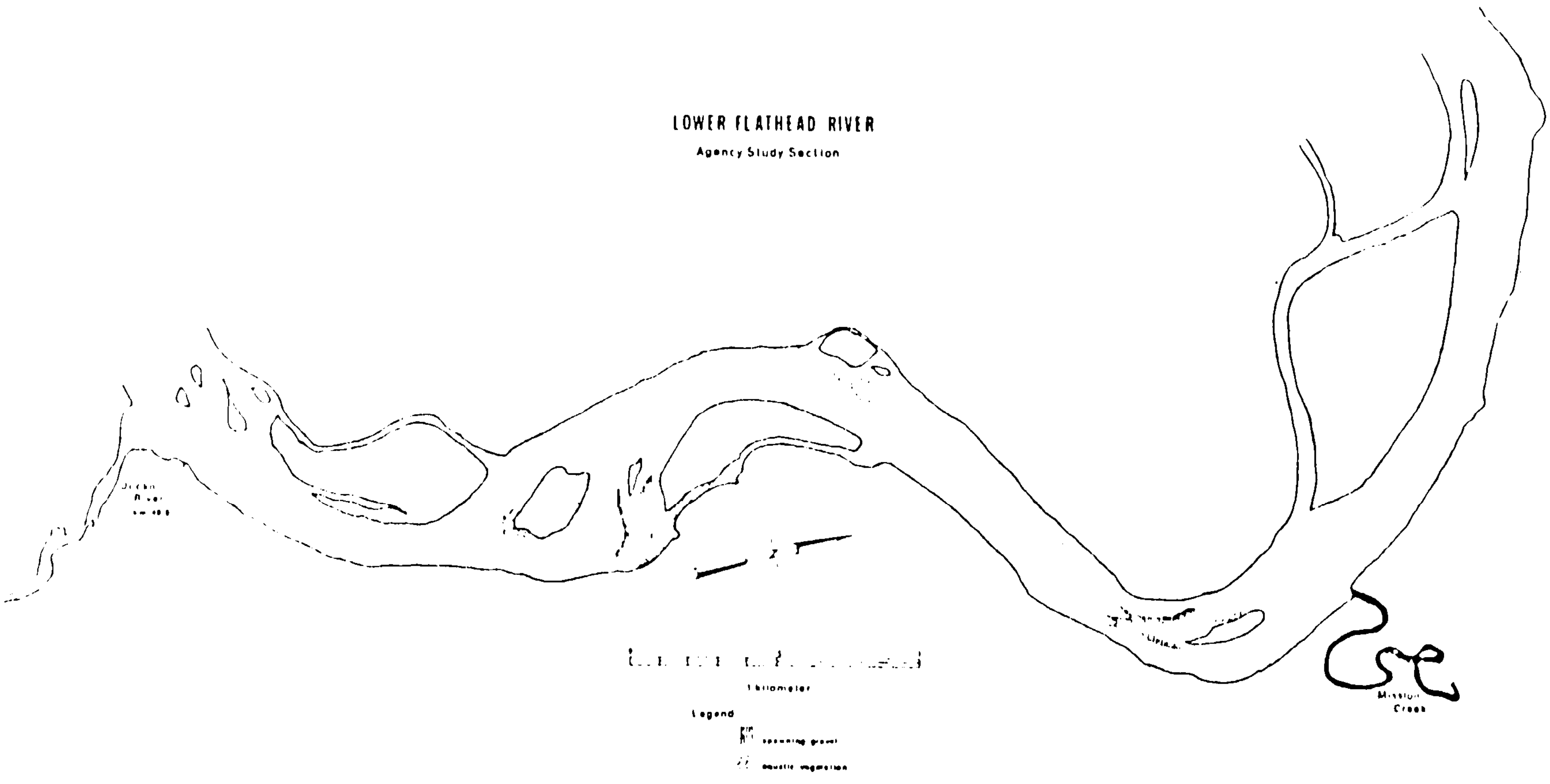



Figure 7. The Dixon study section, potential salmonid and northern pike spawning substrates.

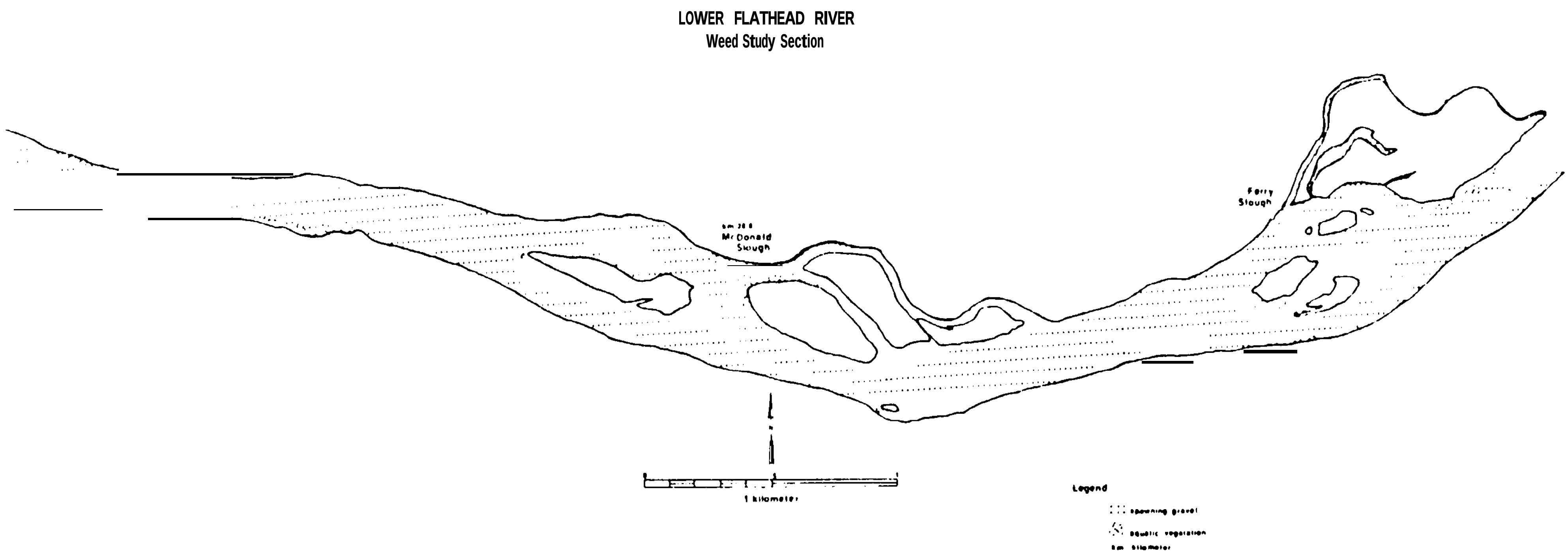



Figure 8. The Weed study section, potential salmonid and northern pike spawning substrates.

hectares; 29% was too deep to adequately assess substrate composition. Forty-three percent of the gravels within this study section met size suitability standards for spawning trout. . Aquatic macrophytes covered 98.5 hectares (Figure 9).

## Kerr Dam Flow Releases

Discharges from Kerr Dam during the northern pike spawning season (April, May, June) were consistently lower in 1984 than 1983 (Figure 10). Minimum daily discharges during the month of April 1984 were below 141.6 $m^3$/second 23 of 30 days; weekly average discharges for the month ranged from 23 to 33% lower than the previous year. Minimum daily discharges during the month of May 1984 were below 141.6 $m^3$/second 21 of 31 days, weekly average discharges for the month ranged from 11 to 78% lower than the previous year. During the last week of May, flows averaged only 97 $m^3$/second compared to 434.5 $m^3$/second for the same period in 1983. Minimum discharges for this week only exceeded 28.3 $m^3$/second one day, and reached a low of 21.3 $m^3$/second. Twenty-one $m^3$/second was the lowest flow ever recorded for the month of May since the establishment of discharge recording by the USGS in 1907. The weekly average discharge for the first week cf June 1984, was 48% lower in 1984 than in 1983. Flows for the remaining part of June averaged 25 % greater than in 1983.

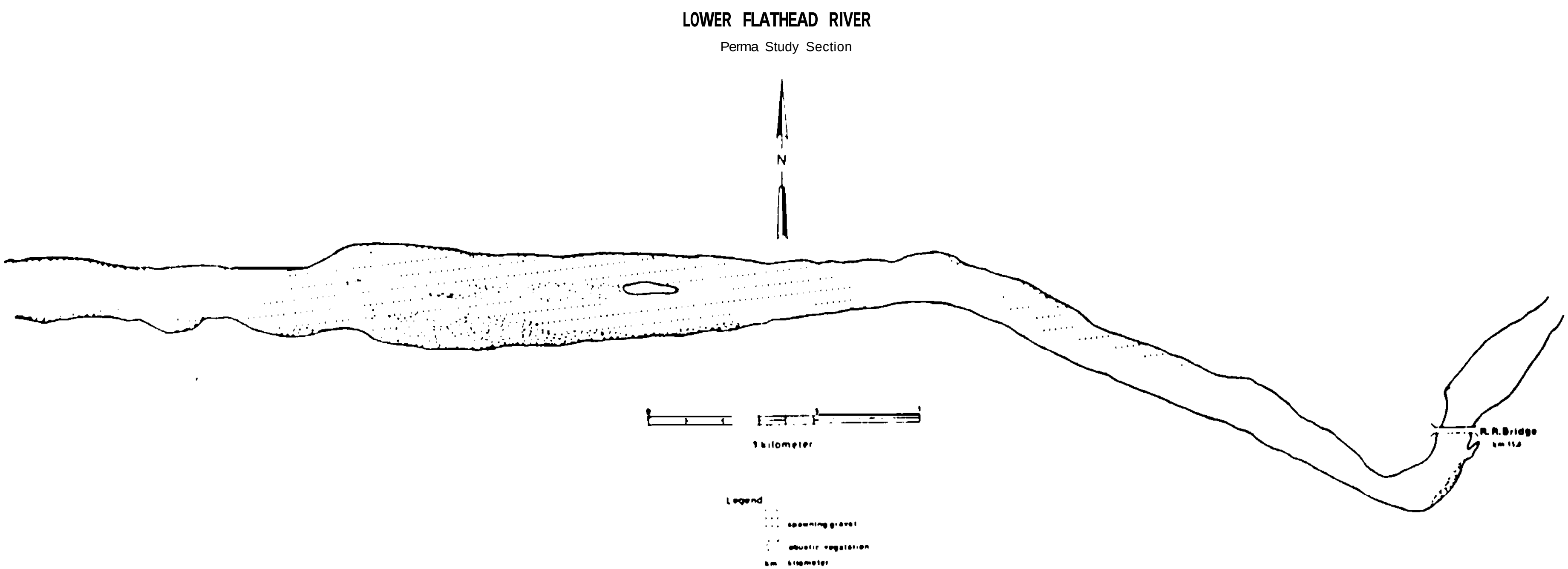



Figure 9. The Perma study section, potential salmonid and northern pike spawning substrates.

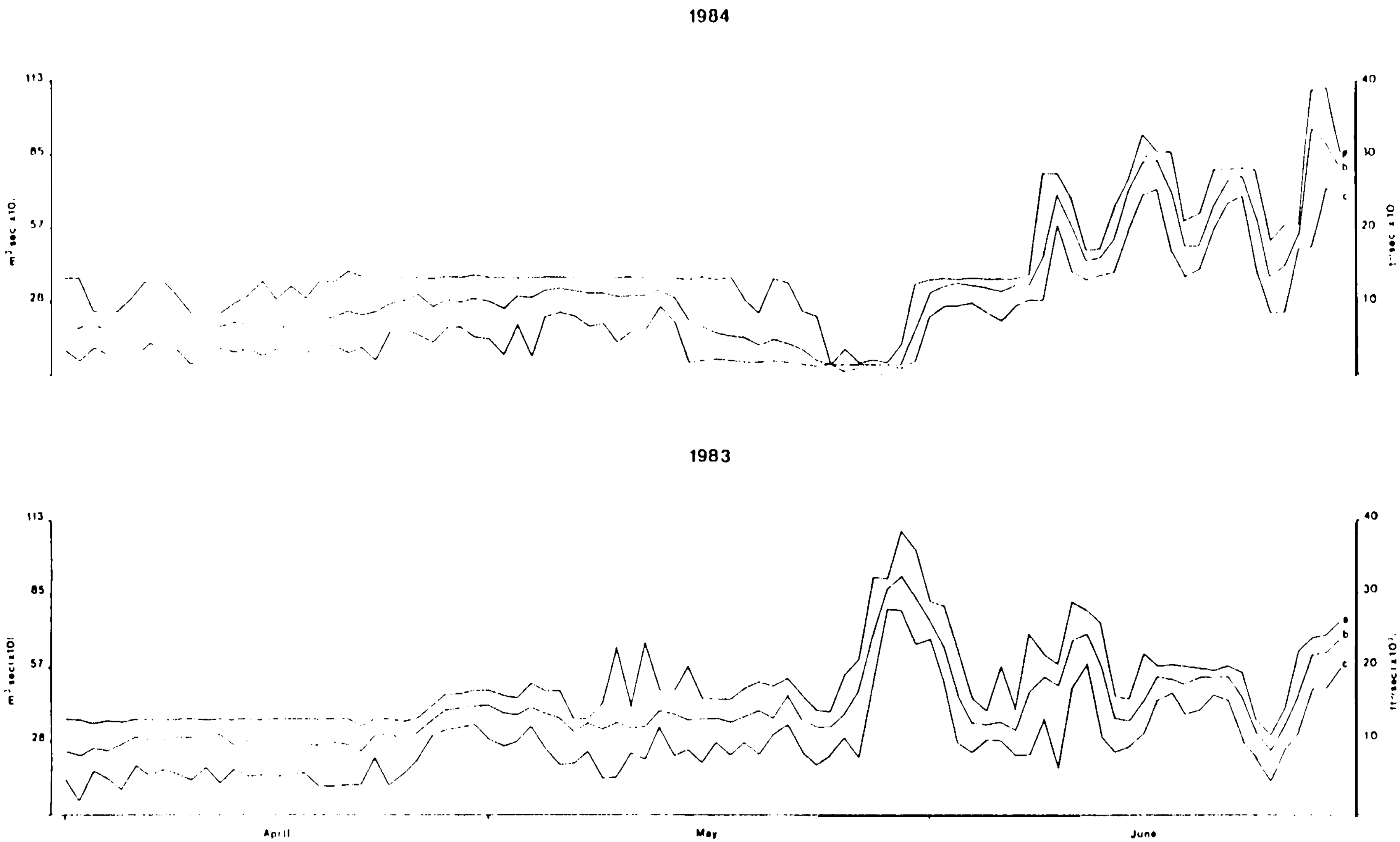



Figure 10. Daily discharges (maximum(a), mean(b) and minimum(c)) from Kerr Dam for April, May and June 1983 and 1981 recorded at RK 114.3.

## Temperature Monitoring

Average monthly low, mean, and high river-water temperatures recorded directly below Kerr Dam from January to September 1983 are given in Figure 11. The USGS discontinued all temperature monitoring after September 30, 1983.

Main river summer water temperature exhibited a consistent pattern. Water temperature between Kerr Dam and Sloan Bridge warmed by 1 to 2 degrees Centigrade (°C). Water temperature dropped two degrees between Sloan and Dixon due to inflow of water from the Little Bitterroot River, Mission Creek and the Jocko River. At Perma bridge river water had warmed by 2 °C, the same temperature observed at Sloan's bridge. Daily temperatures varied as much as 8.5 °C directly below Kerr Dam (RK 115), whereas temperature variation at Perma (RK 18) rarely exceeded 2° C.

## Spawning Surveys

Northern pike in varying stages of reproductive condition were captured at three of eight known spawning areas this spring. Gill net sets and seining identified four additional areas being used by spawning fish. Electrofishing captures and seasonal observation indicated nine main channel slack water areas contained reproductively ripe northern pike.

One hundred twelve northern pike were captured and tagged between 14 March 1984 and 22 June 1984; 33% were

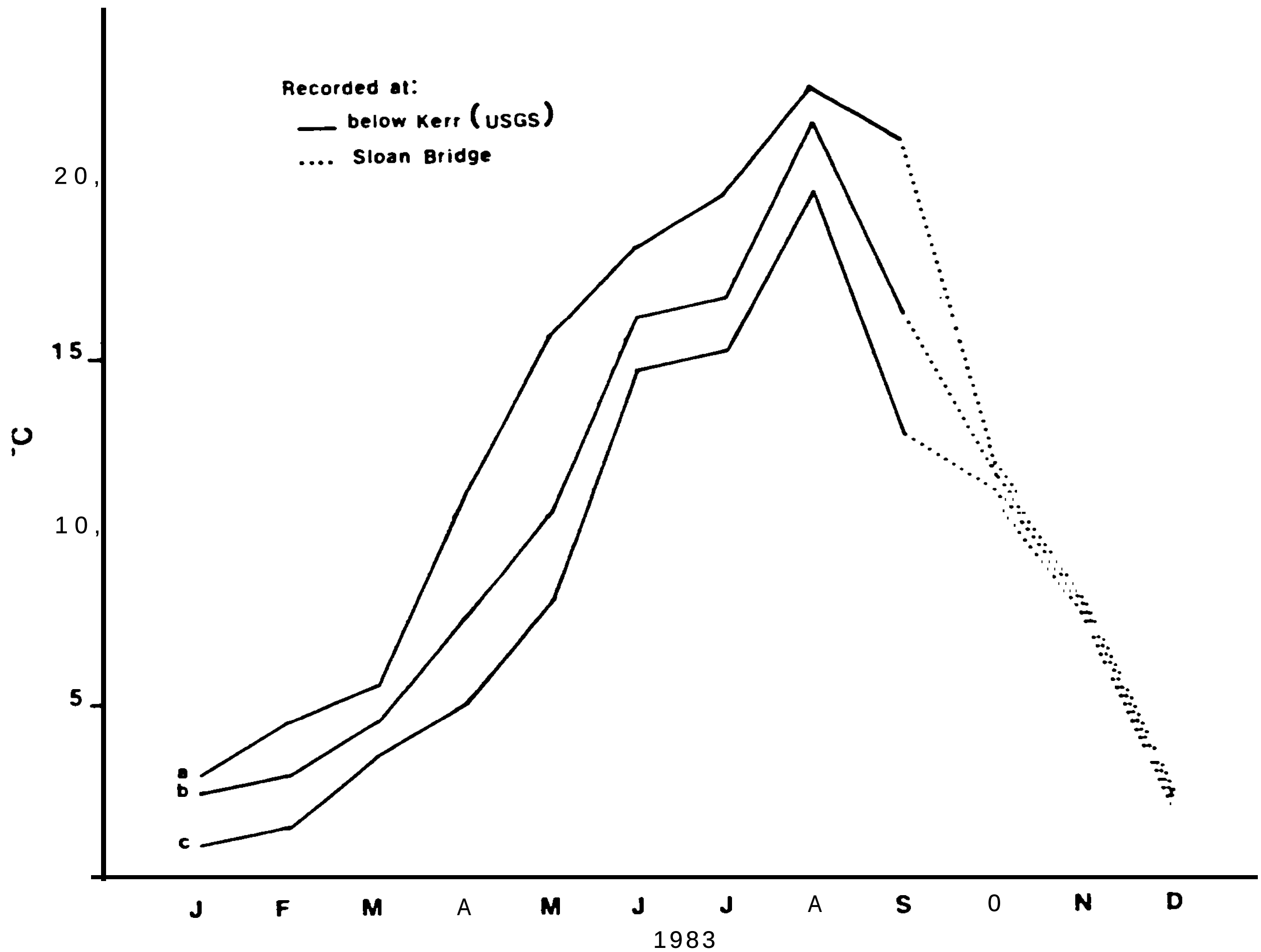



Figure 11. Water temperatures (monthly maximum (a), mean (b) and minimum (c)) for the lower Flathead River recorded directly below Kerr Dam (RK 114.9) and at Sloan bridge (RK 71.4).

immature at the time of capture. Of the mature spawners captured and sexed, 41% were males and 26% percent were females, resulting in a male-female sex ratio of 1.6 to 1.0 (Table 1).

The first ripe male northern pike was collected on 2 April 1984, and the first ripe female on 11 April 1984. After 2 May 1984, 16% of all males handled were partially spent. The first spent female was captured on 31 May 1984.

Northern pike were trapped entering shallow areas where the remains of last year's aquatic vegetation, cattail (Typha latifolia), horsetail rush (Equisetum spp.) and bulrush (Scirpus acutus), had been recently resubmerged. Reproductively ripe northern pike were also captured in deeper water areas over aquatic vegetation consisting of last year's dead and newly emerging Elodea spp., Potamogeton spp., Chara spp., Ranunculus spp. and Myriophyllum spp.

Observation during the spring of 1983 and 1984 demonstrated that known spawning areas experience to daily water level fluctuations. A change of only 3 cm can change inflow to outflows at the mouth of some spawning areas, and common springtime water level fluctuations of 0.4 to 1.5 m dewater some spawning areas daily.

Based on staff gage readings, a mean daily discharge of less than 359.7 $m^3$/second causes water to start draining from all spawning areas downstream of RK 50. A mean daily discharge of 371 $m^3$/second causes water inflow into these areas. A discharge of approximately 204 $m^3$/second dewaters the inlets of all off channel spawning areas.

The main river was surveyed in fixed-wing aircraft in April of 1984 to identify salmonid spawning areas. Ten redds were located in the Flathead River immediately above the confluence with the Clark Fork River. No other redds were observed in the main river.

Table 1. Method of capture, numbers, reproductive condition and average length for northern pike captured during the spring of 1984.

| Capture Method | Northern Pike Immature | Male | Female |
|---|---|---|---|
| Netting | 19 | 16 | 6 |
| Electrofishing | 14 | 15 | 20 |
| Trapping | 4 | 15 | 3 |
| Total | 37 | 46 | 29 |
| Average length (mm) (range) | 392.16 (267-490) | 703.28 (428-908) | 690.62 (540-996) |

## Angler Exploitation

From March 1, 1983, to September 30, 1984, 779 target fish were tagged to assess fish movement and fishing mortality. Three hundred seventeen northern pike were tagged, and 37 tags returned; of 17 cutthroat tagged, one tag was returned; of 124 brown trout tagged, five tags were returned; of 91 rainbow trout tagged, one tag was returned;

and of 108 largemouth bass tagged, one tag was returned. These tag returns yield an 18 month return rate for northern pike, cutthroat, brown and rainbow trout, and largemouth bass of 12, 6, 4, 1 and 0.9%, respectively. No tags from mountain whitefish (115 tagged) or bull trout (*Salvelinus confluentis*) (7) have been received.

Results of the creel survey conducted on the Reservation from April to September 1983, and summarized by DosSantos and Cross (1984), are quoted below.

"One hundred seventy-two interviews (17.8%) were conducted on the main river, accounting for 21.7% of all anglers contacted reservation wide. Anglers concentrated on the more accessible reaches of the river; only 111 anglers were contacted from Kerr Dam downstream to Sloan's Bridge, 336 anglers were contacted downstream of Sloan's Bridge.

Approximately one half (52.3%) of the river fishermen were between the ages of 21 and 40; the majority (66.9%) were between the ages of 21 and 64 years of age. Senior citizens accounted for 2.3% of all anglers interviewed.

The primary recreational activity occurring on the lower Flathead River was sport fishing; 61% of those interviewed indicated that fishing was their primary goal. Fishing associated with other activities such as picnicking and overnight camping accounted for 79.1% of the responses. Eleven percent of those people interviewed along the Flathead were seeking solitude.

River anglers fished an average of 4.6 hours, primarily from shore using bait (40.7%) and lures (15.7%) as terminal gear of coolwater species. Catch rates for the period of survey were: yellow perch, 0.78/hr; largemouth bass, 0.44/hr; northern pike, 0.10/hr; and mountain whitefish, 0.01/hr. Catch rates for all other species present in the lower Flathead River were below 0.01/hr."

## Stock Assessment

Stock assessments were conducted at five permanent study sections; Buffalo, Sloan, Dixon, Weed and Perma, on the lower Flathead River during fall 1983 and spring 1984. Popuiation estimates for individual age classes of target fish species were not made due to low numbers of fish captured. Population estimates represent all year classes combined for each fish species.

During fall sampling, catch per unit effort for mountain whitefish was consistent between the Buffalo, Sloan and Dixon study sections averaging 79 fish/hour. Catch per unit effort dropped to 36.48 in the Weed section and 11.73 at Perma. Mean catch rates for rainbow of 0.69 and brown trout, 0.65, were almost identical. Catch per unit effort for northern pike was highest in the Weed section (3.68) during fall sampling. Largemouth bass were only encountered at the Perma study section where the catch per unit effort was 0.28 (Table 2).

Spring 1984 catch per unit effort for mountain whitefish was 80.25 at the Buffalo study section and 77.76 at Dixon, similar to fall 1983 rates. The Perma study section showed the lowest catch rate for mountain whitefish both spring and fall.

Four trout species were captured during spring sampling brown, rainbow, cutthroat and bull trout; only brown trout were found in all sections. Bull trout were captured in the Dixon, Weed and Perma study sections, with

Table 2. Catch per boat hour of operation for target fish species captured during Fall 1983 and Spring 1984 stock assessment.

| | STUDY SECTIONS | | | | |
|---|---|---|---|---|---|
| | Buffalo | Sloan | Dixon | Weed | Perma |
| FALL 1983 | | | | | |
| Mountain whitefish | 73.54 | 73.77 | 90.03 | 36.48 | 11.73 |
| Brown trout | 1.21 | 0.29 | 0.57 | 0.53 | 0.65 |
| Rainbow trout | 0.15 | 0.22 | 1.40 | 1.54 | 0.18 |
| Cutthroat trout | 0.08 | 0.07 | 0.06 | 0.42 | 0.00 |
| Bull trout | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Northern pike | 0.76 | 0.57 | 1.90 | 3.68 | 0.01 |
| Largemouth bass | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| SPRING 1984 | | | | | |
| Mountain whitefish | 80.25 | 54.64 | 77.76 | 48.57 | 31.37 |
| Brown trout | 2.14 | 1.77 | 1.78 | 1.60 | 0.67 |
| Rainbow trout | 0.08 | 0.18 | 1.78 | 1.18 | 0.79 |
| Cutthroat trout | 0.08 | 0.18 | 0.08 | 0.42 | 0.00 |
| Bull trout | 0.00 | 0.00 | 0.08 | 0.14 | 0.17 |
| Northern pike | 0.23 | 0.88 | 1.62 | 1.11 | 0.11 |
| Largemouth Bass | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

an average catch rate for these three study sections of 0.08. During spring sampling northern pike were most common in the Dixon study section with a catch per unit effort of 1.62 (Table 2).

Populations estimates for mountain whitefish at the Buffalo, Sloan and Weed study sections were significantly higher ($p \leq .05$) in the fall of 1983 than the spring of 1984. Fall stock abundance for mountain whitefish was highest in the Weed section followed by Buffalo and Sloan (Table 3). Spring stock levels were similar and highest within the Buffalo, Dixon and Weed study sections, intermediate at Perma and the lowest at the Sloan study section (Table 3).

Brown trout population estimates were highest in the Buffalo section (29 ± 26) and similar in the Dixon (5 ± 3) and Weed (6 ± 5) study sections during the fall of 1983. Spring populations were lowest at the Perma section (5 ± 2), and similar within all other study sections (Table 3).

