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LOWER FLATHEAD SYSTEM FISHERIES STUDY

Main River and Tributaries, Volume II

Final Report 1983

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LOWER FLATHEAD SYSTEM FISHERIES STUDY
Main River and Tributaries, Volume II

Final Report FY 1983 - 1987

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ABSTRACT

The Lower Flathead System Fisheries Study assessed the effects of Kerr Dam operations on the fisheries of the lower Flathead ecosystem. Supported by Bonneville Power Administration funding, and conducted by biologists hired by the Confederated Salish and Kootenai Tribes, the study began in December of 1982 and was completed in late 1987.

Northern pike were found throughout the lower Flathead River, reaching their greatest abundance below the town of Dixon where a proliferation of side channel backwaters best meet their life history requirements and provide exceptional spawning habitat when river discharge is greater than 340 m^3/second (12,000 cfs) and stable.

Trout abundance in the lower Flathead averaged only 19 fish per kilometer, the lowest abundance of trout for a river of this size in Montana. Little main channel spawning by trout was observed and most spawning probably occurs in tributaries.

Lower river tributaries support resident populations of brook, rainbow, brown, and cutthroat trout; and a small resident population of bull trout is present in the South Fork of the Jocko River. Using weirs, spawning runs of rainbow and brown trout from the main river were monitored entering the Jocko River and the Post/Mission Creek system. Utilization of Crow Creek by main river trout stocks of trout was limited to the 6 km segment below Crow Dam. Evaluations of tributary spawning gravels showed high levels of silt which would suggest poor survival of trout eggs. Excessive harvest in the tributaries was indicated by analysis of age class structure and abundance of trout greater than 200 mm.

Study results have described mitigable impacts associated with hydroelectric operations. Kerr dam operational constraints originated from recreational planning for Flathead Lake and coordinated basin wide operational planning for power production. No prior considerations, except an operational minimum discharge, was given to fish and wildlife requirements.

We believe our results have clearly shown Kerr hydroelectric operations and operational contraints have negatively affected Flathead River trout and northern pike populations and the aquatic habitat which support them. Even so, it is possible to mitigate many of these impacts and develop a very important fishery. We suggest the following mechanisms acting independently and in concert have resulted in the existing situation. Present hydroelectric operations:

1. Dewaters and desiccate pike eggs and young northern pike which are attached to littoral vegetation, and strands fish fry and juveniles. Adult fish are rarely stranded.

2. Produce frequent changes in river discharge which modifies salmonid behavior, especially during spawning. Habitat variables used by fish to select spawning sites are constantly changing.

3. Prevents full utilization of the river channel by aquatic zoobenthos, creating varial zones on either side of the channel devoid of aquatic insects even when the channel is fully wetted. This greatly reduces the productive potential at all higher tropic levels and may especially impact the forage base for juvenile fish associated with these lattorail habitats.

4. Creates daily and hourly changes in habitat quality and quantity when flows are less then, or exceed habitat tolerances of a species or specific life stages of species.

5. Results in monthly average discharges triple the historic mean during winter months with severe icing conditions. Combined with flow fluctuation this causes streambank destabilization.

The construction and operation of the Flathead Indian Irrigation Project (FIIP), and general agricultural practices of the Flathead Reservation play a role perhaps equal to Kerr Dam in creating the current status of aquatic habitat and fish population of the lower Flathead ecosystem. We identified the following major impacts:

1. Unscreened irrigation diversions intersect all major (and most minor) tributaries. These diversions have the potential of trapping fish of all species and age classes in irrigation canals, thereby reducing recruitment to the tributaries.

2. Frequent, erratic changes in streamflow below irrigation diversions and dams of FIIP create constantly recurring impacts to fish habitat without regard for the seasonal habitat requirements of those affected fish populations. In some cases aquatic habitat has been seasonally eliminated.

3. Inefficient irrigation practices result in irrigation return flows laden with silt (and possible herbicides and pesticides), increasing stream turbidity and streambed sedimentation. The negative impacts of sediments in streams is well documented.

4. The construction of irrigation diversions, canals, and dams on main-river tributaries reduces gravel recruitment, and eliminates access to more than 100 kilometers of spawning and rearing habitat.

The study concluded with the development of a wide range of fisheries management strategies, which are contained in the Executive Summary, Volume I of these final reports.

INTRODUCTION

Main River and Tributaries

Closed in 1938, Kerr Dam controls discharges into the lower Flathead River. Kerr Dam is a 60.6 m high concrete arch structure located 7.2 km downstream from the outlet of Flathead Lake. The facility is used by Montana Power Company primarily for system load control, with some use for low level base load, and is jointly licensed to Montana Power Company and the Confederated Salish and Kootenai Tribes.

Hydroelectric peaking operations typically store water at night when power demand is low, and release water through generators during the early morning and evening to satisfy peak energy demands. This can result in rapidly varying discharge in the river below a peaking facility with constantly recurring patterns of impacts to the aquatic ecosystem, particularly the aquatic biota component (Gislason 1985, Fraley and Graham 1982, Becker et al. 1981, Stanford and Hauer 1978, Hamilton and Buell 1976). Rapidly varing flows in streams reduced aquatic insect standing crop and diversity, decreases survival of fish eggs and alevin, reduces the condition factor of sport fish, selects for species tolerant of flow fluctuations, strands fish, fish eggs, aquatic insects, and modifies thermal regimes (Chushman 1985, Stanford and Ward 1979).

Many additional Flathead basin studies dealing with Kerr and Hungry Horse Dams are presently being conducted; all have bearings upon aquatic resource conservation and management, and relate to the management strategies discussed in this report (Cross 1987). The Montana Department of Fish, Wildlife and Parks is conducting studies of kokanee in Flathead Lake (Decker-Hess and Clancey 1984) and upper Flathead River (Fraley 1984), and Canada geese (Branta canadensis moffitti) (Casey et al. 1985) in the northern Flathead Valley. Canada geese in the southern Flathead valley are being studied by the Confederated Salish and Kootenai Tribes (Mackey et al. 1985). Staff of the Flathead Lake Biological Station are studying the aquatic insects of the lower Flathead River, how they may be influenced by hydroelectric operations, and the implications to fisheries management, under contract with the U.S. Bureau of Indian Affairs (Hauer and Potter 1986). Wherever possible results of these studies have been integrated into this report.

The Lower Flathead System Fisheries Study began in December of 1982 with a pilot study which developed sampling methods, established permanent study sections, and a sampling schedule for the lower river and its tributaries (DosSantos et al. 1983). Fisheries data were largely lacking on the lower Flathead system except for a general inventory in 1979 and annual spot checks by the United State Fish and Wildlife Service (Peterson 1977 and 1978, Randall 1980). This situation made assessment of historical loss problematical at best, and the study design focused on identification of impacts of existing dam operations upon aquatic habitat and populations of mountain whitefish (Prosopium williamsoni), rainbow trout (Salmo gairdneri), cutthroat trout (Salmo clarki), brown trout (Salmo trutta), brook trout (Salvelinus fontinalis), bull trout (Salvelinus confluentus), and northern pike

(*Esox lucius*) and largemouth bass (*Micropterus salmoides*) in the lower river and its tributaries.

The river and tributary portion of the study described in this volume of the Final Report was designed to provide sufficient biological and physical data on the fisheries resource of the Lower Flathead system from which management strategies could be developed. The objectives for this segment of the study were:

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 trout species (including whitefish), 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 operational changes or mitigation.

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

The Tribes in cooperation with the Montana Department of Fish, Wildlife and Parks will be developing an interagency fisheries mitigation, protection plan (IMP), which will be presented to the Northwest Power Planning Council in October of 1989. This plan will incorporate the findings and recommendations from all the Flathead Basin fisheries studies, producing a comprehensive, system approach, management/mitigation plan.

DESCRIPTION OF STUDY AREA

Main River

Montana's Flathead River-Lake ecosystem, with tributaries originating in Canada, Glacier National Park, and the Bob Marshall Wilderness, is nationally known for its clean, clear, waters and near pristine conditions and constitutes the northeastern most drainage of the Columbia River, (Figure 1). The lower Flathead system, as defined for this study, included the south half of Flathead Lake, the lower Flathead River below Kerr Dam, and its major tributaries.

The lower Flathead River is one of Montana's largest rivers, with an annual average discharge of 340 m^3/second (11,700 cfs) and is regulated by Kerr Dam, located 7 km southwest of Polson, Montana. The river flows south and west for 116 km, to the confluence with the Clark Fork of the Columbia River near Paradise, Montana (Figure 2). 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. Descriptive habitat terms used throughout this report are defined in Appendix A.

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

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

During the summer, lower Flathead River water temperatures are 3 to 4^{o}C higher than those recorded in the upper Flathead River above Flathead Lake due to the natural warming of South Bay. Summer water temperatures in the main river are near 20^{o}C being as much as 10^{o}C warmer than any lower river tributary inflow. Winter temperatures reach 0.0^{o}C. Average annual water temperature is 9.0^{o}C (Dos Santos et al. 1983, Shields et al. 1983 and Darling et al. 1984)

The annual hydrograph for releases from Kerr Dam shows a reduction in peak flows and an increase in winter flows from the pre-impoundment hydrograph (Figure 3).

The lower Flathead River is a low gradient river (0.65m/km) draining a 386,205 hectare watershed. Riffle and pool areas blend, forming a comparitively smooth flowing shallow river. Based on general valley characteristics, gradient, and channel morphology, the lower Flathead was divided into four distinct river reaches (Figure 2).

Reach I of the lower Flathead extends from Kerr Dam (River Kilometer (RK) 116) to the mouth of White Earth Creek (RK 102). The river averages 114 m wide and has a gradient of 1.5 m/km. The river is confined in a steep rocky canyon for the first 6 km of this reach, after which the canyon widens. The channel bottom is composed of a large boulder-bedrock mixture blending into a cobble-gravel veneer over heavy

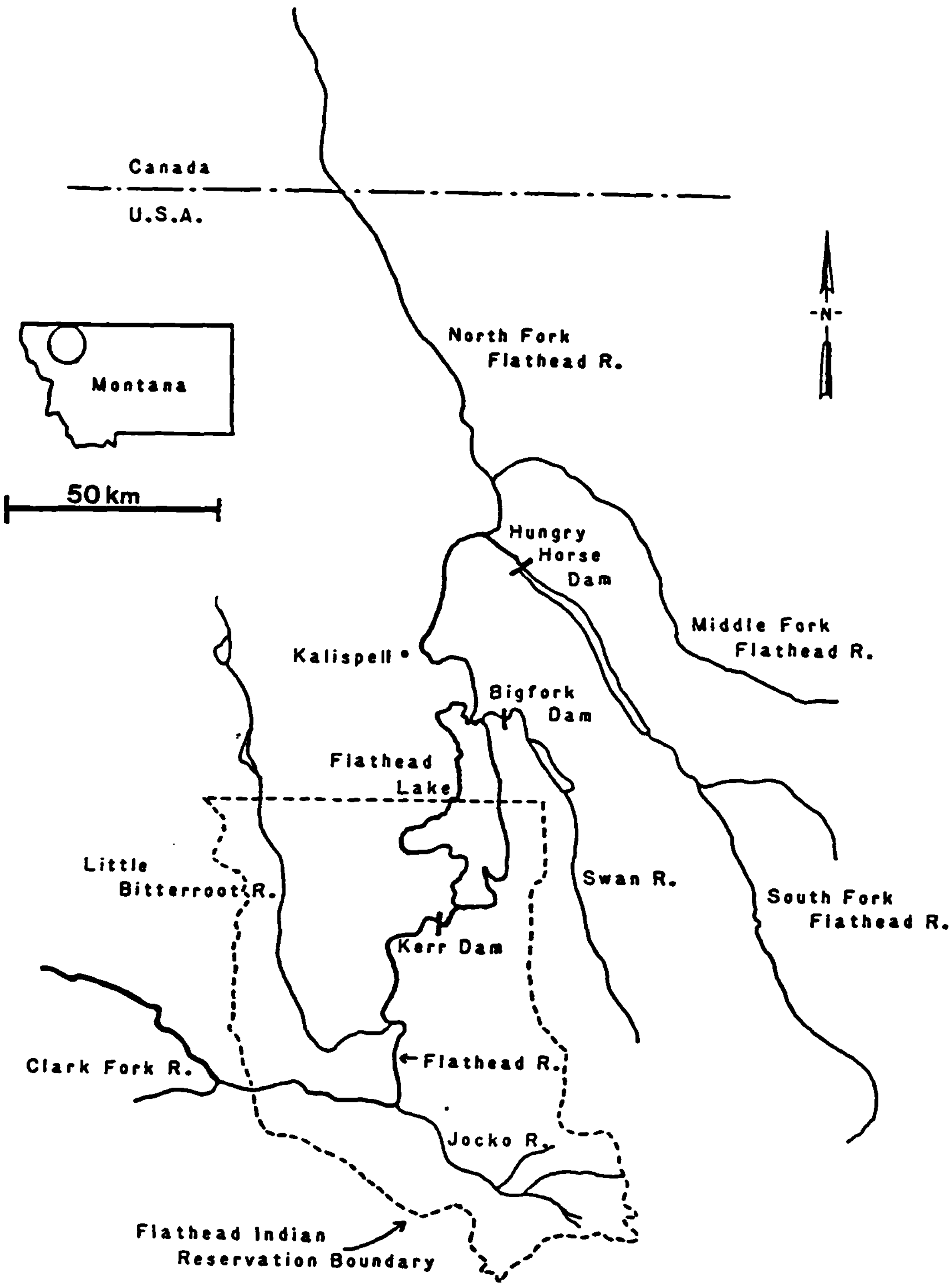


Figure 1. The Flathead River System, Montana.

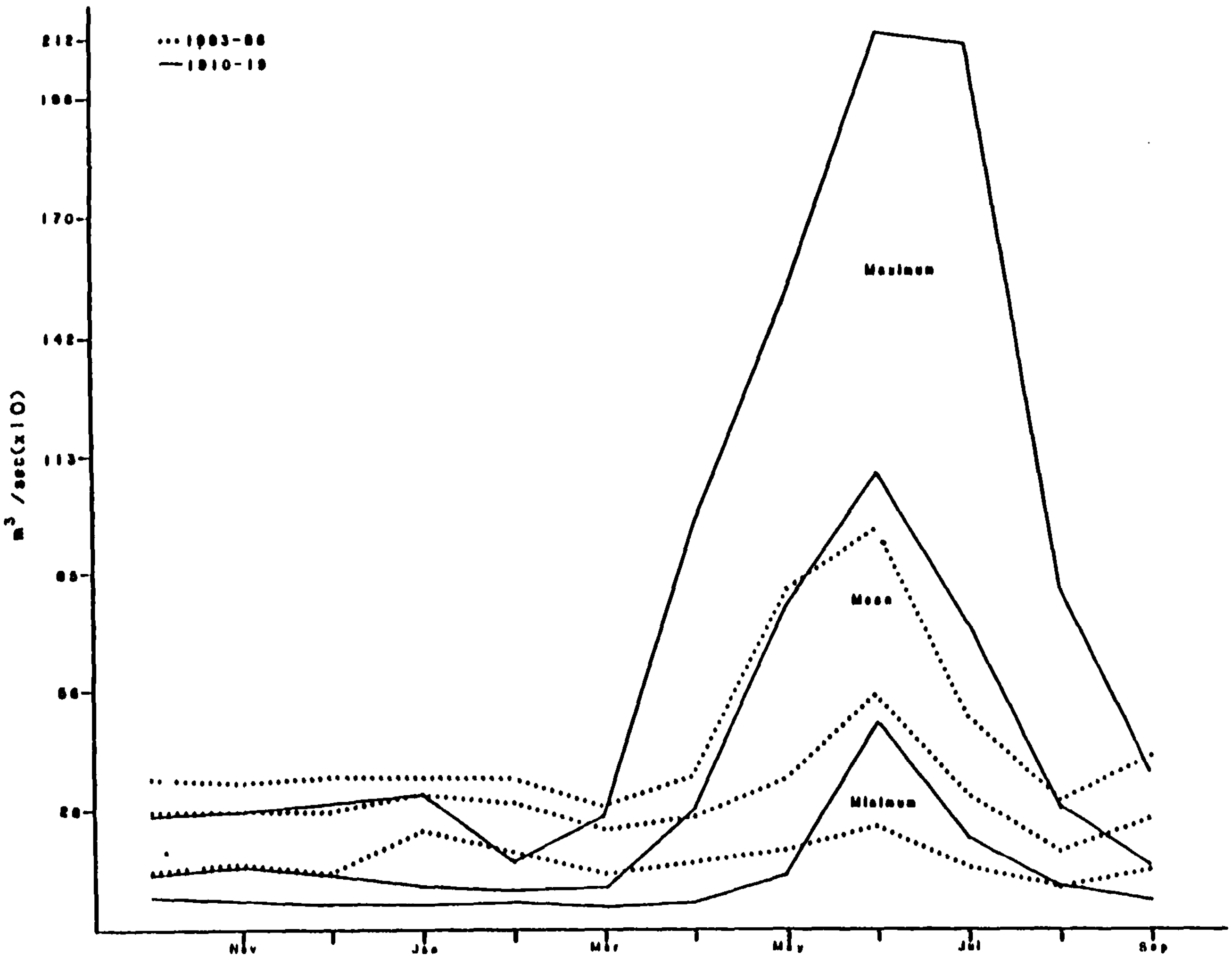


Figure 2. Preimpoundment (solid lines) and study period (1983-1986) average monthly flows for the lower Flathead River recorded directly below Kerr Dam by the USGS.

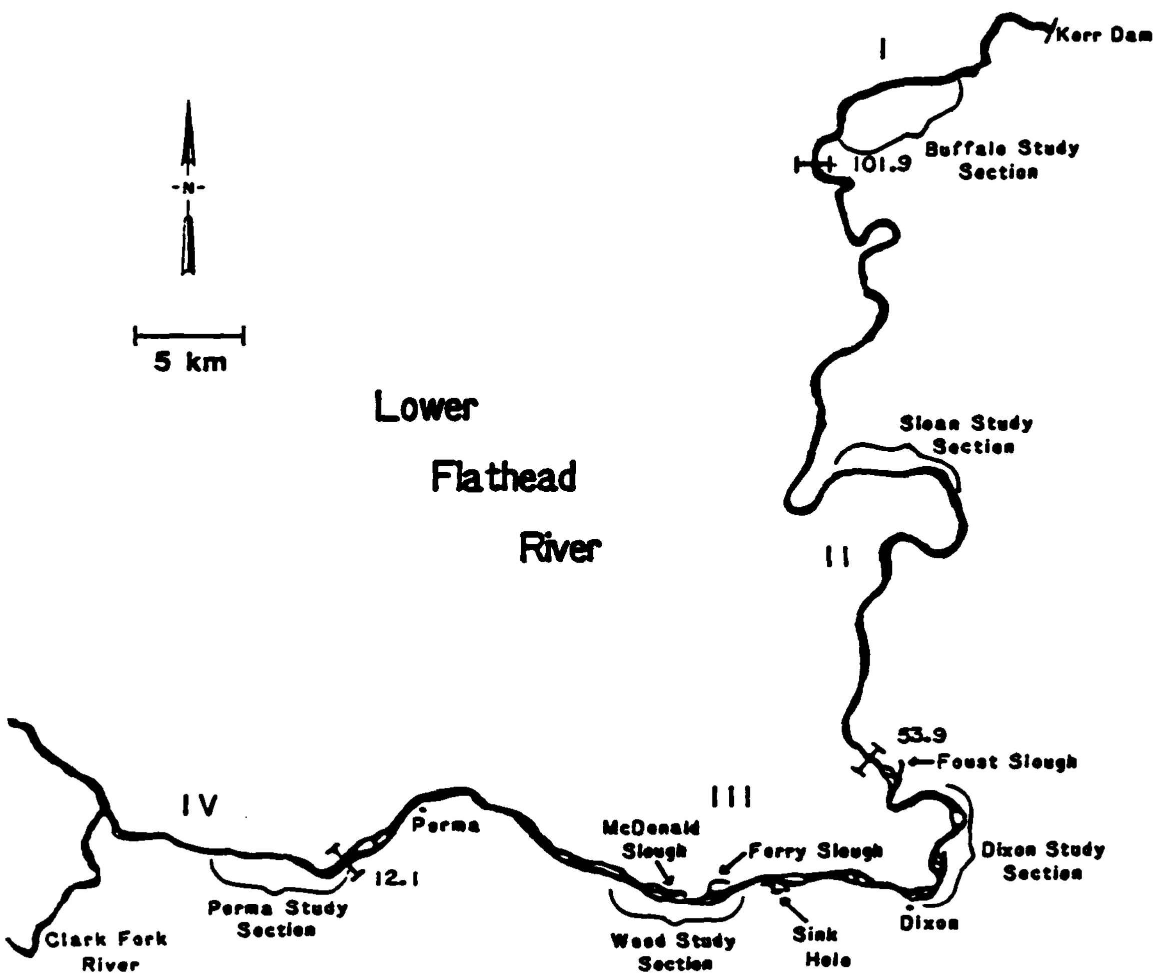


Figure 3. Reach breaks, permanent study sections and important backwater areas of the lower Flathead River.

clay toward the end of the reach. The canyon portion of this reach is characterized by deep pools and several sets of rapids and could actually be considered a separate reach, unique to the lower river. The lower section of the reach is a smooth, fast flowing glide with two riffle areas. This river reach is subject to severe water level fluctuations due to hydropower peaking operations at Kerr Dam and the narrowness of the channel. At the United States Geological Survey (USGS) gaging station downstream from Kerr Dam, water levels have fluctuated as much as 0.6 to 2.4 m in three hours (USGS, unpublished data).

The Buffalo study section, from RK 109.4 to RK 102.9, represented 46 % of Reach I in the lower Flathead River. The study section has an average width of 114 m with a gradient of 1.5 m/km. The channel substrate is composed of a large boulder-rubble mixture blending into a cobble-gravel mixture toward the end of the section. The section is a single channel, fast flowing glide containing two riffle areas, subject to rapid water level fluctuation of up to 2.4 m/3 hrs due to the hydropower peaking operations at Kerr Dam. No tributaries enter this study section, and the only boat access is at Buffalo Bridge (RK 104.6) (Figure 2).

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

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

The Sloan study section extends from RK 75.6 to RK 69.2, represented 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 veneer over heavy clay 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; its delta constricts the main river channel to approximately one half its average width, forming a fast turbulent chute. Pablo A Canal, an irrigation canal, also empties into this section at RK 69.9. The boat access point is Sloan Bridge (RK 71.4) (Figure 2).

Reach III of the river extends from RK 54 to RK 12. Average gradient and width within this reach are 0.3 m/km and 104 m, respectively. Habitat is variable, and the river channel is braided. Major island complexes, gravel bars, and extensive backwater areas are common. McDonald Slough (RK 29) has a surface area of 5.2 hectares and a maximum depth at average river discharge (340 m^3/second (11,700 cfs)) of approximately 4.5 meters. By mid-summer, a heavy growth of aquatic macrophytes completely encircles this backwater, leaving only the deepest water free of vegetation. The "Sink Hole" (RK 34) has surface area of 12.6 hectares and a maximum depth of 5.4 meters (Figure 2). Growth of aquatic macrophytes is similar to that which occurs in McDonald Slough, however there is more open water in the "Sink Hole".

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

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

The Weed study section extends from RK 32.2 to RK 25.7, and represents 15.4% of Reach III. General river characteristics, gradient and channel width are similar to the Dixon section. This section has two large backwater areas and only one small intermittent tributary, Magpie Creek, entering at RK 27,2 (Figure 2).

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

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

METHODS and MATERIALS

Main River

Physical Habitat Evaluation

Kerr Dam Flow Releases

Staff gages were installed at RK 37.8 and 31.1 in 1983 and RK 40.2 and 27.2 in 1984 to monitor water level fluctuations. In 1985 a staff gage was installed at the mouth of Foust Slough (RK 49.9) and the gage at RK 31.1, damaged by ice, was replaced. Gages were read while checking fyke traps during the northern pike spawning season and during other routine field work. Daily water level fluctuations at other specific spawning areas were calculated by:

1. taking daily minimum and maximum 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 river cross-sectional profile data (USFWS, unpublished data), and
4. computing vertical changes in water surface at areas of interest.

Daily discharge records recorded at RK 115, approximately one kilometer below Kerr Dam, for the lower Flathead river were provided by the USGS; records at the USGS station date from August 1907.

Water Temperatures

Water temperatures were recorded at two permanent sites along the lower Flathead River using continuously recording 90-day Ryan thermographs installed at Sloan (RK 71.4) and old Perma (RK 17.6) bridges. Dixon bridge (RK 40.2), used as a thermograph location during 1983, was destroyed by ice in January 1984. The recording of daily water temperatures by the USGS at their gage house (RK 115) directly below Kerr Dam was discontinued as of 1 October 1983. Surface water temperatures were also recorded during routine field operations.

Substrate Analysis

Mapping of channel substrate types 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 snorkeling were recorded on field maps. Areas with rooted aquatic macrophytes were mapped, and 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 (Bovee 1978) were delineated on the photos. Total areas of the study sections, amount of potential spawning gravel, and aquatic vegetation were calculated using a digital planimeter.

Substrate samples were taken at three of the five permanent study sections in areas where habitat variables (gravel size, water depth, and water velocity) appeared suitable for trout spawning (Darling et al. 1984). Samples were collected during March 1985, before high water, when substrates were most embedded. A total of 18 samples were collected: six from the Buffalo, four from Dixon and six from Weed study section. One paired sample was taken from a large gravel bar located at RK 48, which is not included within any permanent study section.

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

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

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

Spawning Surveys

Spawning northern pike were captured using experimental gill nets and 1.2 m diameter double-throated hoop nets. Hoop nets were set in the inlets of suspect off-channel spawning areas and along main channel shallow bench areas. Experimental gill nets were set for relatively short periods, usually two to four hours and tended every half hour. Spawning pike were collected using boat-mounted electrofishing gear to increase sample size. Sexual maturity and sexes were determined on captured pike using an extrusion method (Harrison and Hadley 1983). Trapping operations began by the middle of March and were usually complete by the first of June during the four year period 1983 to 1986.

Redd surveys in the spring of 1984 and 1985 were conducted from boat and helecopter in an effort to identify trout spawning areas in the main river channel.

Stock Assessment

Target fish species were collected at night using boat- mounted electrofishing gear (Loeb 1957), following guidelines presented by Vincent (1971 and 1983) and Peterman (1978). Stock assessment data were collected at five permanent study sections located in the four reaches of the main river during 1983 and 1984; one study section was dropped during the 1985 and 1986 field season.

River reach III originally contained two study sections, Weed and Dixon. The Dixon study section, was established to identify any influence of tributary inflow (Mission Creek and the Jocko River), on fish density, or species composition, while the Weed section was selected as representative of reach III. Since catch rates and species composition for target fish at the two study sections were similar in 1983 and 1984, the Dixon study section was not sampled in 1985 and 1986.

Main river study sections were 6.4 km long. Two electrofishing passes per run were made along each bank for a total of 25.7 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 to allow redistribution of marked fish within the study section (Vincent 1971 and 1983).

During marking runs, target fish species captured were sexed and weighed to the nearest 0.01 kg if they weighed less than 5 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 selected fish for age and growth analysis.

All trout and pike greater than 250 mm TL were tagged with individually numbered Floy "T-tags" inserted just under the posterior margin of the dorsal fin. Fish between 100 and 249 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 1983 and 1984 sampling.

During recapture runs, all unmarked fish, except mountain whitefish, were processed as above. Only lengths 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. Mountain whitefish were excluded from 1985 and 1986 stock assessments because of their abundance.

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

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

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 0.2 cm clear acetate. The acetate sheet was pressed between two stainless steel plates at 93°C and 9,090 kg 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 contrasted with length and age data presented in Carlander (1969) and Brown (1971) and histograms of captured fish.

The use of scales alone for aging northern pike is difficult and can be misleading (Williams 1955). Cleithra have been shown to be reliable in assessing the age of northern pike (Casselman 1973 and 1979). Age of Flathead River pike was verified by Minnesota Department of Natural Resources fisheries personnel (Bob Strand, per. com.) using cleithra and representative scale samples from Flathead River pike.

Age class structure of sampled largemouth bass and northern pike populations was analyzed using Anderson's (1975, 1976) Proportional Stock Density (PSD) model.

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 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 sedated in water lightly treated (20 ppm) with tricaine methanesulfonate (MS-222) 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 PVC pipe operating table and into a tub of fresh water similarly treated with MS-222 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 incision and into the body cavity. By pulling on the antenna, the transmitter was held snugly over the pelvic girdle. The incision was closed with sutures made at approximately 5 mm interval 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 that a closer annealing of the tissues and less inflammation 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 100:1 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 (B. Strand, Minnesota DNR, per. com.). Fish were placed in a freshwater holding car until they regained almost total preoperative vigor. Signal transmission was checked and the fish released. The entire process from initial anesthesis to final release took approximately 15 minutes.

Tracking of Radioed Northern Pike

Radio-tagged northern pike were tracked using a hand-held directional loop antenna and programmable scanning receiver (Darling et al. 1984). Tracking operations were normally conducted by floating mid-channel downstream in an open boat. During poor weather, locations were plotted from land. When individual fish could not be located using the above methods, aerial surveys proved to be effective. 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 detection range of 800 m.

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

Instream Flow Incremental Method

The Instream Flow Incremental Methodology (IFIM) was selected for use in this study because it represents the current state of the art in analyzing the impact of flow alteration on aquatic life and fisheries (Bovee 1982, Orth 1987). Criticisms of the method include the interpetation and application of weighted usable area (WUA) and a lack of evidence that fish populations respond to changes in WUA (Mathur et al. 1985; Shirvell 1986). Clearly microhabitat is not the only limiting factor affecting fish population. Water quality and nutrients, food, species interactions and intra-actions, and seasonal changes in habitat preference are also known to influence fish populations (Orth 1987). We believe that IFIM has the potential to identify some limiting habitat events and flow regimes can be developed which avoids them. It was recognized that intensive, longterm monitoring will be required to fine tune the initial flow regime developed using IFIM.

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

Frequent communication between the Instream Flow Group in Fort Collins, Colorado was maintained during study plan development. On February 6, 1985 and January 29, 1986 interagency coordination meetings were held to present, discuss and review the study plan. Personnel from the U.S. Fish and Wildlife Service, U.S. Geological Survey, University of Montana Flathead Lake Biological Station, Bureau of Indian Affairs and Montana Power Company attended.

For the purposes of IFIM segmentation the river was divided into two large macro-segments. IFIM river segment I extended from RK 108.5 to RK 54, encompassing river reaches I and II and characterized the single-channel portion of the lower Flathead River. Aside from a slight gradient difference, the lower section of river reach I (RK 108.5-102) below Buffalo Rapids, had macrohabitat features similar to river reach II (RK 102-54), repeating hydrological features of pool, riffle, run, and river widths. The study section chosen to represent this single channel portion of the river extended from RK 75.5 to RK 73.4, and was within the Sloan habitat and stock assessment study section. The Sloan IFIM study sectin contained all the macrohabitat features found within River Segment I, which were described using a combination of 6 cross-sectional profiles (Figure 4).

IFIM river segment II, encompassing river reaches III and IV, from RK 54 to RK 6, characterized the braided channel portion of the

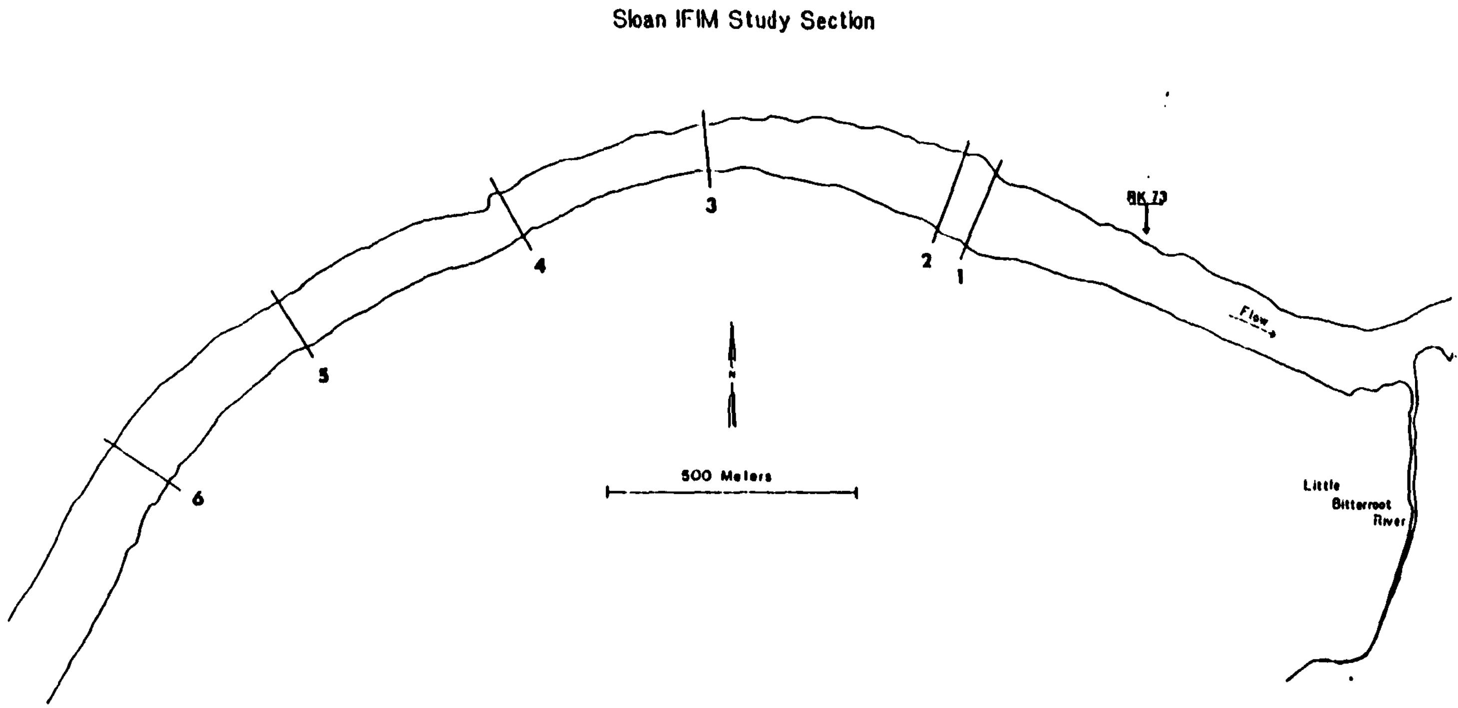


Figure 4. The Sloan IFIM study sections showing transect locations and reference river kilometer (RK).

lower Flathead River. The upper half of river reach IV (RK 12-6) had macrohabitat features similar to the single channel portion of river reach III (RK 54-12) (Darling et al. 1984). Gradient and channel width were similar. The IFIM study section chosen to represent this braided channel portion of the river extended from RK 30.1 to RK 28.2 and was within the Weed habitat and stock assessment study section. The McDonald IFIM study section contained all the macrohabitat features found within River Segment II, which were described using a combination of 7 flowing and 2 standing water cross sectional profiles (Figure 5).

Selection of IFIM study sites was based on accessibility, inclusion of fish stock assessment sections and all the geomorphic macrohabitat features present within a particular river segment.

The downstream-most transect within each IFIM study area was placed to transect the hydraulic control which influenced all upstream transects within that study area. All other transects were habitat descriptors chosen to best represent habitat types found in the river segment. Complete transect descriptions for both the Sloan and McDonald IFIM study sections are presented in Appendix B. Standard survey techniques described by Bovee and Millhous (1978) and Trihey and Wegner (1981) were used in the establishment of transects.