Insufficient numbers of rainbow trout were captured in the Euffalo and Sloan study sections in fail, 1983 and spring, 1984 to make population estimates. Rainbow trout population levels were similar during both sampling periods in the Dixon, Weed and Perma sections (Table 3). The highest estimate was made for the Dixon section (27 ± 19) during the fall sampling period. Although all trout species are relatively uncommon, rainbows were found to be the most

Table 3. Petersen mark - recapture population estimates of target fish species for main river study sections. Eighty percent confidence interval given in parentheses.

| | STUDY SECTIONS | | | | |
|---|---|---|---|---|---|
| | Buffalo | Sloan | Dixon | Weed | Perma |
| FALL 1983 | | | | | |
| Mountain whitefish | 5,969(± 1,883) | 3,514(± 904) | * | 6,339(± 3,041) | *** |
| Brown trout | 29(± 26) | ** | 5(± 3) | 6(± 5) | *** |
| Rainbow trout | ** | ** | 27(± 19) | 19(± 10) | *** |
| Northern pike | 6(± 5) | 5(± 3) | 32(+ 19) | 103(± 56) | *** |
| SPRING 1984 | | | | | |
| Mountain whitefish | 2,034(+ 331) | 977(± 185) | 2,549(+ 523) | 2,323(± 613) | 1,879(± 563) |
| Brown trout | 13(± 5) | 11(+ 6) | 11(+ 6) | 16(+ 8) | 5(± 2) |
| Rainbow trout | ** | ** | 14(+ 6) | 18(+ 13) | 11(+ 8) |
| Northern pike | ** | 5(± 2) | 18(+ 10) | 11(± 6) | ** |

*recaptures insufficient for estimation
**present, but numbers too low for estimation
***not completed in 1983

common in the lower reaches of the river.

Fall northern pike population estimates were similar at the Buffalo and Sloan study sections, and significantly higher ($p \leq .05$) at the Dixon and Perma study sections. Sprirg population levels varied little between the Sloan, Dixon and Weed study sections, with no significant difference ($p \leq .05$) between them.

## Age and Growth

Fall '83 and spring '84 catches of mountain whitefish were dominated by age 4 fish, which represent 61% of the fall catch and 60% of the spring catch. Age 3 fish were the next strongest year class, representing 14% of the fall '83 catch and 22% of the spring '84 catch. There was an approximate 20 mm increase in average total length between fall and spring catches of mountain whitefish.

Growth of male and female northern pike was similar through age 3. Fish older than age 4 show differential growth between the sexes, with females exhibiting faster growth. Young-of-the-year pike grew to approximately 250 mm by the end of their first year. By their third year they have doubled their length. By their fifth year male northern pike range from 700 to 840 mm TL, and female pike may reach 920 mm TL. Seventy percent of all northern pike handled from August 1, 1983, were age 3 or younger.

Catches of rainbow trout were dominated by age 2 fish, representing 55% of all rainbow trout handled. Age 2 fish ranged from 200 to 289 mm TL. Age 3 rainbow trout comprised 40% of all fish handled, and ranged from 290 to 389 mm TL. Age 1 and 4 rainbow trout each comprised only 2.5% of all rainbow handled. During the fall 1983, sampling, rainbow trout averaged 269 mm TL; during spring 1984, rainbow average 309 mm TL.

Catches of brown trout were dominated by age 3 fish, representing 40% of all brown trout handled since August 1983 (n = 104). Age 3 fish ranged from 270 to 389 mm TL. Age 4 and 5 brown trout represented a combined 35% of the sample, and were the only age classes which showed a considerable size overlap. Age 4 fish ranged from 390 to 489 mm TL, and age 5 fish ranged from 430 to 519 mm TL. Age 6 brown trout comprised 14% of the total sample and reached 620 mm in total length. Age 2 fish comprised 11% of the total sample and ranged from 200 to 270 mm TL. Only two age 1 brown trout have been collected in the main river.

## Fish Movement

Of nine tag returns for brown trout, all fish were captured within 4.8 km of the initial point of release. Five tagged brown trout captured at fish weirs installed on the Jocko River and Mission Creek showed an average movement of 32.5 km from their initial marking point.

One cutthroat trout moved 44.2 km down the lower Flathead and then 11.3 km up the Clark Fork River within a 5 month period.

Of 42 northern pike tag returns, 20 fish (47.6%) were captured by fishermen at the initial point of release. Twelve pike showed an average upstream movement of 6.0 km, ranging from 0.8 to 13.7 km, and four pike showed an average downstream movement of 18.3 km, ranging from 0.6 to 48.3 km.

## Radio Telemetry

Seven northern pike, five males and two females were radio-tagged between 1 April 1984 and 5 June 1984. Average length and weight for the males was 821.8 mm and 5,150 g, respectively; for females, 817.5 mm and 5,250 g.

One male northern pike has remained in the general vicinity of the original tagging location throughout the period of tracking. Two males began moving downstream during June. On 29 July 1984 pike #0.064 was captured by a fisherman after moving downstream 88.5 km in almost four months. Pike 110.693, tagged at RK 31, moved out of the lower Flathead River and approximately 24 km downstream into the Clark Fork River. One male moved 46.7 km upstream in less than 1 month. During the month of August no males moved a significant distance upstream or downstream (Figure 12).

One of two radio-tagged female northern pike remained in the general vicinity of the original tagging location throughout the period of tracking. The other female coved 12.6 kc downstream in 52 days, and then another 43.3 km

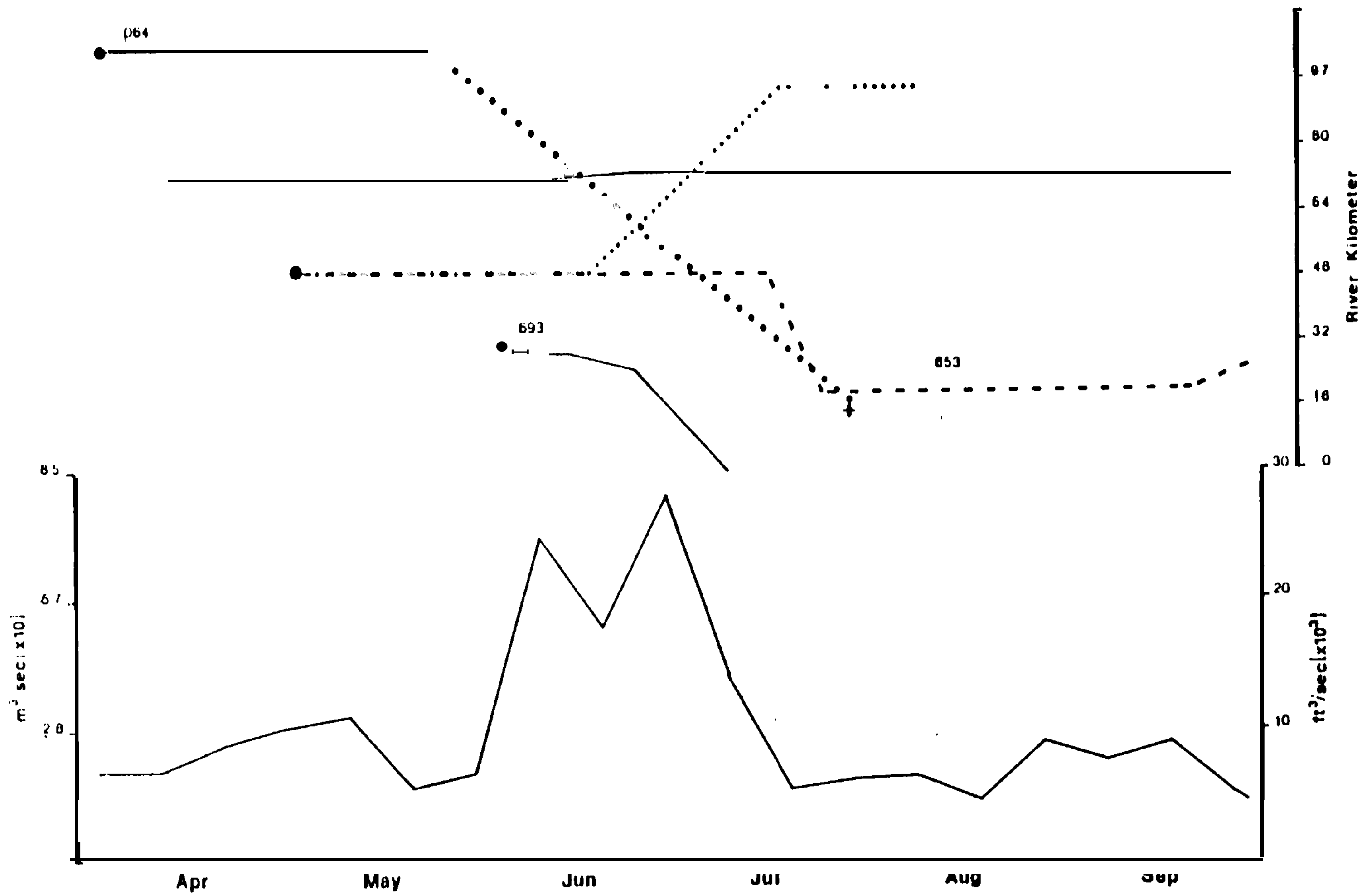



Figure 12. Movements of five radio tagged ma e northern p·ke as related to river discharge.

downstream in just 12 days. The fish remained at that location (RK 49.1) for approximately 1 month, and has slowly begun to move upstream again (Figure 12).

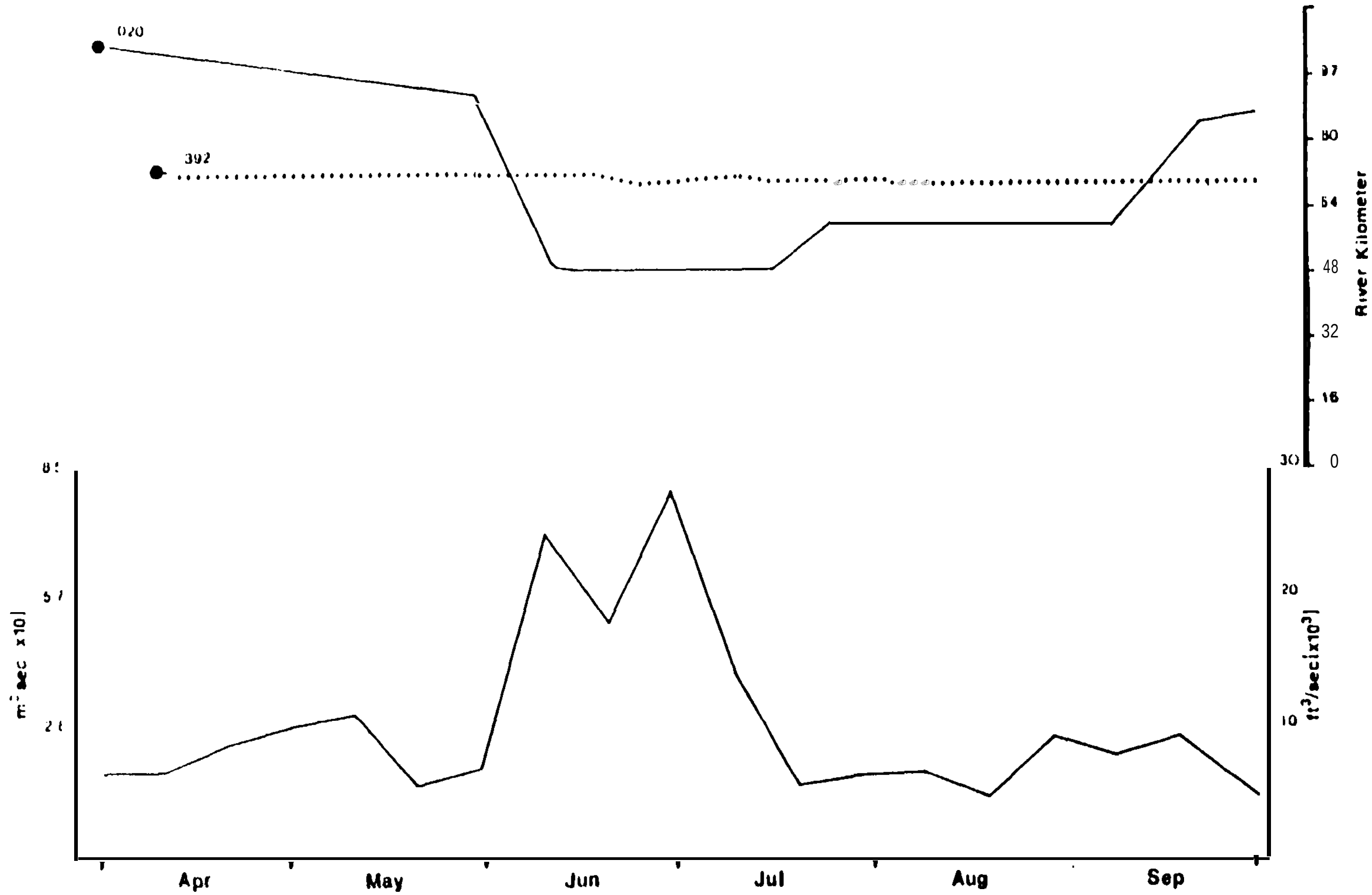



Figure 13. Movements of two radio tagged female northern pike as related to river discharge.

TRIBUTARIES

RESULTS

## Stock Assessment

Longitudinal changes in fish species composition and relative abundance were evident in three of the four drainages sampled. These changes were most marked in the Little Bitterroot River. Up to 13 northern pike, the only target fish species found in the Little Bitterroot below the Camas A Canal diversion (km 76.0), were captured per electrofishing hour at established sampling stations (Appendix B). Above the diversion, 59 to 75 cutthroat and eastern brook trout (*Salvelinus fontinalis*) were captured per sampling hour.

Catch per unit effort for trout did not differ noticeably between the lower four reaches and upper three reaches of the Jocko River (Figure 14), but species composition did differ (Table 4). Rainbow and brown trout comprised 95 to 98 percent of the trout captured in reaches 1 through 4, and 4 to 21 percent in reaches 5 through 7, where cutthroat and brook trout represented 71 to 85 percent.

Above the confluence of Post and Mission Creeks (km 13.4), trout catch per unit of effort increased 3 to 5 fold at Post Creek sampling stations and 10 to 20 fold at Mission Creek stations (Figure 14). These increases re-

Figure 14. Longitudinal changes in trout relative' abundance within three tributaries to the lower Flathead River.

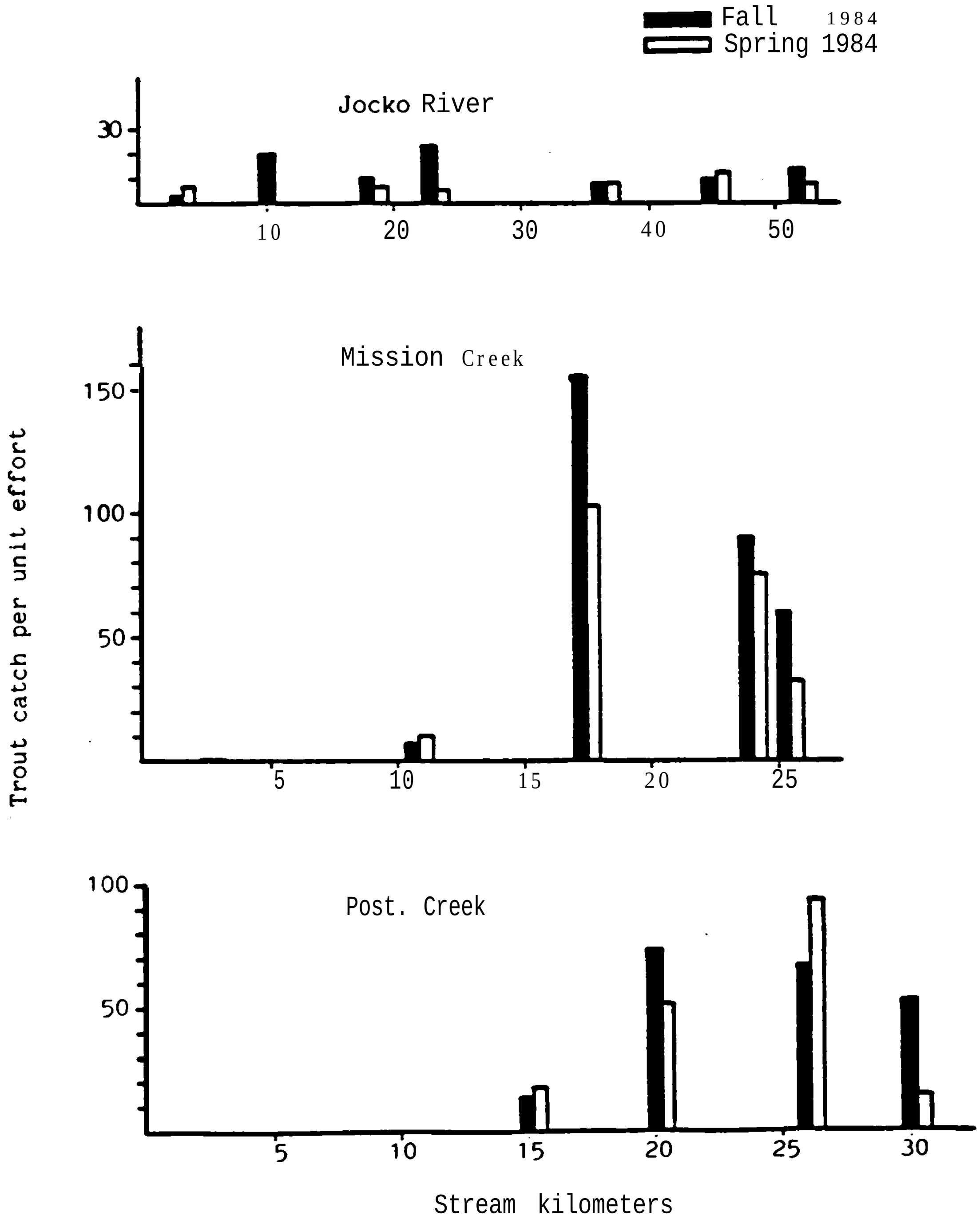


Table 4. Abundance and age class distribution of trout captured in fall 1983 and spring 1984 for five tributaries of the lower Flathead River.

| Stream | Reach No. | Species | No. (% of total) Trout Captured[a] F83 | No. (% of total) Trout Captured[a] 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 | | | | | | |
| Crow Creek | 1 | Rb | 28 (97) | 26 (93) | 61 | 54 | 36 | 0 | 3 | 46 |
| | | LL | 1 (3) | 0 (0) | 0 | 0 | 0 | 0 | 100 | 0 |
| | | Eb | 0 (0) | 2 (7) | 0 | 0 | 0 | 0 | 0 | 100 |
| | | Total | 29 | 28 | | | | | | |
| Little Bitterroot River | 5 | Ct | 27 (12) | 17 (11) | 52 | 59 | 37 | 35 | 11 | 6 |
| | | Rb | 5 (2) | 0 (0) | 60 | 0 | 40 | 0 | 0 | 0 |
| | | Eb | 192 (86) | 131 (89) | 30 | 52 | 63 | 33 | 7 | 15 |
| | | Total | 224 | 148 | | | | | | |

[a]Number captured from one run only in Post Creek Fall 1983 and the Jocko River Spring 1984.

sulted from increases in rainbow trout and brook trout at the stations (Table 5).

The 4.8 km of Crow Creek between Lower Crow Reservoir and the lower Flathead River were represented by one fish-sampling station. No longitudinal change in species composition or relative abundance was evident.

No significant difference ($p<.05$) was found between catch per unit of effort for rainbow and brown trout in lower Crow Creek and the lower five reaches of the Jocko River. The Post/Mission Creek drainages had significantly more ($p<.05$) rainbow trout and significantly fewer ($p<.05$) brown trout than the lower Jocko River and Crow Creek.

Fifty percent or more of trout captured during fall and spring in the five tributaries sampled were age 2 and younger (Table 4). Yearlings generally accounted for 50 percent or more of the trout captured in the lower reaches of the Jocko River, Mission Creek, Post Creek, and Crow Creek. Age 2 trout were nearly as abundant as yearlings in the upper reaches of these streams. Mountain whitefish were found in the lower reaches of ail five drainages.

## Spawning Surveys

Trapping began at the Jocko River weir 2 km above the mouth on 29 February 1984. From then until the trap was closed on 15 May because of high water, 32 adult rainbow trout and 160 mountain whitefish were captured. Rainbow total lengths ranged from 355 mm to 640 mm representing ages 3 to 6. Mountain whitefish were 250 mm to 417 mm long and ranged in age from 3 to 6.

From 13 August through 3 December, 20 brown trout were captured in the Jocko River weir.

Twenty-eight brown trout redds were found within the 12 km reach of the Jocko River between the mouth of Valley Creek (km 19.0) and Finley Creek (km 30.7) during January. An ambitious stock assessment schedule and early onset of high water precluded spring redd surveys.

Trapping began at Mission Creek weir, 6 km above the mouth, on 9 March 1984. Until high water forced trap closure on 16 May, 28 rainbow trout, one bull trout, one brown trout, and 41 mountain whitefish were captured. The rainbow trout were 330 to 574 mm long, representing ages 3 and 4. Mountain whitefish were 228 to 549 mm long, representing ages 3 to 7.

The weir design chosen for this study and construction techniques employed withstood two-year flood events in Mission Creek (28 $m^3$/second) and the Jocko River (34 $m^3$/second). High water piled bedload on to the weir faces and scoured trenches approximately 2 m deep immediately downstream from both structures.

When water in Mission Creek dropped to the top of the weir, rod panels were removed, and the bed load washed through. The larger bed load material in the Jocko River pushed three gabion baskets near the north bank slightly downstream into the scoured hole, causing the weir superstructure to twist. Removing the rod panels allowed enough bedload to move through to expose all gabion baskets. Fourteen weir modules left of the trap were removed from the gabion base, realigned, and laced back onto the base, requiring 68.5 man-hours over 1.5 days.

From 21 July through 3 December, five brown trout were captured in the Mission Creek weir.

No trout species were captured in the trap set at km 2.5 in Crow Creek from 14 March through 7 May 1984. A survey of the 6 km below Lower Crow Reservoir for brown trout redds during October 1983 revealed one definite redd. The trap set below the Lonepine marsh (km 60) on 7 February 1984 and removed 30 July 1984 captured 29 northern pike, one moving upstream and 28 moving downstream. Two pike captured moving downstream below the marsh on 21 April and 25 May 1983 were recaptured moving the same direction on 1 May 1984.

The trap set above the Lonepine marsh (km 61) on 20 February and removed 8 June captured no fish. Near the mouth (km 2), one pike was captured moving upstream on 25 April, and one dead pike was found in the downstream trap on 23 April.

## Fish Movement

Rainbow and brown trout from the Flathead River have been captured in the Jocko River and Mission Creek (Table 5). Brown trout tagged as far downstream as Perma and as far upstream as Buffalo Rapids in the main river have been recaptured in the Jocko River near Ravalli, 78 km from their tagging locations. A northern pike captured 23 June 1983 moved from a trap 4.5 km upstream from the mouth of the Little Bitterroot River down to Sloan's bridge on the main river and was recaptured 27 July 1983.

Within the tributaries, one rainbow trout spawner trapped at the Jocko River weir was caught by a fisherman 4 km upstream from the town of Arlee on 27 May 1984 (Table 5). Seven Mission Creek rainbow trout, 11 Post Creek rainbows and one brook trout, one Jocko River cutthroat trout, and eight Little Bitterroot River northern pike tagged during fall 1983 were recaptured by electrofishing at or near their original tagging Site the following spring.

Table 5. Fish movement to, from, and within tributaries to the lower Flathead River during 1983 and 1984.

| Species[1] | First Capture Date | First Capture Location | Second Capture Date | Second Capture Location | Approximate Distance moved (km) |
|---|---|---|---|---|---|
| Rb | 7-19-83 | FR km 13.2 | 3-22-84 | Mission km 6 | 38 |
| Rb | 11-16-83 | Post km 6.8 | 3-13-84 | Post km 8.3 | 1.5 |
| Rb | 11-29-83 | Post km 6.8 | 4-?-84 | Post km 7.8 | 1 |
| Rb | 3-18-84 | Mission km 6.0 | 5-27-84 | FR km ? | ?[2] |
| RbxCt | 3-21-84 | Jocko km 2.0 | 5-27-84 | Jocko km 24 | 22 |
| LL | 6-15-83 | FR km 11.0 | 8-27-83 | Jocko km 13.8 | 44 |
| LL | 9-26-83 | FR km 104.6 | 8-8-84 | Jocko km 13.8 | 78 |
| LL | 4-2-84 | FR km 104.6 | 8-8-84 | Jocko km 13.8 | 78 |
| LL | 4-10-84 | FR km 71.1 | 8-26-84 | Jocko km 2 | 32 |
| LL | 6-15-83 | FR km 11.3 | 8-20-84 | Jocko km 2 | 32 |
| LL | 4-15-84 | FR km 44.2 | '8-13-84 | Jocko km 2 | 5 |
| LL | 4-23-84 | FR km 41.8 | 4-29-84 | Jocko km 2 | 3 |
| LL | 8-2-83 | Mission km 6 | 8-g-84 | Mission km ? | ?[2] |
| NP | 6-23-83 | L.Bitt. km 4.5 | 7-27-83 | FR km 72.1 | 5 |

[1] Rb = rainbow trout; RbxCt = rainbow x cutthroat trout hybrid; LL = brown trout; NP = northern pike

[2] ? = exact location not reported by angler

## Water Temperatures

Water temperatures near the mouths of the four major tributaries entering the lower Flathead River were highest during' August (Table 6) and lowest during January. August water temperatures were coolest in the Jocko River and Mission Creek.

Table 6. Mean, maximum, and minimum water temperatures (°C), recorded during August 1983 near the mouths of four tributaries and the lower Flathead River at Kerr Dam.

| Stream | Mean | Max | Min |
|---|---|---|---|
| Jocko River | 16 | 20 | 12 |
| Mission Creek | 17 | 22 | 14 |
| Crow Creek | 19 | 24 | 15 |
| Little Bitterrot River | 22 | 30 | 16 |
| Flathead River | 23 | 25 | 19 |

## Angler Exploitation

Results of the creel survey conducted on the Reservation from April to September 1983, and summarized by DosSantos and Cross (1984), are quoted below.

"One hundred fifty-eight interviews were conducted on the seven tributaries surveyed, accounting for 14.5% of all anglers contacted reservation wide. One hundred twelve interviews representing 221 anglers were conducted on the Jocko River, the largest tributary to the lower Flathead River. One hundred nine Jocko River anglers were interviewed in the section of river bordered by Highways 212 and 200.

Age composition for tributary fisherman was similar to fishermen of the main river. Slightly less than one half (44.6%) of tributary fishermen were between the ages of 21 and 40, with the majority (65.3%) between 21 and 64 years of age. Senior citizens accounted for 2.5% of all anglers interviewed. Tribal members and non-member reservation residents almost equally shared in tributary fishing, 28.9% and 34.65, respectively. Twelve percent of those tributary anglers interviewed were not from the State of Montana.

The primary recreational activity occurring on the tributaries was sport fishing. Seventy-seven percent of those interviewed indicated that fishing was their primary goal. Joint activities such as picnicking and fishing, or overnight camping and fishing accounted for 88.1% of the responses. Three percent of tributary users were seeking personal solitude.