Individual transects were weighted based on their percent of linear representation of a particual habitat type found within that IFIM river reach. Field measurements were sent to T.R. Payne and Associates where the data were transformed into micro-computer format, entered, and calibrated. After stage-discharge relationships for all transects were calculated, using the Water Surface Profile (WSP) model, transect data was run through the IFG4 program, which calculates individual transect hydralic parameters (i.e., depths and velocities) for any given discharge. Final output of Weighted Usable Area (WUA) was generated by combining output from the IFG4 program together with fish species probability-of-use criteria within the HABITAT computer program.

Probability-of-use criteria for rainbow trout life stages of fry, juvenile and adults were taken from Raliegh et al. (1984a). The spawning curves for rainbow and all life stages of cutthroat trout were taken from Bovee (1978). Brown trout criteria were taken from Raliegh et al. (1984b). All above salmonid criteria data were reviewed to asses applicability to the Flathead River, (Pajak et al. 1986). Bull trout because of their very low numbers, were not considered a target fish species of IFIM analysis. Northern pike probability-of-use criteria were taken from Bovee's (1978) original criteria, and modified to reflect measured habitat selection of pike in the lower river (See Appendix D).

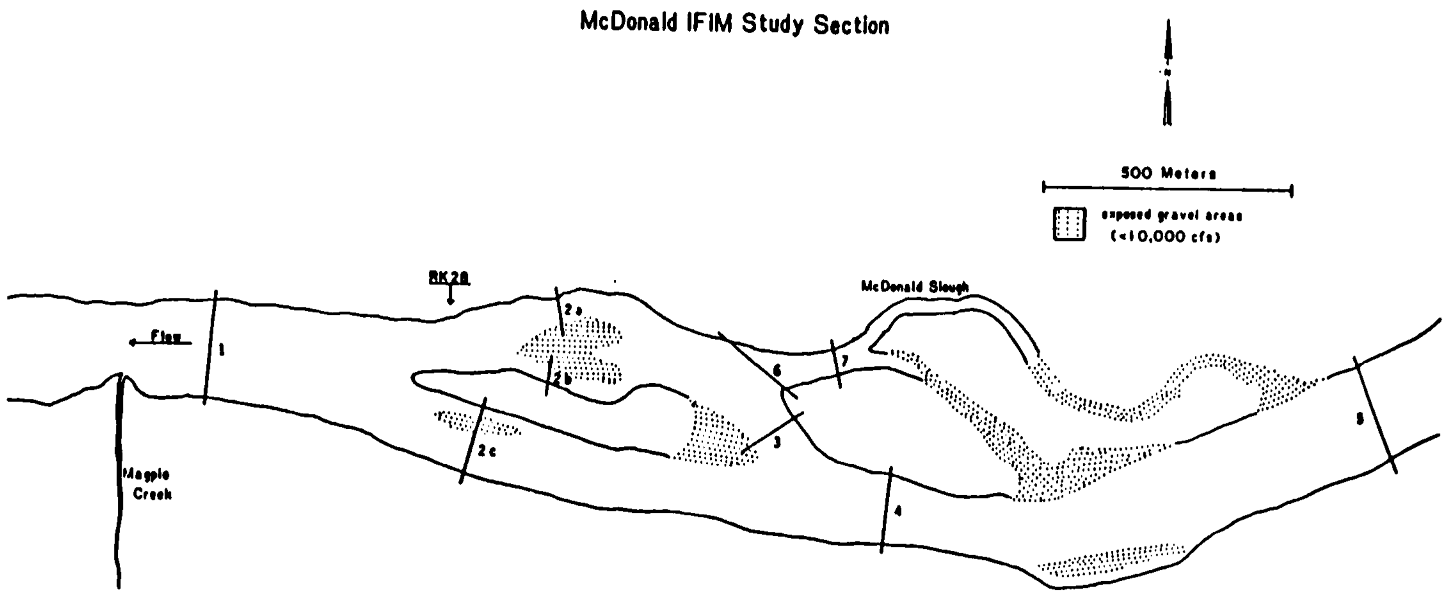


Figure 5. The McDonald IFIM study sections showing transect locations and reference river kilometer (RK).

RESULTS

Main River

Physical Habitat Evaluation

Kerr Dam Flow Releases

The lower Flathead's annual hydrograph (1983-1986) has been modified from the pre-impoundment period 1910-1919; high run-off flows have been diminished and winter flows dramatically increased. Presently average monthly discharges are 40% of pre-impoundment averages from April through August. From September through March average monthly discharges are 235% greater than pre-impoundment average discharges.

Discharges from Kerr Dam, recorded by the USGS at RK 114.9, from January 1983 through December 1986, are presented in Appendix C. Considerable variation between average monthly discharges was observed in the months April through September. Highest discharges were observed in May and June, corresponding to spring run-off. The unusually low average monthly discharges observed from November 1985 through December 1986 result from requested low flows to facilitate aquatic invertebrate collection, and are not a reflection of normal dam operations.

Kerr's operations create constantly reoccuring water level fluctuations in the river with considerable variation in frequency and magnitude. Variations in monthly discharges are generally greatest from April through September, while relatively stable discharges are experienced from October through March. Only daily average discharges are published by the USGS (Shields et al. 1985), however hourly discharges from the Kerr facility can be obtainted from either USGS or MPC.

Discharges from Kerr Dam during the northern pike spawning season (April, May, June) were consistently lower in 1984 than 1983 (Figure 6). Minimum daily discharges during the month of April 1984 were below 141.6 m^3/second (5,000 cfs) 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 (5,000 cfs) 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 1984, flows averaged only 97 m^3 /second (3,425 cfs) compared to 434.5 m^3/second (15,342 cfs) for the same period in 1983. Minimum discharges for this week only exceed 28.3 m^3 /second (1,000 cfs) one day, and reached a low of 21.3 m^3/second (752 cfs, 28 May 1984)). Twenty- one m^3/second (752 cfs) 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 of June 1984, was 48% lower in 1984 than in 1983. Flows for the remaining part of June averaged 25% greater than in 1983.

Discharges from Kerr Dam, in excess of 306 m^3/second (10,800 cfs), during the 1985 northern pike spawning season (April, May, June) provided adult fish better access to known spawning areas than in 1984 (Figure 7). Record low flows observed during the later part of May 1984

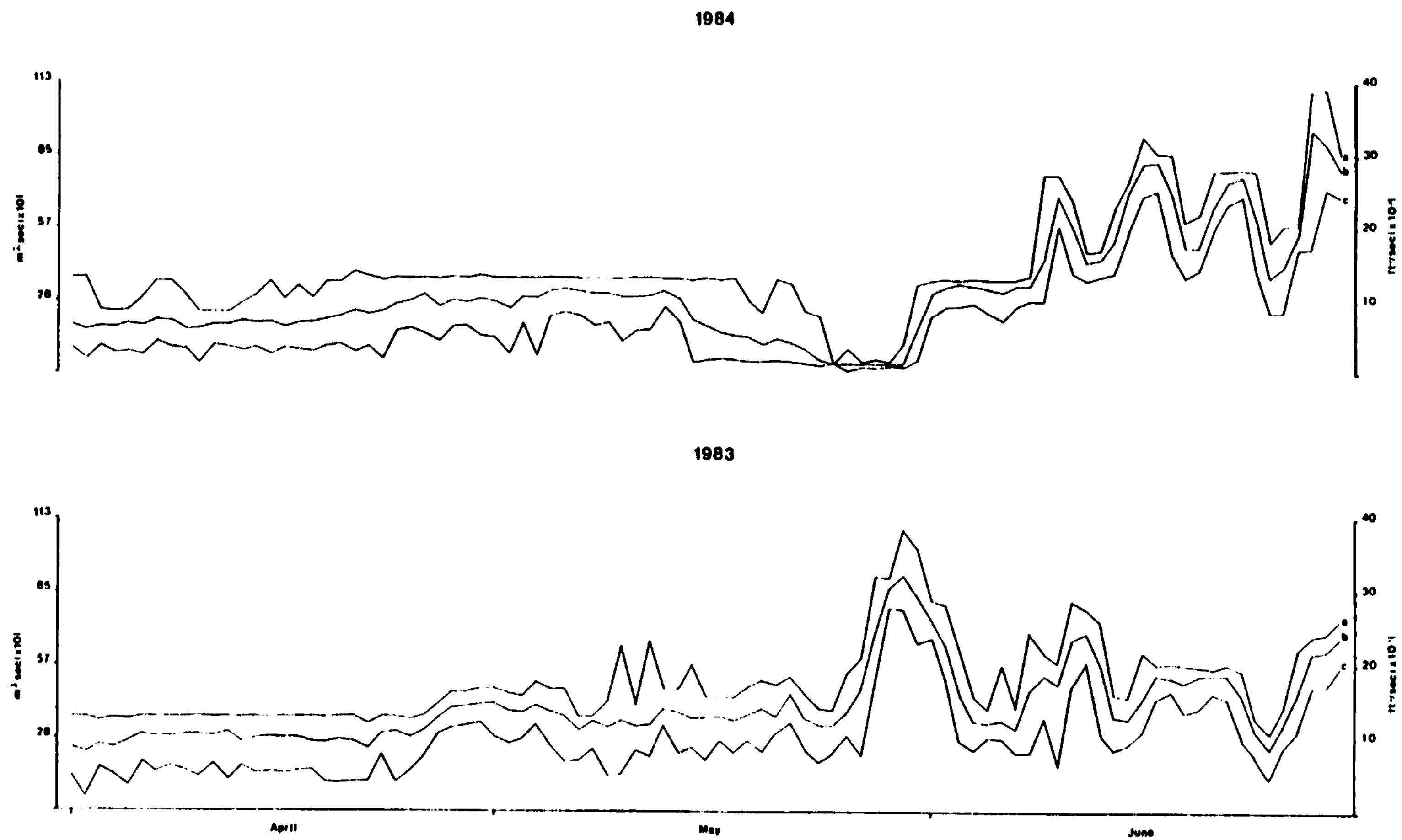


Figure 6. Daily discharges (maximum (a), mean (b), and minimum (c) from Kerr Dam for April, May and June 1983 and 1984 recorded at RK 114.9.

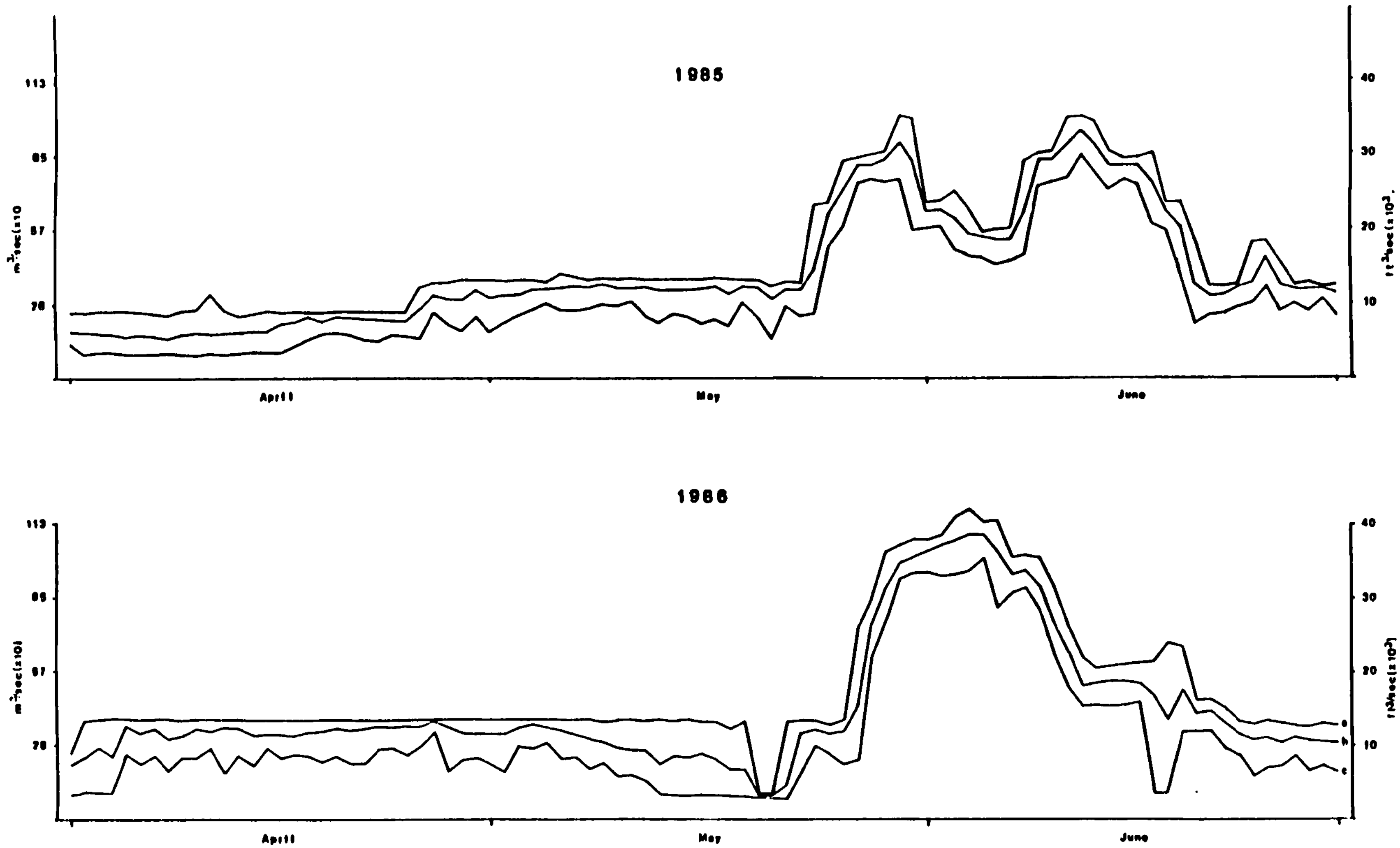


Figure 7. Daily discharges maximum (a), mean (b), and minimum (c) from Kerr Dam for April, May, and June 1985 and 1986 recorded at RK 114.9.

were not seen during the remainder of the study. Flows remained well above 312 m^3/second (11,000 cfs) during May and June of 1985. May 1985 flows were 37 to 53.5% greater than those observed in 1984; June flows averaged 30% lower than 1984. Discharges from Kerr during July and August 1985, critical periods for fry development of northern pike and largemouth bass, were also greater than in 1984.

Mean daily discharges from Kerr Dam were in excess of 204 m^3/second (7,200 cfs) during April and May of 1986, providing northern pike less than optimum depths in inlet channels to known spawning areas (Figure 7). From 18 May to 22 May 1986, discharges from Kerr Dam averaged 91 m^3/second (3,200 cfs) as requested for IFIM measurements. After this requested low flow period, discharges from Kerr remained well above 204 m^3/second (7,200 cfs) until 16 June 1986. Discharges from Kerr after 16 June 1986 and throughout the month of July were variable, and therefore suboptimal for northern pike egg incubation and fry development within off channel spawning areas.

Water Temperatures

Average monthly low, mean, and high river water temperatures recorded at Sloan (RK 71.4) and Perma (RK 17.6) from 1 March 1983 through 31 October 1986 are presented in Appendix C. The USGS discontinued all temperature monitoring at their Kerr gage station (RK 115) after 30 September 1983.

Main river summer water temperature exhibited a consistent pattern. Water temperature between Kerr Dam and Sloan Bridge warmed by 1 to 2 °C. Water temperature dropped two degrees between Sloan and Dixon due to inflow of water from Crow Creek, Mission Creek and the Jocko River. At Perma bridge river water had warmed by 2 °C, the same temperature observed at Sloan's bridge. River water temperatures reached a high of 24.5 °C (August 1983) and a low of 0.1 °C (December 1983) during the study period. Monthly fluctuation in temperature ranged from 1.2 °C (January 1985) to a maximum of 10.8 °C (September 1983).

Substrate Analysis

Gravels from 16 to 63 mm in size predominated most samples from potential spawning sites in the lower Flathead River (Appendix C). With few exceptions, the remaining fractions generally representing 20% or less of the total sample. Comparisons of our data with the Idaho laboratory results of Irving and Bjorn (1984) indicate main river rainbow trout embryo survival in the Buffalo study section would average 28% using the substrate combinations of 0.85 mm and 9.5 mm (Figure 8, Appendix C).

In the Dixon study sections, an average 31% survival by rainbow trout embryos could be expected based on the combination of 0.85 and 9.5 mm fractions, and average survival in the Weed study section would be 61%. The combined percentages of fines smaller than 0.85 and 9.5 mm for the two samples from gravel bar located at RK 48 predicts 52% survival (Figure 8).

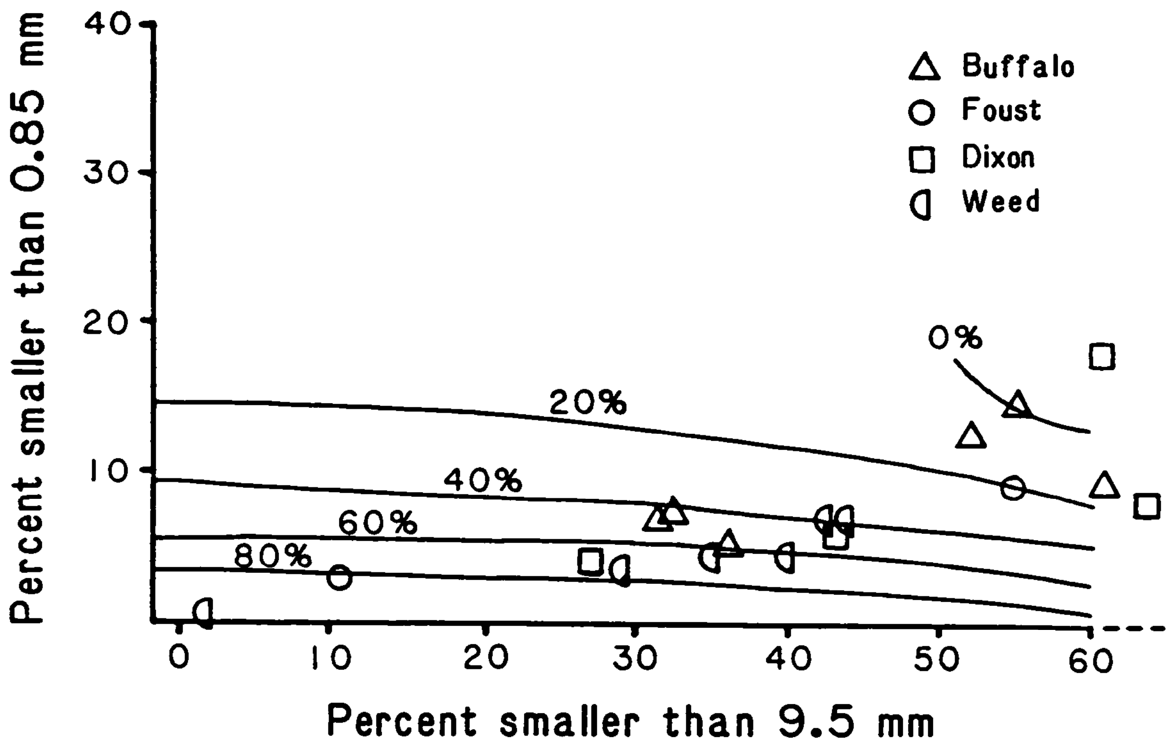


Figure 8. Predicted rainbow trout embryo survival in the lower Flathead River related to various combinations of natural spawning gravel. (Adapted from Irving and Bjorn 1984).

Fish Populations

Largemouth Bass

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

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

Year	Weed	Perma
1983	0.0	0.3
1984	0.1	0.4
1985	0.0	0.6
1986	0.4	0.5

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

Population estimates were attempted in the fall of 1985 at two backwater areas. Macrophyte growth in McDonald Slough limited gear efficiency, so an estimate was attempted in the Sink Hole. Boat electrofishing yielded a CPUE for largemouth bass of 12.6 and a population estimate of 433 ($\pm$ 213), or approximately 34 bass/hectare for the Sink Hole. Average length for all bass captured at the Sink Hole (N = 41) was 303 mm TL (Age 4). Sizes ranged from 131 to 515 mm TL.

From 1 March 1983 through 30 September 1986, a total of 199 largemouth bass were captured, averaging 311 mm TL(Age 4). Catches were dominated by Age 2 and 3 largemouth bass comprised 12 and 10%, respectively, of the total catch (Figure 9), averaging 169 and 221 mm in length, respectively.

Analyzing the length frequency distribution with Anderson's (1975, 1976) Proportional Stock Density (PSD) model produced a value of 68%. Their original models of balance for largemouth bass population resulted in a range of PDS from 45 to 65% and later increased to 70% (Anderson and Weithman 1978). Based on those values, populations of largemouth bass in the lower Flathead are balanced, exhibiting a slightly greater proportion of large individuals, which may be attributed to sampling gear selectivity.

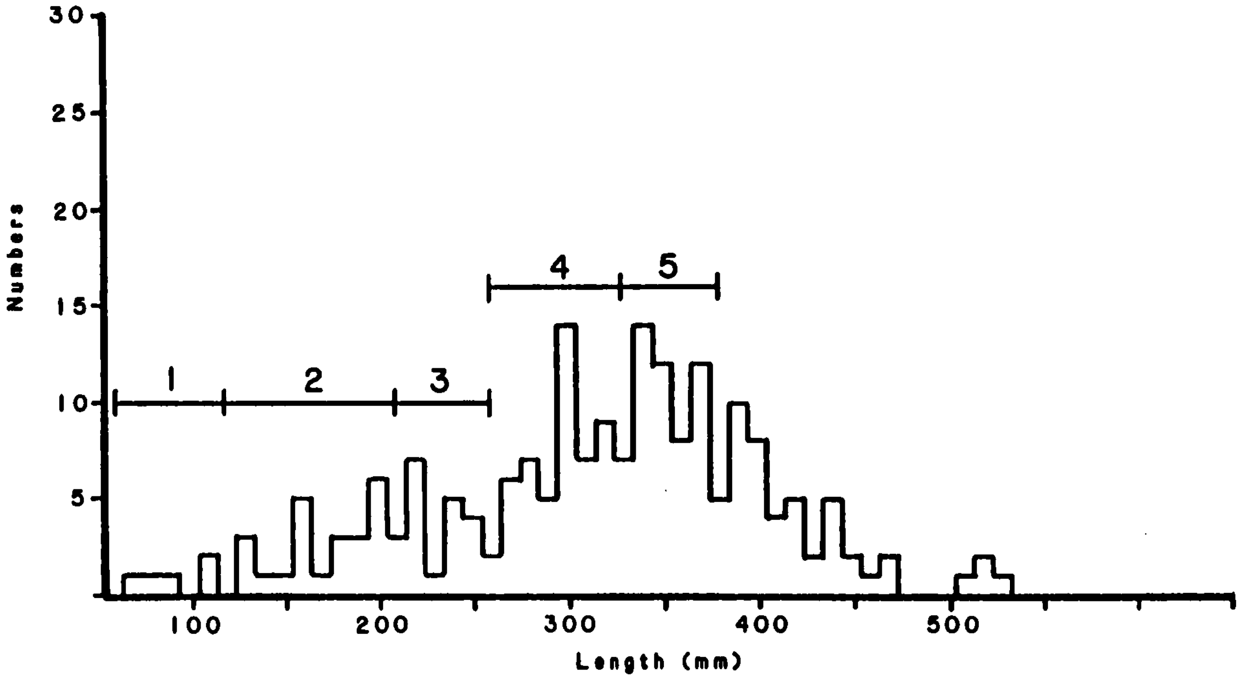


Figure 9. Length frequency distribution of 199 largemouth bass collected from the lower Flathead River 1 March 1983 through 31 October 1986 and their ages based on scale analysis.

Salmonids

During 1983 and 1984 fall sampling, CPUE for mountain whitefish was comparable between the Buffalo, Sloan and Dixon study sections averaging 71.7 fish/hour. CPUE averaged 34.2 for the Weed section and 7.5 at Perma.

Population estimates for mountain whitefish were comparable between the Buffalo and Dixon study section, highest at Weed and lowest at Sloan. Low numbers of recaptures at the Weed study section resulted in the largest population estimates, and the largest (80%) confidence intervals. Overall, whitefish estimates averaged 2,263 fish/km (Table 2).

Mountain whitefish were excluded from the 1985 and 1986 stock assessments after sampling in 1983 and 1984 showed population levels of whitefish were comparable to other western Montana rivers of similar size (Darling et al. 1984).

Cutthroat and bull trout, the two native trout species to the lower Flathead River, are the least common of all salmonids in the river. From September 1983 through October 1986, 40 cutthroat trout were captured, ranging in size form 214 to 440 mm TL. These fish averaged 288 mm TL (Age 3) and 281 g in weight.

Table 2. Catch-per-unit-effort (CPUE) and Peterson mark-recapture population estimates (fish/km) for mountain whitefish from main river study sections, 1983 and 1984, fall sampling.

Year	Buffalo	Sloan	Dixon	Weed	Perma
CPUE					
1983	73.5	73.8	90.0	36.5	11.7
1984	*	42.8	78.5	31.8	3.3
Average	-	53.3	84.2	34.2	7.5
PopEst (80% CI)					
1983	2,306(727)	1,357(350)	-	2,448(1,174)	*
1984	*	-	2,143(723)	3,063(2,257)	*

* not sampled

Numbers of cutthroat trout encountered during fall stock assessment sampling were too low for population estimates. Average CPUE for the four year period, 1983 through 1986 was comparable between the Buffalo (0.16), Sloan (0.12) and Dixon (0.12) study sections, and lowest at Perma (0.02). Catches of cutthroat were significantly higher ($P<.05$) at the Weed study section (0.40, Table 3).

From September 1983 through October 1986, 17 bull trout were captured, ranging in size from 190 to 850 mm TL. These fish averaged 480 mm in TL (Age 5) and 1,311 gr in weight.

The limited numbers of bull trout encountered during fall stock assessment sampling made population estimates impossible. Average CPUE for the four year period 1983 through 1986 was similar between the

Buffalo (0.03) and Sloan (0.02) study sections, intermediate at Weed (0.08) and highest at Perma (0.13). No bull trout were captured at the Dixon study section (Table 4).

Table 3. Catch-per-unit-effort for cutthroat trout within the five permanent river study sections, fall sampling.

Year	Buffalo	Sloan	Dixon	Weed	Perma
1983	0.08	0.07	0.06	0.42	0.00
1984	*	0.00	0.19	0.00	0.00
1985	0.28	0.20	*	0.60	0.00
1986	0.11	0.23	*	0.60	0.09
Average	0.16	0.12	0.12	0.40	0.02

* not sampled

Table 4. Catch-per-unit-effort for bull trout within the five permanent river study sections, fall sampling.

Year	Buffalo	Sloan	Dixon	Weed	Perma
1983	0.00	0.00	0.00	0.00	0.00
1984	*	0.00	0.00	0.08	0.07
1985	0.09	0.10	*	0.22	0.00
1986	0.00	0.00	*	0.00	0.44
Average	0.03	0.02	0.00	0.08	0.13

* not sampled

Although the sample size is extremely small, there is a obvious gradation in the average size of fish captured. Bull trout captured at the Perma and Weed study sections averaged 577 and 408 mm TL, respectively, whereas fish captured upstream from the Weed study section only averaged 276 mm TL.

Rainbow trout are the second most abundant trout species found in the lower Flathead River. Average CPUE for the four year period 1983 through 1986 was similar for Buffalo (0.27) and Sloan (0.28) study sections, highest at Dixon (1.80) and Weed (1.30) and lowest at Perma (0.18, Table 5). Rainbow trout are most abundant ($P<.05$) in river reach III.

Low numbers of rainbow trout captured precluded consistent population estimation. Estimates could be calculated at Buffalo and Sloan only in 1986, but were extremely low ($1\pm.5$ fish/km). The Dixon and Weed study sections produced population estimates, ranging from 6 ± 3 to 11 ± 8 fish/km.

From June 1983 through October 1986 a total of 183 rainbow trout were tagged, ranging in size from 148 to 469 mm TL and averaging 268 mm TL (Age 2). Age 2 fish ranged from 190 to 289 mm TL and comprized 65.6%

of the total catch. Age 3 rainbow trout ranged from 290 to 389 mm TL and comprized 29% of all fish handled. Age 1 and age 4 rainbow trout comprized 1.6 and 3.8%, respectively, of the total catch (Figure 10).

Table 5. Catch-per-unit-effort and Peterson mark-recapture population estimates (fish/km) for rainbow trout from main river study sections, 1983 - 1986.

Year	Buffalo	Sloan	Dixon	Weed	Perma
CPUE					
1983	0.15	0.22	1.40	1.54	0.18
1984	*	0.21	2.23	0.70	0.22
1985	0.09	0.10	*	1.95	0.15
1986	0.57	0.57	*	1.00	0.17
Average	0.27	0.28	1.80	1.30	0.18
PopEst	(80% CI)				
1983	-	-	10(7)	7(4)	-
1984	*	-	11(8)	-	-
1985	-	-	*	6(3)	-
1986	1(.5)	1(.5)	*	-	-

* not sampled

Only two tag returns (1%) were recieved from fisherman for rainbow trout over the four year period of study.

Brown trout were the most abundant salmonid found in the lower Flathead River. Average CPUE for the four year period 1983 through 1986 was significantly higher (P<.05) at Buffalo (3.15) than any other study sections. Data from Dixon produced the next highest CPUE (1.12), the Sloan and Weed study sections were identical (0.90); the lowest catches were at Perma (0.28). Based on catch rate, brown trout are most abundant in River Reach I (Table 6).

The low numbers of brown trout captured precluded consistent population estimation. As with CPUE data, population estimates for brown trout were again highest at the Buffalo section, ranging from 12$\pm$5 to 19$\pm$12 fish/km. The Dixon and Weed study section produced identical ranges of 2$\pm$1 to 7$\pm$5 fish/km Only one successful population estimate was made at Sloan (3$\pm$2) and none at Perma (Table 6).

From April 1983 through October 1986 a total of 277 brown trout were tagged, ranging in size from 184 to 624 mm TL, and averaging 350 mm TL (Age 3). Age 2 fish ranged in size from 250 to 279 mm TL, comprising 37.9% of the total catch. Age 3 brown trout ranged from approximately 280 to 389 mm TL and comprized 25.6% of the total catch. Age 4 and older brown trout accounted for 33.9% of the total catch. The oldest brown trout captured was Age 6. Only seven Age 1 brown trout (2.6%) were handled (Figure 11).

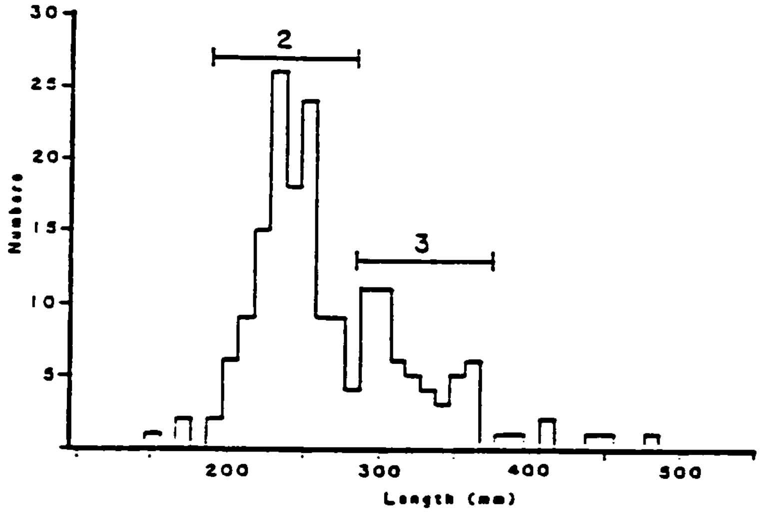


Figure 10. Length frequency distribution of 183 rainbow trout collected from the lower Flathead River 1 June 1983 through 31 October 1986 and their ages based on scale analysis.

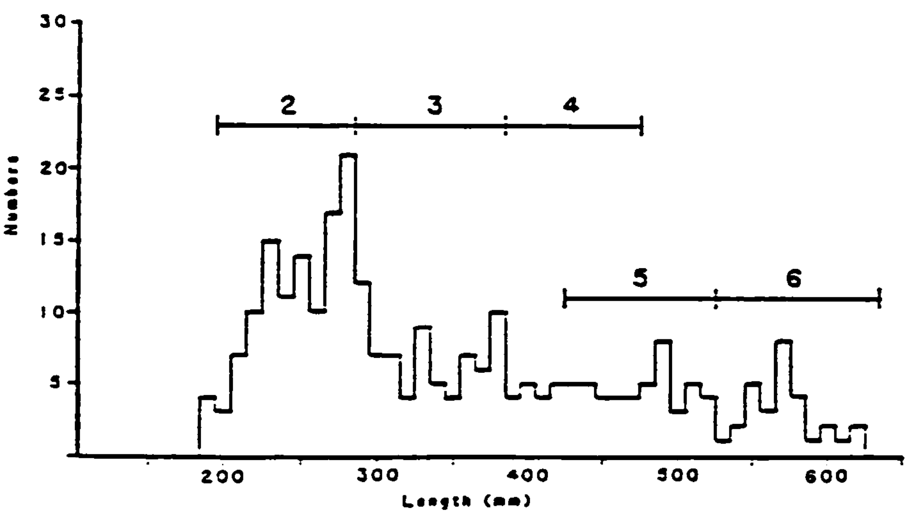


Figure 11. Length frequency distribution of 277 brown trout collected from the lower Flathead River 1 April 1983 through 31 October 1986 and their ages based on scale analysis.

Table 6. Catch-per-unit-effort (CPUE) and Peterson mark-recapture population estimates (fish/km) for brown trout from main river study sections, 1983 - 1986.

Year	Buffalo	Sloan	Dixon	Weed	Perma
CPUE					
1983	1.21	0.29	0.57	0.53	0.65
1984	*	0.82	1.67	0.47	0.07
1985	3.44	0.88	*	0.90	0.15
1986	4.82	1.59	*	1.70	0.26
Average	3.15	0.90	1.12	0.90	0.28
PopEst (80% CI)					
1983	-	-	2(1)	2(1)	-
1984	*	-	7(5)	-	-
1985	19(12)	-	*	-	-
1986	12(5)	3(2)	*	7(5)	-

* not sampled

Only four tag returns (1.4%) were received from fishermen for brown trout over the four year period of study.

Northern Pike

Northern pike were collected throughout the river. Though most common in and around backwater areas they were frequently found in main channel eddies along the entire course of the river. CPUE data has consistently shown that the center of the northern pike abundance was within river Reach III and their abundance tapered off upstream and downstream of this reach (Table 7).

Low numbers of northern pike captured precluded yearly population estimates in all but the Weed study section. As with CPUE data, population estimates for northern pike were highest at the Weed section, ranging from 10±7 to 40±22 fish/km. Only one successful population estimate was made at the Dixon and Perma study sections, 13±8 and 17±9 fish/km, respectively. Pike abundance drops off in the Sloan (2±1 and 10±7) and Buffalo (3±2) sections.

From March 1983 through October 1986 a total of 553 northern pike were tagged, ranging in size from 168 to 1,040 mm TL, and averaging 559 mm TL (Age 3). 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 TL by the end of their first year. By their third year they doubled their length. By their fifth year male northern pike reach 675 mm TL, and female pike reach 965 mm TL. Seventy two percent of all northern pike handled from 1 March 1983, were age 3 or younger (Figure 12).

Table 7. Catch-per-unit-effort (CPUE) and Peterson mark-recapture estimates (fish/km) for northern pike from main river study sections, 1983 - 1986, fall sampling.

Year	Buffalo	Sloan	Dixon	Weed	Perma
CPUE					
1983	0.76	0.57	1.90	3.68	0.01
1984	*	0.61	0.19	1.64	0.66
1985	0.47	0.69	*	1.73	1.00
1986	0.68	2.39	*	3.00	3.51
Average	0.64	1.06	1.04	2.51	1.30
PopEst (80% CI)					
1983	3(2)	2(1)	13(8)	40(22)	*
1984	*	-	-	10(7)	-
1985	-	-	*	12(8)	-
1986	-	10(7)	*	19(14)	17(9)

* not sampled

Analyzing pike length frequency distribution with Anderson's (1975, 1976) Proportional Stock Density (PSD) model produced values ranging from 64 to 68%. Anderson and Weitherman (1978) suggest that stocks of northern pike exhibit satisfactory or favorable structure, i.e., balance, when PSD is near or within a range of 30 to 60%. The Flathead pike population exhibits a slightly greater population of larger individuals. This might be attributed to sampling gear selectively or low survival rates in the younger year classes.