*Table 7. Catch rates for fish species creeled on reservation tributaries between April and September of 1983.

| | |
|---|---|
| Brook trout | 1.65/hour |
| Brown trout | 1.05/ " |
| Bull trout | 0.50/ " |
| Rainbow trout | 0.35/ " |
| Cutthroat trout | 0.30/ " |
| Mountain whitefish | 0.08/ " |

* From DosSantos and Cross, 1984

Tributary anglers fished an average of 3.0 hours using primarily bait (56.0%) as terminal gear. Fly fishing was used by 16.4% of tributary anglers. The most productive fishing in the reservation tributaries was for brook trout and brown trout with catch rates of 1.65/hr and 1.05/hr, respectively, for the period of survey (Table 7)."

## MAIN RIVER

## DISCUSSION AND CONCLUSIONS

Study reaches I and II, extending 54 km below Kerr Dam, provide limited salmonid spawning gravel, only 1.8% of the channel substrate surveyed meet spawning gravel size criteria as established by Bovee (1978). The lack of adequate gravel in these sections reflects the scouring effect of regulated river discharges and resultant substrate armoring. Gravel recruitment from above Kerr Dam or from the also regulated Little Bitterroot River no longer occurs. The substantial increase in spawning gravel in study reaches III and IV can be attributed to a reduction in stream gradient, reduced scour, and gravel recruitment from Mission Creek and the Jocko River.

Subjective observations of gravels surveyed indicated that compaction with sediment may have a significant impact upon gravel quality. Sediment sources include erosion of river clay banks, the Little Bitterroot River, and irrigation returns. A qualitative evaluation of salmonid spawning habitat will be conducted in FY85 which will assess gravel size, water velocity and depth over time and percent fines at selected sites within each study section. The evaluation will provide a more accurate assessment of actual available habitat.

The ecological significance of aquatic vegetation, both submergent and emergent to successful northern pike spawning has been extensively documented (McCarracher and Thomas 1972), and recruitment has been found to be directly related to the amount of suitable spawning habitat (Hassler 1970, Groen and Schroeder 1978).

The presence of aquatic macrophytes are limited to slack water eddy areas, or along river banks within the Buffalo and Sloan study sections. No true backwater areas exist in these two study sections (Figures 5 and 6). In the Dixon and Weed study sections, river gradient decreases, backwater areas which are essentially totally vegetated are common, and areas of main channel macrophytes also increases (Figures 7 and 8). In the Perma study section where river gradient is the lowest (0.2 m/km), the presence of main channel macrophytes is the greatest, and in some areas spans the entire width of the channel (Figure 9). These areas of aquatic vegetation are important in providing a nursery area with protective cover for young pike (Groen and Schroeder 1978), and also provide protective cover and feeding stations for adults.

Discharges from Kerr were inadequate to flood off-channel spawning areas for any length of time during spring 1984. Northern pike actively seek areas of inflowing water for spawning (Priegal and Krohn 1975), but a mean daily discharge of less than 360 $m^3$/second causes water to drain from all known spawning areas downstream of RK 50. A discharge of approximately 204 $m^3$/second dewaters the inlets of all off-channel spawning areas; between 204 and 360 $m^3$/second the quality and quantity of northern pike spawning areas change subject to continual changes in accessability and suitability directly due to the hydroelectric operations.

Mean daily discharges from Kerr did not exceed 360 $m^3$/second until 9 June 1984, 60 days after the first ripe female pike was captured. During the last week of May 1984, discharges from Kerr averaged only 97 $m^3$/second and on 26 May 1984 reached a low of 21.3 $m^3$/second, the lowest flow recorded for this month since 1907. As a result of hydroelectric operations off-channel spawning areas were generally inaccessible to spawning northern pike this spring. Most spawning must have taken place in deeper, main channel, slack water areas. These main channel areas are usually no less than 2.5 m deep. Optimal depth for northern pike spawning has been found to be less than 1 m (Inskip 1982). Due to depths and velocities, it is doubtful that spawning in main channel areas provide sufficient recruitment to this riverine pike population. Attempts to locate juvenile pike in backwaters and main channel areas this year were unsuccessful.

Eased upon patterns of growth described by Anderson and Weithman (1978), northern pike in the lower Flathead exhibit a moderate growth rate up to age 4. Lower Flathead pike age 5 or older exhibit a fast growth rate.

Seasonal and daily variability in discharge from Kerr Dam, highest in the spring and fall, are suspected of having serious impacts upon spawning success of all target fish species present in the lower Flathead River. Year class strength in northern pike populations has been found to be dependent upon stabilization of water levels in spawning and nursery areas (Franklin and Smith 1963, Hassler 1970). Hamilton and Buell (1976) concluded that increasing discharges and the abrupt changes associated with fluctuating flows due to hydro-peaking operations caused serious recruitment problems for salmon and trout in the Campbell River system, British Columbia.

Population levels and population structure of trout species observed in the 1983-84 reflect a lack of successful recruitment within the lower Flathead River. Rainbow trout population estimates were highest in the Dixon study section during the 1983 fall sampling (27 fish/km), but only averaged 9 fish/km river wide during both 1983 fall and 1984 spring sampling. Relative to other Montana rivers such as the Kootenai River with rainbow populations ranging from 80 to 706 fish/km (May and Huston 1983), and the Missouri River where the lowest rainbow estimate in 1983 was 653 fish/km (Berg 1983), the lower Flathead River trout populations and age class structure reflect serious recruitment problems. Catches of rainbow trout in the lower Flathead are dominated by age. 2 and 3 fish, which comprised 55% and 40%, respectively, of all rainbow trout handled (n = 85). Age 1 fish only comprised 2.5% of the catch, whereas in the Kootenai River age 1 rainbow trout comprised 77.6% of the catch, with age 2 and 3 fish comprising 17% and 5.41, respectively (May and Huston 1983). While the sample size of the rainbow trout from the lower Flathead was small the lack of age 1 fish is obvious.

Growth of rainbow trout in the lower Flathead is somewhat slower than that reported from the Kootenai River. May and Huston (1983) found that age 2 and 3 rainbows in the Kcotenai averaged 328 and 394 mm TL, respectively. Lower Flathead River rainbows age 2 and 3 averaged 248 and 324 mm TL.

Brown trout population estimates were highest at the Buffalo study section during 1983 fall sampling (29 fish/km) and averaged 10 fish/km river wide. During 1984 spring sampling, brown trout estimates averaging 11 fish/km river wide. On the Missouri River, the lowest brown trout estimate was 74 fish/km (Berg 1983). As with rainbow trout, a lack of younger aged fish in brown trout catches from the river was observed. Age 3 and older brown trout comprised 87% of the total catch (n = 102), with age 1 and 2 fish comprising only 2 and 11%, respectively, of the total catch. Growth of brown trout is consistent with average lengths reported by Brown (1971).

The above comparisions between lower Flathead fish populations with those from the Kootenai and Missouri Rivers are merely for demonstration. There are no implications that the physical habitat or biological productivity of these rivers are comparable to the lower Flathead.

The observed structure of brown trout populations in the lower river suggest similar limiting factors effect both rainbow and brown trout recruitment. Few trout redds have been found in the main river, and few age 3 or older rainbow or brown trout were captured in the lower reaches of Mission Creek or the Jocko River. In contrast, relatively high numbers of age 1 and 2 trout were captured in these tributaries, suggesting that these waters may provide the most successful spawning and recruitment to the main river.

Slower growth rates of lower Flathead rainbow trout may reflect the effects of hydroelectric operations upon the quality and quantity of aquatic insects available. Additionally, aquatic insects are also negatively impacted by sedimentation. Growth rates of lower Flathead River brown trout may reflect a tendency toward a more piscivorous diet, a food source less directly affected by hydroelectric operations.

Mountain whitefish population levels are comparable with those reported for the Kootenai River, however lower Flathead populations are dominated by age 4 where Kootenai River whitefish populations were dominated by age 3 fish (May and Huston 1983). Although mountain whitefish fry are susceptible to stranding by rapid water fluctuations, their present population level appears to be consistent with other rivers of this size.

The present food base in the Flathead may be more suitable to the maintenance of whitefish than trout. Whitefish in the upper Flathead and the Kootenai feed predominantly on caddisflies and dipterans (Perry and Graham 1982, DosSantos and Huston 1983). Based upon field observations, both of these insect groups are common within the lower Flathead.

While tags actually returned are most likely lower than the number of captured tagged fish, exploitation appears low for all species. Anglers harvested 4% of the brown trout and 1% of the rainbow trout tagged within an eighteen month period. Berg (1983) found that harvest rates were approximately equal (7%) for brown and rainbow trout within the middle Missouri River. Based on 447 anglers interviewed, catch rates for any of the five salmonid species present in the lower river never exceeded 0.01/hour, reflecting present low populations.

Anglers harvested 12% of the northern pike tagged within an 18 month period. This exploitation rate is low compared to 31% reported by Williams and Jacob (1971) and over 50% reported by Beyerle and Williams (1972). High annual mortality rates (Anderson and Weithman 1978) and non-returned tags could account for the low return rate. Catch rate for northern pike in the river was found to be 0.10/hour.

Based on tag returns from Anglers and weir trapping, it is evident that main river rainbow and brown trout move both downstream and upstream considerable distances to enter spawning tributaries. Movement between the lower half of the river and the Clark Fork River has also been documented.

Based on tag returns from northern pike, almost one half of all northern pike showed essentially no significant movement from the initial points of release. Other pike have shown upstream and downstream movements ranging from 0.6 to 48.3 km. Radio telemetry data, documented pike movements of up to 88.5 km. Of the seven radio tagged pike, two fish have remained in the general vicinity of the initial tagging; one male and one female. Four pike moved downstream during the second week of June, after flows had doubled from the previous veek. During the period of high water, which lasted from June until the last week of July, pike continued to move downstream. Once flows dropped below 566 $m^3$/second, most radioed pike maintained their position, or slowly began to move back upstream. One male, showed a steady upstream movement throughout the high water period. During FY85 these fish and three more to be tagged this fall, will continue to be monitored to establish annual movement patterns which may be related to reproductive condition and river discharge.

TRIBUTARIES

DISCUSSION AND CONCLUSIONS

Tag return data from trapping, stock assessment sampling, and anglers confirm that rainbow and brown trout in the lower Flathead River system migrate between the main river and two major tributaries, the Jocko River and Mission/Post Creek drainage. Tagged trout have moved from the extreme upper and lower ends of the main river to spawn in these two tributaries. What remains unclear is the fate of the offspring of these fish.

Age 2 and older brown and rainbow trout are conspicuously lacking in the lower reaches of the Jocko River and Mission Creek. Natural mortality, cropping by fishermen, and outmigration to the main river are likely explanations for this observation. The extremely low number of trout in the main river suggest that poor habitat quality under the present conditions of flow fluctuation, temperatures, and sedimentation in the main river, results in poor survival of tributary out-migrants.

Species compcsition and age class structure of fish in the upper reaches of Mission Creek and the Jocko River are indicative of resident populations. Cutthroat and brook trout are predominant in samples from the upper Jccko River; brook trout are predoninant ir. samples from upper Mission and Post Creeks. Very few of either species have been found in the lower reaches of these streams and in the lower Flathead River. The low number of age 3 and older trout in these areas is probably due to natural mortality and heavy fishing pressure.

Sampling to date has shown that the relative abundance of rainbow trout in terms of catch per unit of effort is significantly higher ($p<.05$) in the Mission/Post Creek drainage than in the Jocko River. Nevertheless, nearly equal numbers of rainbow trout spawners were captured by electrofishing in these two streams from March through mid-May. Mission and Post Creeks probably receive less fishing pressure than the Jocko River, and Post Creek is inadvertantly stocked annually when a small hatchery is flooded by high water.

The significantly higher ($p<.05$) catch per unit of effort for brown trout in the Jocko River stock assessment stations relative to Mission Creek is corroborated by the spawning run monitored at the Jocko weir where 20 adults were recorded. At the Mission Creek weir only five spawning brown trout were captured during fall 1984.

The 12 km of the Jocko River between Valley Creek and Finley Creek is heavily utilized by spawning rainbow and brown trout. Whether other areas in both the Mission/Post Creek and Jocko River drainages are equally important is unresolved.

The results of spring trapping and redd counts in Crow Creek below Lower Crow Reservoir indicate that this stream is not presently used extensively for spawning by rainbow trout from the main river. A healthy population of resident rainbow trout did exist in Crow Creek before the stream was dewatered while a reservoir gate was repaired. A major fish-kill was documented during the dewatering. Preliminary redd surveys suggest that brown trout may ascend from the main river to spawn in Crow Creek.

The Little Bitterroot River can be considered as two separate streams. Above the Camas A Canal diversion, this river supports resident populations of cutthroat trout and brook trout. Below the diversion, the stream supports northern pike and is generally turbid, as well as seasonally dewatered and overgrown with aquatic macrophytes.

The status of the pike population, spawning success, and movement within the system are difficult to assess. No pike have been captured by electrofishing at stations in reaches 1 and 2 below Hot Springs Creek, which introduces very turbid water. Much of the stream in reach 4 (km 55.7 to 76.0) is too deep and/or overgrown to shock effectively, confining viable population estimates to reach 3.

Below Lonepine marsh (km 60) on the Little Bitterroot River, traps were set two months earlier this year than last and left in two months later, yet far fewer northern pike were trapped. One pike was trapped moving upstream this year compared to 29 last year, a 97% reduction. Twenty-eight pike were trapped moving downstream this year compared to 110 during 1983, a 75% reduction. This substantial reduction in trapped fish may have resulted from runoff of approximately 8 $m^3$/second near Lonepine marsh (25 $m^3$/second near the mouth) during January 1984. These flows could have carried potential spawners over the banks to be stranded in fields, or far enough downstream so that they spawned elsewhere.

One northern pike captured near the mouth of the Little Bitterroot River moved down into the Flathead River. No pike from reaches 2, 3, or 4 have been recaptured in the main river. It is unlikely that a pike, having moved upstream 60 km from the main river to Lonepine marsh, could traverse the vegetation-clogged, dewatered sections of the Little Bitterroot and return to the main river while our traps were still in place.

Trout, perhaps avoiding warm temperatures, may be attracted from the Flathead River into the tributaries during August. Unripe brown trout from the main river were captured at the Jccko River weir throughout August. Water temperatures in the Jocko River near its mouth averaged 7°C cooler than main river water temperatures near Kerr Dam, which were comparable to those near the Jocko.

Although it is likely that the Jocko River receives most of the tributary fishing pressure on the Flathead Reservation, creel survey results were biased by the Jocko's accessibility to anglers and to creel clerks. Highways 200 and 93 and a county road run along most of the Jocko River and its upper forks. To survey Mission Creek, Post Creek, Crow Creek, and tributaries to the Jocko River, a clerk would have to drive off the main roads and walk sections of each stream. The Little Bitterroot River drainage was not surveyed.

Concentrating the survey along the Jocko River also biased estimates of age composition and origin of tributary anglers. Children are known to fish many of the smaller tributaries, and reservation residents (members and non-members) are more likely to fish areas less well known to the general public.

Catch rate estimates show that brook trout fishing is productive for those anglers willing to drive to the upper reaches and forks of the Jocko River. Bull trout catch rate estimates are surprisingly high considering how scarce this species is in the entire lower Flathead River system. Mountain whitefish, however, abound in this system, and the low catch rate reported must reflect angler preferences for other species.

# PART II

## SOUTH BAY, FLATHEAD LAKE

## DESCRIPTION OF STUDY AREA

The Flathead system, located in northwestern Montana, is the most northeastern river basin in the Columbia River drainage. Flathead Lake divides the river into upper and lower reaches and covers 50,992 ha (U.S. E.P.A. 1983). The study area (Figure 1) is the southernmost lobe of Flathead Lake, called South Bay. The area is made distinct from the main lake by an island-dotted channel, the Narrows, and bounded on the south by Polson Bridge which spans the outlet of the lake. South Bay, the most extensive shallow area in Flathead Lake (Moore et al. 1982), has a maximum depth of 10.6 m, an average depth of 4.6 m, and a surface area of 5,448 ha.. The 18,379 $km^2$ drainage area of Flathead Lake (U.S. E.P.A. 1983) encompasses the upper Flathead River, the Swan, Stillwater, and Whitefish Rivers, though none of these directly enter South Bay. Morphological and hydrological information for the study area are summarized in Table 1.

Hydroelectric power generation within the Flathead River drainage plays a major role in the hydrologic profile of Flathead Lake (see Figure 3 in Stanford et al. 1983). The operation of Kerr Dam results in a maximum annual fluctuation of lake surface elevations between 878.7 m and 881.8 m. Minimum lake elevations are usually reached in

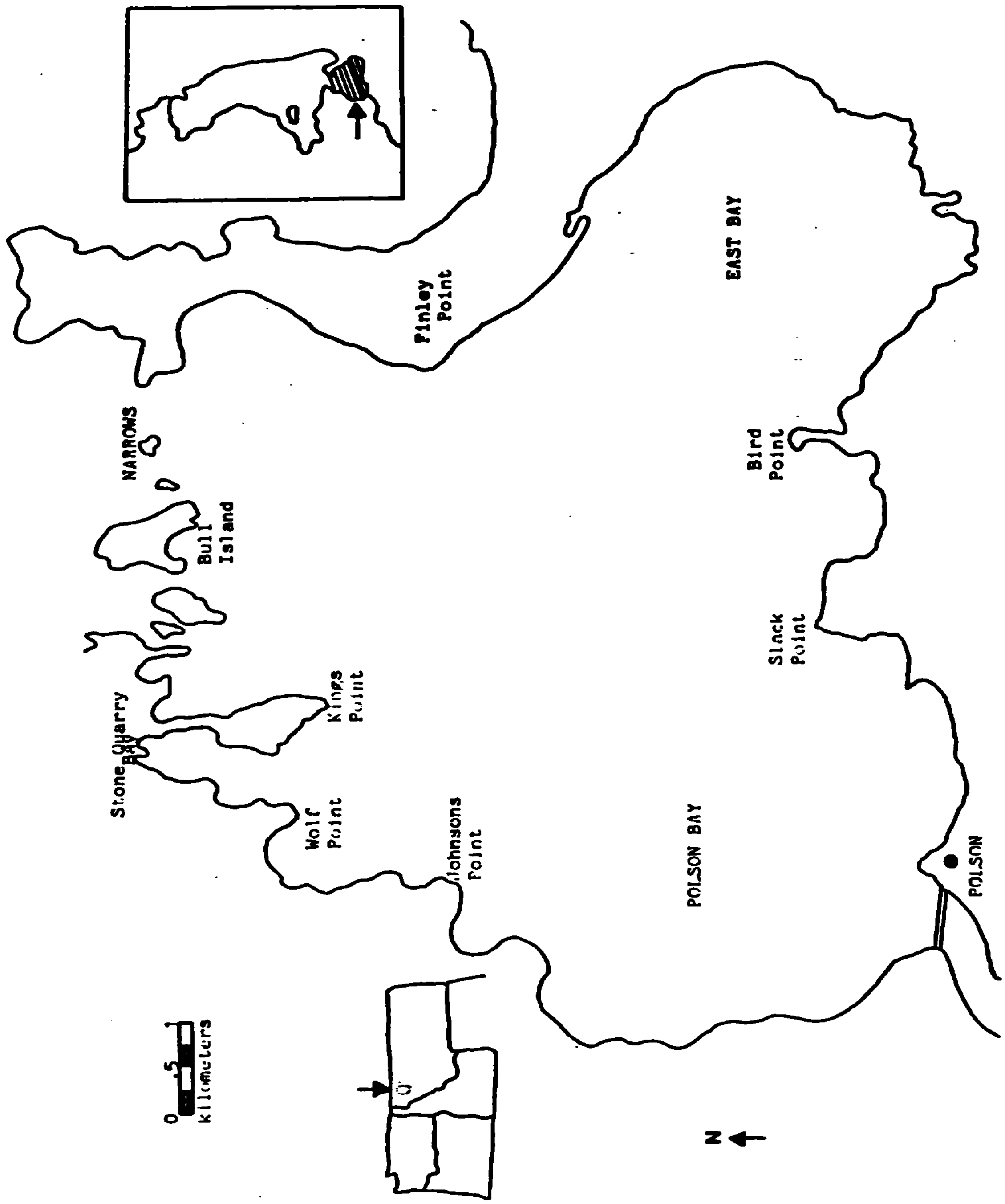



Figure 1. Location and important features of South Bay, Flathead Lake, Montana.

Table 1. Physical features of South Bay, Flathead Lake, Montana.

| | |
|---|---|
| Land Description | Range 19,20 West<br>Township 22,23 North |
| Elevation (full pond) | 881.8 m |
| Elevation (low pond) | 878.7 m |
| Maximum length (north-south) | 8.6 km |
| Maximum breadth (east-west) | 10.5 km |
| Maximum depth | 10.6 m |
| Mean depth | 4.6 m |
| Area | 5,448 surface ha |
| Mean annual discharge | 10.9 $km^3$ (U.S. E.P.A. 1983) |
| Mean annual inflow | 10.4 $km^3$ (Stanford et al. 1983) |

March and are followed by a rapid fill period which ensures elevations of 880.9 m by May 30 and the maximum of 881.8 m by July 1. This maximum is maintained through Labor Day, at which time the extended drawdown period is initiated and continues until minimum elevations are again reached in March. The May 30, July 1, and Labor Day dates are the result of a Memorandum of Understanding between the Montana Power Company, the U.S. Army Corps of Engineers, and the Flathead Lake Owners Association (Montana Power Company 1976). Changing lake levels have a disproportionate influence on South Bay because it is relatively shallow and has more gently sloping bottom contours compared to other parts of the lake. Such annual dewatering and reflooding of extensive littoral areas and the associated vegetation may adversely impact resident fish populations dependent upon shallower habitats.

The conifer-forested Mission Mountains rise steeply from the eastern shore of South Bay. The southern and western shores have less relief and are composed primarily of dry grasslands and agricultural tracts. Shoreline vegetation is dominated by emergent Typha, Carex, and Scirpus while principal aquatic genera include Chara, Myriophyllum, and Potamogeton.

The weather of the Flathead basin (U.S. E.P.A. 1983), moderated by Flathead Lake, is warmer than nearby Rocky Mountain areas. At Polson, the mean January temperature is -3.8 °C, and mean July temperature is 19.6°C, with an annual mean of 7.5°C. Precipitation averages 38.1 cm per year, half of which typically falls during May and June. Total snow cover seldom exceeds 0.3 m. Surface ice generally forms over the entire lake once in ten years. Shallow bays, including South Bay, freeze over almost every year. Prevailing winds are from the south and north, paralleling the major valley axis.

During the Pleistocene epoch about one million years ago, four glacial advances scoured the soft sedimentary rock of the Rocky Hountain Trench with ice sheets. The last of these advances deposited the Polson Moraine located just south of the present-day town of Polson. When it retreated approximately 10,000 years ago, Flathead Lake was formed from waters dammed to the south by the Polson Moraine (Alt and Hyndman 1972). South Bay resulted from the melting of a lobe of the glacier and is regarded as a "kettle" lake, connected to the glacially scoured main body of the lake at the Narrows (Lorang 1982).

Flathead Lake accumulates sediment at an average rate of 0.3 mm a year, and total sediment depth presently ranges between 4 and 7 m (Moore et al. 1982). Most inorganic sediment enters the lake via the upper Flathead River during spring runoff, resulting in an annual sediment plume that courses from the river, south through Flathead Lake, and into South Bay. Most of the larger silt particles in the plume settle to the bottom near the mouth of the river, while the smaller clay portions are carried further south (Stanford et al. 1983). Deposition of organic material from yearly summer algal blooms results in alternate organic and non-organic layers that record annual sediment influx and algal productivity. Lake sediments are well oxidized to a sediment depth of 1 cm, and chemically reduced below that (Moore et al. 1982).

Moore et al. (1982) provided a detailed account of the sediment geochemistry of Flathead Lake. Due to the shallow nature of South Bay, its sediments are unique to Flathead Lake in several aspects. Algal productivity can be twice as high in shallow bays as in open water areas (U.S. E.P.A. 1983) and has resulted in thicker organic layers in areas such as South Bay than in the main lake. In addition, wave processes unique to shallower areas have redistributed an accumulation of coarse sand to the northern part of South Bay, an area which receives little sediment from the annual lake plume. South Bay also has higher amcunts of non-transported silt in surface sediments than the main lake, likewise a result of the reworking of shoreline sediments by wave action (Moore et al. 1982:.

Flathead Lake is oligo-mesotrophic in terms of algal oroductivity, water clarity, dominant phytoplankton species, and total dissolved solids. Eutrophication of Flathead Lake has been accelerated in recent years, primarily due to effluent from increased cultural development (Stanford et al. 1983).

MATERIALS AND METHODS
LAKE

## Habitat Evaluation

Mapping of dominant habitat types and the development of physical habitat evaluation methods were the primary activities in 1984. A variety of survey techniques (Johnson and Nielsen 1983, Terre11 et al. 1982, Johnson and Stein 1979) were reviewed and select methods tested to assess their relative efficacy for completion of this study.

Preliminary maps of dominant habitat types were prepared using overlays of sediment distribution and depth contours as reported in Lorang (1982). Resultant maps were groundproofed using the following techniques.

Twenty nine SCUBA and snorkel surveys were completed both within and across mapped habitat types to confirm substrate homogeneity and boundaries respectively. Initial groundproofing surveys were conducted in permanently inundated areas from March to June, before maximum lake levels were reached. Each dive surveyed approximately 100m in an effort to substantiate the presence of mapped substrate types. A stratified sampling approach (Johnson and Nielsen 1983) was used to subsample all major habitat types, additional surveys being used to groundproof similar, noncontiguous areas.

Aerial and shoreline photos were taken in conjunction with substrate samples in groundproofing surveys of all seasonally inundated areas. Substrate samples were visually classified by dominant particle size and compared with mapped types. Aerial and shoreline photos will be used to facilitate revisions in habitat maps.

Sixteen permanent photo stations were established around the shoreline of the South Bay study area to maximize qualitative data collection within the annual drawdown zone (Appendix D). All stations were visited monthly. Criteria used in their selection included proximity to seasonally inundated areas, collective inclusion of all habitat types, and year-round accessibility. Monthly photos were taken from permanent locations and focused on constant reference points to enhance seasonal comparisons.

In addition to substrate surveys, depth measurements were made to verify the mapped classification of habitat types as shallow, mid-depth, or deep. Fifteen equally spaced transects were sounded using a Lowrance X-15 depth-finder. These transects were permanently marked with anchored yellow polypropylene line or numbered floats. Sonar surveys were initiated and terminated as close to the highwater mark as boat draft would allow. Corrections were made for the shallower, inaccessible portions of each transect. Depthfinder adjustments and boat speed were held constant throughout individual runs to minimize confounding in the interpretation of recorded depth data. All sonar tapes were subsequently analyzed for mean and maximum depths (@ 881.8 m elevation), linear distance within the drawdown zone, and agreement with existing depth contour maps.

Independent records of lake elevation and weather, provided by Montana Power Company, have been reviewed and are being used to further characterize the environmental constraints imposed on South Bay. Mean, minimum, and maximum monthly lake elevations were summarized for the last seven years (1977-1983). Seasonal trends in daily air temperature and precipitation recorded at Kerr Dam were also examined.