Spawning northern pike were captured in the spring from 1983 through 1986. Trapping and gill netting operations began by the first of April and were completed by the end of May. Two hundred thirty nine pike from 16 different river locations were captured, 96% below RK 50 (Table 8). Electrofishing surveys conducted concurrently captured 60 additional spawning pike.

Of the 299 northern pike captured, 37% were sexually immature. Mature spawners captured and sexed were 70% male and 30% female, a sex ration of 2.3:1.0 (Table 9). Seventeen (33%) of the 51 spawners captured in 1985 were recaptures from 1983 and 1984 spring sampling. In 1986, 4(17%) of the spawners captured (23) were recaptures from previous years.

Analysis of radio tracking data provided evidence that male pike begin movements to spawning areas during the early part of April, and stay near spawning areas for approximately three months. Females move to spawning areas by the first of May and stay near spawning areas for approximately one month. Off channel staging areas used by pike during the spawning period ranged from 1.2 to 2.3 m in depth with water velocity not exceeding 0.5 m/second (1.6 ft second).

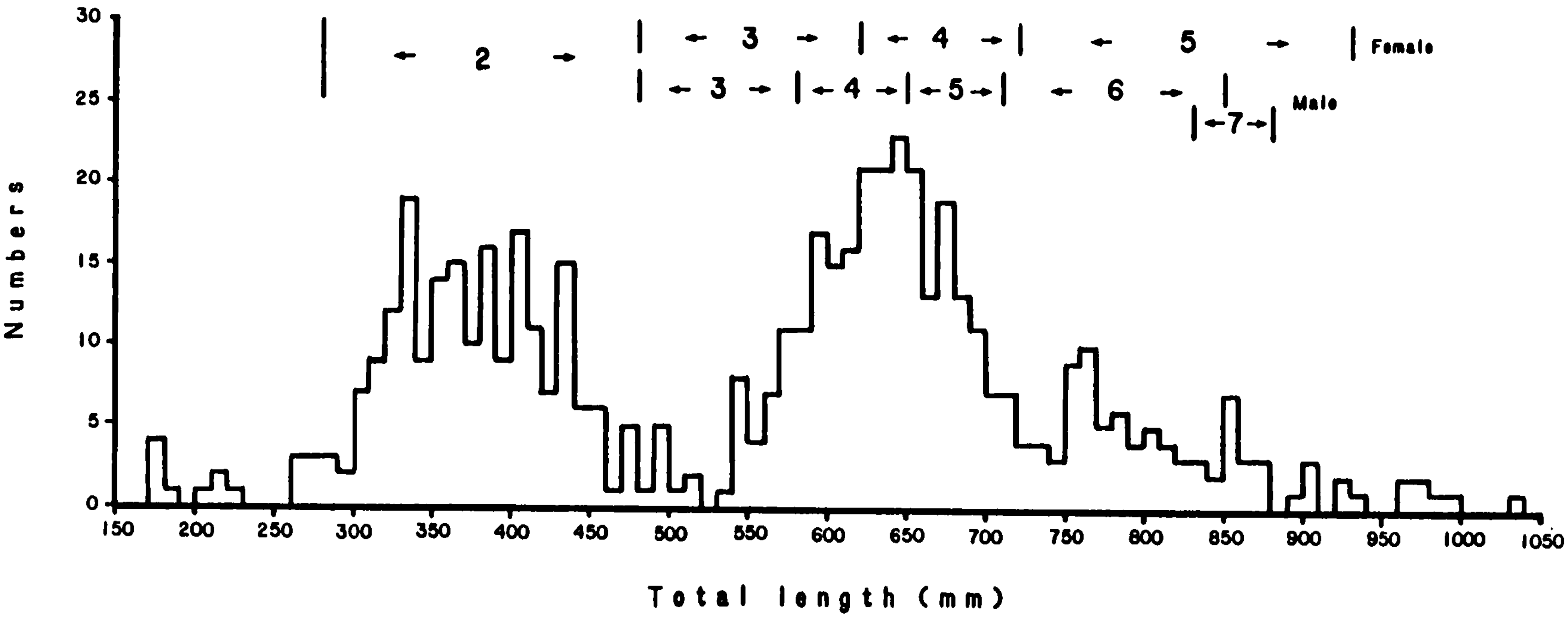


Figure 12. Length frequency distribution of 553 northern pike collected from the lower Flathead River 1 March 1983 through 31 October 1986 and their ages based on scale and Clithrum analysis.

Table 8. Summary of trapping and netting locations sampled to collect spawning northern pike, 1983-1986.

Location	River Kilometer	1983 Trap	1983 Net	1984 Trap	1984 Net	1985 Trap	1985 Net	1986 Trap	1986 Net	Total
Buffalo Slough	104.6	-	-	-	-	-	1	-	-	1
Goose Bend	99.0	-	-	-	-	-	1	-	1	2
Horseshoe Bend	93.3	-	-	-	-	-	1	-	-	1
Sloan #1	74.0	-	-	-	-	-	-	-	2	2
Ski Rock	70.8	-	-	-	-	-	-	-	3	3
Foust Slough	49.9	-	13	-	1	-	-	-	-	14
Pike Hole	48.9	-	3	-	25	-	8	-	9	45
Beaver Lodge	43.4	-	-	-	-	7	1	-	-	8
Agency Slough	42.6	-	-	-	-	4	-	-	3	7
Duck Pond	36.5	1	-	-	-	-	-	-	-	1
Sink Holes	33.8	1	29	1	4	-	1	-	5	41
Pike Alley	32.0	-	-	-	3	1	1	-	-	5
Ferry Slough #2	31.2	7	-	-	-	-	-	-	-	7
Ferry Slough #1	31.1	11	-	21	-	28	-	-	-	60
McDonald Slough	29.0	5	20	1	8	-	7	-	-	41
Pipeline Slough	21.9	-	-	-	1	-	-	-	-	1
	Totals	25	65	23	42	40	21	0	23	230

Table 9. Numbers, reproductive conditions and average length (mm) for northern pike captured during the spring 1983-1986.

Year	Immature	Male	Female
1983	62	33	17
1984	37	46	29
1985	3	41	7
1986	9	10	4
Total	111	130	57
Average Length	377	688	699
Range	267-490	428-975	540-996

Northern pike enter shallow areas to spawn where the remains of last year's aquatic vegetation, cattail (Typha latifolia), horsetail rush (Equisetum spp.) and bulrush (Scirpus acutus), has been recently resubmerged. Reproductively ripe northern pike that were captured in staging areas were over aquatic vegetation consisting of last year's dead and newly emerging Elodea spp., Potamogeton spp., Chara spp., Ranunculus spp. and Myriophyllum spp. A complete listing of emergent and submergent aquatic vegetation found within backwater areas of the lower Flathead River is presented in Appendix C.

Spawning occurs during daylight hours, and has been observed in two backwater areas. Spawning groups, consisting of a female plus one or two males, move in short rapid bursts after which the fish are stationary, presumably at rest. Eggs adhere to vegetation and at water temperatures above $10^{o}C$ hatch in 12 days or less (Inskip 1982). After hatching fry also adhere to vegetation and remain attached for 10 to 24 days (Inskip 1982).

Based on observation during the spring of 1983 through 1986 known spawning areas are subject to daily water level fluctuations due to Kerr operations. A change of only 3 cm can change inflow to outflows at the mouth of some spawning areas, thereby effecting pike movement into these areas. Common daily springtime water level fluctuations of 0.4 to 1.5 m dewater known spawning areas repeatedly, exposing eggs and fry to both desiccation and predation.

Based on staff gage readings, a mean daily discharge of less than 360 m^3/second (12,700 cfs) causes water to start draining from all spawning areas downstream of RK 50. A mean daily discharge of 371 m3/second (13,100 cfs) causes upstream water inflow into these areas, while a discharge of approximately 204 m^3/second (7,200 cfs) dewaters the inlet of all off channel spawning areas.

Aerial photo comparisons revealed even the larger, permanently wetted backwater areas could be greatly affected by river discharge. At the Pike Hole, Ferry and McDonald sloughs, a river discharge of 360 m^3/second produced almost twice the available wetted area as does 204 m^3/second (Figure 13).

Tag returns and radio tracking data showed two patterns of movement for northern pike in the lower river. Twenty five floy tagged pike (43%) were recaptured at their original tagging location. Twenty three (40%) showed upstream movements averaging 18 km, ranging from less than 1 to 70 km. Ten fish (17%) showed downstream movement averaging 17 km, and ranged from less than 1 to 88 km (Appendix D). Interpretation of movements based on floy tag return data only is difficult because of the lack of knowledge of movement between tagging and recapture locations.

To better assess seasonal habitat use and movement, eleven pike were surgically implanted with radio transmitters (Appendix D). Pike implanted with radios averaged 838 mm TL. Radios of five fish (radio #693, 832 758, 223 and 293) transmitted an average of 73 days and showed no appreciable movement from the original tagging location. Pike #064, tagged on 2 April 1984 and RK 105, was captured, in good health with surgical scar completely healed, by a fisherman 77 days after implantation at RK 17, a straight line downstream movement of 88 km.

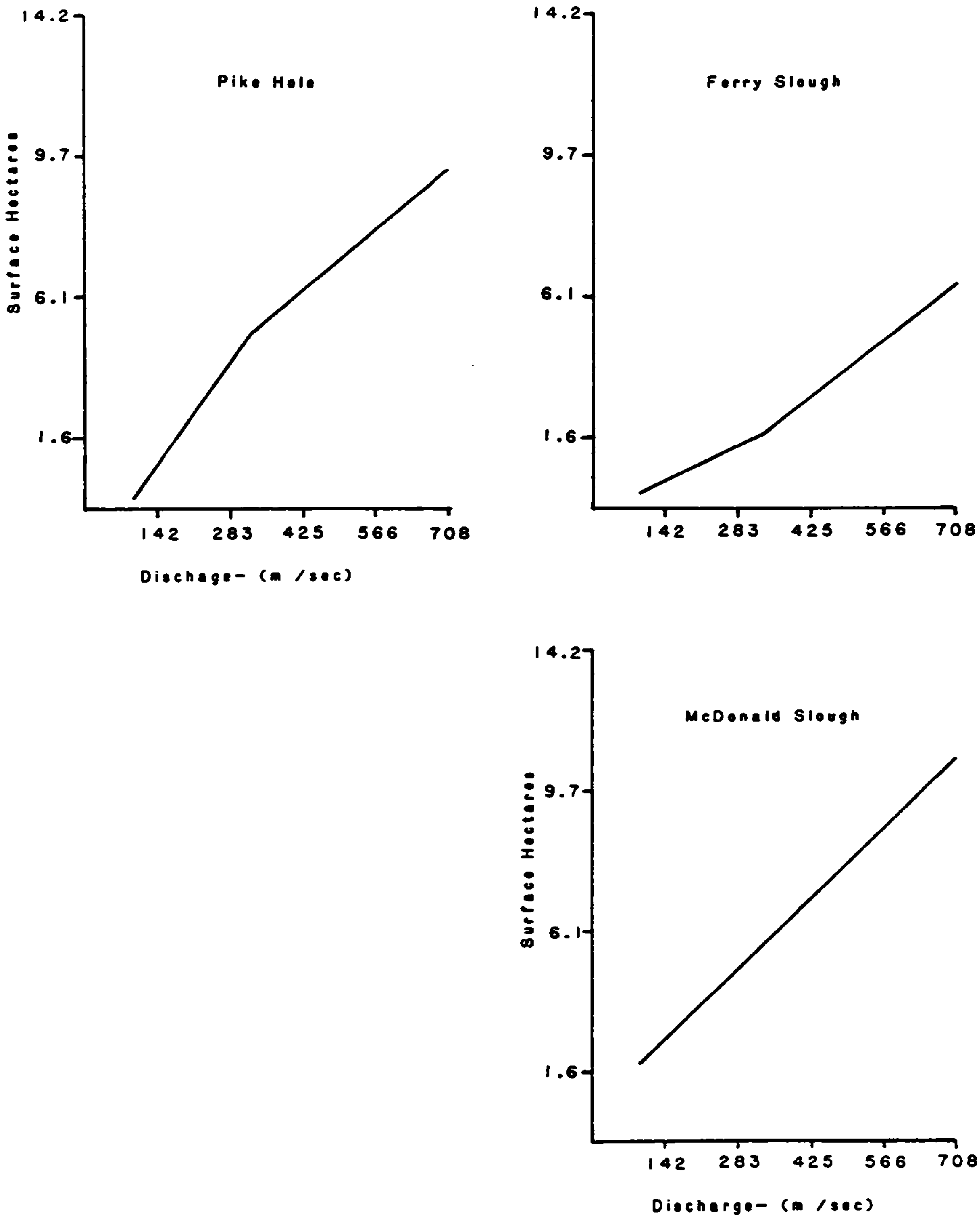


Figure 13. Relationship of river discharge to surface area of three known northern pike spawning areas of the lower Flathead River.

Radios of five northern pike (radio #020, 163, 392, 553 and 655) transmitted for an average of 778 days, and data infer two different patterns of seasonal movement within the lower Flathead River.

Pike #653, a male, which was originally tagged on 3 May 1984, was the only radioed fish in River Reach III. A pattern of spring upstream movement to the Pike Hole, a known spawning site, and post spawning downstream movement to a preferred holding area was observed for four years with this male. This fish was captured at the Pike Hole by a fisherman on 19 April 1987. The observed activity pattern of this pike (#653) consisted of 3 months at the Pike Hole during the spawning season, arriving in early April and leaving in early July with the remaining nine months spent in a 1.6 km area around Ferry Slough (RK 30.6 - 32.2). The 16 km upstream trip averaged 10 to 15 days (Figure 14).

Two pike, #163 a male and #392 a female were captured and radio tagged on 11 April 1984 at RK 72.1. Their radios were monitored for two years. The monitored activities of these fish established a much smaller home range then observed in fish #653. The center of activity of these two fish was the confluence of the Little Bitterroot River (RK 72.4). The male pike (#163) would move downstream in and around the mouth of the Little Bitterroot River during the early part of April for spawning and move back upstream, permanently, by June. Unlike male #653, this fish (#163) would not stay near the spawning area, but rather make from two to three visits at about one month intervals to the Little Bitterroot River. From the later part of June through the month of March activities centered in a main channel eddy area at RK 74.2, only 1.8 km upstream from the confluence of the Little Bitterroot River (Figure 15).

The female pike (#392), tagged at the same time and location as the fish #163, showed a mirror image of his movement pattern. She would move upstream to the Little Bitterroot River area during early April and return to a preferred holding site at RK 70.5 no later than late June. Female #392 did not move to the Little Bitterroot River during the spring of 1985, as she did in 1984 and 1986 (Figure 15).

The female pike (#020) tagged at Buffalo Bridge (RK 105) on 1 April 1984 began to move downstream shortly there after and reached the Pike Hole (RK 48.9) on or before 15 June 1984. Staying at the Pike Hole for slightly over one month she began to move upstream again after high water had begun to receed. After the spawning season, she (#020) spent almost two months in a main area at RK 62.3, 1984 was at RK 95.4; a large eddy on the upstream side of Horseshoe Bend. The fish over wintered here. On 25 April 1985 she was relocated at RK 99.6, the Goose Bend area, and remained there for almost one year, until captured by a fisherman on 4 April 1986 (Figure 16).

Male pike #553 was radio tagged on 3 May 1984 at the Pike Hole (RK 48.9) and remained there through the latter part of June. On 18 July 1984 he was located at the upper end of Horseshoe Bend (RK 95), traveling some 47 km upstream in roughly one month. He overwintered here, as did the female #020. Sometime after 9 April 1985, a downstream movement was monitored and by 25 April 1985 the fish was again at the Pike Hole (RK 48.9), and remained there through 8 July 1985 at which time its signal was lost. For almost nine months #553 was presumed

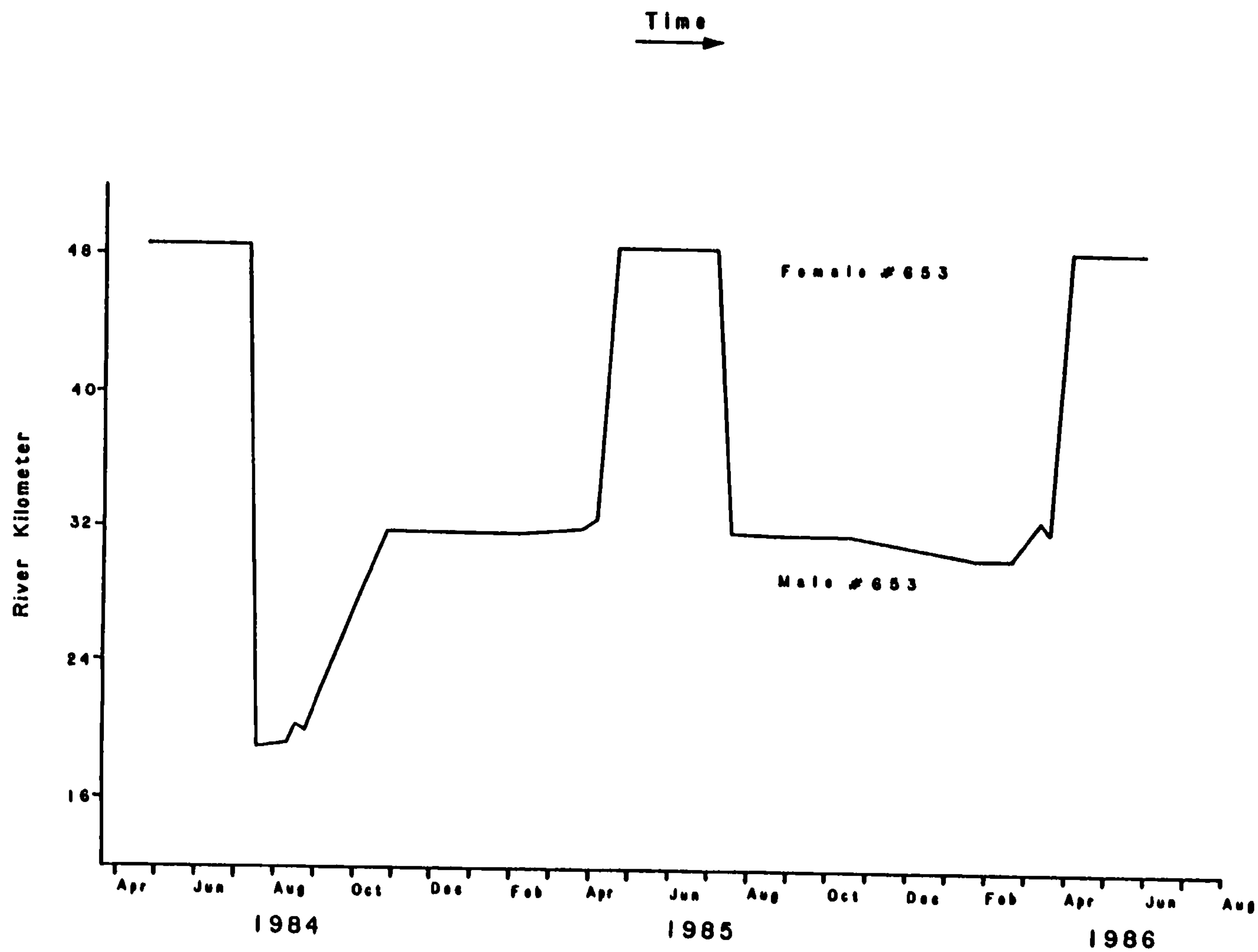


Figure 14. Seasonal movements of one male (#653) radio tagged northern pike within the lower Flathead River. River kilometer 48 is a known spawning area.

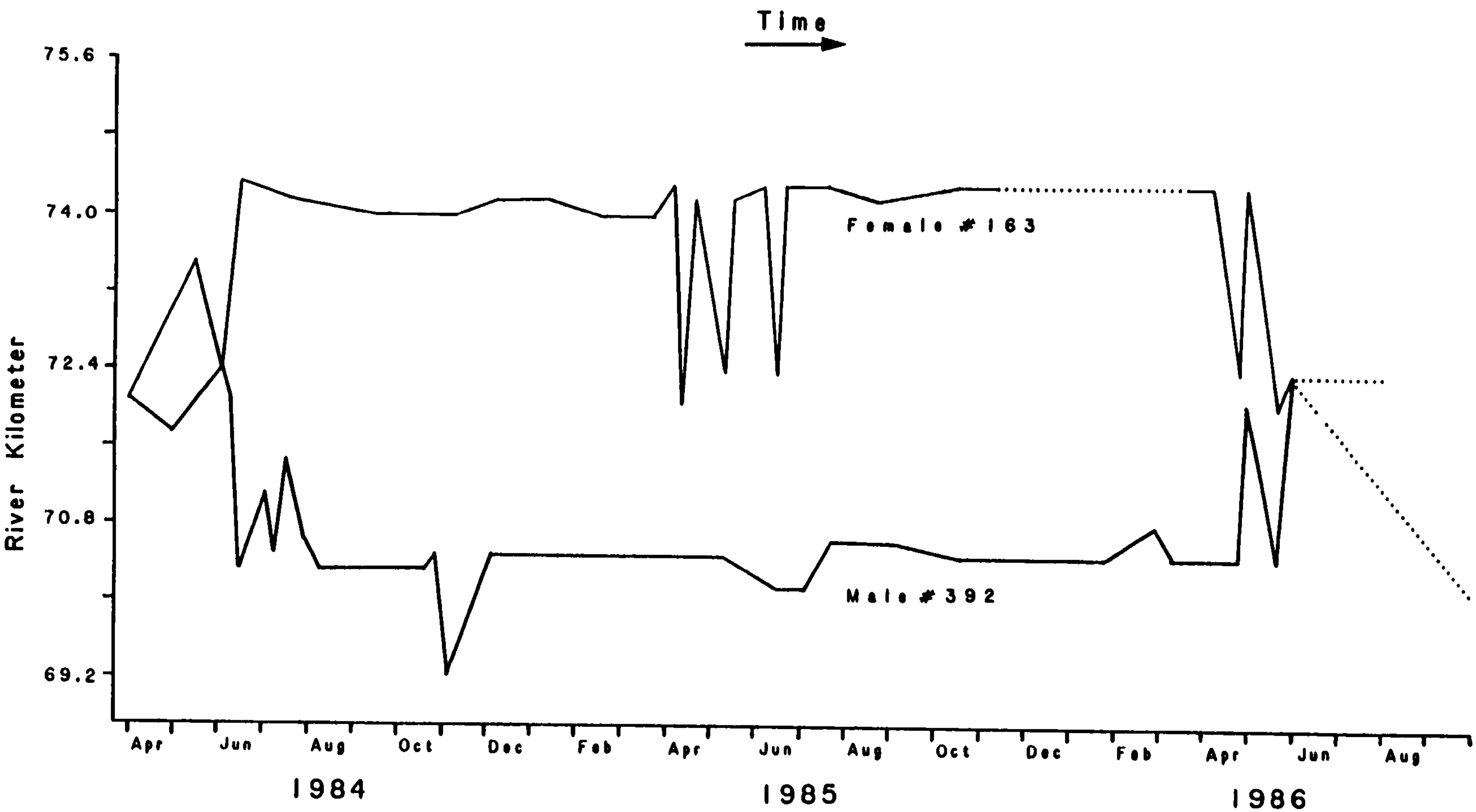


Figure 15. Seasonal movement of one male (#163) and one female (#392) radio tagged northern pike within the lower Flathead River. The area in and around river kilometer 72.4 is a known spawning area.

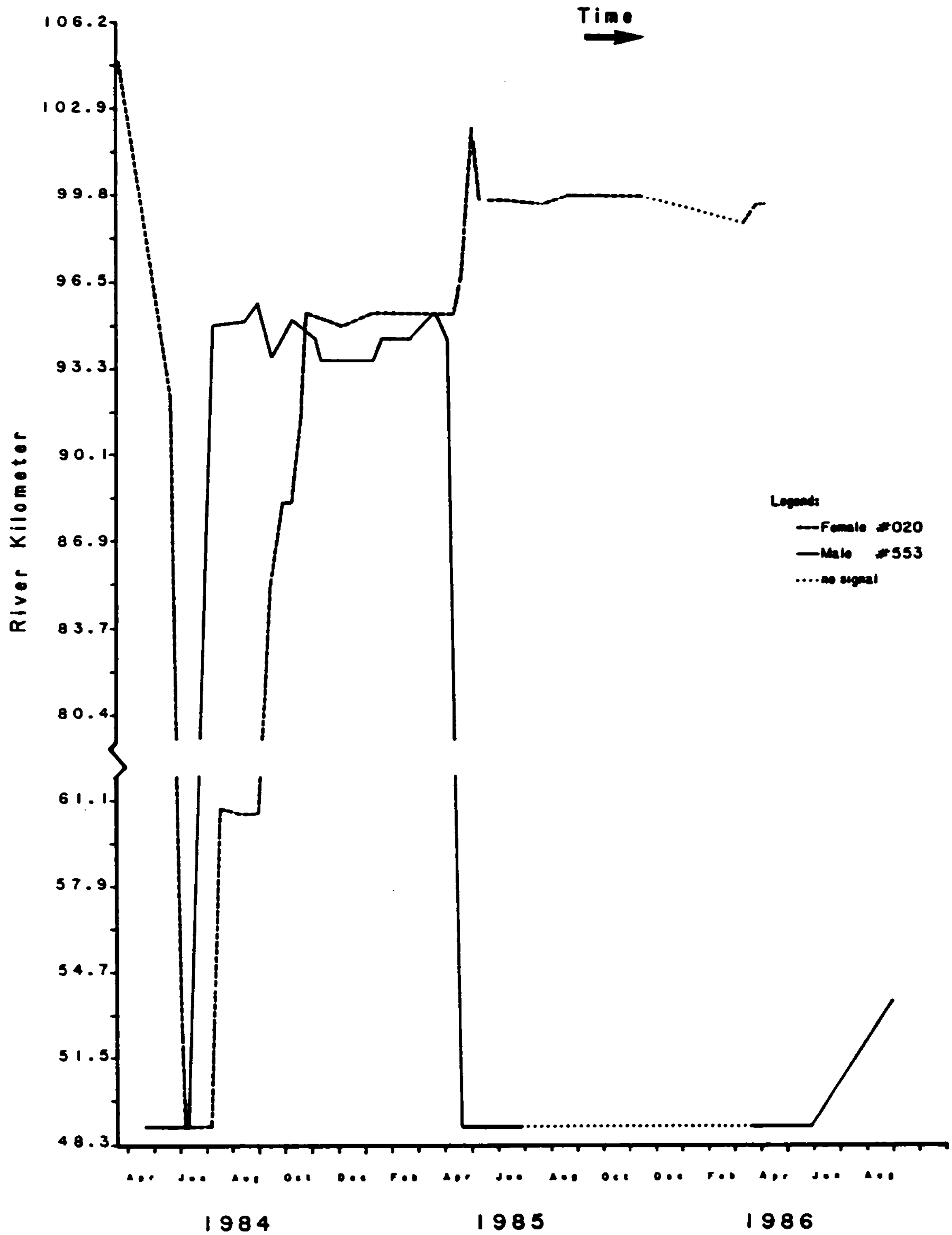


Figure 16. Seasonal movements of one male (#553) and one female (#020) radio tagged northern pike within the lower Flathead River. River Kilometer 48 is a known spawning area.

captured; repeated attempts to reacquire the signal proved unsuccessful. Routine tracking operation on 20 March 1986, again located #553 at the Pike Hole, and he remained there at least through 28 May. Our last location for #553 was at RK 53.6 on 27 August 1986, 846 days after implantation (Figure 16). It is presumed that during the nine months when no signal could be received that #553 could have been in relatively deep water upstream from the Pike Hole.

Specific northern pike habitat parameters collected during the length of these radio tracking operations are presented in Table 10. Average length and weight of radio tagged male and female pike were similar as were water depth and substrate type. Although sample size was small, females were found in main channel areas (60%) more. Average water column velocities for female pike were higher (0.2m/second (0.64 ft/sec)) than that for males (0.1 m/second (0.34 ft/second)). Males were found in marsh areas (43%) more often than females (P<.05, Table 10).

Table 10. Mean microhabitat parameters chosen by radio tagged male (n=6) and female (n=3) northern pike in the lower Flathead River.

	Male	Female
Length (mm)	838	840
Weight (g)	5,733	6,307
Water Velocity (ft/sec)	0.34 (40)*	0.64 (23)*
Water Depth (m)	2.57 (91)	2.67 (55)
Habitat Type (% Observed)		
Channel	43% (82)	60% (62)
Marsh	30% (56)	17% (18)
Eddy	25% (25)	22% (23)
Substrate Type (% Observed)		
Cobble	18% (22)	19% (11)
Ag. Veg.	73% (89)	72% (41)

* numbers within parenthesis represent actual number of field observations or measurements used in the formulation of mean values.

Based on radio tracking fixes, slackwater sites chosen by northern pike during non-spawning daylight hours range from 2.3 to 3.2 m in depth, with water velocities not exceeding 0.2 m/second (0.6 ft/second). Off channel staging areas used during spawning ranged from

1.2 to 2.3 m in depth with water velocities not exceeding 0.5 m/second (1.6 ft/second). Habitats most frequently occupied by radioed pike were totally vegetated.

Instream Flow Incremental Method

River segment evaluation for IFIM resulted in two study sections. IFIM River Segment I extended from RK 108.5 to RK 54 and was characterized as the single channel portion of the river. The study section chosen to represent this portion of the river extended from RK 75.5 to RK 73.4 and was described using a combination of 6 cross-sectional profiles (Figure 17).

IFIM River Segment II extended from RK 54 to RK 6 and was characterized as the braided channel portion of the river. The IFIM study section chosen to represent this braided channel portion of the river extended from RK 30.1 to RK 28.2 and was described using a combination of 7 flowing and 2 standing water cross sectional profiles (Figure 18).

A requested flow of 91 m^3/second (3,200 cfs) was provided by Montana Power Company beginning 19 May 1986. Field measurements began on 20 May 1986. Twenty four hours were allowed for stabilization of flows at the study sites. Using two field crews, three working days were required to evaluate both the Sloan and McDonald sites. Measured river discharges varied by 22.8 m^3/second (807 cfs) at the Sloan study site and 17.4 m^3/second (616 cfs) at the McDonald site. A total of 180 and 261 observations were made to evaluate instream cover types and substrate composition at the Sloan and McDonald sites, respectively, during this requested low flow.

A second requested flow, averaging 242 m^3/second (8,560 cfs) was provided by MPC from 13 May through 17 May 1986. Field measurements began on 14 May and were completed on 16 May 1986. Measured river discharges varied by 40 m^3/second (1,401 cfs) at the Sloan study site and 19 m^3/second (662 cfs) at the McDonald site. A summarization of physical measurement obtained at both study sections during the requested flows are presented in Table 11.

At the Sloan study section, maximum Weighted Useable Area (WUA) for the adult life stage of the three trout species was produced at discharges ranging from 99 to 127 m^3/second (3,500 to 4,500 cfs). Fry and juvenile habitat (WUA) was maximized at discharges of 113 and 99 m^3/second (4,000 and 3,500 cfs), respectively, for the three trout species. Predicted spawning habitat was extremely small for both rainbow and cutthroat trout, but was at moderate levels for brown trout, showing maximum values at or below 127 m^3/second (4,500 cfs). Brown trout habitat in general, decreased less with increasing discharge, than did other trout habitat. (Figure 19).

At the McDonald study section, maximum WUA for the fry, juvenile and adult life stages of the three trout species was predicted at 71 m^3/second (2,500 cfs). At discharges above 71 m^3/second (2,500 cfs), WUA tapers off for all three species at varying rates. Spawning habitat for cutthroat and rainbow trout is limited at all flows

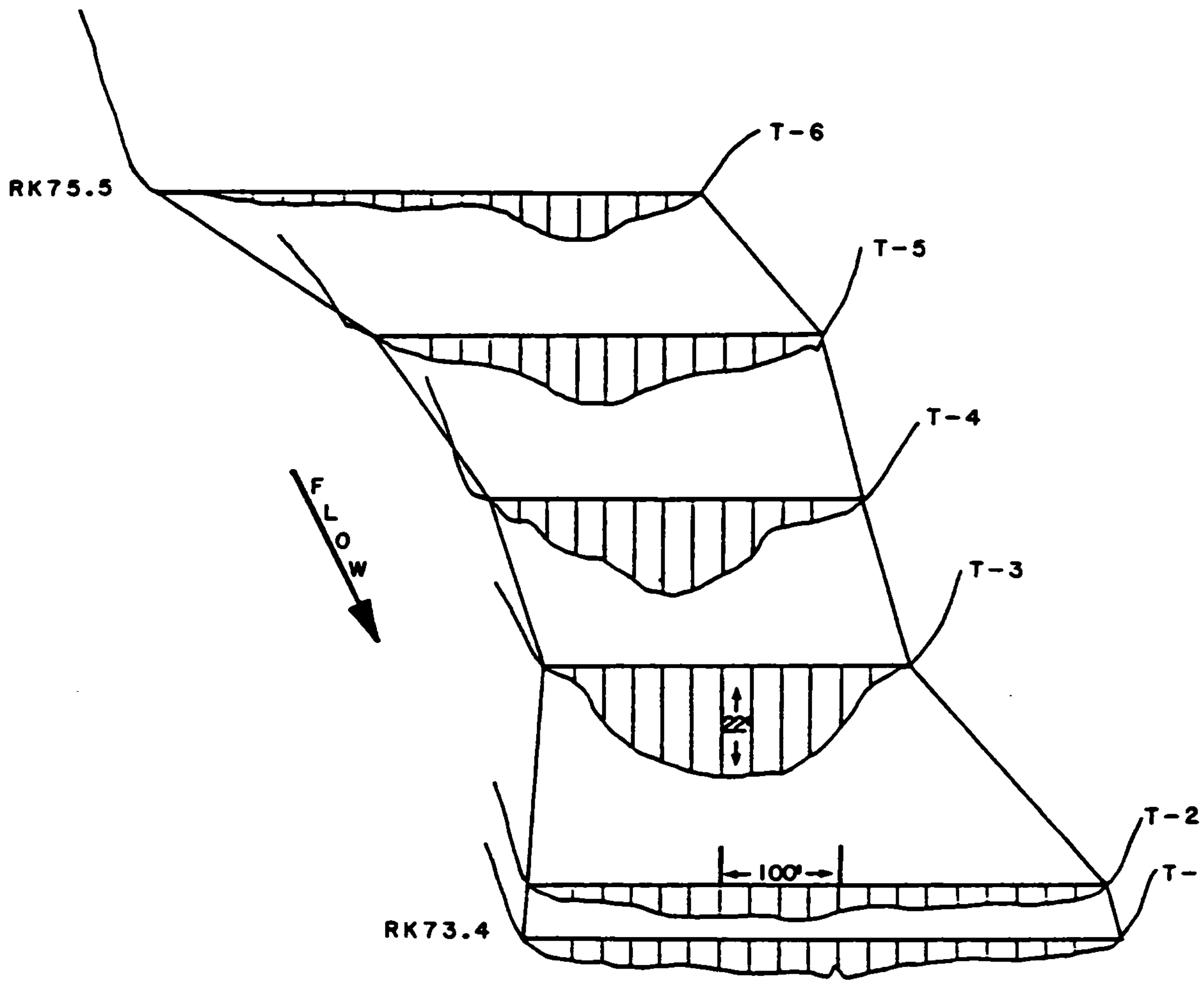


Figure 17. Three dimentional representation of the Sloan IFIM study section. The vertical scale is exaggerated five times. Representative river kilometers are given.

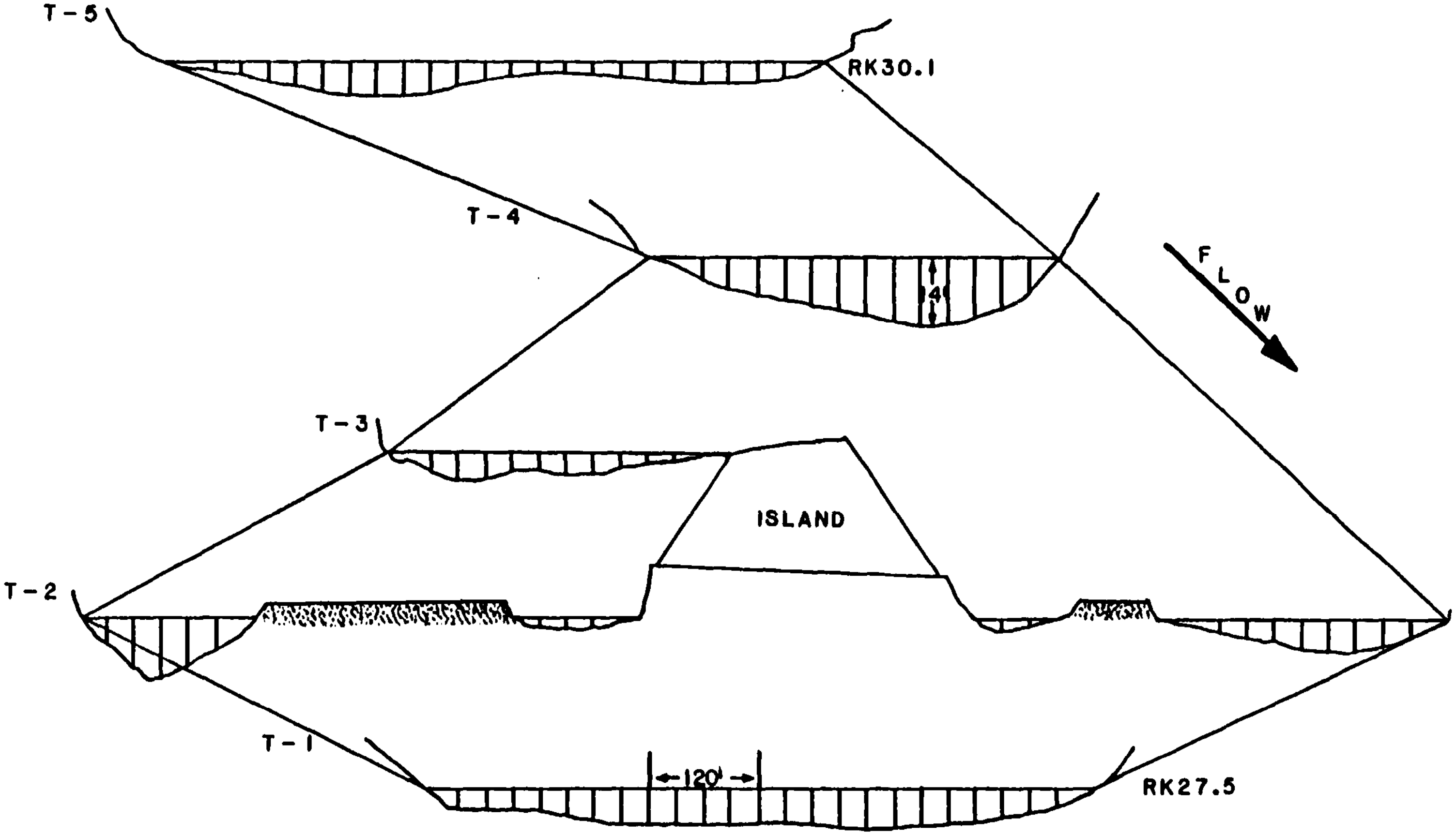
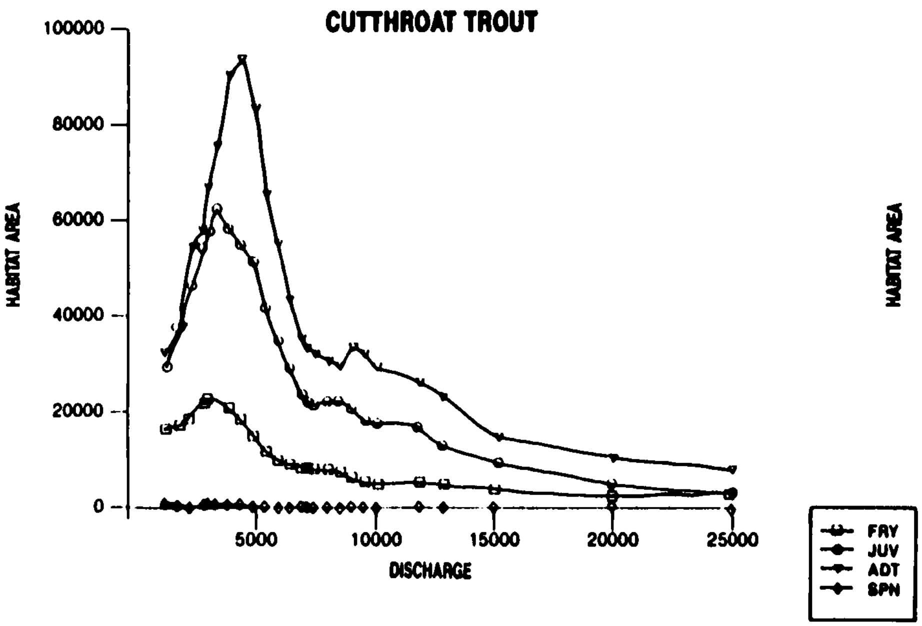


Figure 18. Three dimentional representation of the McDonald IFIM study section. The vertical scale is exaggerated five times. Representative river kilometers are given.

Table 11. Summary of Physical measurements taken for IFIM analysis at the Sloan and McDonald study sites during Low and High requested flows.

	Transect	(Weighting)	Transect Length (ft)	Low Flow: Estimated Discharge (cfs)	Low Flow: Maximum Depth (ft)	Low Flow: Maximum Average Water Velocity (ft/sec)	High Flow: Estimated Discharge (cfs)	High Flow: Maximum Depth	High Flow: Maximum Average Water Velocity (ft/sec)
Sloan	1	(0.87)	641.4	3,386	4.7	5.65	9,143	6.8	6.77
	2	(17.73)	588.4	3,193	4.6	3.98	8,732	6.2	5.65
	3	(7.56)	457.5	2,899	19.4	1.42	8,656	22.3	2.72
	4	(14.24)	472.1	3,539	17.3	2.21	9,750	19.6	4.55
	5	(32.56)	557.3	3,520	8.9	3.98	10,057	11.8	5.85
	6	(27.04)	648	3,706	7.6	5.65	9,480	10.1	6.92
McDonald	1	(23.81)	784	4,558	5.6	2.15	10,138	7.5	3.18
	2a	(9.39)	207.5	3,373	11.5	3.62	6,416	13.5	5.88
	2b	(6.25)	166	94	1.3	1.2	586	2.6	2.86
	2c	(15.64)	541.8	903	4.4	1.88	3,642	6.4	3.74
	3	(4.42)	493.6	3,131	5.2	4.2	6,980	6.7	5.25
	4	(17.01)	526.9	4,433	13.8	1.75	10,445	15.2	3.35
	5	(23.47)	813.9	4,650	6.9	2.81	10,801	8.6	4.15
Backwater	6		666.3	--	2.55	--	--	--	--
Transects	7		328.4	--	9.6	--	--	--	--



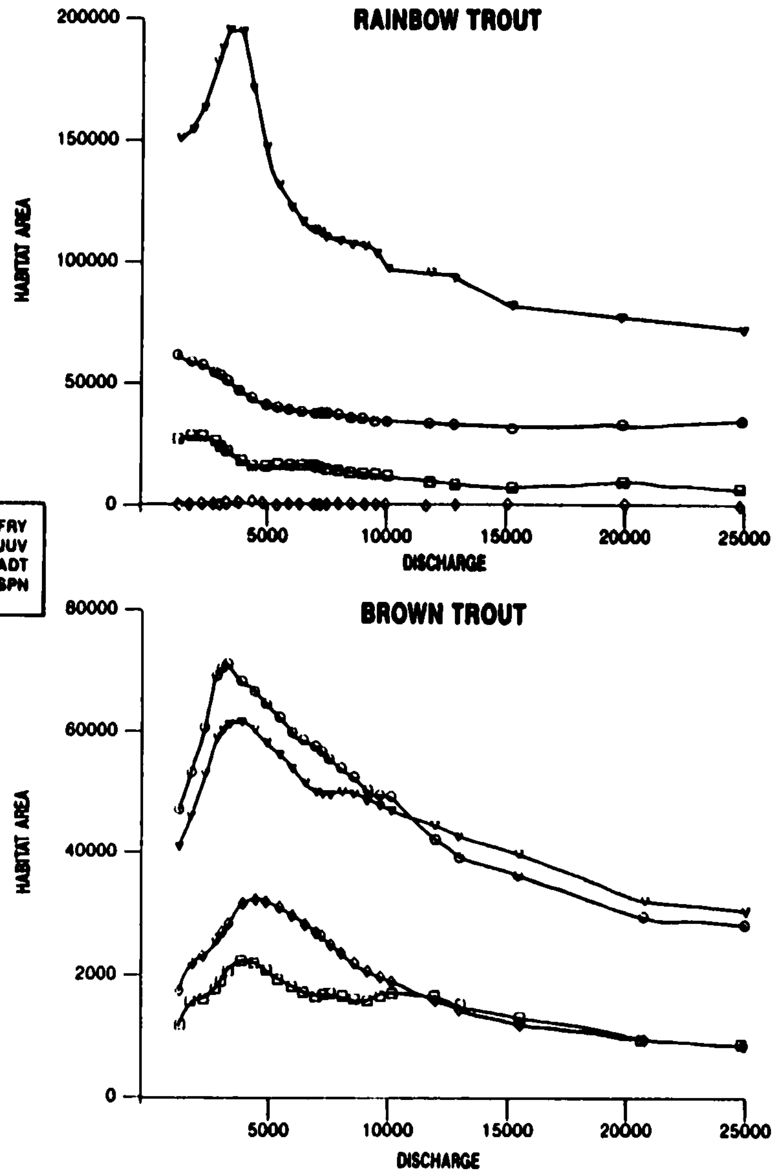
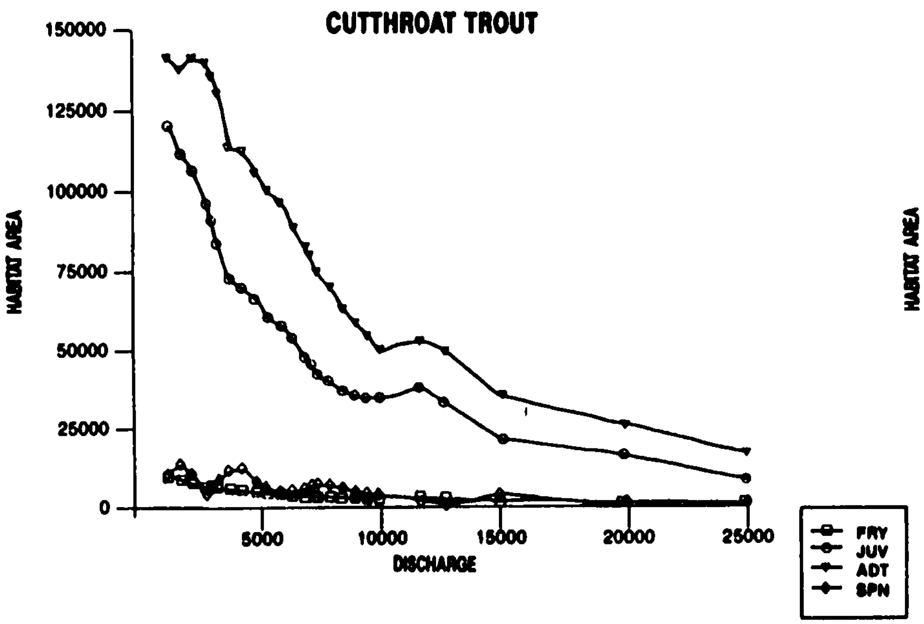


Figure 19. Predicted available habitat (ft^2/1000 linear ft of river) as a function of discharge for differing life stages of select salmonid species found within the Sloan IFIM study section.

and abundant for brown trout relative to the other species. As with the Sloan study section, brown trout habitat (WUA) was less effected by increasing discharges (Figure 20).

Changes in northern pike habitat (WUA) with changes in river discharge showed similar responses at both study sections. Adult habitat increases throughout the range of flows, while available fry habitat declined with increasing flows. At the Sloan study section spawning and juvenile habitat peaked at 269 and 212 m^3/second (9,500 and 7,500 cfs), repectively. At the McDonald site habitat for these two life stages peaked at 169 and 113 m^3/second (6,000 and 4,000 cfs) respectively. Spawning and juvenile habitat decreased gradually as discharge increased (Figure 21). Complete Tape 8 (WUA) output is presented in Appendix B.

Based on analysis of main river IFIM results, Kerr Dam flow scenarios for each of three fish species and one overall composite were developed (Tables 12 to 15). Mean discharge values for each month and the flow windows around them reflect the greatest possible weighted useable area (WUA) within the constraints of available flows accomodating the need for hydroelectric flexibility.



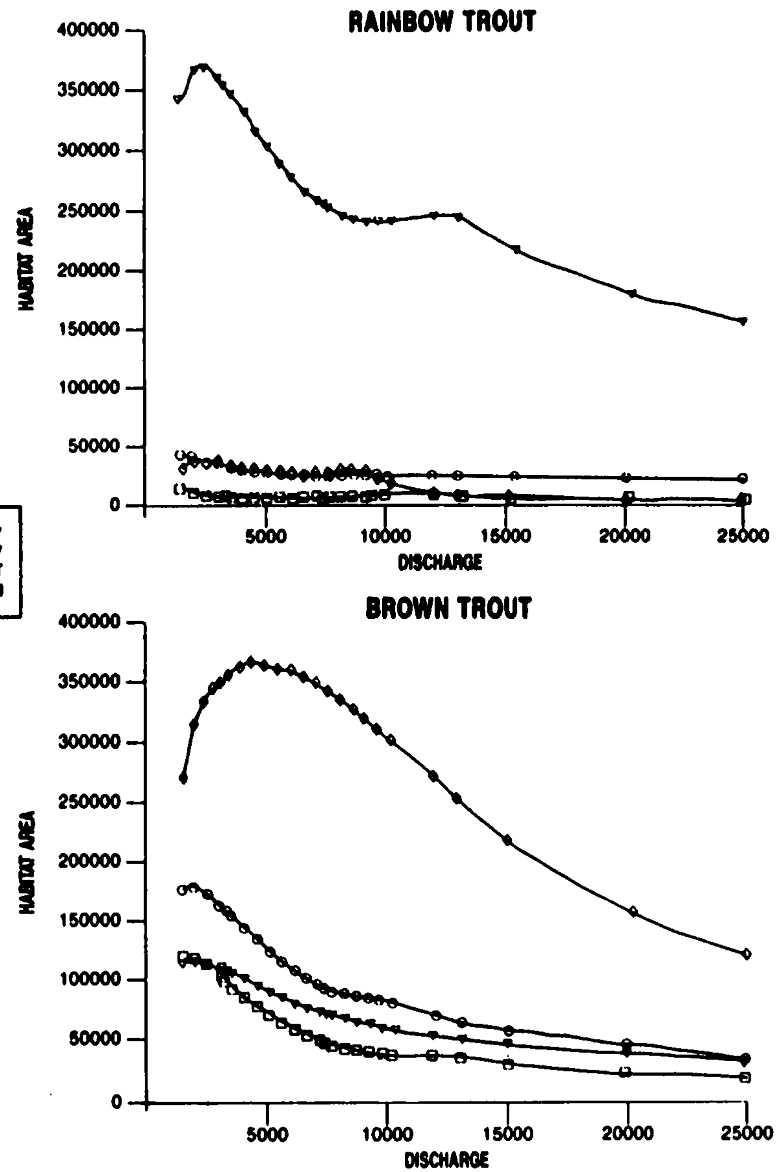


Figure 20. Predicted available habitat (ft^2/1000 linear ft of river) as a function of discharge for differing life stages of select salmonid species found within the McDonald IFIM study section.

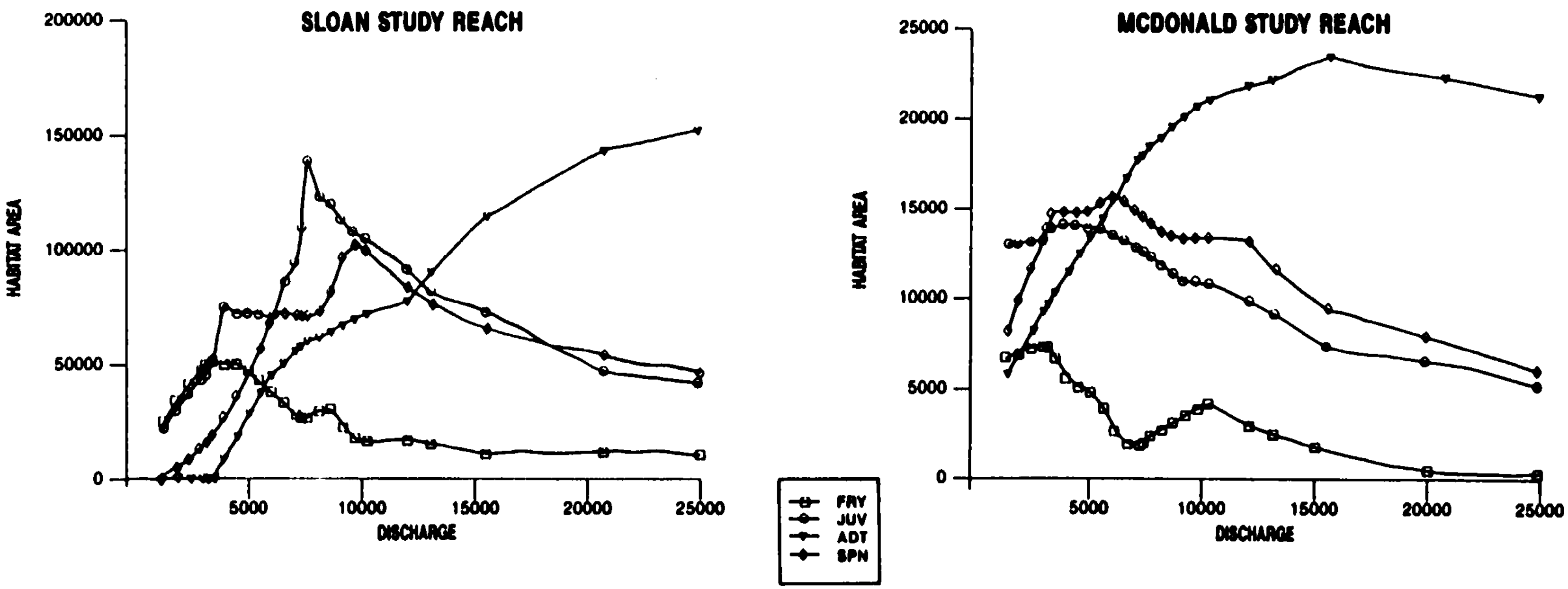


Figure 21. Predicted available habitat (ft^2/1000 ft of river) as a function of discharge for differing life stages of northern pike found within the Sloan and McDonald IFIM study sections.

Table 12. Monthly Kerr Dam flow releases which would provide some improvement for rainbow and cutthroat trout habitat in the lower Flathead River.

Month (days)	Mean Monthly Discharge (cfs)	Flow Window
Oct	4,000	3,200 - 9,500
Nov	4,000	3,200 - 9,500
Dec	4,000	3,200 - 9,500
Jan	4,000	3,200 - 9,500
Feb	4 000	3,200 - 9,500
Mar	8,238	3,200 - 9,500
Apr	9,381	3,200 - 9,500
May 1-15	5,000	3,200 - 6,000
May 16-31	8,000	6,000+
Jun	15,000+	6,000+
Jul 1-15	15,000+	6,000+
Jul 16-31	9,200	3,200 - 9,500 *
Aug	6,000	3,200 - 9,500 *
Sep	9,200	3,200 - 9,500 *

Explanation: Flows from October through February address adult and juvenile trout needs. March, April and May flows and flow windows are designed to improve instream spawning conditions. June and July lower flow limits reflect incubation needs while ramping rates from 15 July through 30 September are suggested to reduce stranding of fry and fingerlings.

* A ramping rate of 1,000 cfs/1 hrs is recommended on all descending flows at or below 10,000 cfs.

Table 13. Monthly Kerr Dam flow releases which would provide some improvement for brown trout habitat in the lower Flathead River.

Month	Mean Monthly Discharge (cfs)	Flow Window
Oct	5,000	4,000 - 6,000
Nov	5,000	4,000 - 6,000
Dec	9,947	4,000 - 15,000
Jan	10,000	4,000 - 15,000
Feb	10,000	4,000 - 15,000
Mar	6,500	3,200 - 6,500 *
Apr	6,500	3,200 - 6,500 *
May	8,000	3,200 - 15,000 *
Jun	12,500+	3,200 - 15,000
Jul	12,500+	3,200 - 15,000
Aug	6,748	3,200 - 15,000
Sep	9,200	3,200 - 15,000

Explanation: Flows in October and November address spawning requirements of brown trout. Flows in December through February are designed for incubation while flows in May, June and July reflect spring run-off. August and September flows address juvenile and adult fish needs. Ramping rates in March, April and May are designed to reduce stranding of trout fry.

* A ramping rate of 1,000 cfs/1 hrs is recommended on all descending flows at or below 10,000 cfs.

Table 14. Monthly Kerr Dam flow releases which would provide some improvement for northern pike habitat in the lower Flathead River.

Month	Mean Monthly Discharge (cfs)	Flow Window
Oct	9,200	3,200 - 15,000
Nov	9,200	3,200 - 15,000
Dec	9,200	3,200 - 15,000
Jan	9,200	3,200 - 15,000
Feb	9,200	3,200 - 15,000
Mar	9,200	3,200 - 15,000
Apr 1-15	9,384	8,200 - 10,000
Apr 16-30	9,384	9,000 - 10,000
May	11,500	12,400 +
Jun	19,736	15,000 +
Jul 1-15	9,000	5,000 + 10,000 *
Jul 16-31	9,000	3,200 - 10,000 *
Aug	6,748	3,200 - 10,000 *
Sep	9,200	3,200 - 10,000 *

Explanation: Flows from October through March address adult and juvenile fish needs. Flows in April and May meet the observed habitat needs of spawning fish for main river staging areas, access to spawning marshes, and flooding of spawning habitat. Flow windows for April and May represent operational minimums. Spring runoff is reflected in June and July flows. Flows for August and September are designed to address juvenile and adult habitat needs. Late summer ramping rates are suggested to reduce stranding of pike fry.

* A ramping rate of 1,000 cfs/1 hrs is recommended on all descendng flows at or below 10,000 cfs.

Table 15. Monthly Kerr Dam flow releases which would provide some improvement for all target fish species habitat in the lower Flathead River.

Month(days)		Mean Monthly Discharge(cfs)	Flow Window	Specifics
Oct		5,000	4,000 - 6,000	spawning brown trout
Nov		5,000	4,000 - 6,000	spawning brown trout
Dec		9,500	6,000+	egg incubation
Jan		9,500	6,000+	egg incubation
Feb		9,500	6,000+	egg incubation
Mar		6,500	3,200 - 7,000	brown trout fry
Apr	1-15	9,384	8,000+	pike spawning
Apr	16-30	9,384	9,000+	pike spawning
May		12,400	12,000+	pike spawning
Jun		15,000	12,000 - 25,000	run-off
Jul		9,500	3,200 - 15,000	rearing & adults
Aug		6,500	3,200 - 15,000	rearing & adults
Sep		6,500	3,200 - 15,000	rearing & adults

A ramping rate of 1,000 cfs/1 hours is recommended on all descending flows at or below 10,000 cfs.

DISCUSSION

The date of the introduction of largemouth bass in the lower Flathead River could not be determined. Largemouth bass were primarily backwater residents of the lower Flathead and were collected from all permanent backwater areas in river reaches III and IV. They were rarely found in main channel areas. The highest concentration of bass were found in the largest backwater areas.

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

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

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

Angler exploitation of largemouth bass appears minimal, with only two tags returned (1%) in three years. During the summer of 1983, river anglers caught bass at an average rate of 1 fish every 2.3 hours (DosSantos and Cross 1984). Largemouth bass were found in only a few areas in adequate numbers to support heavy fishing pressure. Low exploitation may be due to fishermen not knowing where to fish for bass.

The relative abundance and population structure of trout species studied in the Lower Flathead River from 1983 through 1986 reflected a lack of successful recruitment. Cutthroat and bull trout, although incidently collected throughout the length of the river, are rare. Forty cutthroat and 17 bull trout were captured and tagged during 4 years of study. The most probable origins of these cutthroat and bull trout are the upper reaches of the river's tributaries, the Clark Fork River, or from successful passage through or over Kerr Dam.

Based on results from application of the Instream Flow Incremental Methodology (IFIM), weighted available habitat (WUA) in the lower Flathead River for cutthroat trout is higher in the braided channel portion of the river than in the single channel portion. The highest catch rates (CPUE) also occurred in this reach. Based on IFIM results, significant losses in habitat (>50%) occur for all cutthroat trout life stages at discharges greater than 170 m^3/second (6,000 cfs). Available spawning habitat for cutthroat trout is extremely limited in the main river regardless of discharge.

Rainbow trout are found along the entire length of the river, but were most abundant in river reach III (Table 5). Population estimates for this reach ranged from 6 to 11 fish/km. The age class structure of lower Flathead River rainbow trout reflected serious recruitment problems relative to rainbow trout populations in other Montana rivers such as the Kootenai (May and Huston 1983) and the Missouri (Berg 1983). Catches of rainbow trout in the Flathead are dominated by age 2 and 3 fish; age 1 fish comprise only 1.6% of the catch. In the Kootenai River, using similar sampling methods, age 1 rainbow trout comprise 77.6% of the catch (May and Huston 1983). While the sample size of rainbow trout from the lower Flathead is small (N = 183) the lack of age 1 fish is obvious (Darling et al. 1984).

Based on main river IFIM analysis WUA for adult rainbow trout is twice as great in the braided channel versus single channel section of the main river. Catch rates and population estimates supports this analysis. IFIM analysis also points to limited suitable habitat for the juvenile, fry and spawning life stages of rainbow trout throughout the river (Figure 20 and 21).

Brown trout are found along the entire length of the river, and were most abundant in river reach I (Table 6). Population estimates for this reach have averaged 16 fish/km. On the upper Missouri River, the lowest brown trout estimate was 74 fish/km (Berg 1983). As with rainbow trout, the lack of age 1 fish in brown trout catches from the river was observed, and comprised less than 3% of the total catch (N = 277).

The observed structure of the brown trout population in the lower river suggests similar limiting factors affect both rainbow and brown trout recruitment. Few age 3 or older rainbow and brown trout were captured in the lower reaches of known spawning streams, Mission Creek or the Jocko River, but were predominate in main river samples. In contrast, age 1 and 2 rainbow and brown trout dominated samples in the tributaries, but are rarely captured in the main river. In the Buffalo study section, brown trout averaged 292 mm (Age 3) during fall sampling 1983 through 1986, but average 425 mm (Age 4) during spring sampling 1984. The shift to larger brown trout in the main river during spring sampling may reflect the return of adults from tributary spawning. Age class differences between river and tributary rainbow and brown trout suggest that recruitment to main river stocks is presently supported by tributary spawning.

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

Limited gravel sampling was conducted on the main river substrates during 1985. Eighteen samples were collected from approximately 654 hectares of potentially suitable spawning gravel (Darling et al. 1984). Comparing our results with those of Idaho laboratory studies of sediment and embryo survival conducted by Irving and Bjorn (1984), projected rainbow trout embryo survival in the main

Flathead River at 42% relative to the 0.85 and 9.5 mm substrate fractions. Gravel showing the highest predicted embryo survival was from the Weed study section (Reach III). This area also showed the highest density (fish/km) of rainbow trout. Within river reaches I and II channel substrates are merely a thin veneer layer (usually less than 0.3m thick) over heavy clays. Survival rates reported by the study for lower Flathead trout, and based on the above comparisons, should be viewed cautiously; additional work is needed to adequately evaluate the problem.

Detailed evaluations of substrate composition and instream cover throughout the river, conducted in conjunction with IFIM modeling, has shown that structural diversity is limited in the lower Flathead River. In the single channel portion of the river, larger substrates and an occational boulder provide the only instream cover. In the lower reaches of the river, where substrates are primarily gravel, the river channel contour has little relief, affording essentailly no instream cover. The recruitment of large woody debris is very limited. The structural homogeneity of the lower river channel results in limited feeding and resting stations for salmonids, as well as limited conspecific visual isolation.

Seasonal and daily variability in discharge from Kerr Dam are highest in the spring and fall, and suspected of having serious impacts upon spawning success of lower Flathead River trout. Constantly changing water depths and velocities over suitable spawning substrate may confuse adult trout seeking spawning sites in the main river, and cause behavioral changes such as spawning late or not spawning at all. Hamilton and Buell (1976) concluded that the abrupt changes associated with fluctuating flows due to hydro-peaking operations caused serious recruitment problems for salmonids in the Campbell River system, British Columbia.

IFIM analysis conducted on the Flathead River supports the above conclusion, the narrow ranges of acceptable discharges to maximize habitat for spawning and the fry life stages of rainbow and cutthroat trout (Figures 20 and 21) in the lower Flathead River are seldom met for any extended period because of Kerr operations.

Daily fluctuations in river discharge, which in the lower Flathead River may be more than an order of magnitude, preclude the establishment of invertebrate rich, slow-moving areas usually favored by young riverine fishes (Holden 1979). Chapman and Bjorn (1969) reported habitat preferences of 0+ salmonids to be areas shallower and slower than those selected by older fish. Young-of-the-year salmonids were reported to prefer to over-winter in shallow water with low velocity by Cunjak and Power (1986). This preference for shallow water and low velocity is apparently a function of energetic considerations related to body size (Smith and Li 1983). Microhabitat sites of shallow water and low vehocities utilized by young-of-the-year trout are the most affected by frequent changes in river discharge due to Kerr's operations.

Stock assessment investigation in 1983 and 1984 showed population levels of mountain whitefish to be comparable to other western Montana rivers of similar size (Darling et al. 1984). Whitefish spawning requirements (water depth, velocity and substrate composition) are not as specific as those for trout because they are broadcast spawners with higher fecondity than trout (Scott and Crossman 1973, Brown 1971, Bovee 1978). The variability of discharges from Kerr, highest in spring and fall, has not affected recruitment of mountain whitefish in the lower Flathead.

The question of competitive interactions between mountain whitefish and other salmonids, namely rainbow trout, has troubled many western fisheries managers for nearly half a century. Early studies (McHugh 1940, Sigler 1951 and Laakso 1951) concluded that mountain whitefish, with a higher fecondity than trout (Scott and Crossman 1973), were serious competitors for food and space with rainbow trout.

One effect of river regulation is a shift in the benthic insect community (Baxter 1977, Stanford and Ward 1979), with Chironomidae being one of the insect families flourishing in regulated rivers (Appert-Perry and Huston 1983). The potential for competition for a specific food item (Chironomidae) exists between small rainbow trout and small whitefish (<200 mm) and habitats occupied by these smaller fish are similar (DosSantos and Huston 1983, and DosSantos 1985). Odum (1971) defines interspecific competition as "any interaction between two or more species populations which adversely affects their growth and survival". This definition may apply to present-day rainbow trout populations within the lower Flathead River.

Recent investigations have questioned this theory of competition between these two salmonids (Pontius and Parker 1973, Thompson 1974). Several have concluded that mountain whitefish and trout in some western rivers (Kiefling 1978 and DosSantos 1985) do not actively compete for resources. In these studies, trout populations were several hundred fish per kilometer. In the lower Flathead, due to the ratio (approximately 325:1) of whitefish to trout it may not be a question of interspecific competition, but actual species suppression. Predation by whitefish on trout fry may also be a contributing factor. Although not thoroughly investigated, Ricker (1941) demonstrated mountain whitefish will eat young fish; one speciman he examined contained ten small sockeye salmon in its stomach.

Zoobenthic studies (Hauer, UMBS, per. com.) of the lower Flathead River clearly demonstrated that on either side of the wetted river channel exists a varial zone in which zoobenthic production is severely limited due to daily dewatering. Similar conditions have been described for other rivers subjected to variations in discharge due to hydroelectric operations (Gislason 1985). Zoobenthic production in the permanently wetted section of the lower Flathead River channel was found to be comparable with that of the Kootenai River below Libby Dam (Hauer and Potter 1986, Appert-Perry and Huston 1983). A varial zone devoid of aquatic insects may have significant impacts on the successful recruitment of young trout dependent, due to energetics and swimming ability, on micro-habitats and food located in this zone. Young fish are more susceptible to stranding due to daily fluctuations in discharge, and available food in the form of zoobenthos may be severely restricted (Thompson 1970, Phenney 1974, Olson and Metzger 1987). Adult fish, physically capable of making full utilization of the main channel and thus able to access and exploit a food source unavailable to younger fish were found to be in excellent condition despite fluctuations in discharge.

Survival in the early life history of many fish species is a significant determinent of adult population size, and these life stages in many riverine fishes require near-zero velocities (Larimore 1975, Ottaway and Clark 1981, Ottaway and Forrest 1983). We believe it is the constantly recurring impacts of Kerr Dam flow fluctuations on: fish behavior such as spawning, egg survival, juvenile habitat, over-wintering survival, and possibly the interaction between an overwhelming whitefish population and a severely depleted trout population; which significantly restricts the size of the annual standing crop of young trout in the lower Flathead River. Orth (1987) has suggested fish densities may be strongly related to habitat conditions during the critical early life stages. In the lower Flathead River the greatest daily fluctuations in river discharge due to Kerr operations occur during the early life histories of all important game fish creating the hostile environment we have termed the varil zone.

Northern pike are found throughout the length of the lower Flathead River, occupying lentic habitats. Within the single channel portion of the river, reaches I and II, northern pike are found along deep, slow moving river bends, shoreline eddies, and slackwater shoreline areas. The upper reaches of the river provide limited habitat for pike as reflected in CPUE data (Table 7).

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

Reach IV of the lower Flathead had the lowest gradient and greatest abundance of main channel macrophytes of all river reaches, however pike abundance in this reach was comparable to reaches I and II. Deep water holding habitat, preferred by pike during the daylight hours and as overwintering sites, is not found in reach IV. This suggests that increased macrophyte cover may not be as important as deep water holding habitat in providing optimum habitat in a riverine environment. Reach IV affords no protective cover from ice scour during winter thaws and spring break up, which may explain why pike populations are lower in reach IV than observed in reach III.

Radio tagged adult pike in the Flathead River preferred water depths in excess of 2 m and water velocities not exceeding 0.2 m/second (0.6 ft/second, mean = 0.45 ft/second). Inskip (1982) reported that optimal water velocities for riverine pike should not exceed 0.06 m/second (0.2 ft/second). Limitations in metering gear did not allow for an accurate average water column velocity or focal point measurement in depths in excess of 2 meters. Measured velocities within deep water areas were probably higher than those actually experienced by the fish, assuming laminar flow at these sites. Habitats utilized by northern pike in the lower Flathead River were usually heavily vegetated (Table 10). These areas not only provide protective cover and feeding stations for adults, but are also important in providing a well protected nursery area for young pike (Groen and Schroeder 1978).

Chapman and Mackey (1984) observed pike 81% of the time in totally vegetated areas.