Planimetric methods were used to determine more accurately the relative extent of seasonally inundated areas. The study area was divided into two major subareas, Poison Bay and East Bay, based on observed differences in sediment distribution, water quality data, and currents as indicated in LANDSAT photographs. A Lasico rolling disk pianimeter was then used to determine surface area of South Bay, both subareas, and the maximum drawdown zone within each. These measurements were compared with similar estimates derived from the transect surveys. (Note: All depths and computed areas were adjusted to the maximum lake elevation of 881.8m.)

Guidelines developed by the U.S. Fish and Wildlife

Service (Terrell et al. 1982) were consulted in the development of habitat evaluation field methods. Habitat variables potentially important to target species (Appendix E) were selected and a variety of underwater evaluation methods tested at 51 sites within the study area. Reference charts and preserved samples of five substrate and three vegetation types respectively were prepared to assist diver identification of these physical variables. Dive slates and data sheets were developed (Appendix F).

Water Quality

Beginning in April 1984, bi-monthly measurements of temperature, dissolved oxygen, pH, and conductivity were taken at ten permanent sites. Eleven inshore stations were added to the sampling schedule in June when rising water levels had reflooded seasonally exposed areas. All water quality measurements were taken at 0.5 m depth intervals. Secchi visibility, air temperature, wind and water conditions were also recorded at each station (Appendix G).

Spawning Surveys

Several potential spawning areas were surveyed during the observed or expected reproductive periods of yellow perch and largemouth bass. Evidence of habitat suitability for spawning was assessed using a combination of SCUBA, physical habitat, and electrofishing surveys.

Yellow perch egg counts were conducted using SCUBA at seven locations within East Bay during the observed April-May spawning period. All surveys were over silt substrate types, four in permanently inundated areas and three in the seasonally inundated zone. Egg skeins were counted by divers swimming along 200 m transects randomly located in vegetated areas where relatively high concentrations of adult perch were present. Dominant substrate and vegetation types were recorded.

Two surveys for evidence of largemouth bass spawning were also completed. Physical habitat in a large backwater area, locally known as the "Bass Pond" and contiguous with the lake at summer elevations, was evaluated as potential spawning habitat. Fish observations were recorded and water quality data collected during this mid-June survey. The second, a more extensive electrofishing survey, was conducted in early July along eastern shores of South Bay where catches of this species had been reported by fishermen. Nearly 2 km of inshore habitat (< 1.5 m deep) were sampled at night by electrofishing. Sampling efforts were concentrated in or around structural cover generally preferred by this species.

Larval fish

Inshore and offshore areas of South Bay were intensively sampled for larval fish from late March through late May 1984 with a half-meter diameter plankton net. All of the South Bay shoreline and several offshore habitat types were surveyed. Tows were conducted over varying distances and positions in the water column and during day and night hours to determine optimal times and procedures for standardized sampling. Exploratory sites were established in June and sampled monthly June through August.

The half-meter net was constructed of 900 micron Nitex mesh and equipped with a General Oceanics flowmeter, 13.5 kg lead weight, and plankton cup. During standard sampling the net was suspended from a 2 m PVC outrigger mounted near the starboard bow of the boat. This gear was towed close to the shoreline in inshore areas and between predetermined compass points in offshore areas. Standard tows were at idle speed, with flowmeter readings taken before and after each tow.

The volume of water filtered by the half-meter net during each tow was calculated from the difference in flow meter readings multiplied by a calibration factor. The calibration factor was derived from a series of tows over a known distance at a given speed using the formula: $C = \frac{AL}{D}$, uhere C is the calibration factor ($m^3$ per revolution of the flowmeter), A is the area ($m^2$) of the net opening, L is the length (m) of the tow, and D is the mean difference in revolutions between beginning and ending flow meter readings. Total catches of larval fish were paired with associated water volumes. Catch per unit effort (CPUE) was measured as fish per $m^3$ of water filtered.

Specimens from each tow were washed from the plankton cup into a collection jar in the field and preserved in 5% formalin stained with Rose Bengal. In the laboratory, larval fish were separated from vegetation and debris and stored in vials containing a mixture of 74% distilled water, 15% methyl alcohol, 10% formalin, and 1% acetic acid. All specimens will be measured and identified to the lowest taxonomic unit possible.

- f i s h

Sixteen seine sites in shoreline habitat types, designated as Sl through S16, were chosen for exploratory juvenile fish sampling during June through August 1984 (Figure 2). Sampling was conducted with a 106.7 m by 2.4 m beach seine constructed of 6.35 mm heavy delta square mesh knotless nylon netting. Standardized seine hauls were made by extending the seine perpendicular to shore by boat and towing it in a half-circle back to shore. Both ends were then simultaneously hauled in to shore by hand.

The surface area covered in a seine haul was calculated by determining the area of a half-circle with a circumference of 213.8 m (twice the length of the seine! and a radius of 34.0 m: Area (seine haul) $= \pi r^2/2 = 1814.9\ m^2$.

All captured fish greater than 100 mm TL of the target species were measured, marked with tags or fin scars and clips, and released. Captured fish less than 101 mm TL were

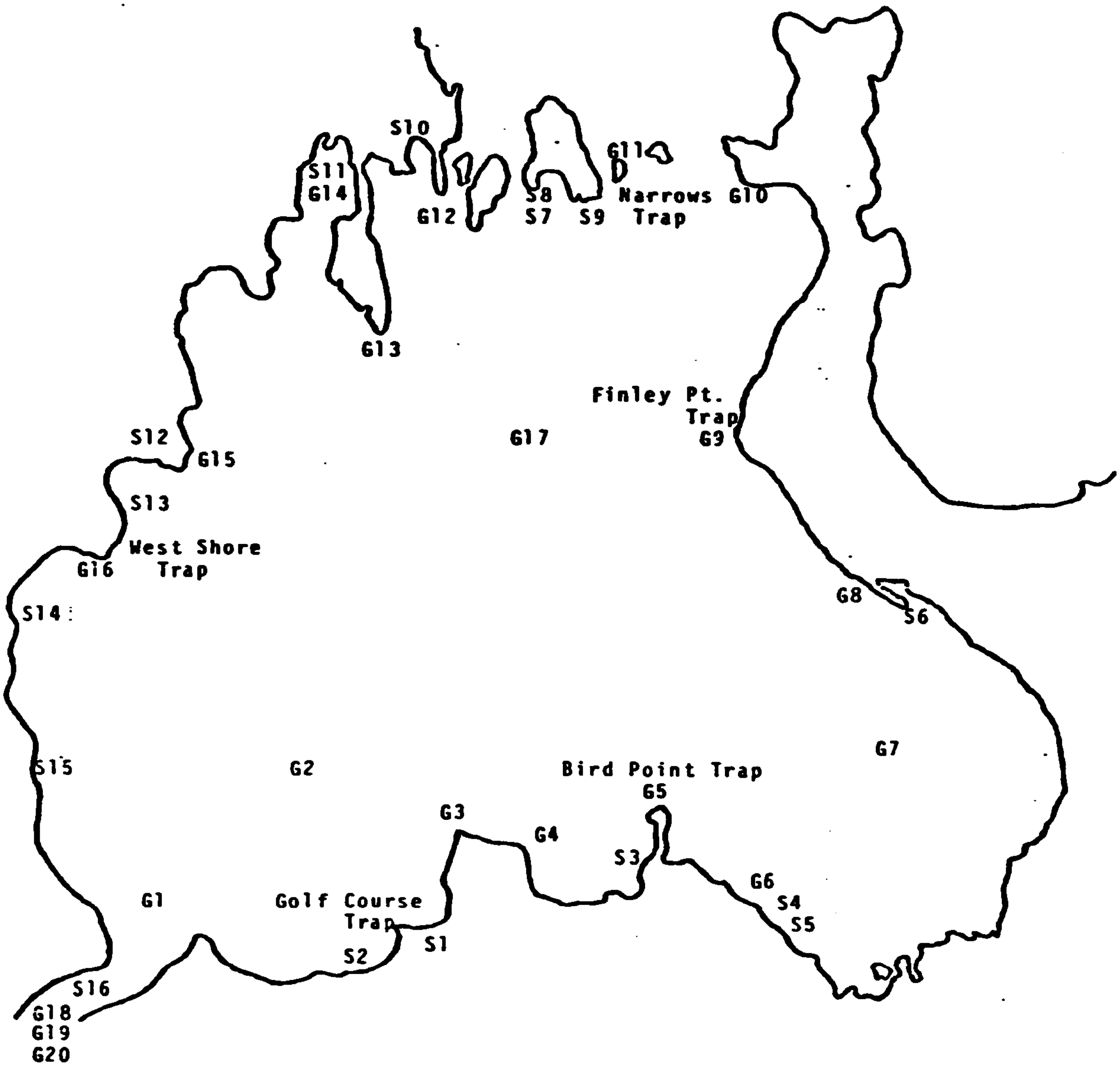



Figure 2. Location of fyke trap, seine (S1-S16), and gillnet (G1-G20) sites in South Bay, Flathead Lake, March through August 1984.

identified, counted, a subsample measured and weighed, and released. When many small untaggable fish were caught in a seine haul, dipnets were used to estimate total catch. All fish in five dipnets containing fish in a given size range were counted to give the mean number of fish in that size range per dipnet subsample. This mean was multiplied by the number of dipnet subsamples required to count the remaining fish. The product was added to the sum from the five counted dipnets to estimate the total number of fish captured.

Experimental batch-marking was conducted on subsamples of yellow perch at sites S2, S3, and S5. A combination of soft dorsal fin-ray scars and paired-fin clips was used for marking fish from each site. All fish from each site marked in this manner were in the 101-150 mm size range.

Adult fish

Experimental sampling for adult fish was conducted at five sites (Figure 2) from March through June 1984 using three fyke traps. Only three of five sites were sampled at any one time. Fyke traps were 1.8 m in diameter and constructed of #15, 25.4 mm tarred nylon mesh. Up to 122 m of 25.4 mm mesh lead material in 30.5 m lengths, 1.3 m deep, was used on inshore and offshore sides of eacn trap. Inshore leads extended to the shoreline. Traps and leads were anchored with fence posts in soft bottom areas and cement block clusters in rocky bottom areas. The traps were checked two to seven times per week and moved as necessary when water levels fluctuated. All traps were removed by the end of June.

Adult fish were captured June through August 1984 in experimental sinking multifilament gillnets measuring 38.1 m by 1.8 m. Nets were constructed of five 7.6 m panels with square mesh sizes ranging from 19.1 mm to 50.8 mm. Gillnet sampling was conducted at 20 exploratory stations (Figure 2) with two nets set at each station. Nets were checked hourly during sampling periods of 0.5 to 3.0 hours.

All trapped and gillnetted fish of the target species were measured, weighed, and tagged. Scale samples were taken and sex determined, when possible, prior to fish release. Tagged fish recaptured by either method were remeasured and the location and method of capture recorded. The original methods and locations of captures were determined from previous data records.

RESULTS

LAKE

## Habitat Evaluation

Preliminary review of LANDSAT photographs, sediment distribution data, and bay morphometry suggests two distinct subareas within South Bay (Figure 3). LANDSAT photographs of Flathead Lake, taken during peak runoff in June 1974, reveal a continuous sediment plume from the north boundary southwest through Polson Bay to the river outflow. Although this plume was one of the most intense since 1964 (J. Stanford, pers. comm.), it does infer basic differences in the current patterns between Polson and East Bays. The eastern margin of this plume was approximated by the boundary line separating the Polson (I) and East Bay (II) subareas (Figure 3). Sediment distribution data from Lorang (1982) are also consistent with this subarea division. Coarser, transported sand types were reported within subarea I only, but were more related to prevailing winds and wave energy dynamics. The noticeably bi-lobed shape of the entire bay offers additional justificaticn for two physically distinct regions within the study area. Polson Eay, the larger of the two, has its principal axis (Al) running southwest from the main lake connecticn to the outflow. The second, East Bay, has it primary axis (A2) extending south-

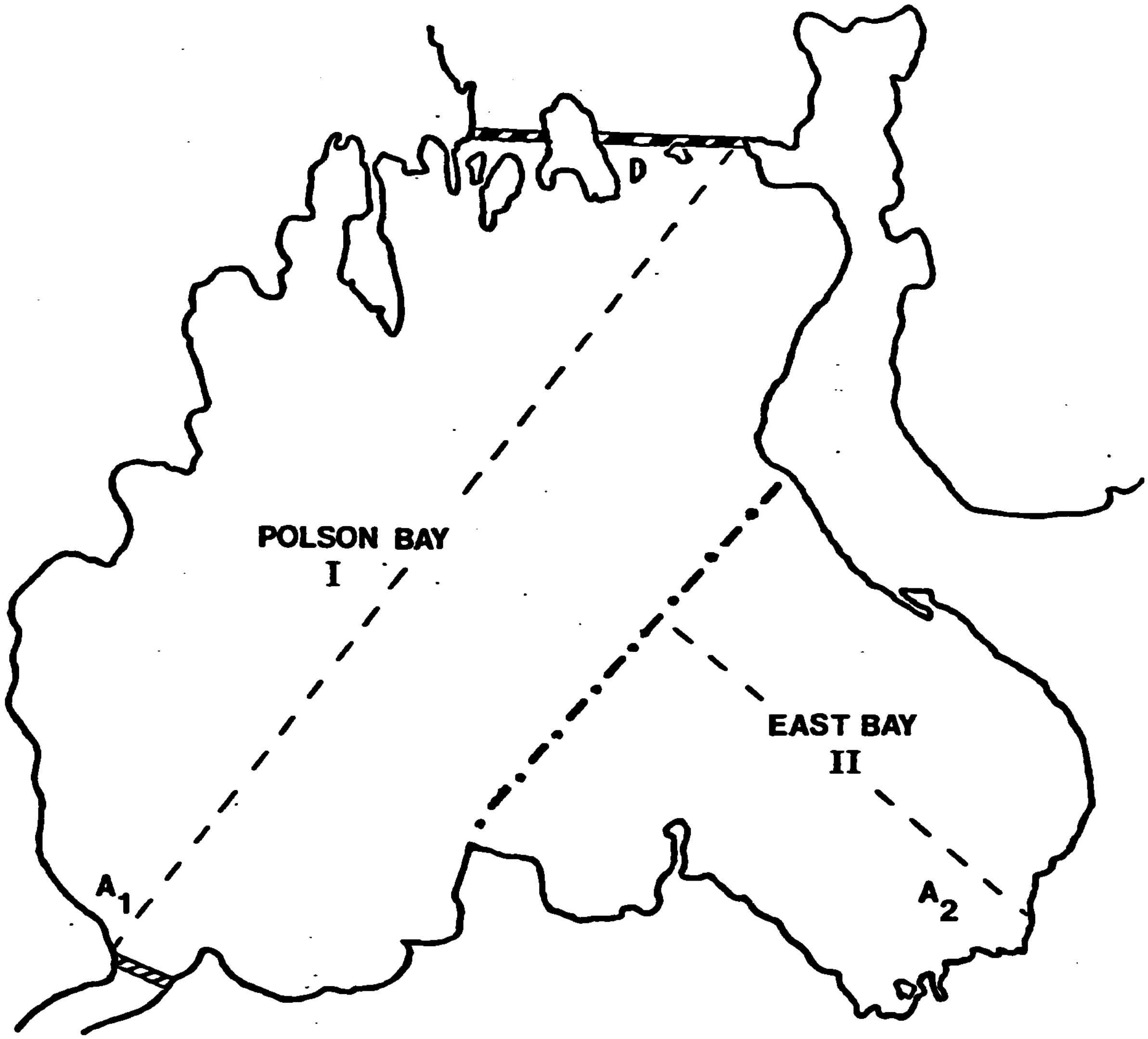



Figure 3. Major subareas within South Bay based on water current, sediment type, and general morphometry. North and south study boundaries are also shown.

east, nearly perpendicular to the first. Comparisons of aerial photographs further delineate East Bay as a noticeable subarea by the unique presence of persistent aquatic vegetation.

Planimetric analysis of the total study area indicated that approximately 18.1%, or 986 ha, is within the maximum drawdown zone (Figure 4). Of this area regulated by hydroelectric operations, 71.0% is located in East Bay (II). This subarea comprises only 30.4% of the total study area which in turn represents 10.7% of the total lake surface.

Overlays of three depth intervals and five substrate types resulted in 12 out of the 15 habitat types possible (Figure 5). The three possible types not found in the study area were shallow sandy mud (SSM), deep sandy mud (DSM), and deep untransported sand (DS2). Although in the same category as one of the types tabulated in Figure 5, nine additional evaluation areas resulted from map overlays. These secondary areas were evaluated separately because they were not contiguous with larger, similar areas, or were not located within the same physical subarea (I or II).

SCUBA, shoreline, and aerial surveys generally confirmed mapped boundaries and habitat type homogeneity based on the data of Lorang (1982), but several inconsistencies were observed. Seasonally inundated portions of

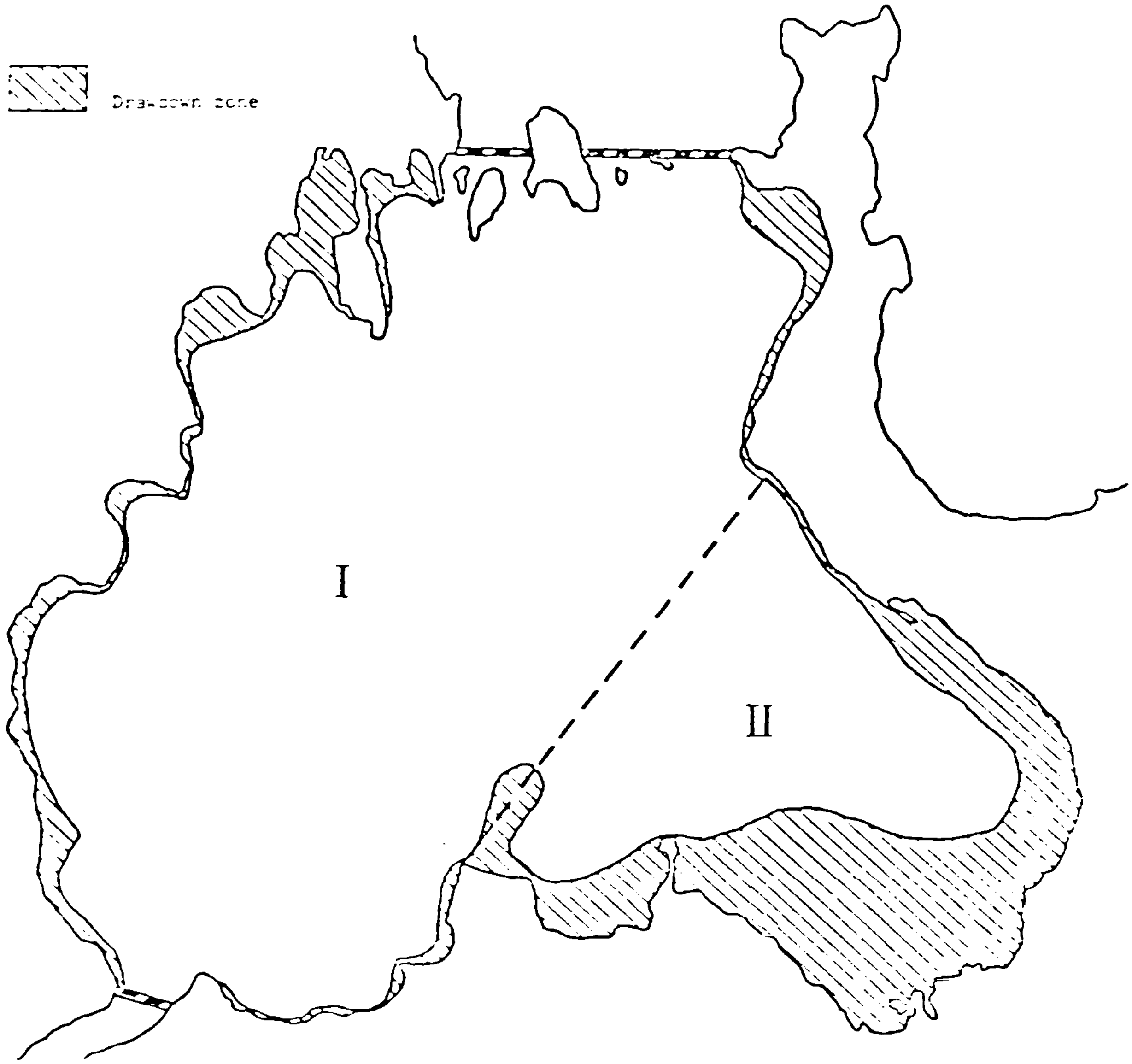



Figure 4. Maximum drawdown zone within major subareas of South Bay, Flathead Lake.

| | Habitat Types | | | | |
|---|---|---|---|---|---|
| Depth Interval | Transported Sand (S1) | Untransported Sand (S2) | Sandy Cobble (SC) | Sandy Mud (SM) | Muddy Ooze (MO) |
| S-Shallow (less than 3 m) | SS1 | SS2 | SSC | SSM* | SMO |
| M-Middepth (3 m to less than 6 m) | MS1 | MS2 | MSC | MSM | MMO |
| D-Deep (greater than 6 m) | MS1 | DS2* | DSC | DSM* | DMO |

*These types not observed within the study area.

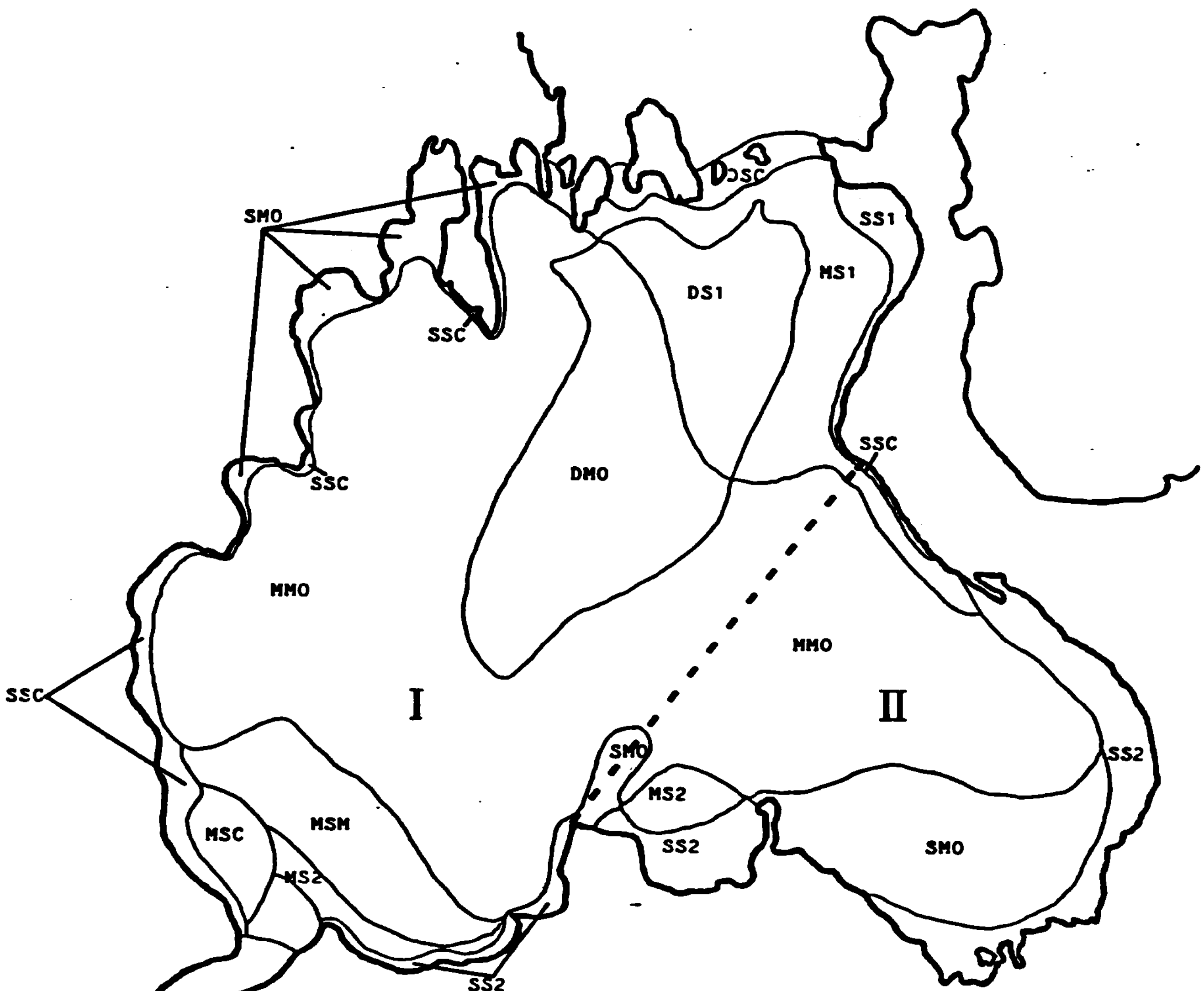



Figure 5. Habitat types of South Bay, Flathead Lake, based on water depth and substrate type (from Lorang 1982). Polson (I) and East Bay (II) subareas are also shown.

Polson Bay (I), typed as sand (SS2) and muddy ooze (SMO), contained extensive areas of cobble and gravel respectively. Large deposits of cobble and boulder were also observed in habitat types in both Polson and East Bays mapped as sandy mud (MSM) or muddy ooze (MMO). A third and recurring inconsistency was the lack of observable boundaries between finer substrates, particularly the sand, sandy mud, and muddy ooze types. It should be noted that these smaller substrate types were not easily distinguished by evaluators.

Shoreline surveys of seasonally inundated habitat types during the drawdown period permitted the most extensive and least costly groundproofing of the associated substrate types. Underwater surveys of permanently inundated areas were best conducted using SCUBA and a towed two-man dive sled (Appendix H). Excessive water depths precluded visual evaluation of these regions from the surface. Free swimming SCUBA or snorkel surveys were well adapted to evaluations of shallow areas and areas with extensive vegetation or structure, the latter being hazardous to safe boat navigation. Use of aerial photographs resulted in the location of major areas of vegetation , sediment deposition, and anomalous substrate types not previously mapped. Substrate samples alone were not sufficient to groundproof relatively large habitat types because they represented an unacceptably small percentage of the total sample area.

The depth component of each habitat type was ground-proofed using sonar surveys. In all, a total of 53,280 m of transect were sounded (Table 2). Individual transect locations and corresponding subareas are shown in Figure 6. Based on transect data, mean and maximum depths for subarea I were 5.19 m and 10.63 m respectively. Comparable figures for subarea II were 3.48 m and 6.02 m. A gradual increase in depth was observed towards the central axis of each subarea and towards their respective northern boundaries as well. The mean depth for all transects combined was 4.62 m, and the maximum 10.63 m, the same as that reported for subarea I. Average transect length was 3,552 m.

Seasonally inundated areas, or those less than 3 m deep at maximum lake levels, comprised an average of 10.4% of each transect (Table 2). This proportion is substantially less than the 18.1% determined using planimetric methods and the data of Lorang (1982). Further comparisons of depth data from this study with that of Lorang (1982) were not possible because lake elevation reference measures were not reported in the latter study. Bathymetric maps prepared by the MDFWP incorporate much of the Lorang (1982) data for South Bay and thus could not be used for independent comparison either. However, gross trends in bottom contour data are simiiar in this and the studies cited.

Table 2 . Mean and maximum transect depths and transect proportions within seasonally inundated areas of South Bay, Flathead Lake.

| Transect no. | Total length(m) | mean depth(m) | maximum depth(m) | Seasonally inundated length(m) | Seasonally inundated % |
|---|---|---|---|---|---|
| 1 | 2820 | 4.16 | 4.96 | 229 | 8.1 |
| 2 | 3920 | 4.67 | 5.64 | 222 | 5.7 |
| 3 | 4140 | 4.90 | 5.64 | 257 | 6.2 |
| 4 | 3930 | 5.26 | 6.45 | 250 | 6.4 |
| 5 | 3860 | 5.71 | 6.45 | 72 | 1.9 |
| 6 | 4530 | 5.62 | 6.58 | 106 | 2.3 |
| 7 | 4210 | 5.86 | 6.40 | <25* | <0.5* |
| 8a** | 525 | 2.27 } 5.08 | 3.02 | 413 | 78.7 |
| b | 3905 | 5.46 | 6.68 | 61 | 1.6 |
| 9a** | 230 | 3.34 | 4.17 | 87 | 37.8 |
| b | 280 | 3.95 } 4.91 | 6.00 | 45 | 16.1 |
| c | 2660 | 5.15 | 6.97 | 61 | 2.3 |
| 10 | 2070 | 5.75 | 10.63 | 71 | 3.4 |
| 11 | 3960 | 4.68 | 6.02 | 103 | 2.6 |
| 12 | 3680 | 3.95 | 5.48 | 446 | 12.1 |
| 13 | 2970 | 3.21 | 4.67 | 696 | 23.4 |
| 14 | 2810 | 3.16 | 4.26 | 709 | 25.2 |
| 15 | 2780 | 2.42 | 3.58 | 1722 | 61.9 |
| Total | 53,280 | - | - | 5550 | - |
| $\bar{X}$ | 3,552 | 4.62 | 5.75 | 370 | 10.4 |
| std. dev. | 728 | 1.05 | 1.66 | 433 | |

* Assumed to be zero for summary statistics.

** Subunits combined and weighted by transect before computing summary statistics.

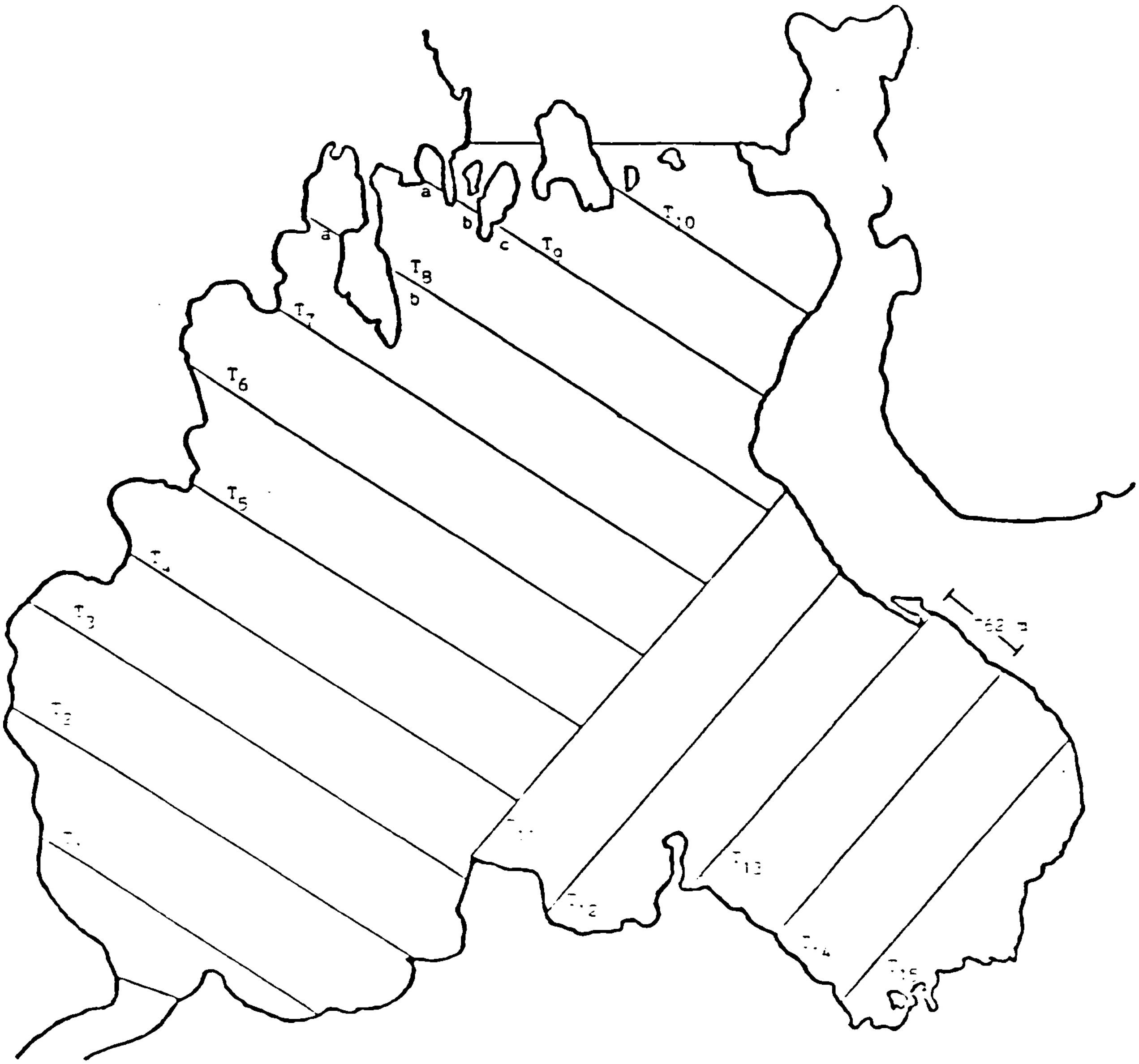



Figure 6. Permanent habitat evaluation transects in South Bay, Flathead Lake.

Lake elevation data for the past seven years (1977-1983), recorded in Polson by the Montana Power Company, are summarized in Figure 7. These years were chosen for evaluation because they represent a discrete period of dam operation according to state researchers (Decker-Hess pers. comm.). The'mean and range of monthly elevations are plotted for those years evaluated. Maximum summer lake levels (881.8 m), controlled by Kerr Dam, were reached in July and observed as late as September. The minimum elevation (878.7 m) was reached most often in March and occurred on a less regular basis than the recreationally mandated maximum. This minimum was observed in March in four out of the seven years examined (1977-83), twice in February (1979, 1980), twice in April (1977, 1980), and in all three of these months in 1980. In contrast to the relative stability of minimum and maximum elevations, much greater fluctuations in mean monthly elevations were observed during the drawdown (September-March) and fill (March-July) periods, particularly the latter. The greatest range (2.35 m) in mean monthly elevation was observed in May, a month of rapid filling.

Photographs were taken monthly at sixteen permanent stations. Periodic evaluation of these photographs resulted in the addition and deletion of several stations in order to increase the amount of qualitative data collected in areas

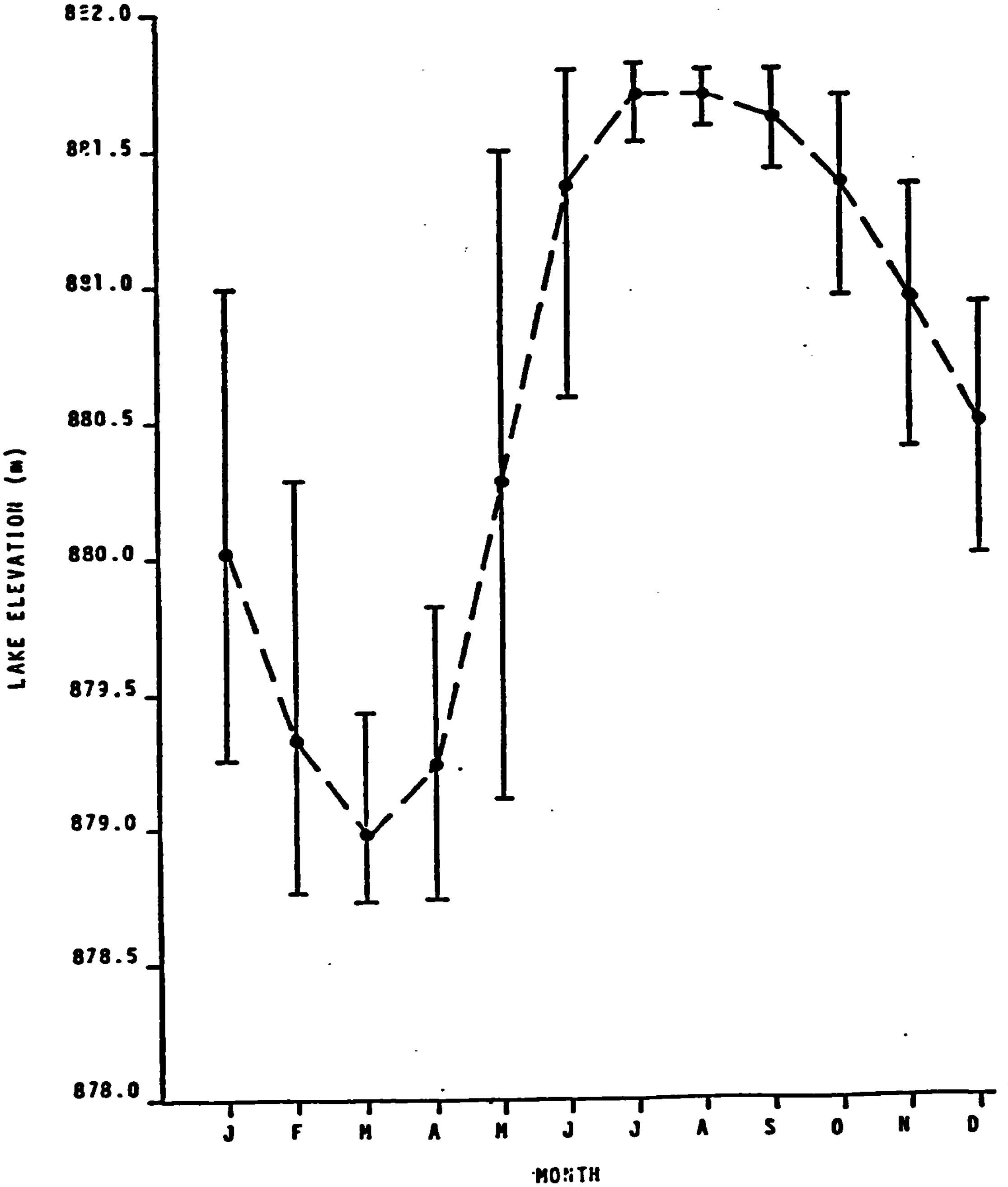



Figure 7. Minimum, maximum, and mean monthly lake elevations (1977-83) for South Bay, Flathead Lake recorded at Polson, Montana.

most affected by lake level fluctuation. No detailed analysis of photos for mapping of habitat types has yet been performed. Detailed locations of established photo stations and subject references have been prepared (Appendix D).

Water Quality

Water quality data reported herein are limited to a four-month period of 1984 and therefore cannot reflect the true annual means or ranges of the variables measured. Mean water temperature at- 2 m depth in South Bay ranged from a low of 5.3" C in April to a high of 21.6 ° C in late July (Appendix F). A gradual warming trend was observed in both subareas during the sampling period, with temperatures averaging 0.6 ° C higher in the East Bay (II) subarea. Water temperatures measured on the surface were consistently more variable than corresponding temperatures at 2 m, but also indicated that East Bay was usually warmer than Polson Bay by approximately 0.8°C for the period sampled.

Mean dissolved oxygen concentrations were observed to decline with increasing water temperatures at all stations and depths. No apparent stratification was observed. Mean dissolved oxygen concentrations at 2 m ranged from a high of 12.73 mg/l in April to a low of 9.55 mg/l in July.

Measurements of pH were relatively stable during the April-July sampling period and showed no apparent trends through time. The range in pH was similar for surface and

2 m readings, and between both subareas. The range observed was from 8.2 to 8.6.

Mean conductivity was also relatively stable in all areas with a range of 170.0 uS/cm to 177.5 uS/cm observed. No consistent trends for this variable were noted between subareas I and II for the period sampled.

Mean values and standard deviations for all water quality parameters were summarized by depth and subarea (Appendix I).

Spawning Surveys

No largemouth bass or evidence of spawning was observed during the June 15 evaluation of the "Bass Pond," a large backwater area. The only access to the lake, a channel which exists at maximum lake elevations, was blocked by two beaver dams. One of the dams had been stabilized by woody vegetation. Emergent and submerged vegetation were extensive throughout the area and the average depth was approximately 1 m. The only fish observed during the extensive survey were three bullheads and one sunfish, neither of which were identified to species. No nests of any type were observed.

The second survey for largemouth bass, conducted in East Bay on July 2, was also negative. No individuals of this species were collected or observed during night electrofishing of nearly 2 km of inshore habitat. Although wave-induced turbidity reduced visibility and electrofishing efficiency, it did not prevent the capture of other species known to frequent this portion of the lake.

Yellow perch spawning surveys conducted in April and May resulted in few observations of egg skeins for this species. No yellow perch eggs were observed during two snorkel surveys (550 m total) conducted in East Bay on April 11. However, several large congregations of adult yellow perch were observed from the boat in nearby areas of nearly 100% bottom vegetation. Vegetation was dominated, in order, by *Chara*, *Potamogeton* and *Myriophyllum*. During a second East Bay survey conducted on May 17, 18 egg skeins were counted along two of the five 200 m transects evaluated. Fifteen of these skeins were inside the wings of the Bird Point fyke trap while the other two were observed along a single transect near the center of the bay. No eggs were observed along the other three transects surveyed on this date.

In contrast, relatively high densities of yellow perch egg skeins were encountered incidental to habitat ground-proofing dives made between April 11 and May 17. Approximately 50 of them were observed during one survey of 150 m off a rocky point along the west shore. These and other skeins observed during the period between spawning surveys were almost always attached to vegetation or occasional cobbles and boulders. The highest egg densities were observed during this intervening period and coincided with peaks in fyke net catches of yellow perch (Figure 8).

<u>Larval Fish</u>

A factor of 0.005383 $m^3$ per flowmeter revolution resulted from the average of five calibration tows with the half-meter net. A 15 minute tow filtered approximately 180 $m^3$ of water, and the distance travelled in this time at idle speed was completed within given habitat types on all transects.

Experimental half-meter net sampling resulted in catches ranging from 0-100 larval fish per tow. Catch analyses have not yet been completed, hence CPUE results will not be presented in this report. Differences between inshore and offshore sites, time of day, and position in the water column were observed upon initial examination of samples. Catches were markedly higher for all larval fish species when a towing position just under the surface of the water was used. Nighttime tows were also relatively more successful for capturing yellow perch. Because of this, surface tows during night hours became standard sampling protocol in June.

Catches from inshore sampling areas were noticeably higher than from offshore areas. Nineteen inshore and five offshore expioratory sites were established in mapped habitat types and each sampled monthly to determine general distribution of target larval fish species.

Lake whitefish was the only species of larval fish caught with half-meter nets in late March and April. Total length of lake whitefish larvae caught in these initial sampling efforts averaged 13.0 mm. This species was consistently more numerous in samples from the sheltered, steep-sided northwestern-bays of South Bay than from any other location.

Larval yellow perch appeared in half-meter net catches in early May and averaged 4.0 mm TL at that time. This species was more numerous in samples from East Bay sites than from any other sample area, and higher catches were observed from more densely vegetated areas.

Juvenile Fish

Varying catch assemblages were observed at the 16 exploratory seine sites (Appendix J). Sites S1 and S2 (Figure 2) were the only sites where mountain whitefish or kokanee were captured. Catches yielded greater than 50 yellow perch per haul in the 51-75 mm size range at sites S3, S6, S10, S11, S14, S15, and S16, and in the 76-100 mm size range at site S15. Similar yields of yellow perch in the 101-150 mm size class were encountered at sites S2, S5, S6, and S10. Young-of-the-year (YOY) lake whitefish were caught at sites S3, S7, S8, S10, and S14.

Four hundred twenty four yellow perch, four lake whitefish, 40 mountain whitefish, and 19 kokanee were captured by seining and tagged. All other captured fish over 100mm TL were batch-marked by scarring soft dorsal fin rays and clipping different paired fins. Left pelvic fins were removed from 557 yellow perch at site S2, left pectoral fins from 600 yellow perch at site S5, and right pectoral fins from 200 yellow perch at site S6.

### Fyke Trapping

The Narrows location accounted for the lowest catches among the five experimental fyke trap locations (Appendix L). The area was difficult to sample effectively with the fyke traps due to limited shallow water and proximity to steep drop-offs. Because of this the site was abandoned.

Trapping at all other locations was more effective and was conducted for varying time periods (Appendix L). In general, more fish were captured when additional lengths of offshore lead material were added. An offshore lead length of 122 m (three 91.5 m leads) was eventually implemented at all trap locations.

The dominant target fish captured at all trap locations was yellow perch. The Bird Point location yielded the highest catches of this species. Lake whitefish and bull trout were caught intermittently at the Bird Point and

Finley Point locations. No northern pike or largemouth bass were captured with the fyke traps. (Appendix L).

Yellow perch catch frequencies at all trap locations exhibited peaks between 15 April and 21 April and between 21 Hay and 24 May (Figure 8). During the time period between and including these peaks, 84.8% of the yellow perch captured were in spawning condition. Sixty percent were female and 40% were male. Sizes ranged from 100 mm TL to 313 mm TL.

Catches of lake whitefish per trap day at the Finley Point site were higher than at any other site (Appendix L). Relatively large numbers were captured on 18 March and 25 April. Catches of lake whitefish at the Bird Point site remained steady at a rate of one to ten fish per week and did not exhibit any obvious peaks. Lake whitefish were captured in relatively low numbers at the Narrows, West Shore and Golf Course trap sites.

A total of 22 bull trout were captured during fyke trap sampling: five at Finley Point, nine at Bird Point, five at West Shore, and three at Golf Course. All except one were over 400 mm TL (Appendix M).

Catches of kokanee in fyke traps were not significant with the exception of a single catch on June 8 at the Bird Point site. On that day 13 kokanee were captured, ranging in size from 300 mm TL to 330 mm TL. The trap had been fishing for two days.

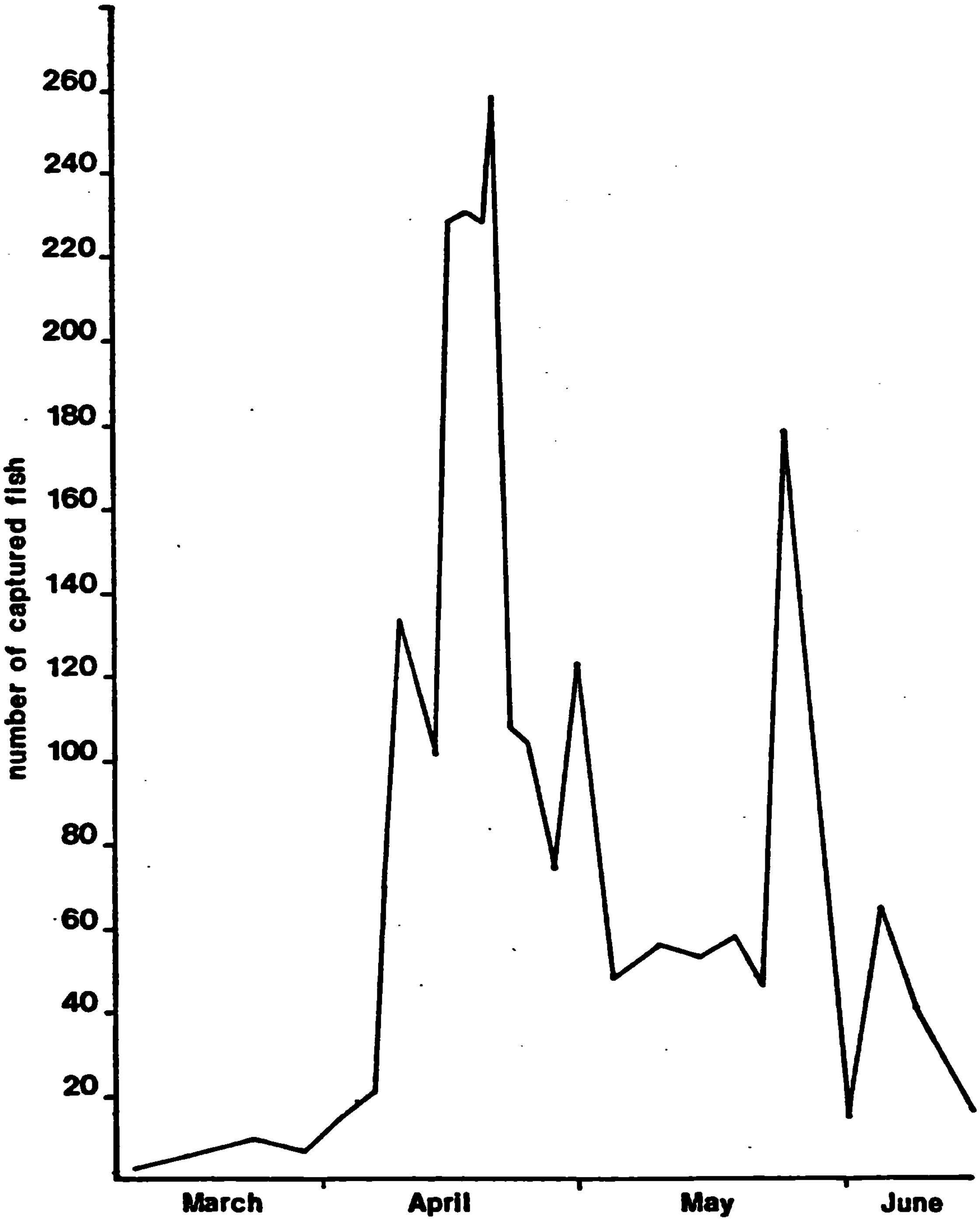



Figure 8. Total catch by date of yellow perch from all fyke traps in South Bay, March through June 1984.

## Gillnetting

Based on experimental sets (Appendix K), a time interval of two hours was selected as optimum for gillnet sampling. Sets for less than two hours resulted in small sample sizes at some locations, and mortality increased with longer sets. Hourly checks were necessary to minimize mortality of more sensitive species such as lake whitefish and bull trout. All gillnet sets conducted on and after August 8, 1984 were for two-hour time periods.

Yellow perch was the dominant target species caught during gillnet sampling. Eight hundred and eighty nine yellow perch, six bull trout, and six lake whitefish were captured in 58.25 hours of gillnet fishing. Adults of the salmonid species were not encountered after June 12, 1984. No northern pike or largemouth bass were caught with this sampling method.

## Tag Returns

Six of the 22 bull trout over 400 mm TL which were tagged during 1984 were recaptured by anglers (Appendix M). Five were captured in the Upper Flathead River, and one -at the Polson City Docks. This resulted in a 27.3% catch rate of all bull trout 400 mm TL tagged in South Bay.

One hundred fifty eight tagged yellow perch were recaptured with fyke traps, gillnets, and by anglers. One hundred twenty eight yellow perch tagged at the Bird Point trap and six tagged at the West Shore trap were recaptured in those same traps. Forty three of these fish (34%) were recaptured within one or two days of tagging. The range of days between capture and recapture for the remaining 66% was bimodal, peaking at 7 and 13 days. These fish were all tagged on or before 25 April, 1984, and recaptured on or before 4 June, 1984. Fourteen yellow perch were recaptured at or near original tagging locations by anglers. The time period between capture and recapture ranged from l-109 days. Two female yellow perch, tagged at the Finley Point and Bird Point traps, were recaptured in the West Shore trap. The fish from Finley Point was recaptured 11 days after tagging, and the fish from Bird Point, 17 days after tagging. Seven yellow perch tagged at the Bird Point trap were recaptured by anglers along the western shore of South Bay. One yellow perch was recaptured in a gillnet on August 1, 1984 at the northern end of Finley Point. It was tagged 57 days earlier at Bird Point.

## DISCUSSION

Habitat evaluation within South Bay resulted in the mapping of major physical habitat types and the development of field methods needed to complete phase II of the study. Although physical data collected this year identify potentially important habitat variables, insufficient data are available at this preliminary stage to define significant fish-habitat relationships.

Original habitat types in South Bay (Figure 5) were generally confirmed by groundproofing. However, these types were based on mean diameter of the associated substrate and do not necessarily delineate habitat types according to their ecological significance to the fish species of concern. Platts et al. (1983) discuss the potential shortcomings of substrate evaluations which rely solely on mean particle diameter. They note that substrates with similar geometric means may have very different suitability regarding salmonid fry emergence and survival. Stuber et al. (1982) use the dominant substrate size, not mean substrate diameter, to determine the relative suitability of substrates for largemouth bass reproduction. In this study, the sandy mud (SM) and sandy cobble (SC) substrate types were reported to have the same mean particle diameter (0.23 mm) (Lorang 1982), but may have different suitability to target fish species if the mud or cobble components predominate. For this reason the substrate categories used in the evaluation of habitat for largemouth bass (Stuber et al. 1982) will be adopted and the original types reclassified accordingly. This should result in a more ecologically based evaluation of South Bay substrates.

In addition to substrate and depth components, vegetation and cover variables will be incorporated in the FY85 habitat types. The inclusion of these factors is based on their observed importance to the target species, particularly yellow perch (Walburg 1979; Nelson and Helfman 1977). Percent cover (eg. vegetation, brush, debris, standing timber) in littoral areas has been shown to be important to yellow perch reproduction and as a measure of food availabiiity (Krieger et al. 1983). Direct observation in this study has also documented extensive use of submerged (Chara, Myriophyllum, and Potamogeton) and emergent (Scirpus, Typha) vegetation by adult and juvenile yellow perch. An apparent correlation between finer substrates and rooted macrophytes may facilitate mapping of the latter and improve estimation of related cover types. Ultimately, the combination of three cover types (vegetation, other cover, no cover) and five substrate types (silt, sand, gravel, cobble, boulder) will produce a maximum of 15 potential habitat types within the study area.

Lake elevation data (Figure 7) illustrate the annually repeating pattern of spring fill and fall drawdown in Flathead Lake. Comparisons of observed and projected lake elevations also reveal that actual lake levels were as much as 1.25 m above and 0.85 m below anticipated elevations. Considering this pattern of fluctuation and its potential impact on fish habitat in the drawdown zone, most notably shallow water spawning areas and vegetative cover, three evaluation periods are suggested. The periods are characterized by different combinations of lake elevation nd the presence or absence of vegetation. The first period is during minimum elevations, typically January through April, and includes only permanently inundated habitat types. The second period, from June through July, includes both permanently and seasonally inundated areas, the latter presumably before revegetation. The third period is during maximum elevations, the same as the second, but later in the year (August through October) when seasonally inundated zones have again become heavily vegetated. Lake elevations will be carefully monitored during all three evaluation periods and subsequently related to fish habitat and distribution data.