At night, lower river pike were found in extremely shallow water near the river bank. Visual predators by day, they may use the shallow bench areas to rest with darkness protecting them from potential avian predation. Pike were rarely observed in these locations during daylight hours. These sites are severely impacted by Kerr operations.

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

Based on radio telemetry data, male pike spent up to three months in and around spawning grounds, leaving during the later part of June or the middle of July. Females spent only about six weeks at spawning areas, usually centered around the month of June. Peak spawning occurred between the later part of May through the first half of June, with the center of spawning activity occuring between the Pike Hole (RK 48.9) and McDonald Slough (RK 29.0). Limited spawning sites were found both up and downstream from this 20 km river area, and some spawning may occur in these isolated areas. Radio telemetry data demonstrated that pike moved considerable distances, up to 56 km, both upstream and downstream to reach this river area, passing other isolated areas where spawning fish were also found.

Bryan (1967) reported a one-week spawning season for northern pike, while Priegel and Krohn (1975) report a season of over two weeks. On the lower Flathead, spawning activities continued for several months, which may ensure some spawning success each year. Minimum flows experienced in the river begin to increase during the later part of April and remain high during May and June. The probability of successful spawning would be greater later in the spawning season due to higher water levels and more permanently wetted marsh areas.

A total of 299 mature pike were captured either entering spawning areas or in staging areas adjacent to them, showing an overall male to female ratio of 2.3:1. Priegal and Krohn (1975) reported a healthy sex ratio of 2:1 for some pike populations in Wisconsin. Disproportionate angler harvest of larger pike, almost all females, within the lower Flathead may explain the observed higher number of males within the spawning population. Harrison and Hadley (1983), who studied the Niagra River, gave another possible explanation. They reported a sex ratio of 4:1, and postulated a bias toward males because of the longer time during which males are sexable by the extrusion method. We experienced a similar situation, perhaps explaining the unusually high sex ratio (5:1) observed in 1985.

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).

Northern pike actively seek areas of inflowing water for spawning. Fluctuating water levels which reverse flows at spawning site entrances inhibit pike movement. While the aquatic vegetation communities present in the backwaters of Flathead River create suitable pike spawning habitat (McCarraher and Thomas 1972, Forney 1968, Priegel and Krohn 1975), river surface fluctuations due to Kerr operations create unfavorable conditions for spawning and incubation by dewatering spawning marshes.

Spawning occurs during daylight hours. Eggs adhere to vegetation and at water temperatures above 10°C hatch in 12 days or less. After hatching fry also adhere to vegetation and remain attached from 10 to 24 days (Inskip 1982). During the approximately 30 day period from egg laying to mobile fry movement, northern pike year class strength can be directly influenced by Kerr Dam operations. Water level fluctuations at spawning sites can aggravate suspended sediments and contribute to egg suffocation. Hassler (1970) attributed 97% egg mortality to silt deposition caused by fluctuating water levels in two main-stem Missouri River impoundments. Attached eggs and fry that successfully hatch and attach to vegetation are subject to desication due to dewatering as the river discharge varies. A change of only 3 cm in water surface elevations can change inflow to outflow in some spawning areas affecting pike movements into these areas (DosSantos et al. 1983).

Average size of captured Flathead River male and female pike spawners was 688 and 699 mm, respectively. These lengths correspond to age 4 fish for the lower Flathead, the usual age of maturity for northern pike (Scott and Crossman 1973). Spawning males range in size from 428 to 975 mm (Age 2 and older), whereas females range from 540 to 996 mm (Age 3 and older). Because of the highly aggressive nature observed in males, it is doubtful whether young males contribute significantly to spawning success. Growth of male and female northern pike in the Flathead River was similar through age 3 (Darling et al. 1984). Fish older than age 4 show differential growth between the sexes, with females growing faster. Similar observations have been noted in other studies (Anderson and Weithman 1978, Komyshwaya and Tsepkin 1973, and Philips 1980). Flathead River young-of-the-year pike grow to approximately 250 mm by the end of their first year. By their third year they have doubled their length. By their fifth year male northern pike may reach 675 mm TL, and female pike may reach 965 mm TL. Seventy percent of all northern pike handled were age 3 or younger.

Northern pike are the most highly sought after fish species in the lower Flathead River (DosSantos and Cross 1984). The exploitation rate observed during this study, 12% for Flathead River pike based on tag returns, is low compared to exploitation rates of 31% reported by Williams and Jacob (1971) and over 50% reported by Beyerle and Williams (1972). However, at best this 12% exploitation rate is the lowest estimate when one considers that most fisherman do not report catching tagged fish.

CONCLUSIONS

The results of this study have described the impacts associated with hydroelectric operations, irrigation project development and operation, and agricultural practices in the lower Flathead River and its tributaries. We believe that these activities, acting in concert, have determined to a great extent the present degraded status of the lower Flahtead system aquatic habitat and dependent fish stocks. Even so, it is possible to mitigate many of these impacts and develop a very important fishery.

We believe our results have shown Kerr hydroelectric operations and operational contraints have negatively affected Flathead River trout and northern pike populations and the aquatic habitat which support them. We suggest the following mechanisms acting independently and in concert have resulted in the existing situation:

1. Present hydroelectric operations result in frequent changes in river dishcharge of sufficient magnitude to kill fish eggs and young northern pike which are attached to littoral vegetation, and strands fish fry and juveniles. Adult fish are rarely stranded.

2. Frequent changes in river discharge resulting from present operations modifies fish behavior, especially during spawning, by constantly changing habitat variables used by fish to select spawning sites.

3. The present operational regime of Kerr prevents full utilization of the river channel by aquatic zoobenthos, creating varial zones on either side of the channel devoid of aquatic insects even when the channel is fully wetted. This greatly reduces the productive potential at all higher tropic levels and may especially impact the forage base for juvenile fish associated with these lateral habitats.

4. Present river regulation creates daily and hourly changes in habitat quality and quantity when flows are less than, or exceed habitat tolerances of a species or specific life stages of species.

5. The present operational regime results in monthly average discharges triple the historic mean during winter months with severe icing conditions. Combined with flow fluctuation this causes streambank destabilization, aggravating instream sediment problems.

6. Extreme and detremental fluctuations in river discharge during the spawning period of northern pike, have been allowed because coordinated operational planning for Flathead Lake recreation and for power production failed to incorporate requirements of lower river fish and wildlife.

Substantial mitigation will not be possible without major operational changes at Kerr which would result in more stabalized flows in the lower river benefiting the zoobenthos and the early life histories of many of the game fish.

DESCRIPTION OF STUDY AREA

Tributaries

Glacial till and lacustrine sediments from prehistoric Lake Missoula underlie the tributary portion of the study area. Much of the runoff from the Mission Mountains descends through porous till at the mountain base into the underlying groundwater system, resurfacing in springs found throughout the valley (Morrison-Maierle and Montgomery 1977).

Most of the surface water used on the Reservation is diverted, impounded, and distributed by the Flathead Indian Irrigation Project (FIIP). In total, the FIIP system includes 173 km of main supply canals, approximately 1,733 km of distribution canals, and 10,000 irrigation structures (U.S. Department of Interior 1985). FIIP serves three irrigation districts formed under Montana law, supplying Tribal and non-Tribal lands within the service area, as well as a few properties that are non-district. To supply these irrigation concerns, the major tributaries are impounded at their headwaters or mid-valley and are intersected throughout by canal diversions and irrigation returns. Consequently, the Flathead River tributaries, for the most part, have fair to poor water quality caused by irrigation return flows and agricultural diversion dewatering (Nunnalee and Botz 1976). Bank erosion as a result of livestock grazing, and streambank trampling is another significant cause of poor water quality.

The tributary portion of the study was confined to the main stems of five major streams entering the lower Flathead River: the Jocko River, Mission Creek, Post Creek, Crow Creek, and the Little Bitterroot River (Figure 22).

The Jocko River flows westerly from the Mission Mountains and enters the Flathead near Dixon. It drains an area of 67,747 hectares, with approximately 12 percent of the drainage under irrigation (Morrison-Maierle and Montgomery 1977). Silviculture and logging activities, road construction and maintenance, along with increasing residential development within the floodplain influence the upper drainage water quality. In past years, one segment of the Jocko has been totally dewatered below Big Knife Creek due to irrigation diversion. Downstream from the town of Arlee, Finley Creek and Valley Creek enter the Jocko, introducing considerable sediment seasonally. The lower river flows through hay and pasture lands and is channelized and heavily rip-rapped along the National Bison Range. Average annual discharge has been estimated as 10.4 m^3/second (367 cfs, Montana State Study Team 1975) and 5.2 m^3/second (184 cfs, Morrison-Maierle and Montgomery 1977).

Post Creek headwaters are impounded by McDonald Lake dam. From the lake outlet the creek flows westerly, picking up irrigation return flows from Pablo Feeder Canal and Mission "B" and "C" Canals, and flows through agricultural land in the Mission Valley before flowing into Mission Creek just east of the National Bison Range. Post Creek's average annual flow of about 2.5 m^3/second (88 cfs, Montana State Study

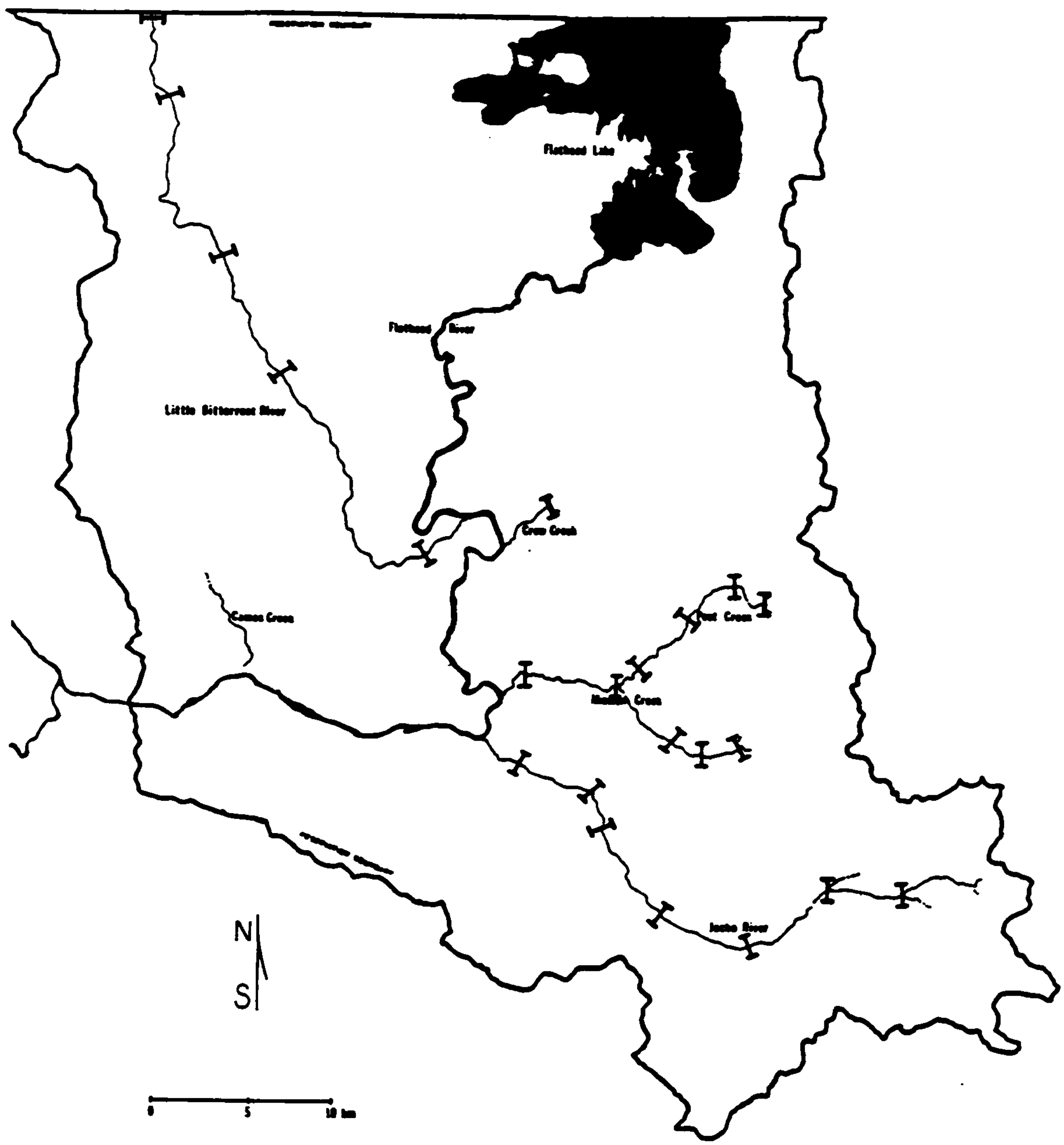


Figure 22. The five major tributaries to the lower Flathead River. Reach boundaries established for habitat surveys and stock assessment are denoted by brackets.

Team 1975) is subject to direct regulation by the FIIP. Much of Post Creek is turbid year-round due to irrigation runoff returns.

Mission Creek headwaters are impounded by Mission Dam. From Mission Reservoir the creek flows westerly through St. Ignatius. Three canals, Pablo Feeder Canal and Mission "B" and "C" Canals, intercept its flow. Between St. Ignatius and its confluence with Post Creek, the stream receives sewage-lagoon and irrigation returns, and travels through marshy and agricultural lands. Downstream along the Bison Range, Mission Creek receives agricultural return water, feedlot runoff, and intermittent discharges from Charlo sewage lagoons via Dublin Coulee. Hillside Reservoir overflow, composed entirely of irrigation return flow and agricultural runoff, enters the creek just below the Bison Range. The stream then winds through an erosive clay-bank canyon and receives Moiese Valley irrigation return before reaching the Flathead River. Flows near the mouth can average from 2.04 m^3/second (72 cfs, Montana State Study Team 1975) to 4.7 m^3/second (166 cfs, Morrison-Maierle and Montgomery 1977) because flows are subject to year-round regulation by the FIIP.

North, Middle, and South Crow Creeks flow west from the Mission Mountains converging to form the main stem of Crow Creek approximately 13 km east of its confluence with the lower Flathead River. Above Lower Crow Reservoir two major tributaries, Ronan Spring Creek and Mud Creek, bring urban stormwater runoff and irrigation runoff and returns to Crow Creek. Lower Crow Reservoir is used to store irrigation water for the Moiese area. Flows in the 6 km stream section below Lower Crow Dam included in this study are regulated by FIIP via Lower Crow Dam and a major irrigation diversion approximately 1.2 km below the dam. Historically, the creek flow would be withheld completely during a normal irrigation year (Morrison-Maierle and Montgomery 1977); however, some stream flows are now being maintained year-round according to an agreement between the Tribes and FIIP. High spring runoff occasionally prompts large releases from the reservoir, causing mass wasting, scour, and debris movement in Crow Creek. Turbid irrigation returns enter from fields to the North. Average annual flow is 2.4 m^3/second (85 cfs, Montana State Study Team 1975).

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

Twenty-two reaches were selected in 1983 to characterize habitat for the five major tributaries: seven on the Jocko River, five on Mission Creek, four on Post Creek, one on Crow Creek, and five on the

Little Bitterroot River (Figure 22). Stream reaches were established on the basis of marked changes in stream gradient, sinuousity, bank slope, land use, and water flow. Detailed descriptions of tributary reach boundaries and permanent fish and habitat sampling stations established within these reaches are provided in Appendix E.

METHODS and MATERIALS

Tributaries

Habitat Evaluation

Survey Method

Several habitat evaluation methods were reviewed, including surveys developed by N.A. Binns (1979) of the Wyoming Game and Fish Department, Duff and Cooper (1976) of the Bureau of Land Management, and T.W. Chamberlin (1980) of the British Columbia Ministry of Environment. The Montana Department of Fish, Wildlife, and Parks' (MDFWP) modification of the British Columbia method (Fraley et al. 1981) and U.S. Forest Service (USFS) stream inventory (Pfankuch 1975) were chosen to describe the tributaries found on the Flathead Indian Reservation. Application of these methods provided a thorough habitat evaluation and allowed comparisons with nearby streams inventoried by the MDFWP and USFS.

Tributary reaches were selected on the basis of marked changes in stream gradient, sinuosity, bank slope, land use, and/or water flow. Reach boundaries were determined using topographic maps, aerial photographs, and helicopter reconnaissance, and were verified on the ground.

One-mile-long habitat survey sections were chosen as segments representative of stream reaches. Thirty-one separate physical habitat parameters were measured in each survey section by field crews. These parameters pertained to stream hydraulics, pool-riffle-run ratios, pool class, channel cover and morphology, bed and bank material and stability, debris, and aquatic vegetation (sample form in Appendix E). In addition, the USFS Stream Reach Inventory and Channel Stability Evaluation (Appendix E) were applied twice during each survey to further describe the habitat. Photographs were taken at the beginning and end of each habitat survey section, as well as noteworthy features such as sloughed banks, debris jams, and irrigation diversions.

Substrate Analysis

Substrate samples were taken from known brown trout and rainbow trout spawning areas on the Jocko River, Mission Creek, Post Creek, and Crow Creek (Figure 23) using a McNeil sampler (McNeil and Ahnell 1964) with a 15.2 cm diameter throat, following field procedures outlined by Shepard and Graham (1983). Samples were collected in mid-April and the first of May 1985 (before high water) when substrates were most embedded. A total of 16 samples were collected from eight areas. Substrate samples were processed and analyzed as described in the main river Methods section.

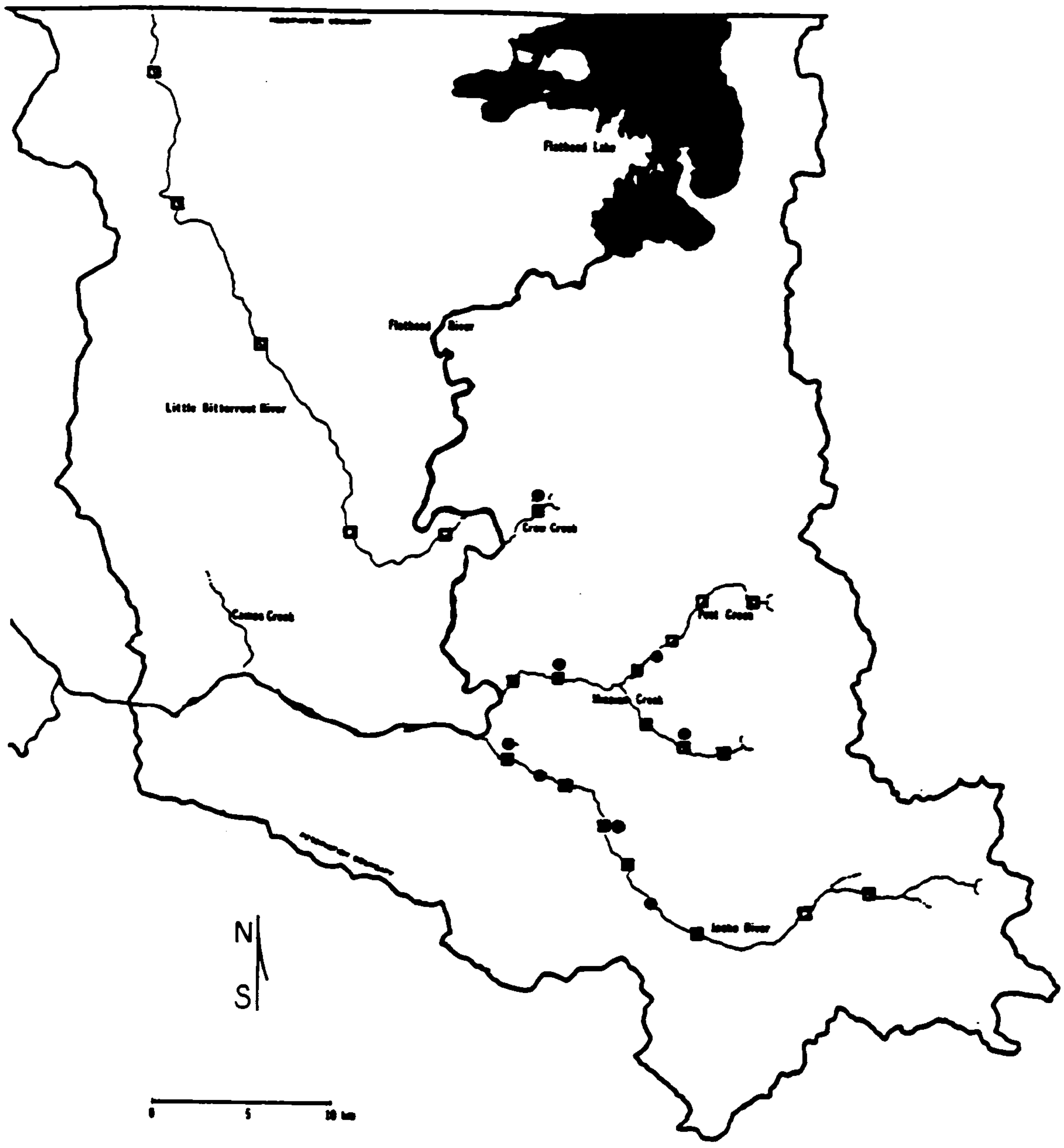


Figure 23. Substrate sampling sites (●) and stock assessment stations sampled during fall 1983 and 1984 (all squares) and fall 1985 (darkened squares) on the major tributaries to the lower Flathead River.

Water Temperature and Turbidity Monitoring

Continuously recording, 90-day thermographs were installed during March 1983 near the mouths of four tributaries: the Jocko River, Mission Creek, Crow Creek, and the Little Bitterroot River. All thermographs were removed in November 1986.

Water samples were collected on 24 October 1985 at 15 stations randomly distributed along the lower 76 km of the Little Bitterroot River. These samples were delivered on ice to the Flathead Lake Biological Station, where they were analyzed for turbidity using a Hach Model 2100A Turbidimeter.

Stock Assessment

Fish abundance was estimated during fall 1983-85 using mark-recapture efforts at 22 stations (Figure 23) within habitat survey sections established on five major tributaries to the lower Flathead River: the Jocko River, Mission Creek, Post Creek, Crow Creek, and the Little Bitterroot River. Intervals between marking and recapture were approximately one week. Each 150 m long station was electrofished during daylight using a bank or backpack shocker. Most stations were sampled as open sections by three persons, one operator and two netters, making one pass upstream. 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. Stream width was measured at ten random transects within each station in order to calculate stream surface area.

During fall 1985, the number of stock assessment stations was reduced to ten (Figure 23) which represented those portions of the Jocko River, Mission Creek, Post Creek, and Crow Creek used by main river salmonids for spawning and rearing as well as resident stream populations. Each station was lengthened to 300 m to increase fish sample sizes for population estimates. Target fish species were measured (TL), weighed, and fin-clipped or tagged with floy anchor or fingerling tags, then released. Scales were removed and later impressed into cellulose acetate for age analysis. After each station was electrofished, stream discharge was measured.

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 and number per 100 m^2 of stream were also determined.

To better describe fish distribution in the Little Bitterroot River, three 150 m long stations were established randomly within each of 5 reaches. Using a backpack electroshocker, one pass was made 150 m upstream to a block net at each site. The 15 sites were electrofished from 11 October through 22 October 1985. Gastric lavage (Light et al. 1983) was used to remove the stomach contents of captured northern pike. Stomach samples were sorted, and contents were identified using a binocular microscope.

The lower reaches of the Jocko River (reaches 1, 2, 3, 4, and 6) were snorkeled in August 1986 to estimate the number of adult trout present. Three snorkelers floating abreast downstream recorded trout greater than 250 mm within a one-mile section. Reach 3 was snorkeled twice to verify counts. Snorkel counts were also verified through comparisons with redd counts and population estimates developed with mark and recapture data from the same reaches.

Spawning and Migration

Redd Surveys

Trout redd surveys on the Jocko River, Mission Creek, Post Creek, and Crow Creek were scheduled for spring and fall each year from 1983 through 1986. Adjustments for the early onset of high flows or ice, or poor visibililty due to turbidity, resulted in concentrating on fall surveys of the Jocko River and spring and fall surveys of Crow Creek.

To establish redd locations, starting time for each survey was noted, and time elapsed to each identified redd was recorded. Each redd observation was ranked as definite, probable, or possible based on Montana Department of Fish, Wildlife and Parks' (Shepard and Graham 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 easily discernable,

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.

Spawner Trapping

Weirs. 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 of 1983. The weir design was developed by Art Dauber, U.S. Forest Service engineer with the Shasta-Trinity National Forest, California, and described by DosSantos et al. (1983).

The basic unit of Mr. Dauber's design was a trapezoid-shaped module 0.6 m tall and 1.2 m wide made of angle iron. Adjacent modules were bolted together and laced with wire onto a row of 3 x 1 x 1 m gabion baskets, which were filled with 10 cm diameter and larger rock and entrenched into the streambed. A prefabricated trap 2.5 m long by

1.2 m wide and 0.6 m high with adjustable entry doors was inserted into one module. On the upstream side of the remaining modules, rod panels were slid into channels to funnel fish into the trap. Weir and trap were orientated perpendicular to streamflow.

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 allow fish passage. Both weirs were permanently removed in May 1986.

Traps. Trapping of spawning northern pike in the Little Bitterroot River evolved from the use of fyke nets with tarred nylon leads to steel hoop traps or box traps with wire mesh leads to better resist shredding by beavers and muskrats. Traps were set near the river mouth (km 2 or 5) and a large marsh near Lonepine (km 60) during early spring of 1983, 1984, and 1985 (Figure 24). In addition, traps were set just upstream from the confluence with Hot Springs Creek (km 44) and in the mouth of the creek. Captured pike were measured (TL), weighed, sexed, and tagged; scale samples were removed, and the fish were released.

Crow Creek Surveys

The 5.6 km of Crow Creek below Lower Crow Reservoir were electrofished for spawning trout during April and November 1985, and April 1986. Two days were required each time using a backpack electroshocker. Redds were counted during these surveys.

Fish Movement

Tags returned by fishermen from fish tagged during stock assessment and spawning runs 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.

Instream Flow Incremental Method

In order to quantify the amount of potential fish habitat available for each life history stage of salmonids, the Instream Flow Incremental Methodology (IFIM, Bovee 1982) was applied to the Jocko River, Mission Creek and Post Creek. Data was collected for application of the IFG-4 hydraulic simulation program, which is best suited for streams with steep gradients, regions with rapidly varied flows, and complex aquatic environments.

Streams chosen for IFIM application were divided into representative segments based upon changes in stream gradient, sinuosity, bank slope, land use, and/or water flow. A total of 11 segments were chosen (Figure 25): eight on the Jocko River, two on Mission Creek, and one on Post Creek.

Segmentation of the Jocko River for application of the IFIM was essentially the same as the habitat survey segmentation (Figure 22) described under "Physical Habitat Evaluation". Boundaries were shifted

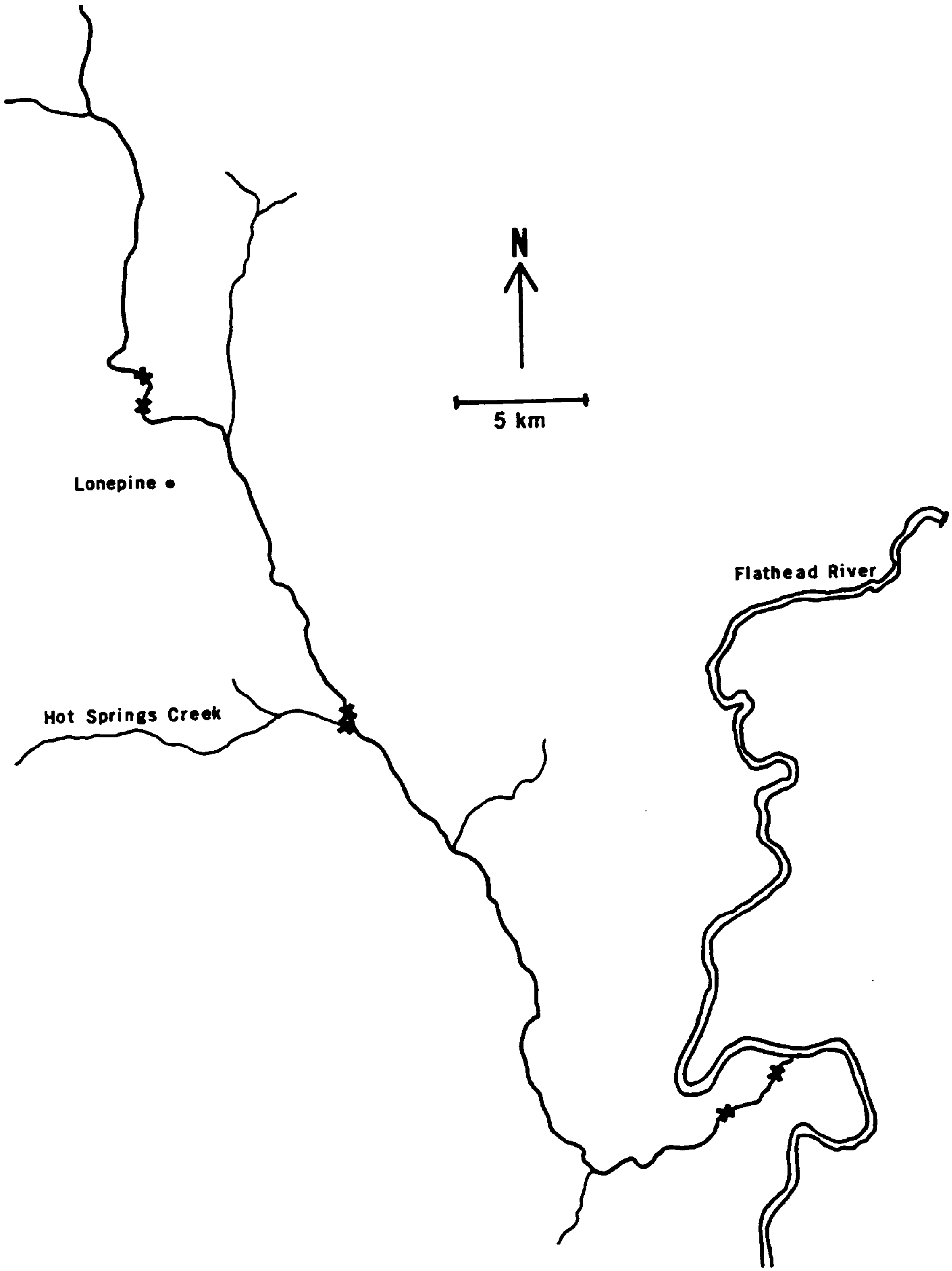


Figure 24. Trapping sites for spawning northern pike in the Little Bitterroot River System.

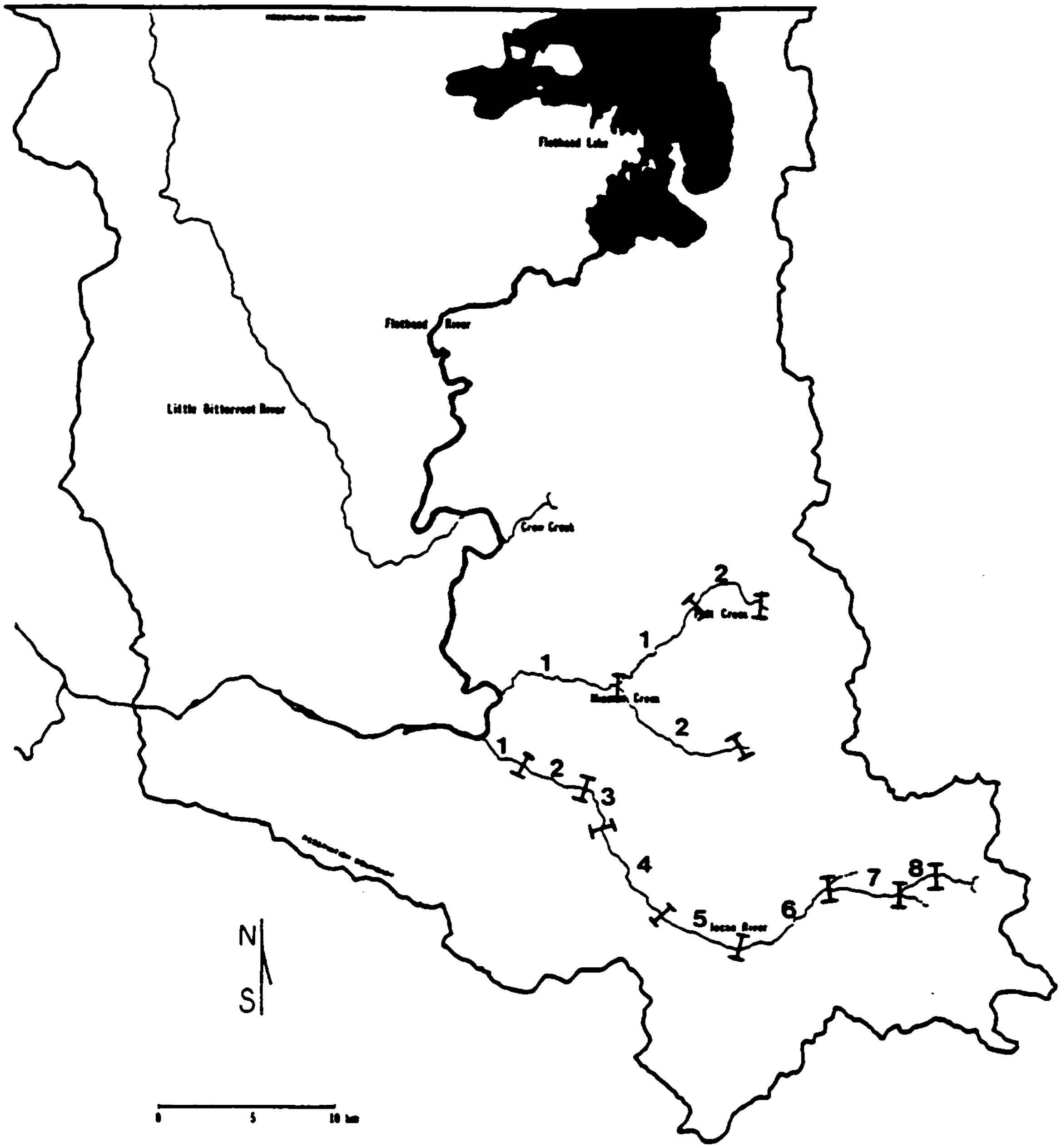


Figure 25. Segmentation for application of the Instream Flow Incremental Methodology (IFIM) to the Jocko River and Mission/Post Creek drainages.

slightly between segments 2 and 3, and 6 and 7; an eighth segment was added between the mouth of the South Fork and the Tabor Canal diversion. No habitat survey was conducted on segment 8.

For Mission Creek, habitat survey segments 1 and 2 were combined to form IFIM segment 1; segments 3, 4, and 5 formed IFIM segment 2. Post Creek habitat survey segments 1 and 2 formed IFIM segment 1.

Transects were placed during high water (June 1986) at sites representative of each IFIM segment. A total of 76 transects were placed within the 11 segments (Table 16). Where IFIM and habitat survey segments were essentially the same (Jocko River segments 1-7), percent occurrence of each feature during habitat surveying was used as a guideline in weighting for IFIM

Table 16. Number of transects placed within each of the IFIM segments.

Stream	Segments	No. Transects
Jocko River	1	2
	2	3
	3	5
	4	12
	5	7
	6	6
	7	6
	8	6
Mission Creek	1	9
	2	11
Post Creek	1	9
Total	11	76

modelling. Where survey segments were combined to form IFIM segments (Mission and Post Creek), habitat survey results were combined to give percent occurrence (and therefore weighting) for the new, larger segment. Where no habitat survey had been done (Jocko River segment 8), transects were weighted using professional judgement.