Gross physical differences within the South Bay study area support subarea stratification of the proposed habitat evaluation. Stratification of the study area into more physically homogeneous units will reduce the variability of random samples and thus increase the precision of overall sampling (Johnson and Nielsen 1983). In addition to the stratification based on substrate-cover type and seasonal versus permanent inundation, observed differences in current patterns, sediment transport, and overall bay morphometry all suggest that increased sampling efficiency will result from separate analyses of the Polson and East Bay subareas. Examination of LANDSAT photographs and sediment distribution data (Lorang 1982) both indicated that East Bay is less influenced by prevailing waves and lake currents. Transported sediments are virtually absent from East Bay which is characterized by shallower average depths (Table 2) and extensive vegetation. The absence of transported sediments within East Bay is consistent with the findings of other researchers (Moore et al. 1982; Stanford et al. 1983) who reported a natural southward movement of turbid surface waters towards the lake outflow. This natural current pattern, which bypasses East Bay, apparently minimizes sediment deposition in this area. Such major differences in substrate type and its relative suitability for the growth of vegetation could influence the distribution of yellow perch (Krieger et al. 1983), the most abundant target species, and thus should be considered in the sampling design. Guidelines for lacustrine habitat evaluations (Terrell et al. 1982) also infer that a Polson and East Bay subarea, each with a major sampling axis, would best sample the morphometrically bi-lobed study area.

Planimetric analyses of the study area also show East Bay to be disproportionately influenced by lake level fluctuations. Because of its contrasting shallowness, East Bay encloses nearly three fourths (71.0%) of the total drawdown zone, yet comprises less than one third (30.4%) of the study area. The relative importance and support for separately evaluating East Bay is demonstrated by its substantial contribution to the yellow perch fishery. During a comparable two week sampling period (4/g/84-4/24/84), yellow perch catch rates at Bird Foint in East Bay were nearly ten times greater than those of the next most productive sample site in South Bay. Utilization of vegetative cover by target fish species, reduced during drawdown periods, also dictates comprehensive evaluation of this apparently important subarea.

A variety of field methods were used and evaluated during the FY84 study year. Deeper, permanently inundated areas were best surveyed using SCUBA divers on a towed two-man sled. This combination resulted in the most efficient surveys based on air consumption and total area visually evaluated. Future evaluations of unobstructed, deepwater habitats will be conducted using this technique. Shallow water habitat types in seasonally inundated areas, and those with obstructions or extensive vegetation, were effectively sampled by snorkeling. This method will be used in similar areas in FY85. All survey methods will be standarized to ensure comparibility of collected data.

Water quality measurements are limited to the period April through July (Appendix I) and are thus insufficient to accurately define the annual range of these variables within South Bay. Although complete ranges are as yet unavailable, data collected to date are consistent with similar measurements for the entire lake taken by the Montana Department of Fish, Wildlife and Parks (Hanzel 1970). State researchers also reported that recent studies of Flathead Lake water chemistry showed no major changes from the relative stability documented in much earlier studies.

Surface water temperatures increased gradually during the reported period and were paralled by the slightly cooler and less variable temperatures at 2 m depth. Except for May, water temperatures in East Bay were consistently warmer than those observed in the Polson Bay subarea. Variation between 0.5 m depth intervals was usually slight or nonexistent and suggest that 1.0 m depth intervals will suffice future sampling needs.

Other water quality readings also indicated relatively stable profiles and the adequacy of a 1.0 m depth interval for sampling purposes. Dissolved oxygen measurements were inversely related to water temperature and remained well above the 8 mg/l concentrations considered optimum for largemouth bass (Stuber et al. 1982), the most tolerant target species. Surface and subsurface waters appeared well mixed regarding pH and conductivity. Without year-round measurments of pH, evaluation of its suitability for all target species would be premature. However, existing ranges fall within the slightly alkaline conditions considered optimal for growth of yellow perch (Krieger et al. 1983), northern pike (Inskip 1982), and largemouth bass (Stuber et al. 1982). Conductivity was also fairly uniform throughout the study area but was not evaluated with respect to the target fish community. As a general measure of lake fertility (Lind 1974), the conductivity may indirectly constrain fishery potential, but it is unlikely that it directly influences fish distribution within the study area. However, the high correlation between suspended solids and total phosphorous in Flathead Lake (Stanford et al. 1983) suggest that production of vegetation, potentially important as fish cover, may be linked to differences in sediment distribution patterns between the Polson and East Bay subareas.

Spawning surveys for yellow perch apparently bracketed the major reproductive period of this species in South Bay.

Low egg skein counts during the two surveys complemented the relative peaks in yellow perch catches (Figure 8) during the intervening period. These peaks in yellow perch activity, likely related to increased spawning movement, were also reflected in high incidental egg skein counts made during other SCUBA dives. Future surveys will be completed in all habitat types during the observed spawning period as indicated by fish sampling data and surface water temperatures approaching 7.45°C. This temperature was the mean observed for East Bay during the apparent spawning peak.

Similar surveys for lake whitefish were not conducted because this species does not spawn untii water temperatures drop to about 7.8°C (Scott and Crossman 1973. These temperatures are usually not observed in Flathead Lake until late October or early November (Stanford et al. 1983). Because this species is a broadcast spawner (Brown 1971), egg counts or similar survey methods may be impractical and larval fish distribution may subsequently be used to assess relative spawning habitat suitability. As with yellow perch, spawning assessment efforts wiil center on the observed reproductive period.

Neither largemouth bass or northern pike were observed or collected during any fish sampling in South Bay. The absence of these species from all fish samples suggests that they are not present in the study area, or if so, remain in exceptionally low densities. According to available state records, largemouth bass were last planted in South Bay in August of 1973 (MDFWF 1984). Similarly, the presence of northern pike in South Bay has not been documented in over ten years, the last catches being reported in 1972 and 1973 from Stone Quarry Bay (Hanzel 1976).

South Bay fish sampling locations and methods were oriented around the mapped habitat types based on depth and substrate type. Habitat types were experimentally evaluated this year with fish sampling methods, and each will be sampled systematically over the duration of the study to determine the relationship of fish populations and their various life stages to aquatic habitat in South Bay. Results will be correlated with habitat quality, habitat quantity, lake surface elevation changes, and selected water quality parameters.

Lake whitefish and yellow perch larvae concentrate along the shorelines of lakes and reservoirs (Faber 1970, Reckahn 1970, Scott and Crossman 1973, Krieger et al. 1983), thus more larvae of these target species were expected in half-meter net catches from inshore habitat types than from offshore habitat types. Experimental sampling confirmed these expectations. To evaluate the spatial and temporal distribution of larvae in littoral habitat types, inshore areas were sampled during June through August with more intensity than offshore areas. Larval fish samples collected this year have not yet been completely analyzed. Initial observations indicate that larval fish species composition and abundance are variable between samples within habitat types. In future sampling years, four lo-minute tows will be conducted monthly in each habitat type. Shorter tows should produce less variability (Faber 1970), and multiple tows will be subject to statistical testing for variance and comparison regarding larval fish utilization within and between habitat types. The addition of another half-meter net to the existing sampling protocol will allow concurrent paired tows, maximizing efficiency in collection of replicate samples.

The half-meter net procedures used to collect larval fish were effective on all transects until late August, when excessive vegetation interfered with boat operation and sample collection along East Bay transects. Larvae were still being captured at that time on less vegetated transects. Alternative sampling methods such as passive light-traps (Faber 1982) are being considered to sample inaccessible habitats in the future.

Faber (1970) and Reckahn (1970) found that larval lake whitefish heavily utilize steep shoreline habitats. Preliminary analysis suggests that our data substantiate this observaticn, as large numbers of lake whitefish larvae were collected in the steep-sided embayments of northwestern South Bay. Because larval fish are subject to the effects of winds and currents due to their small size and undeveloped muscle and fin structure (Houde 1969, Clady 1976), it is not known if the specimens captured in these areas were originally spawned there or were transported there after hatching. To better identify important spawning habitat for this species, gillnet sampling for adults in reproductive condition will be conducted when lake whitefish spawn in November through January.

Site conditions necessary for effective seine sampling include shoreline accessibility with the sampling boat and equipment, shallow water depth, and absence of obstacles such as barbed wire, pilings, and buoys in the seine area. These constraints may bias seine catches by selecting against fish associated with large immovable structures, marshy shorelines, or shorelines with dense overhanging cover. However, seines are generally selective for small, shallow-water schooling fish associated with smooth substrates (Hayes 1983). Beckman and Elrod (1971) and Nelson and Walburg (1977) reported excellent success in capturing juvenile yellow perch in reservoirs using beach seines. Seining was similarly successful in our study, with high CFUE observed for yellow perch 50 to 150 mm TL.

Due to the aforementioned constraints and to the emphasis placed on development of standard methodology, not all shoreline habitat types were sampled this year. Selection of sites in unsampled habitat types will be completed next year. Site S8 was dropped from consideration as a permanent sample site due to limited access. All other locations will be retained as permanent sample sites.

There were thousand-fold differences in catches of juvenile yellow perch between seine sites within and between habitat types (Appendix J). To assess this variability, two sites in each habitat type will be designated as permanent seine sites and sampled during the three evaluation periods outlined for habitat assessment.

Dominant catches of individual size classes (50-75 mm, 76-100 mm, 101-150 mm) of yellow perch were apparent in different habitat types (Appendix J), which may suggest utilization of different habitat types by different age classes. The 76-100 mm size class was dominant only in one of the west shore seine catches, S15. It is likely that, due to the later sampling date for this site, fish of this size were included in the 51-75 mm size class captured earlier in the year. Sampling in other areas during the time intervals indicated will further assess age structure and growth patterns of juvenile yellow perch in South Say.

Fyke trapping was an efficient method of capturing large numbers of target fish species for tagging purposes and for assessment of temporal changes in fish movement. The use of extensive lengths of lead material on the traps was possible during lower lake surface elevations. This enhanced trap efficiency by collecting fish from a large area around each trap. As lake surface elevations increased, fewer fish were captured, trap stability was reduced, and fish removal from traps became more difficult. Additional traps will be used in FY85 to increase sampling data regarding spatial distribution and movement of target species in South Bay during low lake surface elevation periods.

The distinctive peaks exhibited in yellow perch catches from fyke traps fell within two discrete time intervals: 12-20 April and 21-27 May (Figure 8). Because of the large percentage of fish in spawning condition captured during the intervening time period, it is likely that the peaks represent pulses in the well-documented migratory spawning behavior of yellow perch (Scott and Crossman 1973, Thorpe 1977, Weber and Les 1982). In Lake Winnebago, a large regulated lake in Wisconsin, onset of spawning was correlated with time of ice breakup, and length of spawning with mean daily water levels (Weber and Les 1982). Harrington (1947), Amundrud et al. (1974) and Thorpe (1977) relate onset and length of spawning to increasing water temperatures. Trapping results will be related to temperature, water elevation and ice breakup data to determine their influences on spawning activities in South Bay during FY85.

Gillnet sampling during high lake level elevations was an effective method of collecting fish for tagging purposes and for determining relative abundances regarding habitat types. Due to the experimental nature of site selection and to the unstandardized gillnetting effort throughout the study area this year, catches from different sample sites were not compared. Only one marked fish was recaptured with this method. Increased gillnetting efforts, and the greater numbers of marked fish in the system, should heighten the future efficiency of this sampling method in determining the distribution of adult fishes in South Bay during high iake level elevations. All habitat types will be sampled with giilnets three times a year, during the three evaluation periods previously described.

Analyses for age class structure, length frequencies, and condition factors are being conducted on all adult fish captured during FY84. Results will be presented in the FY85 Annual Report.

Seeral reports were received regarding anglers that discarded tags from fish captured in South Bay. Future newspaper announcements and more signs at access areas and local stores should promote public awareness of the study and increase tag-return rate, especially during the ice-fishing season.

A catch rate of 27.3% of all tagged bull trout 400 mm and larger from South Bay was observed this year, a very high exploitation rate for 22 tagged fish. Trapping activities in FY85 will provide a larger number of tagged bull trout before next year's spawning season, and fishing mortality will be closely monitored.

Large numbers of tagged yellow perch were recaptured by anglers and fyke traps at their initial tagging location in East Bay. Movements of up to 6.7 km from East Bay to Polson Bay sites were noted for some individual fish. Present data are insufficient to determine if these movements are random or related in some way to changes in lake level elevations or reproductive condition of the fish.

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# APPENDIX A

Summary of fisheries data collected from the lower Flathead River.

## ELECTROFISHING SUMMARY

| Location | Date | Species | No. Captured | Size Range (mm) |
|---|---|---|---|---|
| Sink Hole | 03-09-84 | LMB | 6 | 277-346 |
| Perma #1 | 03-20-84 | MWF | 221 | 207-412 |
| " | 03-20-84 | Rb | 5 | 243-440 |
| " | 03-20-84 | LL | 3 | 251-580 |
| " | 03-20-84 | DV | 1 | 672 |
| Perma #2 | 03-21-84 | MWF | 115 | 128-380 |
| " | 03-21-84 | Rb | 2 | 262-290 |
| " | 03-21-84 | LL | 1 | 602 |
| " | 03-21-84 | NP | 1 | 996 |
| Perma #1 | 03-27-84 | MWF | | |
| " | 03-27-84 | Rb | 2 | 228-254 |
| " | 03-27-84 | DV | 2 | 524-705 |
| " | 03-27-84 | LL | 1 | 333 |
| Perma #2 | 03-28-84 | MWF | | |
| " | 03-28-84 | Rb | 2 | 234-251 |
| " | 03-28-84 | LL | 1 | 410 |
| " | 03-28-84 | NP | 1 | 670 |
| Buff. #1 | 04-01-84 | MWF | 221 | 150-375 |
| " | 04-01-84 | LL | 4 | 363-473 |
| Buff. #2 | 04-02-84 | MWF | 351 | 129-402 |
| " | 04-02-84 | LL | 10 | 327-552 |
| " | 04-02-84 | NP | 2 | 676-760 |
| " | 04-02-84 | Ct | 1 | 427 |
| Sloan's #1 | 04-03-84 | MWF | 208 | 188-467 |
| " | 04-03-84 | LL | 5 | 347-540 |
| " | 04-03-84 | Rb | 1 | 328 |
| Sloan's #2 | 04-04-84 | MWF | 164 | 214-373 |
| " | 04-04-84 | NP | 4 | 414-688 |
| " | 04-04-84 | LL | 2 | 258-271 |
| " | 04-04-84 | Ct | 2 | 258-367 |
| Buff. #1 | 04-08-84 | MWF | | |
| " | 04-08-84 | LL | 4 | 333-485 |
| Buff. #2 | 04-09-84 | MWF | | |
| " | 04-09-84 | LL | 3 | 314-453 |
| " | 04-09-84 | Rb | 1 | 365 |
| Sloan's #1 | 04-10-84 | MWF | | |
| " | 04-10-84 | LL | 6 | 399-577 |
| " | 04-10-84 | NP | 1 | 674 |
| Sloan's #2 | 04-11-84 | MWF | | |
| " | 04-11-84 | LL | 3 | 289-470 |
| " | 04-11-84 | NP | 2 | 679-815 |
| Agency #1 | 04-15-84 | MWF | 146 | 164-440 |
| " | 04-15-84 | Rb | 7 | 283-365 |
| " | 04-15-84 | NP | 5 | 321-788 |
| " | 04-15-84 | LL | 4 | 302-485 |

## ELECTROFISHING SUMMARY (Continued)

| Location | Date | Species | No. Captured | Size Range (mm) |
|---|---|---|---|---|
| Agency #2 | 04-16-84 | MWF | 232 | 136-458 |
| " | 04-16-84 | Rb | 3 | 276-363 |
| " | 04-16-84 | NP | 3 | 384-415 |
| " | 04-16-84 | Ct | 1 | 278 |
| Weeds #1 | 04-17-84 | MWF | 179 | 147-495 |
| " | 04-17-84 | LL | 7 | 292-581 |
| " | 04-17-84 | NP | 6 | 436-680 |
| " | 04-17-84 | Rb | 4 | 305-385 |
| Weeds #2 | 04-18-84 | MWF | 202 | 152-448 |
| " | 04-18-84 | Rb | 4 | 291-410 |
| " | 04-18-84 | LL | 2 | 323-358 |
| " | 04-18-84 | NP | 2 | 695-701 |
| " | 04-18-84 | LMB | 2 | 320-395 |
| " | 04-18-84 | DV | 1 | 446 |
| Agency #1 | 04-22-84 | MWF | | |
| " | 04-22-84 | LL | 9 | 291-569 |
| " | 04-22-84 | NP | 4 | 354-703 |
| " | 04-22-84 | Rb | 4 | 295-337 |
| Agency #2 | 04-23-84 | MWF | | |
| " | 04-23-84 | NP | 5 | 363-679 |
| " | 04-23-84 | Rb | 3 | 272-345 |
| " | 04-23-84 | LL | 3 | 383-584 |
| " | 04-23-84 | DV | 1 | 850 |
| Weeds #1 | 04-24-84 | MWF | | |
| " | 04-24-84 | NP | 4 | 674-849 |
| " | 04-24-84 | LL | 3 | 275-461 |
| " | 04-24-84 | Rb | 3 | 277-330 |
| " | 04-24-84 | Ct | 1 | 312 |
| Weeds #2 | 04-25-84 | MWF | | |
| " | 04-25-84 | Rb | 3 | 249-278 |
| " | 04-25-84 | Ct | 3 | 254-322 |
| " | 04-25-84 | LL | 1 | 273 |
| " | 04-25-84 | NP | 1 | 476 |
| Mac. SL. | 08-29-84 | LMB | 3 | 371-415 |

<u>GILL NETTING SUMMARY</u>

| Location | Date | Species | No. Captured | Size Range (mm) |
|---|---|---|---|---|
| Mac. SL. | 02-02-84 | NP | 1 | 395 |
| RK 43.3 | 02-08-84 | NP | 2 | 552-584 |
| Mac. SL. | 02-21-84 | NP | 1 | 352 |
| Sink Hole | 05-01-84 | NP | 4 | 365-433 |
| Pike Hole | 05-02-84 | NP | 20 | 346-865 |
| " | 05-02-84 | MWF | 2 | ? |
| " | 05-02-84 | CSU | 1 | ? |
| Mac. SL. | 05-04-84 | NP | 1 | 581 |
| " | 05-07-84 | NP | 3 | 386-428 |
| " | 05-07-84 | NSQ | 2 | |
| " | 05-07-84 | YP | 1 | |
| Foust SL. | 05-09-84 | NP | 1 | 569 |
| " | 05-09-84 | LWF | 2 | 488-503 |
| Pike Hole | 05-17-84 | NP | 5 | 434-692 |
| " | 05-17-84 | LWF | 1 | 544 |
| RK 32.2 | 05-31-84 | NP | 3 | 672-738 |
| Mac. SL. | 05-31-84 | NP | 2 | 415-590 |
| " | 06-08-84 | NP | 2 | 452-473 |
| " | 06-08-84 | LMB | 1 | 294 |
| " | 06-08-84 | YP | 2 | ? |
| " | 06-08-84 | CSU | 2 | ? |
| Foust SL. | 06-12-84 | LWF | 2 | 356-532 |
| " | 06-12-84 | CSU | 11 | ? |
| " | 06-12-84 | PM | 4 | ? |
| " | 06-12-84 | YP | 3 | ? |
| RK 24.9 | 06-13-84 | PM | 2 | ? |
| RK 21.9 | 06-13-84 | YP | 2 | ? |
| " | 06-13-84 | CSU | 2 | ? |
| " | 06-13-84 | NP | 1 | 688 |

## SEINE SUMMARY

| Location | Date | Species | No. Captured | Size Range (mm) |
|---|---|---|---|---|
| Buff. (RK 104.7) | 05-16-84 | YP | 5 | ? |
| Sloan's (RK 72.1) | 05-16-84 | RSS | 8 | ? |
| " | 05-16-84 | YP | 1 | ? |
| " | 05-16-84 | MWF | 1 | ? |
| RK 71.1 | 05-16-84 | SQ | 34 | ? |
| " | 05-16-84 | PS | 1 | ? |
| " | 05-16-84 | RSS | 44 | ? |
| " | 05-16-84 | CSU | 8 | ? |
| " | 05-16-84 | MWF | 3 | ? |
| " | 05-16-84 | PM | 8 | ? |
| " | 05-16-84 | YP | 3 | ? |
| Pike Hole | 05-17-84 | YP | 3 | ? |
| " | 05-17-84 | MWF | 10 | ? |
| " | 05-17-84 | CSU | 1 | ? |
| Buffalo | 05-24-84 | CSU | 3 | 420 |
| " | 05-24-84 | MWF | 3 | ? |
| " | 05-24-84 | YP | 1 | 125 |
| Mouth of LBR (RK 72.4) | 06-19-84 | RSS | 45 | ? |
| " | 06-19-84 | YP | 7 | ? |
| " | 06-19-84 | CSU | 25 | ? |
| " | 06-19-84 | PM | 5 | ? |
| " | 06-19-84 | SQ | 8 | ? |
| " | 06-19-84 | NP | 1 | 781 |
| Buff. (RK 104.7) | 07-19-84 | MWF | 2 | ? |
| " | 07-19-84 | CSU | 12 | ? |
| RK 101.8 | 07-19-84 | YP | 1 | ? |
| " | 07-19-84 | CSU | 1 | ? |
| RK 92.2 | 07-19-84 | CSU | 34 | ? |
| RK 51.6 | 08-01-84 | YP | ? | ? |
| " | 08-01-84 | RSS | ? | ? |
| " | 08-01-84 | CSU | ? | ? |
| " | 08-01-84 | SQ | ? | ? |
| " | 08-01-84 | PS | ? | ? |
| RK 71.9 | 08-09-84 | CSU | 22 | ? |

## TRAPPING SUMMARY

| Location | Date | Species | No. Captured | Size Range (mm) |
|---|---|---|---|---|
| Ferry #1 | 03-14-84 | NP | 1 | 267 |
| McDonald | 03-10-84 | NP | 1 | 413 |
| Sink Hole | 05-01-84 | NP | 1 | 273 |
| Ferry #1 | 05-01-84 | LMB | 1 | 388 |
| " | 05-11-84 | PS | 1 | ? |
| " | 05-11-84 | SQ | 1 | 7 |
| " | 05-22-84 | LMB | 1 | 7 |
| " | 06-04-84 | NP | 3 | 638-708 |
| " | 06-05-84 | NP | 3 | 656-693 |
| " | 06-05-84 | CSU | 5 | 7 |
| " | 06-05-84 | FSU | 1 | 7 |
| " | 06-06-84 | NP | 3 | 605-847 |
| " | 06-06-84 | CSU | 2 | 7 |
| " | 06-08-84 | NP | 2 | 680-793 |
| " | 06-08-84 | CSU | 1 | 7 |
| McDonald | 06-08-84 | CSU | 2 | 7 |
| " | 06-08-84 | SQ | 1 | 7 |
| Ferry #1 | 06-15-84 | NP | 4 | 468-826 |
| " | 06-15-84 | CSU | 3 | 7 |
| " | 06-22-84 | NP | 5 | 670-6[illegible] |
| " | 06-22-84 | SQ | 1 | |
| " | 06-22-84 | CSU | 1 | |

# APPENDIX B

Density and abundance of target fish species in five tributaries to the lower Flathead River.

Appendix B. Density and abundance of target fish species in five tributaries to the lower Flathead River.

| Stream | Reach No. | Species | No./100 m² F83 | No./100 m² S84 | Catch/Hour F83 | Catch/Hour S84 |
|---|---|---|---|---|---|---|
| Jocko River | 1 | Rb | - | - | 0.4 | 3.0 |
| | | LL | - | - | 1.8 | 3.0 |
| | | MWF | 2.7 | - | 9.3 | 31.0 |
| | 2 | Rb | 1.6 | - | 15.0 | - |
| | | LL | 0.3 | - | 5.0 | - |
| | | MWF | 5.9 | - | 27.0 | - |
| | 3 | Rb | 0.4 | - | 4.0 | 1.8 |
| | | LL | 0.4 | - | 6.0 | 4.6 |
| | | MWF | 2.7 | - | 14.0 | 12.9 |
| | 4 | Rb | - | 0 | 2.4 | 0 |
| | | LL | 4.4 | - | 20.8 | 4.0 |
| | | Eb | - | - | 0.8 | 1.0 |
| | | MWF | - | - | 10.0 | 16.0 |
| | 5 | LL | - | - | 1.2 | 4.0 |
| | | Eb | - | - | 5.8 | 3.0 |
| | 6 | DV | 0.3 | - | 3.0 | 2.2 |
| | | Ct | 1.9 | - | 6.0 | 5.5 |
| | | Rb | 0 | - | 0 | 1.1 |
| | | Eb | 0 | - | 0 | 2.2 |
| | 7 | DV | - | 0 | 1.0 | 0 |
| | | Ct | 2.9 | - | 7.7 | 4.0 |
| | | Eb | 1.2 | - | 4.0 | 3.0 |
| Mission Creek | 1 | Rb | - | 0 | 0.4 | 0 |
| | | MWF | - | - | 4.0 | 1.3 |
| | | Ct | 0 | - | 0 | 0.7 |
| | 2 | Rb | 1.3 | 1.4 | 6.0 | 8.8 |
| | | LL | - | - | 0.8 | 0.7 |
| | | MWF | - | - | 2.0 | 2.7 |
| | 3 | Rb | 57.0 | 34.6 | 94.0 | 63.4 |
| | | Eb | 45.2 | 28.0 | 62.5 | 38.6 |
| | 4 | Rb | 9.5 | 9.1 | 23.5 | 21.0 |
| | | Eb | 27.9 | 27.3 | 66.8 | 54.7 |
| | 5 | Rb | 10.9 | 3.2 | 16.8 | 11.5 |
| | | Eb | 20.3 | 4.8 | 44.0 | 20.3 |
| Post Creek | 1 | Rb | 4.5 | 2.1 | 13.5 | 15.0 |
| | | Eb | - | - | 1.0 | 1.8 |
| | | LL | 0 | - | 0 | 0.6 |
| | | MWF | 9.9 | 2.0 | 26.9 | 13.8 |
| | 2 | Ct | 0 | - | 0 | 0.4 |
| | | Rb | 25.7 | 19.8 | 66.4 | 41.6 |
| | | LL | - | - | 0.4 | 3.4 |
| | | Eb | 0.2 | 2.9 | 1.6 | 6.9 |
| | | MWF | 3.5 | 3.9 | 9.2 | 17.6 |
| | 3 | Rb | - | 1.8 | 4.7 | 7.1 |
| | | LL | - | 0 | 1.3 | 0 |
| | | Eb | - | 24.9 | 60.7 | 85.6 |
| | | MWF | - | 0 | 2.0 | 0 |
| | 4 | Ct | - | - | 0.6 | 0.3 |
| | | Rb | - | 3.1 | 37.7 | 10.2 |
| | | Eb | - | 1.6 | 14.3 | 5.4 |
| Crow Creek | 1 | Rb | 4.6 | 4.3 | 9.2 | 19.7 |
| | | LL | - | 0 | 0.3 | 0 |
| | | Eb | 0 | 0.1 | 0 | 1.4 |
| | | MWF | 9.9 | - | 17.8 | 0.7 |
| Little Bitterroot R. | 1 | MWF | 0 | - | 0 | 3.8 |
| | 2 | - | - | - | - | - |
| | 3 | NP | 1.1 | 2.0 | 5.1 | 13.0 |
| | 4 | NP | - | 0 | 3.0 | 0 |
| | 5 | Ct | 1.6 | 5.2 | 7.8 | 10.3 |
| | | Rb | 0.6 | 0 | 2.1 | 0 |
| | | Eb | 16.5 | 16.5 | 48.8 | 65.0 |

# APPENDIX C

Summary of electrofishing and trapping data collected on five tributaries to the lower Flathead River during FY84.