Frequently no pools were intersected by random transects during habitat surveys, yet their importance to fish justified their being included in IFIM transects. Fortunately, all pools were counted and classified as part of habitat surveying. In those reaches where pools were intersected during surveys, one to four pools would occur in transects approximately 1% of the time; five to eight, 2%; and 9-12, 3% on average. Percent occurrence was assigned accordingly where no pools were intersected. Assigned percentages were taken from the feature (usually runs) intersected most often to retain a total of 100%.

Finally, within the general guidelines provided by habitat surveying, professional judgement and familiarity with the system, resulting from four years of intensive field work determined the final IFIM transect weighting shown in Appendix F.

Standard methods (Trihey and Wegner 1981) were used to collect profile, velocity, depth, substrate and cover data at each transect from June to December 1986. Substrate and cover were coded according to guidelines developed by T.R. Payne and Associates, Arcata, California. Hydraulic cell velocities were measured at high and low flows. Only stage-discharge measurements were taken at medium flows. All transects were photographed at each measured discharge.

Field measurements were sent to T.R. Payne and Associates where the data were transformed into micro-computer format, entered, and calibrated. Probability-of-use curves for rainbow trout (Raleigh et al. 1984a), brown trout (Raleigh et al. 1984b), cutthroat and brook trout (Bovee 1978) were combined with the IFG-4 hydraulic model to generate weighted useable area for different life stages of each salmonid species. The microcomputer PHABSIM hydraulic and habitat simulation programs were translated from U.S. Fish and Wildlife Service mainframe programs (Milhous et al. 1984).

No long-term flow gaging data existed for those areas of the tributaries studied. Monthly and mean-annual hydrographs were synthesized by Tribal hydrologists in cooperation with the U.S. Geological Survey (Appendix F). Basin parameters were measured and applied to long-term flow monitoring sites within the lower Flathead River drainage to derive predictive equations for monthly hydrographs. These hydrographs are required to check the validity and applicability of IFIM predicted flows to the present flow situations.

RESULTS

TRIBUTARIES

Habitat Evaluation

Habitat Surveys

Habitat surveys conducted on the main stems of five major tributaries to the lower Flathead River resulted in the designation of 22 distinct stream reaches (Figure 22): seven on the Jocko river, five on Mission Creek, four on Post Creek, one on Crow Creek, and five on the Little Bitterroot River. Reach lengths ranged from 2 km for Post Creek reach 1 to 39 km for Little Bitterroot reach 2. Reach boundaries and locations of habitat survey sections within these boundaries are described in Appendix E.

Stream habitat characteristics and measured discharges for the 22 reaches are summarized in Appendix G. Four of the major tributaries: Mission Creek, Post Creek, Crow Creek, and the Little Bitterroot River, rated fair based on the USFS method for evaluating stream channel stability (Pfankuch 1975); the Jocko River rated good; none rated as excellent. Factors such as channelization, turbidity, lack of pools and/or riffles, and siltation of spawning gravels degraded many tributary reaches.

Jocko River. Runs were the predominant stream feature throughout the Jocko River's seven reaches (Appendix G). Pools were seldom intersected by survey transects. One pool was noted in reach J2; twelve in reach J5.

Bank erosion problems were more common in the Jocko's lower reaches. Areas of mass wasting were frequently encountered in reaches J1 and J2, rip-rap was used along railroad right-of-ways and near farm houses in reach J3, and the stream channel was braided in reach J4. In reach J5, banks contained large, stable rocks, and bed material was more compacted. In reaches J6 and J7, the river was confined by a canyon, and dense riparian vegetation helped to further stabilize the banks.

Areas of spawning gravel were common, particularly within reach J4, between Valley Creek and Finley Creek.

Mission Creek. Below its confluence with Post Creek, Mission Creek flows were high, ranging from 5.1 to 6.8 m^3/second (180-240 cfs), and the water turbid (Sessie Disk visibility <1") during the habitat survey. Mass wasting was common in reaches M1 and M2, and streambed compaction was low (Appendix G). Few pools and riffles were present.

Flows dropped and the water was clear above Post Creek. Reach M3 was characterized by channel shifting; reach M4, by cattle grazing to the water's edge. Despite dense bank vegetation, uppermost reach M5 was scoured and undercut by large flow releases from Mission Dam. Fallen trees criss-crossed much of the stream.

Post Creek. In Post Creek the predominant stream feature in reaches P1, P2, and P3 was the run category (Appendix G). In steeper reach P4, riffles were as prevalent as runs. During the survey, turbidity was high (Sessie Disk visibility <1") in lower reaches P1 and P2, but decreased noticeably in reach P3 above most irrigation returns. Much of the spawning gravel in Post Creek was found in reaches P1 and P2 and was compacted with silt. Mass wasting and rip-rap were common in the lower reaches, especially reach P2. Reach P4, between McDonald Lake Dam and Pablo feeder canal, was characterized by stable, tree-lined banks and clear water.

Crow Creek. Crow Creek commonly experiences large flow fluctuations subject to releases from Lower Crow Reservoir. The streambed and banks were armored immediately below the dam and composed predominantly of fines and gravel within the remaining stream area surveyed (Appendix G). Mass wasting, debris jams and high turbidity resulted from large, unpredictable flow releases from Lower Crow Reservoir and silt laden irrigation returns during the irrigation season. Spawning-size gravel was common throughout the reach, but was silt-laden.

Little Bitterroot River. The British Columbia method of habitat evaluation (Chamberlin 1980) and USFS inventory method (Pfankuch 1975) were both developed to evaluate trout habitat. These methods were not as applicable to much of the Little Bitterroot River, which is better habitat for northern pike. The uppermost reaches, especially reach LB5, had improved water clarity, thicker canopy, and larger bed materials (Appendix G). Consequently, these reaches received higher ratings using the methods chosen.

Stream flows never exceeded 0.3 m^3/second (11.5 cfs) during the survey period. Abundant submergent and emergent vegetation constituted the high instream cover rating given to reaches LB3 and LB4. Turbidity provided cover in the remainder of the Little Bitterroot. Water samples collected on 24 October 1984 along the entire length of the river (within reservation boundaries) were indicative of observed increases in turbidity from headwater to mouth (Figure 26).

Substrate Analysis

Gravels from 16 to 63 mm in size predominated most samples from tributary spawning areas, particularly in samples from the Jocko River (Appendix H). The remaining fractions were relatively equal, each generally representing 20% or less of the total sample.

Comparing Idaho laboratory studies of embryo survival relative to fine sediment in spawning gravel to our substrate data lead to an estimated average potential rainbow trout embryo survival of 36% for Jocko River spawning areas (Irving and Bjorn 1984). This resulted from using substrate combinations smaller than 0.85 mm and 9.5 mm (Figure 27 and Appendix H). Spawning areas in reaches J3 and J4, considered most important in the system, would be expected to have 34% embryo survival based on 0.85 and 9.5 mm fractions.

The combination of 0.85 and 9.5 mm fractions predicted 24%

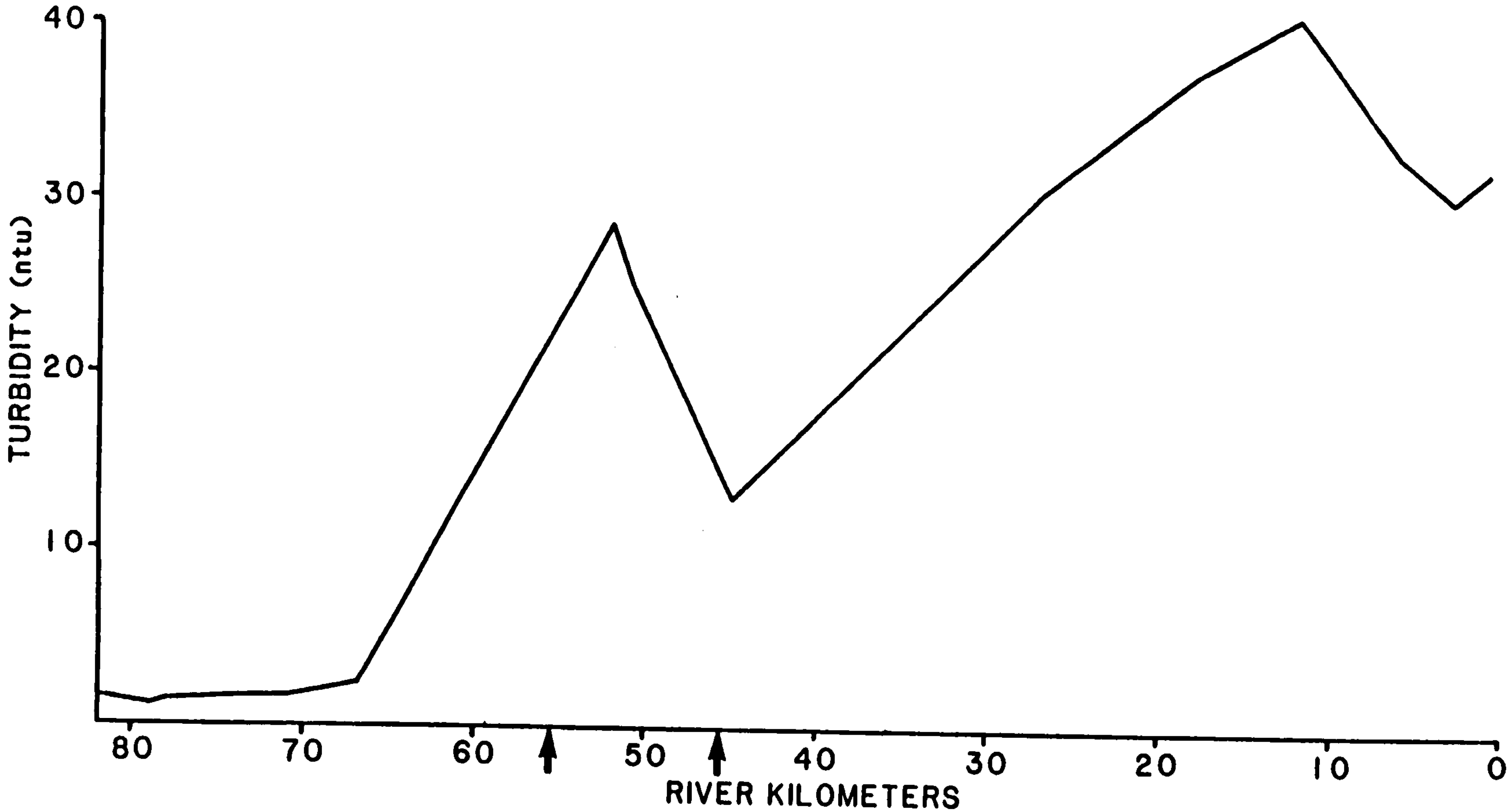


Figure 26. Representative longitudinal changes in turbidity in the Little Bitterroot River throughout the year. Arrows represent known sources of turbid water, i.e. Sullivan Creek (km 56) and Hot Springs Creek (km 44). River kilometer 0 represents the confluence with the lower Flathead River.

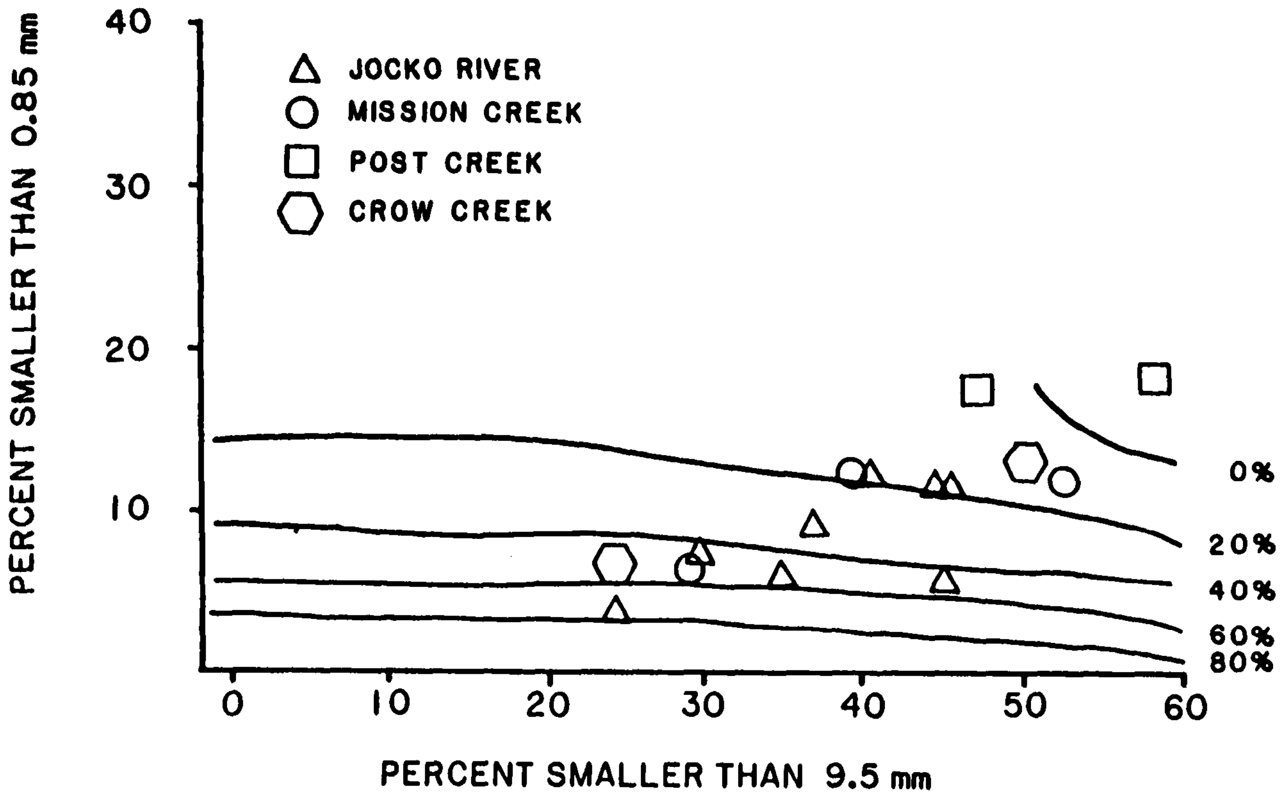


Figure 27. Predicted rainbow trout (rb) embryo survival in spawning areas of the lower Flathead River tributaries related to combinations of substrates smaller than 0.85 and 9.5 mm based upon studies by Irving and Bjorn (1984).

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

Water Temperature

Water temperatures were lowest near the mouths of the four major tributaries to the lower Flathead River during December and January, often remaining near 0°C from November through February (Appendix I). The highest water temperatures were recorded during July and August and were generally slightly cooler than the main river (Table 17).

Table 17. Average low, high and mean water temperatures (°C) recorded during July and August from 1983 through 1986 near the mouths of four tributaries and the lower Flathead River at Perma.

Stream		August 1983	August 1984	July 1985	August 1986
Jocko River	low	13	13	14	13
	mean	16	15	17	15
	high	18	18	20	17
Mission Creek	low	15	14	16	15
	mean	17	16	19	17
	high	19	17	21	18
Crow Creek	low	16	16	15	15
	mean	19	18	19	18
	high	21	20	22	21
Little Bitterroot River	low	19	17	16*	18
	mean	22	20	22*	21
	high	25	23	28*	23
Flathead River	low	17	18	22*	17
	mean	21	22	23*	21
	high	22	24	24*	23

* daily readings incomplete

Stock Assessment

Jocko River

Brown and rainbow trout were the only trout species found in the lower three reaches of the Jocko River, the former being generally more abundant (Figure 28 and Appendix J). Brown trout became predominant in

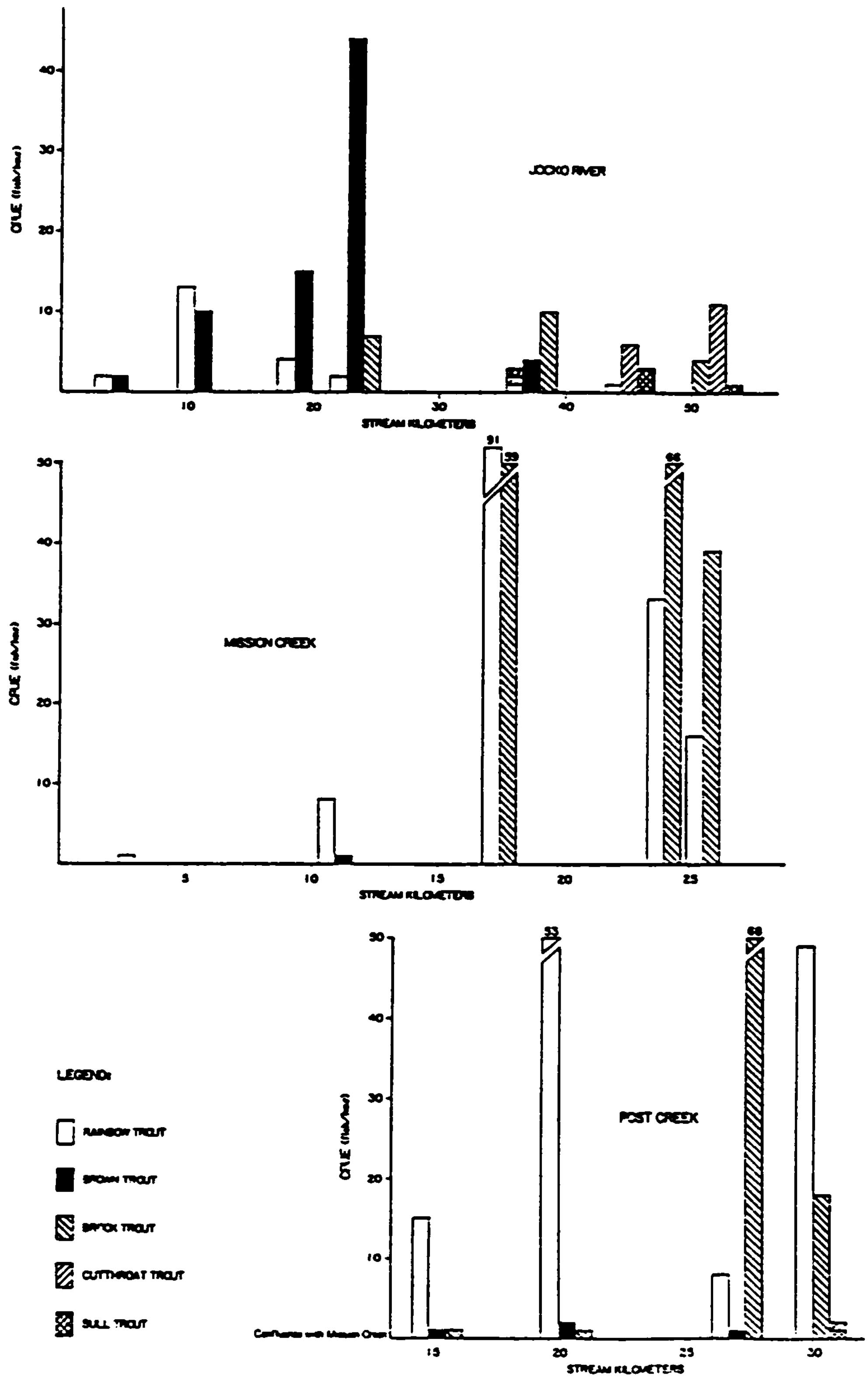


Figure 28. Longitudinal changes in trout relative abundance bases on fall stock assessment during 1983, 1984 and 1985 within three tributaries to the lower Flathead River.

reach J4 where brook trout began appearing. In reach J5, all trout species encountered throughout the drainage were found at some time during the three fall sampling periods; however, none were abundant.

In the lower five reaches of the Jocko River, age 1 fish comprised 84% of the brown trout sample, and 82% of the rainbow trout sample (Appendix K). Of the brook trout found in reaches J4 and J5, 79% were age 1 and 18% were age 2 (Appendix K). The lack of older fish was corroborated by snorkel counts conducted during August 1986. For reaches J1 and J2, snorkel estimates averaged 16 trout larger than 250 mm per stream kilometer. For reaches J3 and J4, estimates were approximately 31/km.

Cutthroat and brook trout were dominant species in reaches J6 and J7, which are above the K Canal diversion, a major barrier to fish movement. A small resident bull trout population was also found in these upper reaches.

Age 1 and 2 cutthroat comprised 98% of the 93 fish captured in reaches J6 and J7 during this study (Appendix K). Age 3 and older brook and bull trout were rare (Appendix K). Snorkel counts of trout larger than 250 mm in reach 6 confirmed that older trout were rare, i.e. approximately 14/km.

Spawning rainbow trout from the lower Flathead River began entering the Jocko River in March and continued into May when high water forced trap closure (Figure 29). The 60 rainbows captured from 1984 to 1986 averaged 423 mm TL; approximately 84% were age 4 or 5 (Appendix K). One spawner tagged at Jocko weir (km 2) was recaptured above the town of Arlee (km 38), and two others were recaptured at Mission weir in subsequent years (Appendix L). One rainbow trout tagged at Jocko weir was caught by an angler fishing the Clark Fork River 88 km away. Thirteen brown trout tagged in the lower Flathead were captured at the Jocko weir with one spawner migrating 18 km to enter the Jocko River.

Brown trout entered the Jocko River from early August through October (Figure 29). Eighty-six percent of the 50 captured from 1984 to 1986 were age 4 or 5 (Appendix K). Average total length of brown trout spawners was 476 mm. One spawner tagged at Jocko weir was recaptured 21 km upstream within the area of reaches J3 and J4 (Appendix L), where 660, 229, and 228 redds were counted during fall 1984, 1985, and 1986, respectively. The 17 km of stream within reaches 3 and 4 contained 76% and 97% of all redds counted along the 31 km surveyed during 1984 and 1985, respectively. Only reaches 3 and 4 were surveyed during 1986.

Mission and Post Creeks

Seventy-six rainbow trout and two yearling brown trout were captured during fall 1983-1986 stock assessment in reaches M1 and M2 of Mission Creek below its confluence with Post Creek (Figure 28 and Appendix J). Captured rainbow trout were relatively evenly distributed among age classes 1 through 4 (Appendix K). Both brown trout were yearlings.

The relative abundance of trout increased fifteenfold in reach M3 of Mission Creek (Figure 28). This reach is above the confluence with Post Creek. Brook trout appeared in the catch and became predominant in reaches M4 and M5. For reaches M3 through M5 age 1 and 2

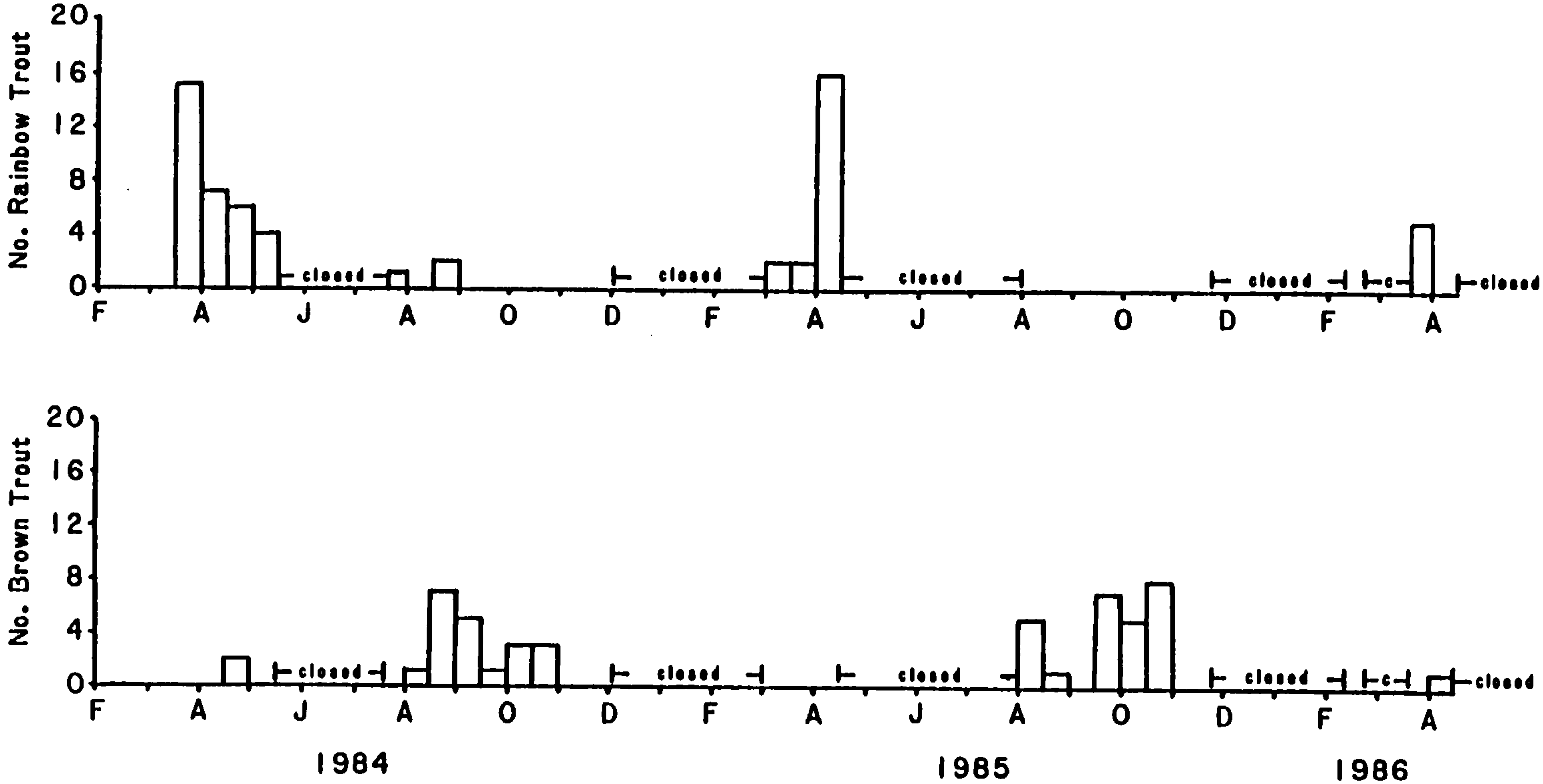


Figure 29. Trout captures at Jocko weir from February 1984 through April 1986.

fish comprised 97% of the brook trout sample and 88% of the rainbow trout sample (Appendix K).

Rainbow trout predominated in the lower two reaches of Post Creek above its confluence with Mission Creek (Figure 28). Brook trout were most abundant in reach P3 where the stream gradient is steeper. Above the Pablo Feeder Canal in reach P4, rainbow trout were again more abundant.

In reaches P1 and P2 of Post Creek, age 1 and 2 fish represented 87% of the rainbow trout and 88% of the brook trout captured during this study (Appendix K). Of the brown trout captured, 96% were age 2 or younger. Eighty-five percent of the rainbow trout and 99% of the brook trout captured in reaches P3 and P4 were age 2 or younger.

Spawning rainbow trout from the lower Flathead River began entering Mission Creek in late February and were monitored until May (Figure 30) when high flows forced suspension of trapping. The 122 rainbows captured from 1984 to 1986 averaged 404 mm (TL); 95% were age 3 or 4 (Appendix K). Three spawners tagged at the weir in 1984 were trapped again the following spring (Appendix L). One rainbow trout was caught in the lower Flathead River 70 days after tagging. Another was caught by an angler fishing the Clark Fork River 92 km from Mission weir 91 days after the trout was tagged. Two rainbow trout tagged in the lower Flathead were captured in Mission Creek; one spawner had migrated 32 km.

Redd surveys of the Mission/Post Creek drainage to identify spawning areas used by main-river rainbow trout were hampered by poor visibility due to turbid water or the early onset of spring runoff. Brown trout spawning in this drainage was considered inconsequential based on a total weir count of 11 fish in 3 years of trapping.

Crow Creek

Brown and rainbow trout were the only trout species found in Crow Creek below lower Crow Reservoir. Rainbow trout (mean CPUE = 7.40, Appendix J) were more abundant than brown trout (mean CPUE = 1.17) at the sampling station during this study. Of the 82 rainbow trout captured at this station, 82% were age 1 or 2 (Appendix K).

A total of 67 adult rainbow trout (mean TL = 362 mm) and six brown trout (mean TL = 406) were captured in the 5.6 km of Crow Creek below Lower Crow Reservoir during a two-day electrofishing effort in April 1985.

During a similar effort conducted in November 1985, we collected 84 rainbow trout (mean TL = 372 mm; 19 recaptures) and 23 brown trout (mean TL = 312 mm; 3 recaptures). All recaptures had been tagged during the previous survey in April. The day after fall shocking, the water temperature in the Flathead River near the mouth of Crow Creek was $0^{o}C$, in Crow Creek near its mouth was $2^{o}C$, and near Lower Crow Dam was 3.5 ^{o}C. Seventy (65%) of the 107 trout captured were within 0.8 km of the dam.

On 16 and 17 April 1986, 41 spawning rainbow trout (mean TL = 385 mm) and 14 brown trout (mean TL = 348 mm) were captured and released in the 5.6 km of Crow Creek below Lower Crow Reservoir. Twenty rainbow and three brown trout were recaptures from earlier spawner surveys.

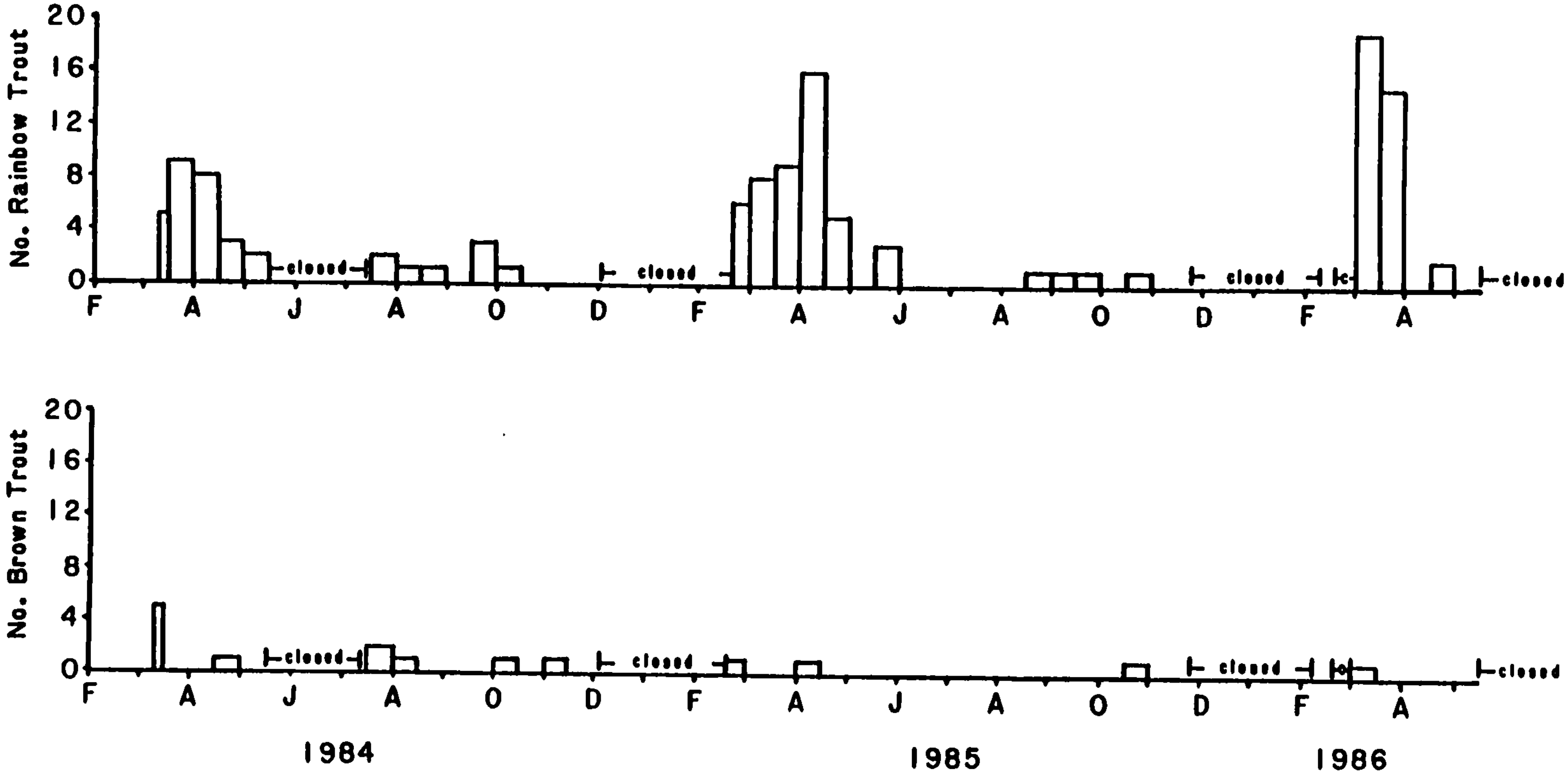


Figure 30. Trout captures at Mission weir from February 1984 through April 1986.

Twenty-seven (66%) of the rainbows were found above the Moiese A Canal diversion (km 4.8)

Eighty-four percent of the rainbow trout spawners sampled during April 1985 and 1986 were age 3 and 4 (Appendix K). Of the brown trout spawners collected in November 1985 81% were age 3 and 4. One rainbow trout tagged at Crow Creek in November 1985 was recaptured at the Mission Creek weir the following March.

Little Bitterroot River

Other than a remnant brook trout population found 3 km below the Camas A Canal diversion in October 1984, trout species in the Little Bitterroot River were confined to the canyon area (reach LB5) above this major barrier (Table 18). Brook trout (mean CPUE = 68.1) were more abundant than cutthroat (mean CPUE = 13.9) or rainbow trout (CPUE = 2.1) at the sampling station in each LB5. Age 1 and 2 brook and cutthroat trout represented 95% and 94% of the samples, respectively (Appendix K). Only eight rainbow trout were found in the Little Bitterroot River during this study.

Table 18. Distribution of fishes in the Little Bitterroot River by stream sections.

	Sections				
Species	V	IV	III	II	I
Slimy sculpin	*				
Cutthroat trout	*				
Rainbow trout	*				
Brook trout	*	*			
Redside shiner	*			*	*
Yellow bullhead		*		*	*
Largescale sucker		*		*	*
Pumpkinseed		*	*	*	*
Northern pike		*	*	*	*
Yellow perch			*	*	*
Northern squawfish				*	*
Longnose dace				*	*
Mountain whitefish					*

Cool-and warmwater species were distributed along the remaining 76 km of the Little Bitterroot below the diversion (Table 18), with northern pike at the top of the food chain. Coldwater species such as mountain whitefish reappeared in samples taken close to the confluence with the lower Flathead River, where whitefish were abundant.

In the composite length-frequency histogram for all northern pike captured from 1983 through 1985 using all methods (Appendix K), age 3 and 4 pike were most abundant, representing 68% of the total. Mean length for all pike captured was 434 mm. A regression of pike weight versus length (Appendix M) yielded the equation: log w = -5.10430 + 2.96961*log TL.

Stomach analysis of northern pike collected during October 1984 indicated that pike smaller than 300 mm fed primarily on aquatic insects and crustaceans. Larger pike (> 300 mm) had eaten crayfish (Orconectes spp.), yellow perch, and northern squawfish (Ptychocheilus oregonensis).

An aerial survey of the Little Bitterroot River identified a large marsh at km 60 near the town of Lonepine as a likely spawning area for northern pike. Trapping during spring 1983 confirmed that this area was used by spawning pike (Table 19). During subsequent years, however, very few pike were trapped at the marsh despite longer trapping intervals.

Table 19. Summary of spring trapping for spawning northern pike on the Little Bitterroot River.

Location	River Kilometer	1983	1984	1985
Mouth	2 & 5	10	2	3
Welch's	44	*	*	41
Lonepine	60	120	30	11

* not trapped until 1985.

A concentration of northern pike was found just upstream from Hot Springs Creek during electrofishing surveys. Trapping in this area during 1985 yielded 41 spawning pike (Table 19).