ELECTROFISHING

JOCK0 RIVER

| Location (stream km) | Date | Species | NO. | Size Range (mm) |
|---|---|---|---|---|
| 3.2. | 10-21 -83 | MWF | 15 | 278-428 |
| " | 10-21-83 | LL | 3 | 103-121 |
| " | 11-04-83 | MWF | 6 | 224-325 |
| " | 11-04-83 | Rb | 1 | 473 |
| " | 11-04-83 | LL | 1 | 416 |
| " | 11-21-83 | LL | 2 | 111-347 |
| " | 11-21-83 | MWF | 8 | 277-337 |
| 10.4 | 10-20-83 | MWF | 33 | 208-380 |
| " | 10-20-83 | Rb | 8 | 78-336 |
| " | 10-20-83 | LL | 6 | 91-138 |
| " | 11-03-83 | MWF | 21 | 293-398 |
| " | 11-03-83 | LL | 4 | 102-141 |
| " | 11-03-83 | Rb | 22 | 71-112 |
| 18.5 | 10-20-83 | MWF | 6 | 249-389 |
| " | 10-20-83 | LL | | 110-409 |
| " | 10-20-83 | Rb | 4 | 79-94 |
| " | 11-03-83 | MWF | 22 | 205-384 |
| " | 11-03-83 | LL | 9 | 81-542 |
| " | 11-03-83 | Rb | 4 | 66-96 |
| 23.2 | 10-19-83 | MWF | 12 | 287-429 |
| " | 10-19-83 | LL | 25 | 90-470 |
| " | 10-19-83 | Eb | 1 | 105 |
| " | 11-02-83 | MWF | 13 | 284-400 |
| " | 11-02-83 | LL | 27 | N-187 |
| " | 11-02-83 | ES | 1 | 112 |
| " | 11-02-83 | Rb | 6 | 76-93 |
| 36.8 | 10-19-83 | Eb | 7 | 86-260 |
| " | 11-02-83 | Eb | 3 | 88-103 |
| " | 11-02-83 | LL | 1 | 301 |
| " | 11-15-63 | Eb | 4 | 91-174 |
| " | 11-15-83 | LL | 2 | 91-202 |
| 45.2 | 10-18-83 | Ct | 7 | 99-229 |
| " | 10-18-83 | DV | 5 | 138-231 |
| " | 11-01-83 | DV | 4 | 139-292 |
| " | 11-01-83 | Ct | 11 | 97-238 |
| 52.1 | 10-18-83 | Ct | 6 | 114-210 |
| " | 10-18-83 | Eb | 4 | 80-208 |
| " | 11-01-83 | Eb | 6 | 140-223 |
| " | 11-01-83 | Ct | 7 | 101-222 |
| " | 11-15-83 | Ct | 10 | 73-210 |
| " | 11-15-83 | Eb | 2 | 174-225 |
| " | 11-15-83 | DV | 2 | 133-216 |

JOCKO RIVER (continued)

| Location (stream km) | Date | Species | No. | Size Range (mm) |
|---|---|---|---|---|
| 3.2 | 04-12-84 | Rb | 3 | 384-440 |
| " | 04-12-84 | LL | 3 | 141-470 |
| " | 04-12-84 | MWF | 27 | 221-490 |
| 18.5 | 05-11-84 | MWF | 14 | 241-433 |
| " | 05-11-84 | Rb | 2 | 97-136 |
| " | 05-11-84 | LL | 5 | 101-434 |
| 23.2 | 05-10-84 | MWF | 16 | 233-405 |
| " | 05-10-84 | LL | 4 | 123-445 |
| " | 05-10-84 | Eb | 1 | 112 |
| 36.8 | 05-10-84 | LL | 4 | 108-398 |
| " | 05-10-84 | Eb | 3 | 104-120 |
| 45.2 | 05-09-84 | Ct | 5 | 103-208 |
| " | 05-09-84 | Rb | 1 | 84 |
| " | 05-09-84 | DV | 2 | 117-153 |
| " | 05-09-84 | Eb | 2 | 85-100 |
| 52.1 | 05-09-84 | Ct | 4 | 95-218 |
| " | 05-09-84 | Eb | 3 | 148-209 |

MISSION CREEK

| Location (stream km) | Date | Species | No. | Size Range (mm) |
|---|---|---|---|---|
| 2.6 | 10-14-83 | MWF | 7 | 138-339 |
| " | 10-28-83 | MWF | 2 | 247-260 |
| 10.8 | 11-10-83 | MWF | 2 | 340-360 |
| " | 11-10-83 | Rb | 8 | 79-464 |
| " | 11-23-83 | Rb | 7 | 103-455 |
| " | 11-23-83 | LL | 1 | 128 |
| " | 11-23-83 | MWF | 3 | 279-359 |
| 17.4 | 10-25-83 | Rb | 101 | 76-300 |
| " | 10-25-83 | Eb | 72 | 77-270 |
| " | 11-10-83 | Eb | 95 | 76-294 |
| " | 11-10-83 | Rb | 149 | 66-280 |
| 24.0 | 10-26-83 | Rb | 21 | 100-282 |
| " | 10-26-83 | Eb | 38 | 84-190 |
| " | 11-08-83 | Eb | 107 | 71-194 |
| " | 11-08-83 | Rb | 30 | 67-265 |
| " | 11-23-83 | Eb | 25 | 60-195 |
| " | 11-23-83 | Rb | 7 | 66-153 |
| 25.3 | 10-27-83 | Eb | 67 | 63-184 |
| " | 10-27-83 | Rb | 26 | 55-171 |
| " | 11-09-83 | Eb | 43 | 67-165 |
| " | 11-09-83 | Rb | 16 | 74-156 |
| 2.6 | 04-06-84 | MWF | 1 | 248 |
| 10.8 | 04-05-84 | Rb | 7 | 152-465 |

## MISSION CREEK (continued

| Location (stream Km ) | Date | Species | No. | Size Range (mm |
|---|---|---|---|---|
| 10.8 | 04-05-84 | MWF | 2 | 348-403 |
| " | 04-16-84 | Rb | 6 | 105-405 |
| " | 04-16-84 | LL | 1 | 159 |
| " | 04-16-84 | Ct | 1 | 267 |
| " | 04-16-84 | MWF | 2 | 345-348 |
| 17.4 | 04-04-84 | Rb | 152 | 64-288 |
| " | 04-04-84 | ES | 114 | 78-279 |
| " | 04-11-84 | Rb | 56 | 82-249 |
| " | 04-11-84 | Eb | 56 | 78-240 |
| 24.0 | 03-23-84 | Rb | 29 | 66-264 |
| " | 03-23-84 | Eb | 86 | 78-261 |
| " | 03-30-84 | Rb | 17 | 92-268 |
| " | 03-30-84 | Eb | 88 | 79-193 |
| 25.3 | 03-22-84 | Rb | 21 | 63-275 |
| " | 03-22-84 | ES | 41 | 74-214 |
| " | 03-29-84 | Rb | 7 | 89-188 |
| " | 03-29-84 | Eb | 4 | 84-163 |

## POST CREEK

| | | | | |
|---|---|---|---|---|
| 1.8 | 11-14-83 | Rb | 14 | 95-360 |
| " | 11-14-83 | Eb | 1 | 300 |
| " | 11-14-83 | MWF | 38 | 118-404 |
| " | 11-28-83 | MWF | 18 | 216-375 |
| " | 11-28-83 | Eb | 1 | 350 |
| " | 11-28-84 | Rb | 14 | 87-320 |
| 6.8 | 11-16-83 | Rb | 101 | 70-420 |
| " | 11-16-83 | MWF | 16 | 122-378 |
| " | 11-16-83 | LL | 1 | 116 |
| " | 11-16-83 | Eb | 1 | 326 |
| " | 11-29-83 | Rb | 65 | 77-505 |
| " | 11-29-83 | Eb | 3 | 122-324 |
| " | 11-29-83 | MWF | 7 | 280-345 |
| 13.7 | 11-16-83 | Eb | 91 | 78-245 |
| " | 11-16-83 | Rb | 7 | 87-220 |
| " | 11-16-83 | LL | 1 | 232 |
| " | 11-16-53 | MWF | 3 | 112-123 |
| 16.9 | 11-17-83 | Rb | 66 | 70-345 |
| " | 11-17-83 | Eb | 25 | 78-298 |
| " | 11-17-83 | Ct | 1 | 185 |
| 1.8 | 04-02-84 | MWF | 13 | 127-404 |
| " | 04-02-84 | Rb | 8 | 98-359 |
| " | 04-02-84 | Eb | 1 | 218 |

## POST CREEK (continued)

| Location (stream km) | Date | Species | No. | Size Range (mm) |
|---|---|---|---|---|
| " | 04-13-84 | MWF | 10 | 151-420 |
| " | 04-13-84 | Rb | 17 | 93-213 |
| " | 04-13-84 | LL | 1 | 143 |
| " | 04-13-84 | Eb | 2 | 163-184 |
| 6.8 | 03-27-84 | MWF | 25 | 281-375 |
| " | 03-27-84 | Rb | 51 | 85-405 |
| " | 03-27-84 | LL | 4 | 130-152 |
| " | 03-27-84 | Eb | 8 | 85-238 |
| " | 04-03-84 | MWF | 8 | 137-350 |
| " | 04-03-84 | Rb | 42 | 77-417 |
| " | 04-03-84 | LL | 4 | 122-269 |
| " | 04-03-84 | Eb | 6 | 89-209 |
| " | 04-03-84 | Ct | 1 | 310' |
| 13.7 | 03-21-84 | ES | 94 | 63-294 |
| " | 03-21-84 | Rb | 6 | 88-260 |
| " | 03-29-84 | Rb | 4 | 78-180 |
| " | 03-28-84 | Eb | 30 | 77-197 |
| 16.9 | 03-19-84 | Rb | 26 | 83-381 |
| " | 03-19-84 | Ct | 1 | 255 |
| " | 03-19-84 | Eb | 11 | 90-293 |
| " | 03-26-84 | Rb | 11 | 132-214 |
| " | 03-26-84 | Eb | 9 | 79-236 |

## CROW CREEK

| | | | | |
|---|---|---|---|---|
| 4.8 | 10-17-83 | MWF | 30 | 151-187 |
| " | 10-17-83 | Rb | 14 | 105-170 |
| " | 10-31-83 | MWF | 13 | 158-192 |
| " | 10-31-83 | Rb | 8 | 111-161 |
| " | 11-14-83 | MWF | 15 | 174-375 |
| " | 11-14-83 | Rb | 11 | 120-343 |
| " | 11-14-83 | LL | 1 | 307 |
| 4.8 | 04-10-84 | Rb | 21 | 126-351 |
| " | 04-10-84 | Eb | 1 | 210 |
| " | 04-10-84 | MWF | 1 | 309 |
| " | 04-16-84 | Eb | 1 | 209 |
| " | 04-16-84 | Rb | 7 | 123-358 |

## LITTLE BITTERROOT RIVER

| | | | | |
|---|---|---|---|---|
| 45.9 | 10-10-83 | NP | 5 | 267-515 |
| " | 10-24-83 | NP | 2 | 213-448 |
| " | 11-22-83 | NP | 3 | 225-304 |

LITTLE BITTERROOT RIVER (continued)

| Location (stream km) | Date | Species | No. | Size Range (mm) |
|---|---|---|---|---|
| " | 11-22-83 | NP | 4 | 223-304 |
| 61.3 | 15-12-83 | NP | 1 | 290 |
| 77.2 | 10-1 3-83 | Eb | 65 | 65-260 |
| " | 10-13-83 | Ct | 12 | 116-260 |
| " | 10-13-83 | Rb | 4 | 67-179 |
| " | 10-24-83 | Rb | 3 | 110-154 |
| " | 10-24-83 | Eb | 56 | 80-246 |
| " | 10-24-83 | Ct | 9 | 114-275 |
| " | 11-07-83 | Eb | 103 | 64-215 |
| " | 11-07-83 | Ct | 15 | 60-238 |
| " | 11-07-83 | Rb | 2 | 60-111 |
| 2.1 | 04-17-84 | MWF | 2 | 143-151 |
| 45.9 | 04-27-84 | NP | 7 | 241-538 |
| " | 05-04-84 | NP | 5 | 202-410 |
| 77.2 | 05-01-84 | Eb | 87 | 74-253 |
| " | 05-01-84 | Ct | 15 | 69-205 |
| " | 05-01-84 | RbxCt | 1 | 241 |
| " | 05-W-84 | Eb | 84 | 70-194 |
| " | 05-08-84 | Ct | 11 | 63-1 97 |

# TRAPPING

## LITTLE BITTERROOT RIVER

| Location (stream km) | Date | Species | No. | Size Range (mm) |
|---|---|---|---|---|
| 2.c | 04-23-84 | NP | 1 | 640 |
| " | 04-25-84 | NP | 1 | 557 |
| 60.0 | 04-25-84 | NP | 1 | 420 |
| " | 05-01-84 | NP | 4 | 455-492 |
| " | 05-31-84 | NP | 2 | 320-330 |
| " | 06-18-84 | NP | 3 | 336-535 |
| " | 06-26-84 | NP | 3 | 359-457 |
| " | 07-03-84 | NP | 5 | 453-504 |
| " | 07-11-84 | NP | 4 | 248-366 |

## JOCKO RIVER WEIR

| Location (stream km) | Date | Species | No. | Size Range (mm) |
|---|---|---|---|---|
| 2.0 | 03-16-84 | MWF | 1 | 375 |
| " | 03-20-84 | Rb | 1 | 640 |
| " | 03-21-84 | Rb | 10 | 405-489 |
| " | 03-21-84 | MWF | 10 | 322-387 |
| " | 03-22-84 | MWF | 1 | 348 |
| " | 03-23-84 | MWF | 2 | 335-395 |
| " | 03-25-84 | MWF | 3 | 335-385 |
| " | 03-25-84 | Rb | 2 | 355-398 |
| " | 03-28-84 | MWF | 1 | 308 |
| " | 03-28-84 | Rb | 1 | 457 |
| " | 03-30-84 | Rb | 1 | 378 |
| " | 04-01-84 | MWF | 1 | 250 |
| " | 04-01-84 | Rb | 2 | 358-475 |
| " | 04-03-84 | MWF | 3 | 332-417 |
| " | 04-06-84 | Rb | 1 | 464 |
| " | 04-06-84 | MWF | 1 | 378 |
| " | 04-09-84 | MWF | 1 | 370 |
| " | 04-10-84 | MWF | 1 | 346 |
| " | 04-11-84 | MWF | 1 | 332 |
| " | 04-13-84 | MWF | 1 | 377 |
| " | 04-14-84 | MWF | 2 | 332-344 |
| " | 04-14-84 | Rb | 3 | 388-438 |
| " | 04-15-84 | MWF | 1 | 345 |
| " | 04-17-84 | MWF | 1 | 328 |
| " | 04-17-84 | Rb | 1 | 435 |
| " | 04-17-84 | LL | 1 | 400 |
| " | 04-18-84 | MWF | 6 | 317-394 |
| " | 04-18-84 | Rb | 3 | 365-451 |
| " | 04-19-84 | MWF | 2 | 330-416 |
| " | 04-22-84 | Rb | | 437 |

## JOCKO RIVER WEIR (cont.)

| Location (stream km) | Date | Species | No. | Size Range (mm) |
|---|---|---|---|---|
| 2.0 | 04-23-84 | MWF | 51 | 300-390 |
| " | 04-23-84 | Rb | 1 | 409 |
| " | 04-24-84 | MWF | 24 | 306-406 |
| " | 04-28-84 | MWF | 3 | 316-342 |
| " | 04-29-84 | MWF | 1 | 355 |
| " | 04-29-84 | LL | 1 | 386 |
| " | 04-30-84 | MWF | 7 | 332-369 |
| " | 05-05-84 | MWF | 1 | 335 |
| " | 05-06-84 | MWF | 1 | 307 |
| " | 05-08-84 | MWF | 7 | 330-377 |
| " | 05-08-84 | Rb | 1 | 397 |
| " | 05-14-84 | MWF | | 361 |
| " | 05-15-84 | MWF | 6 | 325-377 |
| " | 07-22-84 | MWF | 1 | 375 |
| " | 07-28-84 | Rb | 1 | 417 |
| " | 07-30-84 | MWF | 2 | 290-346 |
| " | 08-03-84 | MWF | 2 | 310-325 |
| " | 08-05-84 | MWF | [illegible] | 310 |
| " | 08-10-84 | MWF | 2 | 301-304 |
| " | 08-13-84 | MWF | 2 | 343-376 |
| " | 08-13-84 | LL | 1 | 620 |
| " | 08-22-84 | LL | 1 | 562 |
| " | 08-25-84 | MWF | 1 | 323 |
| " | 08-26-84 | LL | 1 | 449 |
| " | 08-26-84 | MWF | 1 | 313 |
| " | 08-30-84 | MWF | 1 | 360 |
| " | 08-30-84 | LL | 1 | 385 |
| " | 08-31-84 | MWF | 1 | 322 |
| " | 09-02-84 | LL | 1 | 618 |
| " | 09-03-84 | MWF | 1 | 310 |
| " | 09-03-84 | LL | 1 | 469 |
| " | 09-04-84 | LL | 2 | 579-605+ |
| " | 09-04-84 | MWF | 1 | 343 |
| " | 09-05-84 | MWF | 1 | 324 |
| " | 09-05-84 | LL | 1 | 524 |
| " | 09-18-84 | LL | 1 | 561 |
| " | 09-20-84 | MWF | 1 | 318 |
| " | 09-21-84 | MWF | 1 | ? |
| " | 09-22-84 | MWF | 1 | 350 |
| " | 09-23-84 | MWF | 2 | 289-327 |

## MISSION CREEK WEIR

| Location (stream km) | Date | Species | No. | Size Range (mm) |
|---|---|---|---|---|
| 6.0 | 03-12-84 | MWF | 4 | 353-406 |
| " | 03-12-84 | Rb | 4 | 375-480 |
| " | 03-14-84 | Rb | 1 | 446 |
| " | 03-16-84 | Rb | 1 | 410 |
| " | 03-18-84 | Rb | 2 | 380-405 |
| " | 03-22-84 | Rb | 3 | 372-574 |
| " | 03-25-84 | MWF | 1 | 307 |
| " | 03-27-84 | Rb | 1 | 499 |
| " | 03-30-84 | Rb | 1 | 440 |
| " | 03-30-84 | MWF | 1 | 328 |
| " | 03-31-84 | Rb | 1 | 370 |
| " | 04-01-84 | MWF | 1 | 377 |
| " | 04-02-84 | MWF | 1 | 325 |
| " | 04-02-84 | Rb | 1 | 425 |
| " | 04-03-84 | MWF | 1 | 345 |
| " | 04-04-84 | Rb | 2 | 371-425 |
| " | 04-06-84 | Rb | 1 | 404 |
| " | 04-08-84 | Rb | 2 | 377-397 |
| " | 04-08-84 | MWF | 1 | 305 |
| " | 04-09-84 | Rb | 1 | 454 |
| " | 04-09-84 | MWF | 13 | 358-549 |
| " | 04-11-84 | Rb | 1 | 369 |
| " | 04-13-84 | MWF | 1 | 345 |
| " | 04-14-84 | MWF | 1 | 338 |
| " | 04-15-84 | MWF | 2 | 325-327 |
| " | 04-16-84 | MWF | 2 | 338-375 |
| " | 04-17-84 | MWF | 2 | 316-323 |
| " | 04-18-84 | MWF | 1 | 353 |
| " | 04-23-84 | Rb | 1 | 438 |
| " | 04-24-84 | Rb | 1 | 364 |
| " | 04-25-84 | MWF | 1 | 363 |
| " | 04-25-84 | DV | 1 | 423 |
| " | 04-26-84 | MWF | 1 | 375 |
| " | 04-26-84 | Rb | | 330 |
| " | 04-29-84 | LL | 1 | 343 |
| " | 05-01-84 | RbxCt | 1 | 390 |
| " | 05-04-84 | MWF | 2 | 296-338 |
| " | 05-09-84 | Rb | 1 | 355 |
| " | 05-13-84 | MWF | 1 | 326 |
| " | 05-16-84 | MWF | 1 | 358 |
| " | 07-12-84 | MWF | 1 | 309 |
| " | 07-13-84 | Rb | 1 | 355 |
| " | 07-14-84 | MWF | 3 | 309-370 |
| " | 07-15-84 | MWF | 1 | 356 |
| " | 07-17-84 | Rb | 1 | 378 |
| " | 07-17-84 | MWF | 2 | 359-408 |

## MISSION CREEK WEIR (cont.)

| Location (stream km) | Date | Species | No. | Size Range (mm) |
|---|---|---|---|---|
| 6.0 | 07-18-84 | MWF | 1 | 320-321 |
| " | 07-19-84 | MWF | 2 | 318-320 |
| " | 07-20-84 | MWF | 1 | 391 |
| " | 07-21-84 | MWF | 2 | 348-385 |
| " | 07-21-84 | LL | 1 | 355 |
| " | 07-22-84 | MWF | 1 | 365 |
| " | 07-24-84 | DV | 1 | 359 |
| " | 07-25-84 | LL | 1 | 334 |
| " | 07-25-84 | MWF | 6 | 320-400 |
| " | 07-26-84 | MWF | 1 | 310 |
| " | 07-27-84 | MWF | 2 | 330-347 |
| " | 07-28-84 | MWF | 3 | 315-340 |
| " | 07-29-84 | MWF | 1 | 369 |
| " | 07-30-84 | MWF | 8 | 306-424 |
| " | 08-01-84 | MWF | 2 | 357-371 |
| " | 08-02-84 | MWF | 1 | 365 |
| " | 08-02-84 | Rb | 1 | 368 |
| " | 08-02-84 | LL | 1 | 505 |
| " | 08-04-84 | MWF | 3 | 300-361 |
| " | 08-06-84 | MWF | 2 | 320-349 |
| " | 08-08-84 | MWF | 1 | 361 |
| II | 08-11-84 | MWF | 1 | 340 |
| " | 08-13-84 | MWF | 2 | 313-334 |
| " | 08-14-84 | MWF | 5 | 351-406 |
| " | 08-16-84 | MWF | 6 | 329-356 |
| " | 08-17-84 | MWF | 3 | 340-404 |
| " | 08-18-84 | MWF | 3 | 315-362 |
| " | 08-1[illegible]-84 | MWF | 2 | 332-333 |
| " | 08-21-84 | MWF | 1 | 355 |
| " | 08-22-84 | MWF | 1 | 333 |
| " | 08-23-84 | MWF | 4 | 244-376 |
| " | 08-27-84 | MWF | 3 | 325-345 |
| " | 08-28-84 | MWF | 1 | 305 |
| " | 08-29-84 | MWF | 2 | 311-337 |
| " | 08-30-84 | MWF | 1 | 357 |
| " | 08-[illegible]1-84 | MWF | 14 | 305-380 |
| " | 09-02-84 | MWF | 14 | 303-385 |
| " | 09-03-84 | MWF | 6 | 306-351 |
| " | 09-05-84 | MWF | 5 | 325-375 |
| " | 09-06-84 | MWF | 2 | 304-361 |
| " | 09-07-84 | [illegible] | 3 | 314-348 |
| " | 09-08-84 | MWF | 2 | 329-354 |
| " | 09-09-84 | MWF | 8 | 313-357 |
| " | 09-11-84 | MWF | 3 | 330-334 |
| " | 09-13-84 | MWF | 1 | 334 |
| " | 09-14-84 | MWF | 20 | 308-366 |

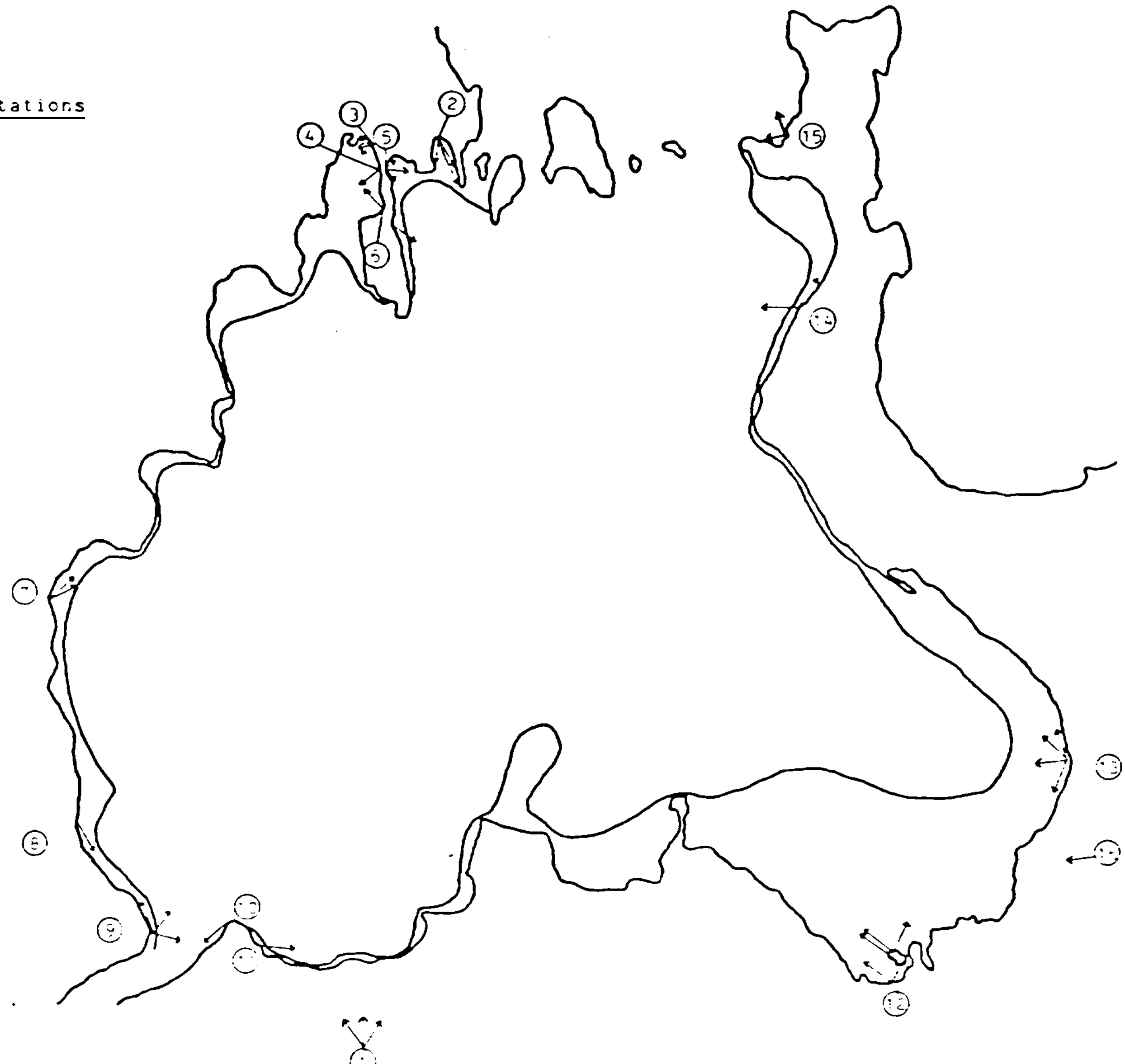
## MISSION CREEK WEIR (cont.)

| Location (stream km) | Date | Species | NO. | Size Range (mm) |
|---|---|---|---|---|
| 6.3 | 09-15-84 | MWF | 8 | 325-375 |
| " | 09-16-84 | MWF | 16 | 312-367 |
| " | 09-17-84 | MWF | 7 | 313-396 |
| " | 09-18-84 | MWF | 3 | 336-345 |
| " | 09-19-84 | MWF | 3 | ? |
| " | 09-20-84 | MWF | 8 | 296-362 |
| " | 09-20-84 | Rb | 1 | 449 |
| " | 09-21-84 | MWF | 11 | 311-386 |
| " | 09-22-84 | MWF | 5 | 331-364 |
| " | 09-24-84 | MWF | 1 | 298 |
| " | 09-25-84 | MWF | 1 | 338 |
| " | 09-26-84 | MWF | 3 | 300-303 |
| " | 09-27-84 | MWF | 3 | 305-353 |
| " | 09-27-84 | Rb | 2 | 349-404 |
| " | 09-28-84 | MWF | 14 | 313-363 |
| " | 09-29-84 | MWF | 2 | 324-337 |

# APPENDIX D

Monthly photo stations on South Bay, Flathead Lake.