Although only 12 pike were captured during three years of spring trapping near the mouth of the Little Bitterroot River (Table 19), three of these were recaptured in the lower Flathead River. One had moved 67 km upstream to Buffalo Bridge (Appendix L), and another 29 km downstream to the Dixon area.

Northern pike movement is restricted within the Little Bitterroot drainage by agricultural dewatering and subsequent establishment of dense instream vegetation. Despite these difficulties, one pike tagged near Hot Springs Creek (km 46) and recaptured twice had moved downstream 34 km and returned to the same area (Appendix L).

Instream Flow Incremental Method

Within the first 13 km (reach 1) of Mission Creek, maximum Weighted Usable Area (WUA) for adult brown and rainbow trout was produced at discharges ranging from 2.3 to 2.5 m^3/second (80 to 90 cfs). Fry and juvenile habitat for both species was maximized at 1.7 m^3/second (60 cfs). Optimal spawning habitat for spring spawning rainbow trout was produced at 2.3 m^3/second (80 cfs), whereas optimal fall spawning habitat for brown trout was produced at 2.8 m^3/second (100 cfs). Projected optimal discharges for reach 2 (km 13.4 to 26.9, Figure 25) were considerably lower, with optimal adult habitat for both species being produced between 0.7 and 1.1 m^3/second (25 to 40 cfs). Fry and juvenile optimal discharges for Mission Creek reach 2 ranged from 0.14 m^3 /second to 0.71 m^3/second (5 to 25 cfs). Optimal spawning discharge was produced at 1.42 m^3/second (50 cfs) for rainbow trout and 1.7 m^3/second (60 cfs) for brown trout. Although needed discharges to produce maximum adult habitat were similar for both trout species, projected maximum WUA for rainbow trout was twice that projected for brown trout.

In Post Creek, maximum adult habitat for both trout species was projected at 1.4 m^3/second (50 cfs). Again, available adult rainbow trout habitat (WUA) was twice that projected for brown trout. Optimal fry and juvenile habitat was also the same for both species; 0.8 m^3/second (30 cfs). Optimal spawning flows for both species within this section of Post Creek was identical to that predicted for reach 2 of Mission Creek. Discharge needed to produce maximum WUA in both Post and Mission Creeks for all life stages of both trout species are well within their respective estimated annual hydrograph (Appendix F). IFIM results for the Post/Mission drainage are also supported by stock assessment data, which clearly shows that rainbow trout are the dominate trout species within these two creeks (Figure 28).

For the Jocko River, reaches 1 through 5 (km 0 to 41.8) were evaluated for brown and rainbow trout habitat, whereas the upper reaches, 6, 7, and 8 (km 41.8 to 63.1) were evaluated for cutthroat trout habitat. This was justified by fish species distributional pattern. Because natural flows, and projected discharges needed to meet optimal WUA, steadily increase from headwaters to the confluence with the main river, the following presentation of IFIM results will also flow downstream.

From Jocko reach 8 (km 63.1) downstream through reaches 7 and 6 (km 41.8) maximum WUA for adult cutthroat trout was produced at increasing discharges from 1, 1.42 and 2.3 m^3/second (35, 50 and 80 cfs), respectively. Discharges needed for optimal cutthroat juvenile and fry habitat were approximately 50 and 35 percent, respectively, of that needed for adults (Appendix F). Optimal cutthroat spawning discharges for these upper Jocko River reaches averaged 4.2 m^3/second (148 cfs), and are well within the range of expected spring flows (Appendix F). Jocko River reach 6 showed the highest available habitat for fry, juvenile and adult cutthroat trout, whereas reach 7 showed the highest available spawning habitat.

Within Jocko reach 5 (km 30.7 to 41.8, Figure 25) optimal WUA was produced at similar discharges for both rainbow and brown trout. Adult habitat is maximized at 1.6 m^3/second (55 cfs) with juvenile and fry habitat being maximized at 50% of the above stated discharge for both trout species. This pattern of similar discharges needed to maximize both rainbow and brown trout habitat is consistent throughout the remaining Jocko reaches, 1 through 4 (Appendix F).

In general, if 1.6 m^3/second (55 cfs) could be maintained through reach 5 (km 30.7 to 41.8) and discharge slowly increased throughout the lower reaches, rising to 3 m^3/second (105 cfs) at the river's mouth, adequate adult habitat for both species could be maintained year round. In some reaches fry and juvenile fish seem to require less water than adults. However, it must be realized that to restore and maintain the Jocko River as a viable, self-sustaining recreational fishery, adult habitat is the variable which should be maximized.

Projected available adult rainbow trout habitat (WUA) was usually double that projected for adult brown trout within reaches 1 through 4. However, there was far more brown trout fry and juvenile habitat than rainbow trout fry and juvenile habitat. Relative abundance of these two species was essentially equal within reaches 1 and 2 (Figure 28). In reaches 3 and 4, brown trout are the dominate species. The data indicate that the lower Jocko is a more suitable rearing area for brown trout than it is for rainbow trout.

Optimal rainbow trout spawning discharges should be available within the lower Jocko River based on estimated annual hydrographs (Appendix F). However, less than optimal discharges can be expected for fall spawning brown trout.

DISCUSSION

TRIBUTARIES

The lower Flathead River tributaries: Jocko River, Post/Mission Creek, and Crow Creek, are the major spawning grounds for trout from the main river. Data collected at weirs on the Jocko River and Mission Creek, redd surveys in the main river and tributaries, and comparisons with data from other drainages i.e. the Kootenai River support the important role the tributaries play in the life history of Flathead River trout.

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

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

No redds were found in the main stem of the lower Flathead River, other than at its confluence with the Clark Fork River. It appears that recruitment of trout to the lower river depends heavily upon successful spawning within a few tributaries. Of these tributaries, only the Jocko River has stable flows in most reaches (unlike the extreme and rapid fluctuations in lower Crow Creek) and good water quality year-round (unlike the turbid lower ends of Post and Mission Creeks).

Small but distinct spawning runs of main river rainbow and brown trout moving into the Jocko River were monitored at the Jocko weir. The Jocko River between the towns of Ravalli (km 14) and Arlee (km 31) is particularly critical to spawning trout, especially brown trout. Redd counts conducted during fall 1984-86 indicate that the majority of brown trout spawning in the lower Flathead River system occurs in this segment, even after accounting for multiple redd-building and spawning by resident trout.

A cursory survey of spawning gravels in the Jocko River indicated that important trout spawning areas have been degraded by sedimentation. Irrigation returns and poor riparian management are the most apparent sources of this sediment. Predicted trout embryo survival averaged 34% within the critical area of the Jocko River between Ravalli and Arlee based on substrate fractions smaller than 0.85 and 9.5 mm, assuming brown trout are at least as sensitive to substrate fines as rainbow trout. Laboratory studies in Idaho by Irving and Bjorn (1984) related survival rates for rainbow trout to the percentage of particles smaller than 0.85 mm in diameter. This high correlation (r = 0.85) is reflected in Figure 28, where the percent of substrate smaller than 9.5 mm has little effect on curves predicting trout survival. No laboratory studies have been conducted on brown trout survival to emergence.

Very few age 2 and older rainbow and brown trout were found in the lower five reaches of the Jocko River during fish population sampling. Out-migration of older trout to the lower Flathead River is one possible explanation; however, fishing pressure may contribute significantly. In a mail-out census of anglers conducted periodically from 1965 through 1986 by the MDFWP, fishing pressure averaged 4,300 (standard error = 2,499) angler-days per year for the Jocko River (memo dated 20 April 1987 from L. Hanzel, MDFWP, Kalispell, Montana), and Tribal members traditionally have been allowed unlimited harvest of fish on the Flathead Reservation.

Of 528 rainbow trout measured during a creel survey conducted from April to September on the Reservation, 98% were 200 mm or longer (DosSantos and Cross 1984). The 12 brown trout creeled averaged 312 mm in length. In contrast, only 15% of the rainbow trout captured during stock assessment electrofishing were longer than 200 mm; 13% of the brown trout were longer than 200 mm.

Concerned by the lack of fish greater than 200 mm in the Jocko River the Tribal Council implemented a catch and release policy in 1987 and will monitor the results in terms of changes in age class structure over the next six years. Adoption of similar regulation on sections of Rock Creek near Missoula resulted in a 475% increase in rainbow trout 279 to 353 mm long (Peters 1983). Dramatic increases in numbers of larger fish were also observed in Kelly Creek and the St. Joe River (Johnson 1977) in Idaho in response to special regulations.

More than double the number of rainbow trout entered Mission Creek weir than Jocko River weir between February 1984 and May 1986. Rainbow trout embryo survival was predicted at a low 23% in Mission Creek and 1% in Post Creek areas sampled, so improved embryo survival cannot explain the larger run. Periodic flooding of a small rainbow trout hatchery on Post Creek (km 7) is the probable source of rainbow trout recruitment from the Mission/Post Creek drainage to the lower Flathead River, explaining the larger spawning run.

Length-frequency histograms of trout from the Mission/Post Creek drainage do not reflect the same dramatic decline in fish abundance from age 1 to age 2 seen in the Jocko River. Mission Creek below its confluence with Post Creek receives less fishing pressure than the Jocko River (Hanzel, MDFWP, per. com.), and much of this reach runs through the section of the National Bison Range which is closed to fishing. The remainder of the stream is turbid during fishing season due to irrigation returns, reducing its desirability to many fishermen; access is generally limited in Post and Mission Creeks above their confluence. Trout in the upper reaches are smaller at maturity than in the more popular Jocko River trout.

Crow Creek has provided an interesting contradiction of results. More than 40 adult rainbow trout were captured during each electrofishing survey of the 5.6 km below Lower Crow Reservoir, yet redd counts never exceeded six. Up to 49% of the trout tagged in Crow Creek were recaptured near their tagging site, yet their large size and the recapture of one rainbow at Mission Creek weir indicate the population is probably not resident in the stream. The majority of Crow Creek trout have been found within 0.8 km of the dam (i.e. above the Moiese A Canal diversion), where armored cobble substrate predominates, and what spawning gravel is available can be accessed only at high flows.

Crow Creek may serve as a thermal refuge from water temperature extremes in the lower Flathead River. The Jocko River, Mission and Crow Creeks are all cooler than the main river during the summer. In addition, Crow Creek is warmer (4^{o}) than the lower river in the winter, and warmest near the dam from where hypolimnetic water is released from Crow Dam. Rainbow trout have been shown to move in response to as little as $1^{o}C$ temperature change under laboratory conditions (Cherry et al. 1975), and Cunjak and Power (1986) have speculated on the importance of "thermal refugia" to over-wintering fish. Spawners attracted into Crow Creek may have built few redds because flow releases from the dam have been extremely erratic historically and an armored substrate may preclude successful redd construction.

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

Although some interchange with the main river does occur, the Little Bitterroot supports a resident northern pike population. In the lower Flathead River, pike reached a length of around 370 mm at the end of their second year compared to 300 mm for Little Bitterroot pike. Main-river pike longer than 1000 mm have been captured in the main river, while pike longer than 500 mm were rare in the Little Bitterroot River.

Northern pike spawning in the Little Bitterroot River appeared to be concentrated in the 32 km between Hot Springs Creek (km 44) and the Camas A Canal diversion (km 76). The diversion was an absolute barrier to all fish, while Hot Springs Creek changed habitat suitability by introducing very turbid water, which hampered the growth of aquatic vegetation critical to successful pike spawning. The dramatic decline in numbers of spawners captured at Lonepine marsh indicated that either spawning sites shifted or weaker year classes were spawning in 1984 and 1985. Events such as early runoff during January 1984 and flooding during February 1985 could have influenced shifts in spawning pike concentrations.

The evaluation of instream tributary habitat was accomplished by using the Instream Flow Incremental Method. Results clearly showed that optimal habitat (based on WUA output) could be made available for all life stages of brown, rainbow and cutthroat trout. Based on basin characteristics regression equations, estimated monthly discharges for Post and Mission Creeks and the Jocko River were adequate to meet IFIM optimal flows. However, actual discharges in these streams are frequently less than the flows projected to produce optimal fish habitat. Therefore, it must be concluded that the construction and operation of the Flathead Indian Irrigation Project, along with general agricultural practices on the Flathead Reservatin are restricting the true potential of the main river tributary system.

CONCLUSIONS

The construction and operation of the Flathead Indian Irrigation Project (FIIP), and general agricultural practices on the Flathead Reservation play a role perhaps equal to Kerr Dam in creating the current status of aquatic habitat and fish population of the lower Flathead drainage. We identified the following major impacts:

1. Unscreened irrigation diversions intersect all major (and most minor) tributaries. These diversions have the potential of trapping fish of all species and age classes in irrigation canals, thereby reducing recruitment to the tributaries.

2. Frequent, erratic changes in streamflow below irrigation diversions and dams of FIIP create constantly recurring impacts to fish habitat without regard for the seasonal habitat requirements of those affected fish populations. In some cases aquatic habitat has been seasonally eliminated.

3. Inefficient irrigation practices result in irrigation return flows laden with silt (and possibly herbicides and pesticides) increases stream turbidity and streambed sedimentation. The impacts of sediments in streams is well documented.

4. The construction of irrigation diversions, canals, and dams on main-river tributaries reduces gravel reecruitment, and eliminates access to more than 100 kilometers of spawning and rearing habitat.

ALTERNATE MANAGEMENT STRATEGIES

Management strategies for the lower Flathead system were developed in part during informal consultation with the Tribal Council and other agencies, and modified as new data became available. The strategies range from no action, regulations of Kerr discharge to enhance fish habitat, to intensive off-site mitigation if the main river were dedicated to hydroelectric operation. The study recognizes the final selection of appropriate mitigation lies with the Flathead Tribal Council. We also recognize that new management strategies could be generated by combining some alternatives and that management strategies now under consideration by Montana Power Company may influence the final decision for the appropriate level of mitigation in the Flathead System.

The Lower Flathead System Fisheries Study has identified the existing condition of aquatic habitat and target fish species in the lower Flathead basin. Despite this, the extensive data base needed to accurately identify trends in habitat quality and fish populations in the lower basin is lacking. The challenge to basin resource managers include fisheries protection and rehabilitation, management of diverse aquatic resources for diverse users, habitat protection, and fish stock allocation among user groups. Short term demands of the fishing public and water users could threaten any long-term recovery of the Flathead system fisheries. These strategies are not meant to be an end in themselves (although they could be adopted as such) rather a starting point for discussion. The final strategy must incorporate conflicting public values and generate public support and understanding of the management goals and methods to achieve them. Implementation of any strategy is not recommended without a extensive long term monitoring program being simultaneously instituted and integrated into a basin wide aquatic resource management plan such as described by Cross (1987). The interested reader can refer to the Executive Summary, Volume I, of these reports for complet details on specific management alternatives.

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APPENDIX A

MAIN RIVER DESCRIPTION
HABITAT TERMS

Table 1. Descriptive terms used to define main river peripheral habitats.

Term	Definition
Backwater:	any place regarded as stagnant; having an upstream inlet channel which flows only at relatively high river discharges (>20,000 cfs).
Slough:	a still backwater which has some intergravel flow; well scoured upstream inlet channel flows at moderate river discharges (>10,000 cfs).
Eddy:	an upstream - circuling current, a whirlpool; usually associated with an obvious indentation of the shoreline.
Slackwater:	a broad expance of shallow water where there is no upstream and virtually no downstream current; not associated with irregularities of the shoreline.
Staging Area:	relatively shallow (3 m deep) benches, close (< 0.5 km) to shallow spawning areas, in which groups of sexually mature northern pike congregate.

APPENDIX B

INSTREAM FLOW INCREMENTAL METHODOLOGY STUDY SECTION TRANSECT DESCRIPTIONS

Table 1. Transect descriptions for the Sloan and McDonald IFIM study sections.

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

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

Sloan #3: a transitional habitat transect representing those areas which grade from deep-water, low velocity habitats into fast-moving runs. This transect shares some of the habitat features common to both transects #2 and #4.

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

Sloan #5: a transitional habitat transect representing those areas which grade from wide cobble-gravel riffles into deeper channeled runs. This transect shares some of the habitat features common to both transects #4 and #6.

Sloan #6: a habitat descriptive transect with one half representing a wide gravel-cobble riffle, the other half, a deep, fast moving, run with large substrate which carries the majority of the flow. This transect characterizes a large depositional point bar commonly associated with river bends. These areas are sometimes found to be important trout spawning areas.

McDonald #1: the downstream-most transect within the McDonald IFIM study section. This cross section sets the stage for the remaining upstream transects and will be used primarily for hydraulic purposes. This transect will be used to calculate the total discharge flowing through the study area, which will be used as a check for the multi-channel transects' discharge measurements.

McDonald #2a, #2b, and #2c: this transect crosses three distinct channels and represents a braided channel island complex. Cross section 2a transects a hydraulic control, 2b a small, shallow secondary channel, and 2c a wide, shallow run.

McDonald #3: a habitat descriptive transect representing a half-channel deep run. Substrates are predominately gravel and appear suitable for salmonid spawning. This half-channel and substrate composition is common throughout River Segment II.

McDonald #4: a habitat-descriptive transect representing a relatively deep single channel. It also encompasses a fairly broad, shallow bench area, previously identified as important habitat for northern pike. Substrates are a gravel mixture. A considerable amount of fine deposition has occurred on the bench, resulting in scattered growth of Chara sp. and Elodea sp.

McDonald #5: the upstream-most transect within the McDonald IFIM study section. This is a habitat descriptive transect representing a shallow, broad, single channel area. Substrates are primarily smaller gravels with a considerable percentage of fines.

McDonald #6: a non-flowing transect and crosses the mouth of McDonald Slough, one of the largest backwaters found in River Segment II. This transect will be used to determine water velocities through and accessability into this backwater area.

McDonald #7: a backwater cross section and transects the deepest part of McDonald Slough. This transect will be used to calculate the total area of the backwater at different stages.

APPENDIX C

MAIN RIVER PHYSICAL DATA

Table 1. Average monthly minimum, mean, and maximum discharges from Kerr Dam, 1983 - 1986.

Month		1983	1984	1985	1986	1983-1986 Average
Jan	min	9,870	9,490	9,300	3,850	8,127
	mean	11,310	10,890	10,810	11,313	11,081
	max	12,450	12,100	12,200	13,700	12,612
Feb	min	8,600	8,130	7,060	2,490	6,570
	mean	11,250	10,010	9,810	10,943	10,503
	max	12,800	11,900	11,700	13,600	12,500
Mar	min	5,990	5,470	5,680	2,240	4,845
	mean	7,865	8,683	7,176	9,226	8,238
	max	8,590	10,800	8,180	14,000	10,392
Apl	min	8,130	6,090	4,990	3,390	5,650
	mean	10,480	7,925	7,580	11,540	9,381
	max	14,600	10,900	12,100	13,700	12,825
May	min	11,100	1,490	10,900	2,920	6,602
	mean	15,310	7,204	15,740	12,685	12,735
	max	32,100	11,900	31,700	38,000	28,425
Jun	min	8,880	11,200	11,100	3,570	8,687
	mean	17,340	19,800	20,350	21,453	19,736
	max	26,100	33,700	33,100	42,100	33,750
Jul	min	9,580	3,940	5,830	1,830	5,295
	mean	17,430	10,040	9,657	7,703	11,208
	max	28,900	17,900	11,600	13,100	17,875
Aug	min	3,310	3,500	5,890	2,130	3,707
	mean	6,556	6,136	9,807	4,493	6,748
	max	10,300	10,700	14,300	8,470	10,942
Sep	min	4,810	3,680	9,280	2,620	5,097
	mean	8,959	7,911	11,730	8,201	9,200
	max	12,100	11,400	20,800	14,400	14,675
Oct	min	7,150	4,550	5,500	2,470	4,917
	mean	9,974	9,605	10,752	9,178	9,877
	max	12,000	11,500	13,100	13,300	12,475
Nov	min	6,050	7,880	3,660	3,330	5,230
	mean	10,030	9,025	10,561	9,856	7,868
	max	12,000	9,900	13,000	13,300	12,050
Dec	min	6,410	8,280	1,850	3,000	4,885
	mean	9,574	10,590	10,068	9,557	9,947
	max	11,800	11,900	13,600	13,300	12,650

Table 2. Average monthly minimum, mean, and maximum water temperatures recorded along the lower Flathead River, 1983 - 1986 (* = incomplete monthly readings).

		1983			1984		1985		1986	
		Kerr	Sloan	Perma	Sloan	Perma	Sloan	Perma	Sloan	Perma
Jan	min	0.8	-	-	0.2	0.5	-	1.0	2.0	0.8
	mean	2.0	-	-	1.6*	1.7*	-	1.4	2.7*	2.1
	max	3.1	-	-	2.8	3.1	-	2.2	3.6	2.9
Feb	min	1.5	-	-	1.2	2.5	-	0.9	1.8	0.8
	mean	3.0	-	-	2.2	3.5	-	1.5	2.3*	2.0*
	max	4.5	-	-	3.0	5.7	-	3.0	3.7	3.6
Mar	min	3.6	4.1	3.3	2.0	2.1	1.0	1.8	2.8	2.8
	mean	4.5	5.6*	4.9*	3.9	5.2	2.6*	3.8	4.7	4.7
	max	5.7	6.6	6.2	6.2	7.6	3.8	5.7	7.1	7.3
Apr	min	4.8	5.0	4.5	4.6	5.5	2.5	3.5	5.0	5.4
	mean	7.5	7.8	7.4	7.3	8.6	5.5	7.4	7.3	7.2
	max	11.2	12.0	12.2	10.2	10.3	9.8	11.1	9.8	9.6
May	min	8.1	8.2	7.4	6.2	7.5	5.8	8.0	-	8.0
	mean	10.5	9.7*	10.4	9.7	11.0	10.6*	11.7	-	10.9
	max	15.6	10.8	15.9	15.8	17.8	16.6	16.3	-	16.3
Jun	min	14.4	-	-	10.5	11.2	-	12.0	-	15.0
	mean	16.0	-	-	13.6	14.4	-	13.0*	-	17.1
	max	17.9	-	-	17.8	18.8	-	14.0	-	19.5
Jul	min	14.9	17.0	14.8	15.0	16.3	-	22.0	-	15.2
	mean	16.5	18.8*	17.2*	16.4*	20.4	-	23.2*	-	18.1
	max	19.4	21.4	21.3	17.8	24.3	-	24.2	-	20.8
Aug	min	19.4	19.9	17.1	-	17.6	-	16.3	-	17.4
	mean	21.5*	21.9	21.1	-	21.8	-	19.1	-	20.6
	max	22.7	24.5	22.5	-	24.1	-	23.2	-	23.0
Sep	min	12.7	12.7	10.8	-	9.6	-	10.4	-	11.5
	mean	16.0	16.2	14.4	-	14.6	-	14.3	-	15.3
	max	21.2	22.0	20.0	-	18.9	-	19.4	-	21.0
Oct	min	-	9.5	9.0	-	6.5	-	6.5	-	10.2
	mean	-	11.3	10.6	-	10.7*	-	8.9*	-	11.3*
	max	-	14.0	13.3	-	13.4	-	11.3	-	12.5
Nov	min	-	4.1	3.7	-	-	1.4	1.0	-	-
	mean	-	7.7	7.1	-	-	4.4	1.0	-	-
	max	-	10.8	10.2	-	-	8.0	7.2	-	-
Dec	min	-	0.4	0.1	-	0.9	1.6	0.6	-	-
	mean	-	2.3	1.8	-	1.6	2.5	1.3	-	-
	max	-	4.2	3.7	-	2.4	3.1	2.1	-	-

Table 3. Aquatic plant species found in backwater habitats of the lower Flathead River, Montana.

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

*dominant species

From Mackey et al. 1985 and Matthews et al. 1986.

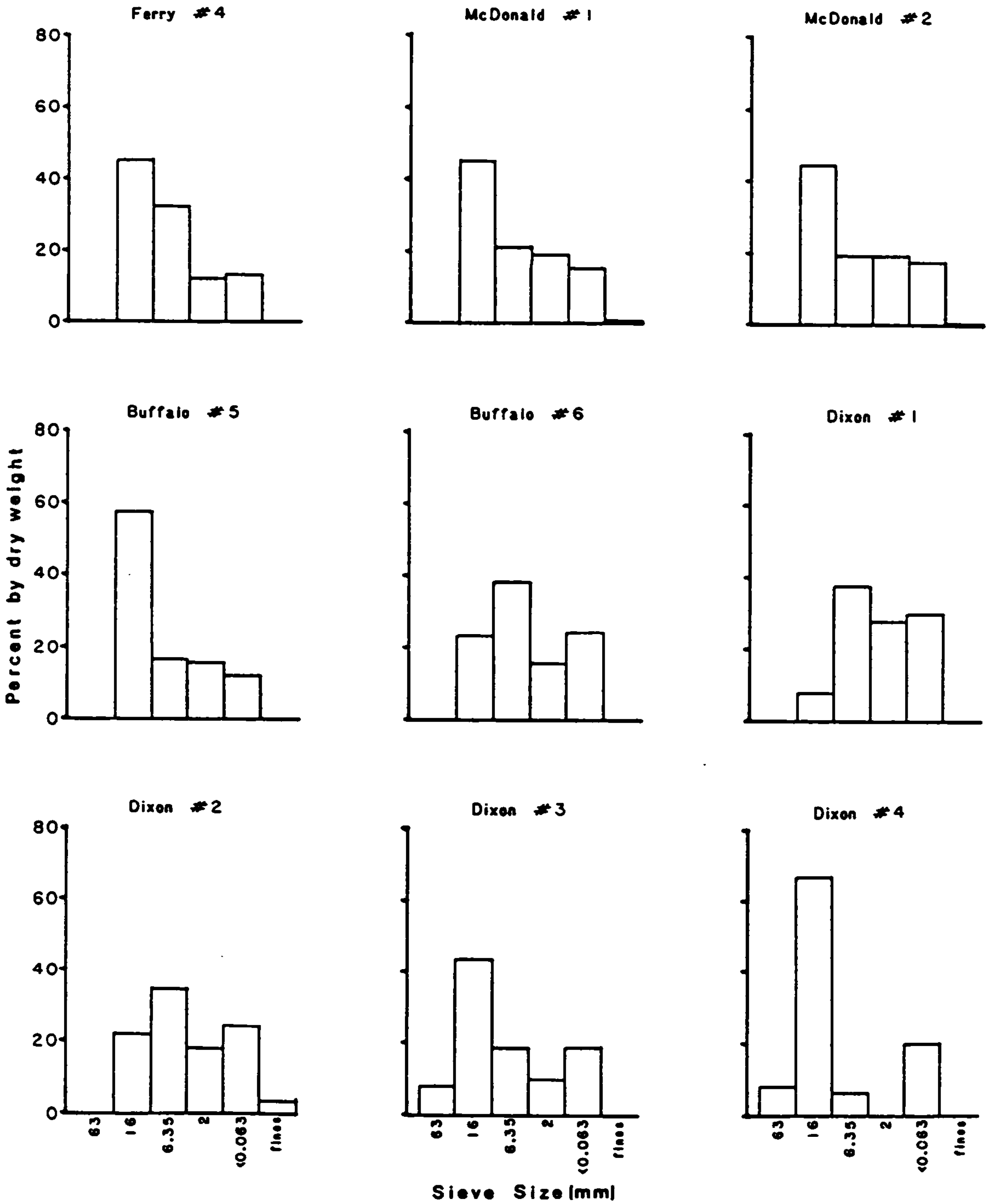

Figure 1. Substrate composition of gravels collected from select areas in the lower Flathead River during spring 1985.

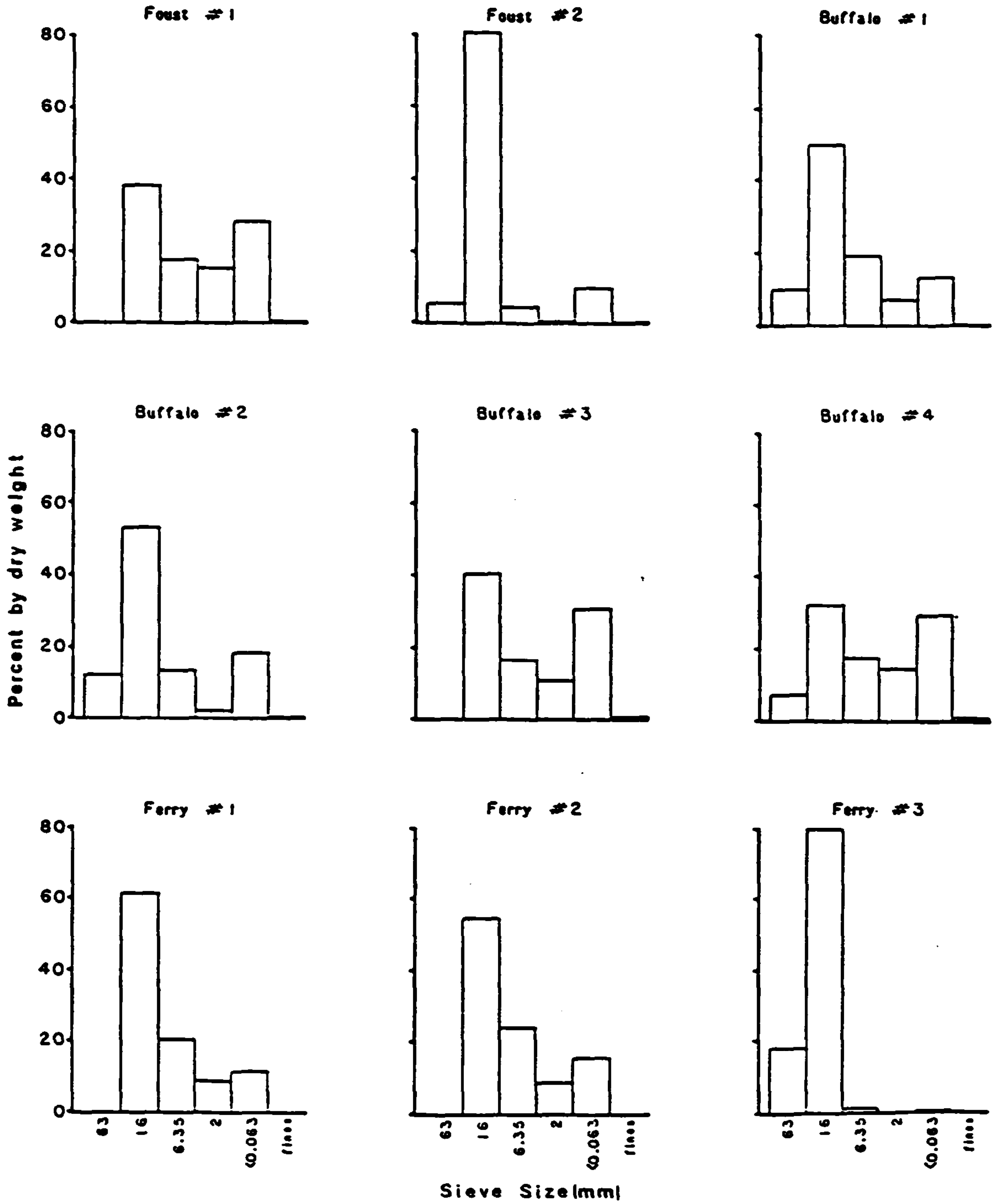

Figure 2. Substrate composition of gravels collected from select areas in the lower Flathead River during spring 1985.

Table 4. Predicted rainbow trout (Rb) embryo survival in spawning areas of the lower Flathead River related to combinations of substrates smaller than 0.85 and 9.5 mm based upon studies by Irving and Bjorn (1984).

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

APPENDIX D

NORTHERN PIKE RADIO TRACKING DATA, LOWER FLATHEAD RIVER, 1984-1986.