Photo Stations



## PHOTO STATIONS - SOUTH BAY

1) Relay Station on Skyline Drive

Photographer's location: northeast corner of relay station fenced in area

Photo reference:

a. Polson bridge at left side of view
b. center on the Narrows; overlap with a.
c. center on Bird Point, include southern boundary of East Bay; overlap with b.

2) Lansing Point at the end of public road

Photographer's location: near large log above high water zone

Photo reference:

a. center on right hand point and corner of log wall
b. center on end of Lansing Point
c. center on nearest boat dock to left, include high water area

3) Kings Point Overlook north of road at last curve before causeway

Photographer's location: on ledge overlook; maximize view of Stone Quarry Bay

Photo reference:

a. include northern shore of Stone Quarry Bay
b. view west across bay, overlap with a.
c. center on Wolf Point, overlap with b.

4) Kings Point Causeway (West)

Photographer's location: high water mark at northern end of causeway, near turnout area

Photo reference:

a. center on Wolf Point, include as much foreground as possible

5) Kings Point Causeway (East)

Photographer's location: high water mark at northern end of causeway, near corner of retaining wall

Photo reference:

a. along retaining wall, include northern high water mark
b. center on corner of dock with gas pump
c. include east side of causeway, overlap with b

6) Maletta Residence

Photographer's location

a. highwater mark on shore facing NNW
b. over top rail of second fence section north of Malletta gate

Photo reference:

a. center on northern end of Stone Quarry Bay, include high water zone in foreground
b. center on small bay in foreground

7) Rocky Point Road I - first turnout south of stream gulley
Photographer's location: from vehicle parked in turnout
Photo reference:
a. northwestern shoreline in left of view
b. thru mouth of bay, permanent island at left of view; overlap with a

8) Rocky Point Road II - first turnout north from route 93
Photographer's location: from concrete steps approx. 25 yards NE from turnout; near cedar
Photo reference: center on SW shoreline and bridge

9) Polson Bridge
Photographer's location: west end of bridge on rock outcrop
Photo reference:
a. NW along shore
b. towards the Narrows; include shoals at minimum lake elevations
c. along northern edge of bridge

10) City Dock
Photographer's location: corner of retaining wall, under street lamp
Photo reference: SW along shore towards Polson bridge

11) Tribal Landing
Photographer's location: entrance to tribal landing and dock
Photo reference: along southern shore towards retirement community

12) Ducharme Point
Photographer's location
a. & b. at cable gateway onto point
c. SW corner of terminal parking area
d. NW corner of terminal parking area
e. SE corner of terminal parking area
Photo reference:
a. center on Bird Point with gatepost to right
b. towards eastshore with gatepost to left
c. Bird Point, with south-facing wall to right
d. Bird Point, with two most NW pilings in foreground
e. center on duck blind (NE) towards east shore

13) Route 35 Turnout just north of KOA campground
Photographer's location: end of path at high water mark
Photo reference:
a. facing NNW with highwater mark to right
b. towards westernmost portion of Finley Point
c. center on Bird Point
d. SSW with highwater mark to left

14) Finley Point State Park

Photographer's location: northern shoreline where retaining wall meets pine trees

Photo reference:

a. view east with corner pilings in foreground
b. view NE towards yellow cabin with highwater mark to right

15) Finley Point Marina at boat ramp

Photographer's location: (see below)

Photo reference:

a. down boat ramp from above, near store corner
b. towards boat ramp thru docking area
c. NNW across face of ledge from elbow in dock
d. boat ramp from end of dock
e. Narrows from corner on north side of boat ramp
f. Narrows, between trees and store over beach area

16) Hell Roaring overlook

Photographer's location: at edge of road between two large pines, across from Morigeau residence

Photo reference:

a. place southern margin of East Bay at left margin of view finder

Note: All photos should include the high water mark where possible

# APPENDIX E

Habitat variables potentially important to target fish species in South Bay, Flathead Lake.

| Species | Habitat Variables | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % littoral area | % cover in littoral area | total dissolved solids | % area ≤ 6 m deep | % bottom cover | water level fluctuation | % vegetation | dissolved oxygen | temperature | pH | turbidity | salinity | degree days | frost-free days | substrate | spawning-summer habitat | trophic status |
| yellow perch | X | X | | | | | | X | X | X | | | X | | | | X |
| largemouth bass | | | X | X | X | X | | X | X | X | X | X | | | X | | |
| northern pike | | | X | | | X | X | | X | X | | | | X | | X | |
| lake whitefish | No SI curves available | | | | | | | | | | | | | | | | |

General habitat variables for which published suitability index (SI) models are available. (See USFWS publications for specific variable definitions).

# APPENDIX F

Sample dive slates and habitat evaluation data sheets.

## Observer-recorder relay slate

YP  Lwf  DV  Lmb  NP  Ot

J  A

1 digit:

1 2 3 4 5 6 7 8 9 0

2 digit:

1 2 3 4 5 6 7 8 9 0

### Use

Species, life stage, and number of fish observed are relayed from the observer to the recorder by pointing to the appropriate codes and digits.

# Dive Slate

| SUBSTRATE | | | VEGETATION | | | COVER | | |
|---|---|---|---|---|---|---|---|---|
| Time | Code | Fish | Time | Code | Fish | Time | Code | Fish |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

## HABITAT EVALUATION CODES

**Substrate Size(mm)**

1 - silt (< 0.06)
2 - sand (0.06-2)
3 - gravel (2-60)
4 - cobble (60-250)
5 - boulder/(250)
bedrock

**Vegetation**

1 - *Chara*
2 - *Myriophyllum*
3 - *Potamogeton*

**Fish**

YP - yellow perch
LWF - lake whitefish
LMB - largemouth bass
NP - northern pike
DV - bull trout
CT - cutthroat trout
Rb - rainbow trout
KOK - kokanee

A - adult
J - juvenile

## HABITAT EVALUATION

Date__________ Time__________ Investigators__________ Lake Elevation__________

Transect No./Location__________ Transect Zero Pt.__________ Dive No.__________

Weather: air temp.__________ surface water temp.__________ sky__________

wind direction__________ velocity__________ wave height__________

Water Depth__________ Secchi Depth__________ Diver Visibility__________ Habitat Type__________

Comments__________

| SUBSTRATE | | | | | | VEGETATION | | | | | OTHER COVER | | | | | TOTAL FISH COUNT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TRANSECT TIME OR LENGTH | SILT | SAND | GRAVEL | COBBLE | BOULDER/BEDROCK | TRANSECT TIME OR LENGTH | CHARA | MYRIOPHYLLUM | POTAMOGETON | OTHER | TRANSECT TIME OR LENGTH | FLOODED VEGETATION | LOGS, STUMPS, BRUSH, DEBRIS | ROCKS, PILINGS | BOULDERS | LIFE STAGE | YELLOW PERCH | LAKE WHITEFISH | LARGEMOUTH BASS | NORTHERN PIKE | [illegible] |
| | | | | | | | | | | | | | | | | A | | | | | |
| | | | | | | | | | | | | | | | | J | | | | | |
| | | | | | | | | | | | | | | | | A | | | | | |
| | | | | | | | | | | | | | | | | J | | | | | |
| | | | | | | | | | | | | | | | | A | | | | | |
| | | | | | | | | | | | | | | | | J | | | | | |
| | | | | | | | | | | | | | | | | A | | | | | |
| | | | | | | | | | | | | | | | | J | | | | | |
| | | | | | | | | | | | | | | | | A | | | | | |
| | | | | | | | | | | | | | | | | J | | | | | |

# APPENDIX G

Sample water quality data sheet.

WATER QUALITY

Date__________ Time__________ Investigators__________ Lake Elevation__________

Station____________________ Habitat type____________________

Wave height __________ Depth__________ Secchi depth__________

Weather: air temp.____________________ sky____________________

wind direction____________________ velocity____________________

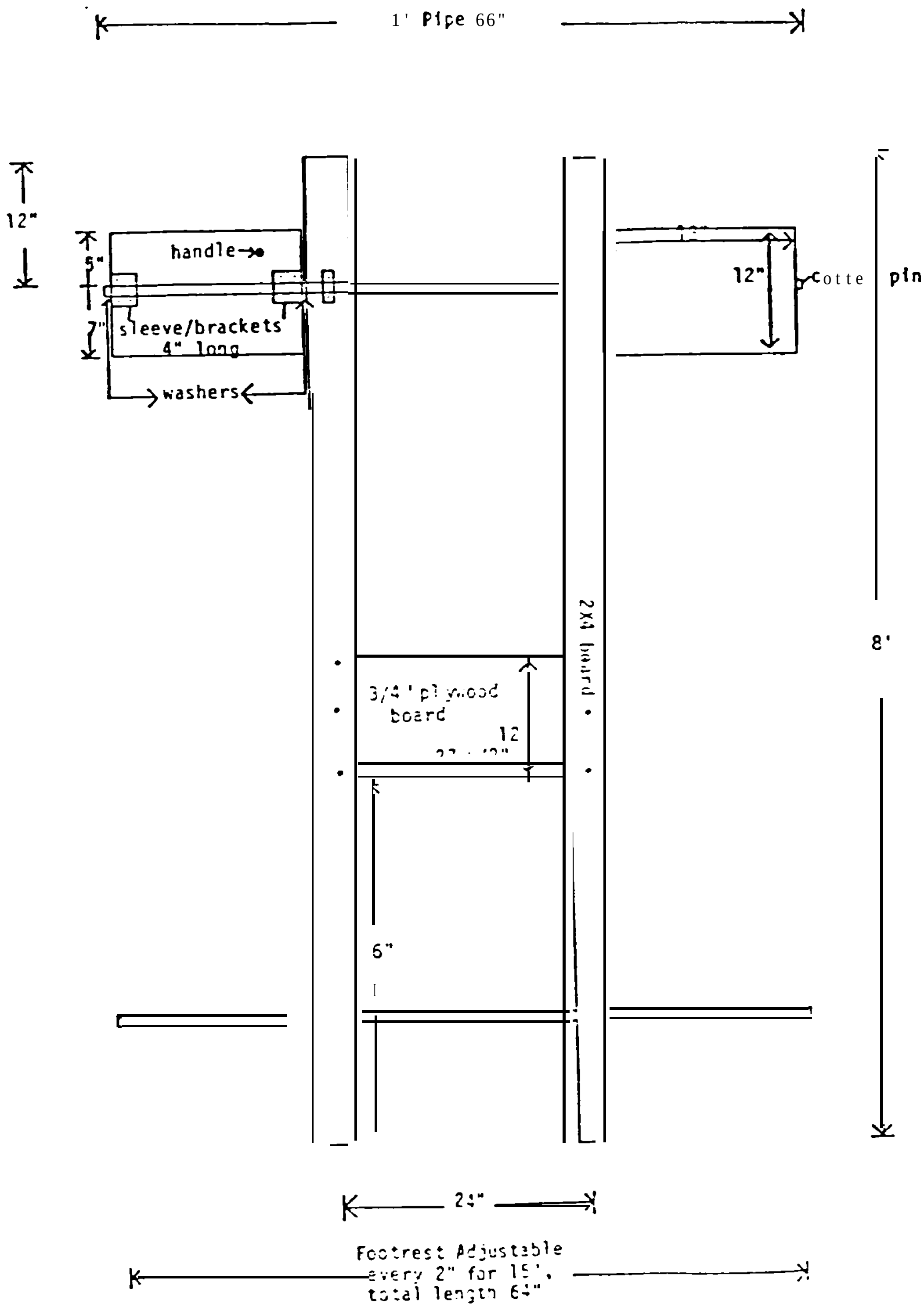
Comments________________________________________

| Depth | Water quality measurement | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Temperature | Dissolved oxygen | pH | Alkalinity | Specific conductance | TDS | Turbidity | |
| Surface | | | | | | | | |
| 1.0 | | | | | | | | |
| 2.0 | | | | | | | | |
| 3.0 | | | | | | | | |
| 4.0 | | | | | | | | |
| 5.0 | | | | | | | | |
| 6.0 | | | | | | | | |
| 7.0 | | | | | | | | |
| 8.0 | | | | | | | | |
| 9.0 | | | | | | | | |
| 10.0 | | | | | | | | |
| 11.0 | | | | | | | | |
| 12.0 | | | | | | | | |
| 13.0 | | | | | | | | |
| 14.0 | | | | | | | | |
| 15.0 | | | | | | | | |

APPENDIX H

Two man dive sled for underwater survey.

TWO MAN DIVE SLED



# APPENDIX I

Water quality measurements for South Bay, Flathead Lake.

Appendix . Mean values for water quality measurements for two subareas of South Bay, Flathead Lake (1984). (std. dev. in parentheses)

| | Surface | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Polson Bay (I) | | | | | East Bay (II) | | | | |
| Date | Temp. | D.O. | Cond. | pH | n | Temp. | D.O. | Cond. | pH | n |
| April 16 | 6.48 (1.75) | 12.48 (0.21) | 173.5 (2.08) | 8.58 (0.05) | 4 | ----- ----- | ----- ----- | ----- ----- | ----- ----- | 0 |
| April 30 | 5.73 (1.44) | 12.78 (0.52) | 170.25 (0.46) | 8.53 (0.05) | 8 | 7.45 (1.77) | 12.25 (0.35) | 177.5 (7.78) | 8.55 (0.07) | 2 |
| May 18 | 9.11 (1.22) | 11.49 (0.55) | 171.5 (1.77) | 8.44 (0.05) | 8 | 8.6 (0.42) | 11.85 (0.07) | 172.0 (1.41) | 8.3 (0) | 2 |
| June 6 | 10.74 (0.78) | 10.91 (0.47) | 175.47 (1.68) | 8.28 (0.60) | 15 | 11.48 (1.25) | 10.94 (0.36) | 174.8 (1.64) | 8.36 (0.09) | 5 |
| June 27 | 17.68 (0.84) | * | 174.0 (1.26) | 8.21 (0.08) | 16 | 17.76 (1.36) | * | 172.0 (2.24) | 8.28 (0.16) | 5 |
| July 12 | 19.92 (1.01) | ----- ----- | 172.8 (1.47) | 8.20 (0.04) | 15 | 21.06 (0.86) | ----- ----- | 170.0 (3.74) | 8.36 (0.18) | 5 |
| July 25 | 22.0 (0.88) | 9.85 (0.42) | 171.0 (2.19) | 8.38 (0.24) | 16 | 22.94 (0.86) | 9.82 (0.69) | 170.4 (2.19) | 8.42 (0.13) | 5 |

*Inaccurate measurements resulted from low battery voltage in the Sonde unit.

Appendix . (Continued)

| | 2 meters | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Polson Bay (I) | | | | | East Bay (II) | | | | |
| Date | Temp. | D.O. | Cond. | pH | n | Temp. | D.O. | Cond. | pH | n |
| April 16 | 5.28 | 12.63 | 173.3 | 8.55 | 4 | ----- | ----- | ----- | ----- | 0 |
| | (0.92) | (0.06) | (2.06) | (0.06) | | ----- | ----- | ----- | ----- | |
| April 30 | 5.7 | 12.73 | 170.3 | 8.48 | 8 | 6.20 | 12.50 | 172.0 | 8.50 | 2 |
| | (1.42) | (0.42) | (0.46) | (0.07) | | ----- | ----- | ----- | ----- | |
| May 18 | 7.59 | 12.04 | 170.3 | 8.40 | 8 | 8.35 | 12.05 | 172.5 | 8.30 | 2 |
| | (0.93) | (0.42) | (1.39) | (0) | | (0.07) | (0.21) | (0.71) | (0) | |
| June 6 | 10.57 | 11.09 | 175.9 | 8.17 | 15 | 11.30 | 11.18 | 176.2 | 8.30 | 5 |
| | (0.78) | (0.47) | (1.73) | (0.55) | | (1.11) | (0.34) | (1.64) | (0.07) | |
| June 27 | 17.21 | * | 173.9 | 8.16 | 16 | 17.93 | * | 171.8 | 8.30 | 5 |
| | (0.80) | | (0.99) | (0.06) | | (1.51) | | (2.50) | (0.18) | |
| July 12 | 19.81 | ----- | 172.9 | 8.19 | 15 | 20.53 | ----- | 171.0 | 8.27 | 5 |
| | (0.93) | ----- | (1.54) | (0.08) | | (0.59) | ----- | (3.61) | (0.21) | |
| July 25 | 21.25 | 9.55 | 170.3 | 8.34 | 16 | 21.62 | 9.98 | 168.0 | 8.42 | 5 |
| | (0.27) | (0.46) | (2.43) | (0.11) | | (0.63) | (1.38) | (5.61) | (0.16) | |

## APPENDIX J

Summary of fish captured at seine sites S1 through S16 (Figure 2) in South Bay, June through August 1984.

Appendix J. Summary of fish captured at seine sites S1 through S16 (Figure 2.) in South Bay, June through August 1984.

| | | | Yellow perch | | Lake whitefish | | Mountain whitefish | | Kokanee | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | Site | Habitat Type | Size (mm) | # | Size (mm) | # | Size (mm) | # | Size (mm) | # |
| 6/5 | S1 | SS2 | 60 | 1 | 301-400 | 2 | 151-250 | 41 | 101-150 | 14 |
| 6/5 | S2 | SS2 | 101-150 | 662 | 151-200 | 2 | | | 101-150 | 35 |
| | | | 151-200 | 17 | 442 | 1 | | | | |
| | | | 201-250 | 11 | | | | | | |
| 6/5 | S3 | SS2 | 51-75 | 1,079 | 0-50 | 9 | | | | |
| | | | 101-150 | 41 | | | | | | |
| | | | 151-200 | 3 | | | | | | |
| 6/19 | S4 | SMO | 151-200 | 4 | | | | | | |
| 6/19 | S5 | SMO | 101-150 | 1,092 | | | | | | |
| | | | 151-200 | 10 | | | | | | |
| | | | 201-250 | 9 | | | | | | |
| 6/19 | S6 | SS2 | 51-75 | 1,[illegible]62 | | | | | | |
| | | | 101-200 | 229 | | | | | | |
| | | | 201-250 | 7 | | | | | | |
| 7/3 | S7 | DSC | | | 51-100 | 25 | | | | |
| 7/3 | S8 | DSC | | | 51-100 | 5 | | | | |
| 7/3 | S9 | DSC | 201-300 | 9 | | | | | | |
| 7/3 | S10 | SMO | 51-75 | 76 | 51-100 | 73 | | | | |
| | | | 101-150 | 56 | | | | | | |
| | | | 151-200 | 20 | | | | | | |
| 7/18 | S11 | SMO | 51-75 | 12,900 | | | | | | |
| | | | 101-150 | 10 | | | | | | |
| | | | 151-200 | 5 | | | | | | |
| 7/18 | S12 | SMO | | | | | | | | |
| 7/18 | S13 | SMO | 51-75 | 25 | | | | | | |
| | | | 101-150 | 4 | | | | | | |
| 8/20 | S14 | SSC | 51-75 | 297 | 101-150 | 3 | | | | |
| | | | 151-200 | 3 | | | | | | |
| 8/20 | S15 | SSC | 51-75 | 57 | | | | | | |
| | | | 76-100 | 2[illegible]9 | | | | | | |
| | | | 151-200 | 18 | | | | | | |
| 8/20 | S16 | - | 51-75 | 642 | | | | | | |
| | | | 101-150 | 2 | | | | | | |

# APPENDIX K

Gillnet catches in South Bay, April through August 1984.

Appendix K. Gillnet catches in South Bay, April-August 1984.

| Date | Hours Fishing | Gillnet Site | Habitat Type | Yellow Perch 101 - 200mm | Yellow Perch 201 - 300mm | Yellow Perch 301 - 350mm | Total | L. whitefish # caught | Bull trout # caught |
|---|---|---|---|---|---|---|---|---|---|
| 4/12 | 2.0 | G12 | MMO | | | | | | |
| 4/13 | 1.5 | G 7 | MMO | 107 | 124 | 6 | 237 | | 1 |
| 5/16 | 3.0 | G 1 | MS2 | | | | | 2 | 1 |
| 6/07 | 2.0 | G13 | MMO | 1 | 4 | | 5 | 2 | |
| 6/12 | 2.5 | G17 | DMO | | | | | 1 | |
| 6/15 | 2.0 | G 6 | SMO | | | | | | |
| 6/15 | 2.5 | G 8 | SS2 | 22 | 43 | | 65 | | |
| 6/26 | 1.5 | G18 | River | | | | | | |
| 6/26 | 2.0 | G19 | River | | | | | | |
| 6/26 | 2.0 | G20 | River | 3 | | | 3 | | |
| 7/09 | 2.0 | G15 | SSC | 1 | 12 | | 13 | 1 | 2 |
| 7/09 | 2.0 | G16 | MMO | 8 | 12 | 3 | 23 | | |
| 7/12 | 3.75 | G 4 | SS2 | | | | | | 2 |
| 7/12 | 2.0 | G 5 | SMO | 4 | 5 | | 9 | | |
| 7/17 | 1.5 | G14 | SMO | 1 | 10 | | 11 | | |
| 7/25 | 1.0 | G 9 | SSC | | 8 | | 8 | | |
| 7/25 | 1.0 | G10 | SS1 | | 11 | | 11 | | |
| 7/27 | 1.0 | G10 | SS1 | 12 | 20 | 8 | 40 | | |
| 7/27 | 1.0 | G 9 | SSC | 2 | 22 | 2 | 26 | | |
| 7/30 | 1.0 | G17 | DMO | | 1 | 6 | 7 | | |
| 7/30 | 1.0 | G12 | MS1 | 1 | 2 | | 3 | | |
| 8/01 | 2.5 | G10 | SS1 | 101 | 29 | 1 | 131 | | |
| 8/01 | 2.5 | G 9 | SSC | 58 | 23 | | 81 | | |
| 8/07 | 3.0 | G13 | MMO | 14 | 7 | | 21 | | |
| 8/07 | 2.0 | G17 | DMO | 1 | 13 | | 14 | | |
| 8/08 | 2.0 | G12 | MS1 | 12 | 13 | | 25 | | |
| 8/08 | 2.0 | G11 | DSC | | 8 | | 8 | | |
| 8/17 | 2.0 | G14 | SMO | 6 | 9 | | 15 | | |
| 8/17 | 2.0 | G15 | SSC | 8 | 4 | | 12 | | |
| 8/23 | 2.0 | G 2 | MSM | 2 | 16 | | 18 | | |
| 8/23 | 2.0 | G 3 | SMO | 1 | 2 | | 3 | | |
| 8/29 | 2.0 | G 7 | MMO | 26 | 1 | | 27 | | |
| 8/31 | 2.0 | G 6 | SMO | 16 | | | 16 | | |
| 8/31 | 2.0 | G 8 | SS2 | 24 | 6 | | 30 | 2 | |

APPENDIX L

Total catches and catch per unit effort (trap-day) from fyke traps in South Bay, March - June 1984.

Appendix L. Total catches and catch per unit effort (trap-day) of target fish species from fyke traps in South Bay, March - June 1984.

| Trap location | Time Interval | (Total Days) | Yellow perch Total catch | Yellow perch (CPUE) | Lake whitefish Total catch | Lake whitefish (CPUE) | Bull trout Total catch | Bull trout (CPUE) | Kokanee Total catch | Kokanee (CPUE) |
|---|---|---|---|---|---|---|---|---|---|---|
| Finley Point | 3/8-4/24 | (64) | 154 | (2.40) | 49 | (0.76) | 5 | (0.08) | 2 | (0.03) |
| Bird Point | 3/22-6/28 | (99) | 1920 | (19.39) | 32 | (0.32) | 9 | (0.09) | 14 | (0.14) |
| West Shore | 3/9-6/13 | (66) | 343 | (5.19) | 3 | (0.05) | 5 | (0.08) | 0 | (0) |
| Golf Course | 4/26-5/28 | (33) | 56 | (1.69) | 3 | (0.09) | 3 | (0.06) | 1 | (0.03) |
| Narrows | 3/9-4/6 | (19) | 3 | (0.16) | 1 | (0.05) | 0 | (0) | 0 | (0) |
| All traps | | (281) | 2476 | (8.81) | 88 | (0.31) | 21 | (0.07) | 17 | (0.06) |

## APPENDIX M

Bull trout tag and recapture data, South Bay, Flathead Lake, 1984.

Appendix M. Bull trout tag and recapture data, South Bay, 1984. FP = Finley Point trap, BP = Bird Point trap, WS = West Shore trap, EB = East Bay, GC = Golf Course trap, PB = Polson Bay, UF = Upper Flathead River.

| Tag# | TL(mm) | Wt(g) | Capture Date | Capture Location | Recapture Date | Recapture Location |
|---|---|---|---|---|---|---|
| 00010 | 571 | 1100 | 03-14-84 | FP | | |
| 00035 | 575 | 1750 | 03-28-84 | BP | 06-15-84 | UF |
| 00178 | 710 | 3700 | 04-10-84 | BP | | |
| 00189 | 600 | 2500 | 04-11-84 | WS | 07-20-84 | UF |
| 00196 | 555 | 1200 | 04-13-84 | FP | | |
| 00197 | 630 | 2500 | 04-13-84 | EB | | |
| 00315 | 483 | 1100 | 04-15-84 | BP | | |
| 00465 | 670 | 3400 | 04-19-84 | FP | 04-31-84 | UF |
| 00483 | 610 | 2400 | 04-19-84 | BP | | |
| 00692 | 610 | 2400 | 04-19-84 | WS | | |
| 00959 | 690 | 4000 | 04-24-84 | BP | 06-21-84 | UF |
| 00938 | 690 | 4000 | 04-24-84 | FP | | |
| 00939 | 530 | 1500 | 04-24-84 | FP | | |
| 00965 | 418 | 650 | 04-27-84 | BP | | |
| 00966 | 585 | 1700 | 04-27-84 | BP | | |
| 01000 | 790 | 5400 | 04-27-84 | WS | 06-09-84 | UF |
| 01001 | 673 | 3300 | 04-27-84 | WS | | |
| 01102 | 492 | 1000 | 04-30-84 | WS | | |
| 01178 | 780 | 4100 | 05-11-84 | BP | | |
| 01189 | 474 | 686 | 05-11-84 | GC | 06-23-84 | PB |
| 01355 | 600 | 2700 | 05-24-84 | GC | | |
| 01424 | 527 | 1200 | 05-15-84 | PB | | |
| 01403 | 351 | | 06-05-84 | GC | | |
| 01771 | 298 | 250 | 07-09-84 | G15 | | |