Record#	DATE	TIME	METHOD	FREQUENCY	SEX	RMILE	BANK	DISCHARGE	CCOVER	WATERTEMP	AIRTEMP	WATERVEL	DEPTH	SUBSTRATE	MARSH
1	04/01/84	200	3	020	f	65.1	l	6910		6.1	11.6	0.0	4.0		2
2	05/30/84	1000	1	020	f	57.3		1640		12.9	29.5	0.0	0.0		1
3	06/11/84	1330	3	020	f	31.5	l	20300		11.5	17.7	0.0	0.0		1
4	06/12/84	1000	3	020	f	31.0	l	15700		11.6	22.2	0.0	0.0	5	2
5	06/15/84	1042	3	020	f	30.4	r	25100		13.7	27.7	0.0	0.0	5	2
6	06/18/84	1249	2	020	f	30.4	r	25100		14.2	25.5	0.0	0.0	5	2
7	06/21/84	1443	2	020	f	30.4	r	23400		14.9	26.1	0.0	0.0	5	2
8	06/25/84	1100	3	020	f	30.4	r	13800		16.2	31.6	0.0	0.0	5	2
9	07/11/84	1230	2	020	f	30.4	r	15000		19.0	34.0	0.0	0.0	5	2
10	07/16/84	1150	3	020	f	30.4	r	9590	1	21.1	34.0	0.0	0.0	5	2
11	07/25/84	1330	3	020	f	37.8	l	6150	1	23.0	38.5	0.0	0.0		1
12	08/06/84	1246	3	020	f	37.9	m	6700	2	22.0	25.0	0.0	0.0		1
13	08/17/84	1340	3	020	f	37.7	l	6160	1	22.0	28.0	0.0	9.0	3	1
14	08/24/84	1401	3	020	f	37.7	l	6980	1	22.0	26.0	0.0	0.0		1
15	08/30/84	1216	3	020	f	37.6	l	10700	3	19.0	19.0	0.0	0.0		1
16	09/07/84	1045	3	020	f	37.7	l	10600	3	15.0	11.0	0.0	0.0		1
17	09/21/84	1044	3	020	f	52.8	m	5600	3	14.0	12.9	0.0	0.0		1
18	10/05/84	1008	3	020	f	54.9	r	9610	1	10.5	18.0	0.0	9.0		1
19	10/15/84	1008	3	020	f	54.9	r	10900	3	9.9	9.0	0.0	9.0		1
20	10/25/84	1100	3	020	f	56.8	r	9020	3	0.0	11.1	0.6	5.5	5	1
21	11/01/84	946	3	020	f	59.3	l	7880	3	0.0	1.0	0.0	7.0	5	4
22	11/13/84	950	3	020	f	59.3	r	9410	2	6.5	6.0	0.0	9.0	5	4
23	11/26/84	945	3	020	f	59.3	l	8950		5.0	1.0	0.0	7.0	5	4
24	12/07/84	1200	2	020	f	59.3	l	8250	3	1.4	-3.8	0.0	0.0	5	4
25	12/12/84	1350	2	020	f	59.0	l	11600	4	1.7	-1.1	0.0	0.0		1
26	01/04/85	1046	3	020	f	59.3	l	9300	3	2.0	-2.0	0.0	10.0	5	4
27	01/16/85	1038	3	020	f	59.3	l	11000	2	3.0	-3.0	0.0	9.0	5	4
28	01/25/85	1400	3	020	f	59.3	l	11000	3	2.5	-1.0	0.4	9.0	5	4
29	02/26/85	1030	3	020	f	59.3	l	7880	1	3.0	3.0	0.0	9.0	5	4
30	03/11/85	1035	3	020	f	59.3	l	7400	1	3.5	4.0	0.0	9.0	5	4

31	03/26/85	1130	3	020	f	59.3	1	6180	1	6.5	7.0	0.0	11.0	5	4
32	04/09/85	0	3	020	f	59.3	1	6040		7.0	13.5	0.0	9.0	5	4
33	04/16/85	1200	2	020	f	59.3	1	7450	1	7.7	15.0	0.0	9.0	5	4
34	04/25/85	0	3	020	f	60.2	r	7890		6.0	3.0	0.9	9.0	3	1
35	05/06/85	1000	3	020	f	63.6	r	12400		8.5	10.0	0.1	7.2	3	1
36	05/15/85	1000	2	020	f	61.9	1	12200	1	9.5	13.0	0.0	0.0		1
37	05/22/85	1000	3	020	f	61.8	1	12100	1	15.0	14.3	1.1	5.5	1	1
38	06/03/85	930	3	020	f	61.9	1	21300	2	12.0	14.0	1.5	6.0	2	1
39	06/10/85	930	3	020	f	61.9	1	29200	1	13.5	17.0	1.6	10.2	2	2
40	06/17/85	940	3	020	f	61.9	1	26400	1	12.0	18.0	0.3	10.5	2	2
41	06/24/85	930	3	020	f	61.8	1	12900	1	15.8	16.0	0.8	7.0	5	2
42	07/08/85	1400	2	020	f	61.8	1	10500		24.5	32.0	0.0	0.0		2
43	07/22/85	930	2	020	f	61.8	1	8500	2	24.9	25.0	0.0	0.0		2
44	07/26/85	728	3	020	f	61.8	1	9060	1	22.0	16.2	0.5	6.0	5	2
45	08/23/85	1117	3	020	f	62.0	1	13900	1	17.0	17.5	0.0	25.0		4
46	10/18/85	956	3	020	f	62.0	1	11300	1	8.0	3.0	0.0	23.0		1
47	11/13/85	930	2	020	f	62.0		11300	3	2.0	-4.0	0.0	0.0		
48	03/12/86	1029	3	020	f	61.4	r	10300	1	4.0	7.0	0.4	7.0	5	4
49	03/20/86	1010	3	020	f	61.4	r	6970	1	4.0	12.0	0.2	0.0	5	4
50	03/27/86	1000	3	020	f	61.8	1	9050	1	6.0	10.0	0.0	0.0	5	2
51	04/03/86	1330	2	020	f	61.8	1	9760	1	0.0	13.8	0.0	0.0		4
52	04/04/86	930	2	020	f	61.8	1	8610	1	0.0	16.6	0.0	0.0		4
53	04/11/84	200	3	163	m	44.8	r	6940		5.8	9.9	0.0	4.0	3	2
54	05/09/84	1320	2	163	m	44.6	r	11300		8.4	16.0	0.0	0.0		1
55	05/25/84	1300	3	163	m	45.7		1680		11.2	15.5	0.0	0.0		1
56	06/11/84	1200	3	163	m	45.0	r	20300		11.5	17.7	0.0	0.0		1
57	06/18/84	1030	2	163	m	44.9	r	25100		14.2	25.5	0.0	0.0		1
58	06/25/84	958	3	163	m	46.2	1	13800		16.2	31.6	0.0	0.0		1
59	07/18/84	0	1	163	m	46.0		8250		21.9	35.0	0.0	0.0		1
60	07/25/84	1135	3	163	m	46.1	r	6150	1	23.0	38.5	0.0	0.0		1

61	08/06/84	1100	3	163	■	46.0	r	6700	3	22.0	21.0	0.0	0.0		1
62	08/17/84	1220	3	163	■	46.0	1	6160	1	21.0	28.0	0.0	18.9		1
63	08/24/84	1301	3	163	■	46.0	1	6980	1	22.0	26.0	0.0	0.0		1
64	08/30/84	1100	3	163	■	46.0	1	10700	2	19.4	20.7	0.0	12.0		1
65	09/07/84	1010	3	163	■	46.0	1	10600	3	15.0	9.5	0.0	0.0		1
66	09/21/84	1105	3	163	■	46.0	1	5600	3	14.0	12.9	0.0	0.0		1
67	10/05/84	1047	3	163	■	46.0	1	9610	1	11.4	18.0	0.0	12.0		1
68	10/15/84	1036	3	163	■	46.0	1	10900	3	9.9	9.0	0.0	0.0		1
69	10/25/84	1210	3	163	■	46.1	r	9020	3	0.0	11.1	0.0	12.0	4	1
70	11/01/84	1040	3	163	■	46.1	1	7880	3	0.0	1.0	0.0	12.0	5	1
71	11/13/84	1041	3	163	■	46.0		9410		6.5	6.0	0.0	0.0		1
72	11/26/84	1030	3	163	■	46.0	1	8950		5.0	1.0	0.0	10.0		1
73	12/07/84	1352	2	163	■	46.0	1	8280		1.3	-3.8	0.0	0.0		1
74	12/12/84	1250	2	163	■	46.1		11600		1.6	-1.1	0.0	0.0		1
75	12/19/84	1400	2	163	■	46.1	r	11400		2.0	-2.0	0.0	0.0		1
76	01/02/85	1049	2	163	■	46.1	r	11600	3	2.0	-5.0	0.0	0.0		1
77	01/15/85	940	2	163	■	46.1	r	10300	2	1.3	2.0	0.0	0.0		1
78	01/29/85	1000	3	163	■	46.2	1	11600	3	2.0	-2.0	0.3	15.0	4	1
79	02/07/85	1300	2	163	■	46.2	1	10800	2	1.0	-6.0	0.0	15.0		1
80	02/20/85	940	2	163	■	46.0		9020		1.9	1.0	0.0	0.0		1
81	02/26/85	1136	3	163	■	46.2	1	7880	2	3.0	3.0	0.0	0.0		1
82	03/28/85	1230	2	163	■	46.0		6580		5.5	8.5	0.0	0.0		1
83	04/09/85	0	3	163	■	46.2	1	6040		6.0	10.5	0.0	0.0		1
84	04/16/85	1430	2	163	■	44.8	r	7450	1	7.7	15.0	0.0	0.0	3	2
85	04/25/85	0	3	163	■	46.1	1	7890		6.0	9.0	0.0	11.0		1
86	05/08/85	930	3	163	■	45.0	r	12500	3	9.9	8.7	0.1	1.8	3	3
87	05/15/85	0	2	163	■	45.0	r	12200	1	12.0	22.0	0.0	1.8	3	3
88	05/22/85	0	3	163	■	46.1	1	12100		14.0	20.0	0.1	7.0	3	1
89	06/03/85	1030	3	163	■	46.2	1	21300	2	13.0	15.0	0.4	7.0		1
90	06/10/85	1033	3	163	■	46.2	1	29200	1	13.5	18.0	0.4	8.7		4

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91	06/17/85	1030	3	163	M	45.0	r	26400	1	15.0	20.0	0.2	2.5	6	3
92	06/24/85	1028	3	163	M	46.2	1	12900	1	16.0	15.0	0.2	8.2	3	4
93	07/08/85	1100	2	163	M	46.2		10500		20.0	27.0	0.0	0.0		
94	07/22/85	1100	2	163	M	46.2		8500	2	22.4	27.0	0.0	0.0		
95	07/26/85	822	3	163	M	46.2	1	9060	1	22.0	17.0	0.2	12.0	3	4
96	08/23/85	1208	3	163	M	46.1	1	13900	1	17.0	20.0	0.0	10.0	5	4
97	10/18/85	1051	3	163	M	46.2	1	11300	1	8.0	4.0	0.0	16.0	3	4
98	11/01/85	914	2	163	M	46.2	1	11400	4	6.0	5.0	0.0	0.0		
99	11/13/85	1317	2	163	M	46.2	1	11300	1	1.0	-2.0	0.0	0.0		
100	01/24/86	1100	2	163	M	46.2		11500	1	2.6	4.0	0.0	0.0		
101	02/17/86	1700	2	163	M	46.2	1	3200	4	2.8	0.5	0.0	0.0		4
102	03/12/86	1134	3	163	M	46.2	1	10300	1	3.5	7.0	0.3	9.0	3	4
103	03/20/86	1125	3	163	M	46.2	1	6970	1	5.0	16.0	0.0	0.0	3	4
104	03/28/86	1000	3	163	M	46.2	1	9150	1	7.0	17.0	0.0	9.0	3	4
105	04/03/86	1220	2	163	M	46.2	1	9760	1	6.5	13.8	0.0	0.0		4
106	04/04/86	1215	2	163	M	46.2	1	8610	1	6.9	16.6				
107	04/24/86	925	3	163	M	45.0	r	12400	1	8.0	7.5	0.2	3.1	3	3
108	04/28/86	1524	2	163	M	46.2	1	12300	3	9.6	13.3	0.0	0.0	5	4
109	05/13/86	919	2	163	M	44.8	r	7690	4	13.0	15.0	0.0	0.0	3	4
110	05/19/86	1345	2	163	M	44.8	1	6950	1	16.5	22.0	0.0	0.0	3	4
111	05/28/86	1050	3	163	M	45.0	r	26600	1	12.5	22.0	0.3	3.4	6	3
112	03/28/86	1100	3	223	M	43.8	r	9150	1	7.0	17.0	0.0	7.5	3	1
113	04/03/86	1200	2	223	M	43.8	1	9760	1	6.5	13.8	0.0	0.0		4
114	04/04/86	1130	2	223	M	43.8	r	8610	1	6.9	16.6				
115	04/24/86	944	3	223	M	43.8	r	12400	1	6.5	7.5	0.1	3.8	3	1
116	04/28/86	1524	2	223	M	43.8	r	12300	3	7.6	13.3	0.0	0.0	3	1
117	05/13/86	910	2	223	M	43.8	r	7690	4	13.0	15.0	0.0	0.0	3	1
118	05/19/86	1315	2	223	M	43.8	r	6950	1	17.5	22.0	0.0	0.0	3	1
119	05/28/86	1107	3	223	M	43.8	1	26600	1	12.0	22.0	0.9	7.2	5	4
120	08/20/86	1230	3	223	M	38.9	r	6830	1	0.0	26.0	0.0	35.0		4

121	03/31/66	1130	3	293	f	30.4	r	9280	1	6.4	11.0	0.0	12.0	3	4
122	04/03/66	1030	2	293	f	30.4	r	11000	1	6.5	13.8	0.0	0.0		4
123	04/18/86	1000	3	293	f	30.4	r	12300	3	9.0	8.0	0.0	13.0	5	4
124	04/24/86	1035	3	293	f	30.4	r	13500	1	7.0	8.0	0.4	19.0	5	4
125	05/13/86	1045	2	293	f	31.2	l	10100	4	13.0	15.0	0.0	0.0	5	2
126	05/19/86	1445	2	293	f	30.4	r	8650	1	26.0	22.5	0.0	0.0	5	4
127	04/11/84	200	3	392	f	44.8	r	6940		7.1	9.9	0.0	4.0	3	2
128	05/09/84	1320	2	392	f	44.6	r	11300		9.7	16.0	0.0	0.0		1
129	05/23/84	0	2	392	f	44.6	r	3720		12.3	15.5	0.0	0.0		1
130	06/07/84	1045	2	392	f	45.0	r	12400		12.3	16.1	0.0	0.0		1
131	06/11/84	1200	3	392	f	45.0	r	20300		11.9	17.7	0.0	0.0		1
132	06/18/84	1050	2	392	f	44.8	r	25100		14.8	25.5	0.0	4.0	3	2
133	06/25/84	1018	3	392	f	43.7	r	13800		16.6	31.6	0.0	0.0		1
134	07/11/84	1015	2	392	f	44.2	r	15000		19.0	34.0	0.0	0.0		1
135	07/16/84	1015	3	392	f	43.8	l	9590	1	21.1	34.0	0.0	0.0		1
136	07/25/84	1200	3	392	f	44.4	r	6150	1	23.0	38.5	0.0	0.0		1
137	08/06/84	1120	3	392	f	43.9	l	6700	2	22.0	21.0	0.0	0.0		1
138	08/17/84	1300	3	392	f	43.7	l	6160	1	21.0	28.0	0.0	18.0		1
139	08/24/84	1330	3	392	f	43.7	l	6980	1	22.0	26.0	0.0	0.0		1
140	08/30/84	1115	3	392	f	43.7	r	10700	3	19.5	20.1	0.0	9.0		1
141	09/07/84	1030	3	392	f	43.7	l	10600	3	15.0	9.5	0.0	0.0		1
142	09/21/84	1120	3	392	f	43.7	l	5600	3	14.0	12.9	0.0	0.0		1
143	10/05/84	1059	3	392	f	43.7	r	9610	1	11.4	18.0	0.0	10.0		1
144	10/15/84	1043	3	392	f	43.7	r	10900	3	9.9	9.0	0.0	10.0		1
145	10/26/84	1017	2	392	f	43.7		10500	4	0.0	5.5	0.0	0.0		1
146	11/01/84	1100	3	392	f	43.8	l	7880	3	0.0	1.0	0.0	10.0	5	1
147	11/13/84	1051	3	392	f	43.0		9410	3	6.0	6.0	0.0	0.0		1
148	11/26/84	1040	3	392	f	43.8	l	8950		5.0	1.0	0.0	8.0	5	1
149	12/07/84	1333	2	392	f	43.8	l	8280	3	1.3	-3.8	0.0	8.0	5	1
150	12/12/84	1235	2	392	f	43.8		11600	4	1.6	-1.1	0.0	0.0		1

151	12/19/84	1340 2	392	f	43.8	11400	2.0	-2.0	0.0	0.0		1
152	01/02/85	1028 2	392	f	43.8	11600 3	2.0	-5.0	0.0	0.0		1
153	01/15/85	916 2	392	f	43.8	10300 2	1.3	2.0	0.0	0.0		1
154	01/29/85	1040 3	392	f	43.8 r	11600 3	2.0	-2.0	0.6	11.6 3		1
155	02/07/85	1320 2	392	f	43.8 r	10800 2	1.0	-6.0	0.0	0.0		1
156	02/20/85	900 2	392	f	43.8 r	9020	1.9	1.0	0.0	0.0		1
157	02/26/85	1152 3	392	f	43.8 r	7880 2	3.0	3.0	0.0	0.0		1
158	03/28/85	1300 2	392	f	43.8 r	6580	5.5	8.5	0.0	0.0		1
159	04/09/85	0 3	392	f	43.8 r	6040	6.0	10.5	0.0	0.0		1
160	04/16/85	1350 2	392	f	43.8 r	7450	7.7	15.0	0.0	0.0		1
161	04/25/85	0 3	392	f	43.8 r	7890	6.0	5.0	1.0	10.0		1
162	05/09/85	932 3	392	f	43.8 1	12900 1	9.2	11.5	0.0	6.3 5		1
163	05/15/85	0 2	392	f	43.8 1	12200 1	12.0	22.0	0.0	6.3 5		1
164	05/22/85	1130 3	392	f	43.8 r	12100 1	15.0	21.6	1.4	9.5		1
165	06/03/85	1130 3	392	f	43.8 1	21300 1	13.0	16.0	0.3	5.0 5		1
166	06/17/85	1045 3	392	f	43.6 1	26400 1	14.0	20.0	0.1	6.1 5		4
167	06/24/85	1130 3	392	f	43.8 1	12900 1	16.0	16.0	0.7	7.5 5		4
168	07/08/85	1030 2	392	f	43.6 1	10500	21.0	26.0	0.0	0.0		4
169	07/22/85	1130 2	392	f	43.6 1	8500 2	22.3	27.0	0.0	0.0		4
170	07/26/85	855 3	392	f	43.9 1	9060 1	22.0	17.3	0.8	4.0 5		4
171	08/23/85	1300 3	392	f	43.9 1	13900 1	17.2	21.0	0.0	7.0 5		4
172	09/06/85	949 2	392	f	43.9	10400 4	15.0	11.0	0.0	0.0		
173	10/18/85	1105 3	392	f	43.8 1	11300 1	8.0	4.0	0.0	9.0 5		4
174	11/01/85	900 2	392	f	43.8 1	11400 4	6.0	5.0	0.0	0.0		
175	11/13/85	1256 2	392	f	43.8	11300 1	1.0	-2.0	0.0	0.0		
176	01/10/86	1110 2	392	f	43.8 1	10800 3	3.0	4.0	0.0	0.0		
177	01/24/86	1145 2	392	f	43.8	11500 2	0.0	4.0				
178	02/17/86	1800 2	392	f	44.1 r	3200 4	2.8	0.5	0.0	0.0		1
179	02/26/86	1000 2	392	f	44.0	10900 1	2.6	12.0				
180	03/12/86	1156 3	392	f	43.8 1	10300 1	3.5	7.0	0.6	6.0 3		4

181	03/20/86	1200	3	392	f	43.8	m	6970	1	5.0	16.0	0.0	0.0	3	1
182	03/28/86	1030	3	392	f	43.8	r	9150	1	7.0	17.0	0.0	7.5	3	1
183	04/03/86	1200	2	392	f	43.8	1	9760	1	6.5	13.8	0.0	0.0		4
184	04/04/86	1130	2	392	f	43.7	1	8610	1	6.9	16.6				
185	04/24/86	944	3	392	f	43.8	r	12400	1	6.5	7.5	0.1	4.5	3	1
186	04/28/86	1524	2	392	f	44.8	r	12300	3	6.1	13.3	0.0	0.0	3	4
187	05/13/86	932	2	392	f	43.8	r	7690	4	13.0	15.0	0.0	0.0	3	1
188	05/19/86	1315	2	392	f	43.8	r	6950	1	17.5	22.0	0.0	0.0	3	1
189	05/28/86	1050	3	392	f	45.0	r	26600	1	12.5	22.0	0.3	3.4	6	3
190	09/24/86	2300	3	392	f	43.6	r	11300		0.0	11.1	0.0	2.0	5	4
191	05/03/84	0	3	553	m	30.4	r	10900		7.3	12.2	0.0	0.0	5	2
192	05/09/84	0	2	553	m	30.4	r	11300		8.4	16.0	0.0	0.0	5	2
193	05/25/84	1400	3	553	m	30.3		1680		11.2	15.5	0.0	0.0	5	2
194	05/30/84	0	2	553	m	30.3		1640		12.9	29.5	0.0	0.0	5	2
195	06/05/84	1000	2	553	m	30.4	r	11800		11.2	16.6	0.0	0.0	5	2
196	06/11/84	1330	3	553	m	30.4	r	20300		11.5	17.7	0.0	0.0	5	2
197	06/15/84	1045	3	553	m	30.4	r	25100		13.7	27.7	0.0	0.0		2
198	06/18/84	1249	2	553	m	30.4	r	25100		14.2	25.5	0.0	0.0		2
199	07/18/84	0	1	553	m	59.0		8250	1	21.9	35.0	0.0	0.0		1
200	07/19/84	1130	3	553	m	59.2	r	3940	1	21.5	34.5	0.0	0.0		4
201	07/25/84	1015	3	553	m	59.1	r	6150	1	23.0	38.5	0.0	0.0		1
202	08/06/84	1000	3	553	m	59.1	r	6700	2	22.0	18.0	0.0	0.0		1
203	08/17/84	1000	3	553	m	59.1	r	6160	1	21.0	24.0	0.0	16.0		1
204	08/24/84	1047	3	553	m	59.1	r	6980	4	21.0	18.0	0.0	0.0		1
205	08/30/84	1013	3	553	m	59.5		10700	2	19.1	20.0	0.0	0.0		1
206	09/07/84	930	3	553	m	59.5		10600	3	15.5	9.5	0.0	0.0		1
207	09/21/84	1017	3	553	m	58.3	1	5600	3	14.0	12.9	0.0	12.0		4
208	10/05/84	950	3	553	m	58.3	1	10300	1	10.5	18.0	0.0	11.0	0	4
209	10/15/84	944	3	553	m	59.1	1	10900	3	9.9	9.0	0.0	7.0	5	1
210	10/25/84	1025	3	553	m	58.8	r	9020	3	0.0	11.1	0.6	5.7	5	1

211	11/01/84	957	3	553	m	58.7	l	7880	3	0.0	1.0	0.0	10.0	5	4
212	11/13/84	1100	3	553	m	58.7	r	9410	3	6.5	6.0	0.0	0.0		1
213	11/26/84	952	3	553	m	58.2	l	8950		5.0	1.0	0.0	10.0	5	4
214	12/07/84	1130	2	553	m	58.2	l	8280	3	1.4	-3.8	0.0	0.0		4
215	01/04/85	1058	3	553	m	58.2	l	9300	3	2.0	-2.0	0.0	0.0		4
216	01/16/85	1047	3	553	m	58.2	l	11000	2	3.0	-3.0	0.0	0.0		4
217	01/25/85	1300	3	553	m	58.7	l	11000	3	2.5	-1.0	0.3	11.3	5	4
218	02/26/85	1050	3	553	m	58.7	l	11500	1	3.0	3.0	0.0	0.0		4
219	03/11/85	1045	3	553	m	58.7	l	7400	1	3.5	4.0	0.0	0.0		4
220	03/26/85	1130	3	553	m	59.3	l	6180	1	6.5	7.0	0.0	11.0	5	4
221	04/09/85	0	3	553	m	59.3	l	6040		7.0	13.5	0.0	0.0	5	4
222	04/25/85	0		553	m	30.4	r	11430		6.5	5.0	1.0	7.0	5	2
223	04/30/85	0	3	553	m	30.4	r	10790		8.5	21.0	0.0	3.0	5	2
224	05/07/85	0	3	553	m	30.4	r	13290	3	14.0	17.0	0.0	2.5	5	2
225	05/09/85	0	3	553	m	30.4	r	13760		12.0	12.0	0.0	0.0	5	2
226	05/15/85	0	2	553	m	30.4	r	12720	1	13.0	21.5	0.0	0.0	5	2
227	05/22/85	1300	3	553	m	30.4	r	12890	1	20.0	22.0	0.1	2.0	5	2
228	05/24/85	1030	3	553	m	30.4	r	13320	1	17.5	21.0	0.0	3.0	5	2
229	06/03/85	1200	3	553	m	30.4	r	22230	1	13.0	16.0	0.0	0.0	5	2
230	06/10/85	1350	3	553	m	30.4	r	29310	1	16.0	22.0	0.1	7.0	5	2
231	06/17/85	1145	3	553	m	30.4	r	27960	1	15.0	21.0	0.1	3.5	6	2
232	06/24/85	1315	3	553	m	30.4	r	12820	1	18.0	17.5	0.1	3.5	5	2
233	07/08/85	1200	2	553	m	30.4		11510		23.5	30.0	0.0	0.0		
234	03/12/86	1307	3	553	m	30.4	r	11700	2	4.0	9.0	0.2	9.0	5	2
235	03/20/86	1300	3	553	m	30.4	r	8310	1	6.0	17.0	0.0	18.5	3	4
236	03/31/86	1130	3	553	m	30.4	r	9280	1	6.4	8.5	0.0	18.0	3	4
237	04/03/86	1030	2	553	m	30.4	r	11000	1	6.5	13.8	0.0	0.0		4
238	04/18/86	1000	3	553	m	30.4	r	12300	3	9.0	8.0	0.0	13.0	5	4
239	04/24/86	1035	3	553	m	30.4	r	13500	1	7.0	8.0	0.4	19.0	5	4
240	05/13/86	1030	2	553	m	30.4	r	10100	4	13.0	15.0	0.0	0.0	5	4

241	05/28/86	1208	3	553	M	30.4	r	22500	1	13.0	23.0	0.1	4.0	6	2
242	08/20/86	1413	3	553	M	33.3	r	7560	1	0.0	27.0	0.0	10.0	5	4
243	08/27/86	1400	2	553	M	33.3	r	6970		0.0	27.0	0.0	0.0	5	4
244	05/03/84	0	3	653	M	30.4	r	10500		7.3	12.2	0.0	0.0	5	2
245	05/09/84	0	2	653	M	30.4	r	11300		8.4	16.0	0.0	0.0	5	2
246	05/25/84	1400	3	653	M	30.3		1680		11.2	15.5	0.0	0.0		1
247	05/30/84	0	2	653	M	30.3		1640		12.9	29.5	0.0	0.0		1
248	06/05/84	1000	2	653	M	30.4	r	11800		11.2	16.6	0.0	0.0	5	2
249	06/11/84	1330	3	653	M	30.4	r	20300		11.5	17.7	0.0	0.0	5	2
250	06/15/84	1045	3	653	M	30.4	r	25100		13.7	27.7	0.0	0.0	5	2
251	06/18/84	1249	2	653	M	30.4	r	25100		14.2	25.5	0.0	0.0	5	2
252	06/25/84	1100	3	653	M	30.4	r	13800		16.2	31.6	0.0	0.0	5	2
253	07/11/84	1230	2	653	M	30.4	r	15000		19.0	34.0	0.0	0.0	5	2
254	07/16/84	1140	3	653	M	30.4	r	9590	1	21.1	34.0	0.0	0.0	5	2
255	07/25/84	1530	3	653	M	11.8	M	6150	1	23.0	38.5	0.0	0.0		1
256	08/06/84	1450	3	653	M	12.0	1	6700	2	22.0	25.0	0.0	0.0		1
257	08/17/84	1530	3	653	M	12.0	1	6160	1	23.0	27.0	0.0	14.5		1
258	08/23/84	1329	3	653	M	12.7	1	4660	2	22.0	30.0	0.0	0.0		1
259	08/30/84	1342	3	653	M	12.5	1	10700	4	19.0	16.0	0.0	0.0		1
260	09/07/84	1335	3	653	M	12.6	1	10600	3	15.0	14.0	0.0	14.5		1
261	09/21/84	1430	3	653	M	12.6	1	5600	3	14.0	12.9	0.0	14.5		1
262	10/04/84	1042	3	653	M	17.9	r	9680	1	11.4	12.4	0.0	5.0	5	2
263	10/16/84	1020	3	653	M	17.9	r	10900	3	9.0	3.6	0.0	5.0	5	2
264	11/01/84	1415	3	653	M	19.8	r	7880	3	0.0	1.0	0.0	8.0	5	1
265	11/15/84	1345	3	653	M	19.8	r	9900		0.0	5.0	0.0	0.0	5	1
266	11/27/84	1045	2	653	M	19.8	r	9490		0.0	4.0	0.0	0.0	5	1
267	12/06/84	1400	2	653	M	19.8	r	9250	1	1.5	-4.4	0.0	0.0	5	1
268	12/12/84	1100	2	653	M	19.8	r	11600	4	1.6	-1.1	0.0	0.0	5	1
269	12/19/84	1140	2	653	M	19.8	r	11400		2.0	-2.0	0.0	0.0	5	1
270	01/02/85	1224	2	653	M	19.8	r	11600	3	1.5	-2.0	0.0	0.0	5	1

271	01/15/85	1245	2	653	■	19.8	r	10300	1	1.3	2.0	0.0	0.0	5	1
272	01/22/85	945	2	653	■	19.8	r	10100	2	3.0	-0.5	0.0	0.0	5	1
273	02/07/85	945	2	653	■	19.8	r	10800	4	1.0	-6.0	0.0	0.0	5	1
274	02/11/85	1000	2	653	■	19.8	r	11100	3	0.9	5.0	0.0	0.0	5	1
275	02/20/85	1100	2	653	■	19.8	r	9020		1.9	1.0	0.0	0.0	5	1
276	03/04/85	1115	2	653	■	19.8	r	7780	3	3.0	5.0	0.0	0.0	5	1
277	03/05/85	1145	3	653	■	19.9	r	7670		3.0	6.0	0.5	6.8	5	1
278	03/12/85	1315	2	653	■	19.9	r	7660		1.6	9.0	0.0	0.0	5	1
279	03/19/85	0	3	653	■	19.9	r	7670	1	6.5	16.0	0.0	0.0	5	1
280	03/28/85	0	2	653	■	20.0		7490		4.0	8.5	0.0	0.0		1
281	04/10/85	1430	3	653	■	20.7	■	6710	1	5.6	22.0	0.0	0.0		1
282	04/25/85	0	3	653	■	30.4	r	8530		6.0	5.0	0.8	10.0	5	2
283	04/30/85	0	3	653	■	30.4	r	11680		8.5	21.0	0.0	3.0	5	2
284	05/07/85	1400	3	653	■	30.4	r	13290	3	9.0	17.0	0.4	7.0	5	2
285	05/09/85	0	3	653	■	30.4	r	13760	1	12.2	12.0	0.0	0.0	5	2
286	05/15/85	0	2	653	■	30.4	r	12720	1	13.0	21.5	0.0	0.0	5	2
287	05/22/85	1315	3	653	■	30.4	r	12890	1	15.0	22.0	0.2	6.5	5	2
288	05/24/85	1030	3	653	■	30.4	r	13320	1	17.5	21.0	0.0	3.0	5	2
289	06/03/85	0	3	653	■	30.4	r	22230	1	13.0	16.0	0.0	0.0	5	2
290	06/10/85	1350	3	653	■	30.4	r	29310	1	16.0	22.0	0.1	7.0	5	2
291	06/17/85	1145	3	653	■	30.4	r	27960	1	15.0	21.0	0.1	3.5	6	2
292	06/24/85	1315	3	653	■	30.4	r	12820	1	18.0	17.5	0.1	3.5	5	2
293	07/08/85	1200	2	653	■	30.4	r	11510		23.5	30.0	0.0	0.0		
294	07/22/85	1430	2	653	■	19.8		9510	2	0.0	36.1	0.0	0.0		
295	07/26/85	1115	3	653	■	19.9	r	9500	1	23.3	23.0	0.5	8.0	5	1
296	08/23/85	1430	3	653	■	19.7	r	13900	1	17.5	22.0	0.0	6.0	5	1
297	09/06/85	1155	2	653	■	19.7		10400	4	15.3	11.0	0.0	0.0		
298	10/18/85	1315	3	653	■	19.7	r	11300	1	8.0	11.0	0.0	4.0	5	4
299	01/10/86	1315	2	653	■	19.0		10800	3	3.0	4.0	0.0	0.0		
300	01/24/86	1300	2	653	■	19.0		11500	1	0.0	4.0	0.0			

301	02/13/86	1300	2	653	m	19.0		12000	2	1.4	-2.0	0.0	0.0		
302	02/18/86	800	2	653	m	19.0		11800	3	2.2	0.1				
303	02/26/86	1152	2	653	m	19.0		10900	1	2.7	12.0				
304	03/12/86	1348	3	653	m	20.5	l	11700	2	5.0	10.0	1.0	5.0	5	1
305	03/20/86	1420	3	653	m	19.8	r	8310	1	9.0	18.5	0.0	6.0	5	4
306	04/03/86	1030	2	653	m	30.4	r	11000	1	6.2	13.8	0.0	0.0		4
307	04/18/86	1000	3	653	m	30.4	r	12300	3	9.0	8.0	0.0	13.0	5	4
308	04/24/86	1035	3	653	m	30.4	r	13500	1	7.0	8.0	0.4	19.0	5	4
309	05/13/86	1030	2	653	m	30.4	r	10100	4	13.0	15.0	0.0	0.0	5	4
310	05/28/86	1208	3	653	m	30.4	r	22500	1	13.0	23.0	0.1	4.0	6	2

Record#	DATE	TIME	METHOD	FREQUENCY	SEX	RMILE	BANK	DISCHARGE	CCOVER	WATERTEMP	AIRTEMP	WATERVEL	DEPTH	SUBSTRATE	MARSH
1	04/02/84	0	3	064	m	65.1	l	6110		6.2	0.0	0.0	0.0		1
2	05/21/84	0	2	064	m	65.6		5600		10.1	0.0	0.0	0.0		1
3	05/24/84	1315	3	064	m	65.7		2300		10.9	0.0	0.0	0.0		1
4	06/11/84	1000	3	064	m	66.0	r	20300		11.5	0.0	0.0	0.0		1
5	06/18/84	949	2	064	m	66.0	r	25100		14.2	0.0	0.0	0.0		1
6	07/11/84	930	2	064	m	66.0	r	15000		19.0	0.0	0.0	0.0		1
7	07/19/84	1000	3	064	m	66.0	l	3940		21.5	0.0	0.0	0.0		1
8	07/25/84	930	3	064	m	66.0	m	6150		23.0	0.0	0.0	0.0		1
9	07/29/84	0		064	m	10.5	r	6210		22.4	0.0	0.0	0.0		1
10	06/05/84	0	3	693	m	19.3	r	11800		12.8	0.0	0.0	0.0	5	2
11	06/11/84	1525	3	693	m	18.2	r	20300		11.9	0.0	0.0	0.0		2
12	06/15/84	0	3	693	m	18.1	r	25100		13.7	0.0	0.0	0.0	5	2
13	06/25/84	1330	3	693	m	15.6	r	13800		16.6	0.0	0.0	0.0		1
14	07/18/84	0	1	693	m	0.0		0	1	21.9	0.0	0.0	0.0		1
15	07/26/84	1140	2	693	m	0.0	r	0	1	0.0	0.0	0.0	0.0		1
16	08/01/84	0	1	693	m	0.0		0		23.0	0.0	0.0	0.0		1
17	09/06/84	0	1	693	m	0.0		0		17.1	0.0	0.0	0.0		1
18	10/26/84	1400	2	693	m	0.0	l	0		0.0	0.0	0.0	0.0		1
19	01/02/85	1330	2	693	m	0.0		0	3	1.5	-2.0	0.0	0.0		1
20	05/28/85	1030	2	693	m	0.0		0		0.0	18.0	0.0	0.0		1
21	04/26/85	1000	3	758	m	30.4	r	8920		0.0	0.0	0.0	10.0	5	2
22	04/30/85	0	3	758	m	30.4	r	11730		8.5	0.0	0.0	16.0	5	4
23	05/07/85	0	3	758	m	30.4	r	13290	3	9.0	17.0	0.4	7.0		4
24	05/09/85	0	2	758	m	30.4	r	13760	1	10.0	0.0	0.0	0.0		0
25	05/15/85	0	2	758	m	30.4	r	12720	1	13.0	21.5	0.0	0.0		0
26	05/22/85	1430	3	758	m	30.4	r	12890	1	15.0	22.0	0.4	12.5		4
27	05/24/85	1030	3	758	m	30.4	r	13320	1	17.5	21.0	0.0	0.0		4
28	06/03/85	1200	3	758	m	30.4	r	22230	1	13.0	16.0	0.0	4.0	5	2
29	06/10/85	1350	3	758	m	30.4	r	29300	1	16.0	22.0	0.1	7.0	5	2
30	06/17/85	1145	3	758	m	30.4	r	27960		15.0	21.0	0.1	3.5	5	2

31	06/24/85	1130	3	758	*	30.4	r	12820	1	18.0	17.5	0.1	3.5	5	2
32	07/08/85	1200	2	758	*	30.4	r	11510		23.5	30.0	0.0	0.0		0
33	07/26/85	1030	3	758	*	26.6	l	9500	1	22.0	22.0	1.5	7.0	2	1
34	08/23/85	1410	3	758	*	26.6	l	13900	1	17.5	22.0	0.0	3.0	2	1
35	10/18/85	1245	3	758	*	26.6	*	11300	1	8.0	9.0	0.0	7.0	3	1
36	11/01/85	1015	2	758	*	26.6	*	11500	3	6.0	7.0	0.0	0.0		
37	04/20/85	0	3	832	*	27.0	r	9370		0.0	0.0	0.0	3.0	2	2
38	04/23/85	1430	3	832	*	26.9	r	8750	2	9.5	10.0	0.0	0.0	5	1
39	04/30/85	0	3	832	*	26.6	l	11730		10.0	0.0	0.0	6.0	5	2
40	05/07/85	0	3	832	*	26.6	l	13290		6.6	0.0	0.0	4.0	5	2
41	05/09/85	1139	3	832	*	26.6	l	13760	1	12.2	12.0	0.0	6.0	5	2
42	05/15/85	0	2	832	*	26.6	l	12720	1	13.0	21.5	0.0	0.0	5	2

APPENDIX E

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

JOCKO RIVER

Reach 1	Stream km
Boundaries: mouth to Spring Canyon	0.0 to 5.8
Habitat survey: Dixon Bridge upstream	1.6 to 3.2
Fish sampling station (150 m): near Hwy 200, Sec 20/21	3.2
Comments: reach open and braided below Bison Range canyon	

Reach 2	
Boundaries: Spring Canyon to Hwy 200	5.8 to 13.8
Habitat survey: Section 25/26 boundary upstream	8.8 to 10.4
Fish sampling station (150 m): Sec 25/26 boundary	10.4
Comments: reach confined along Bison Range	

Reach 3	
Boundaries: Hwy 200 to Valley Creek	13.8 to 19.0
Habitat survey: North Valley Creek Road downstream	16.9 to 18.5
Fish sampling station (150 m): North Valley Creek road	18.5
Comments: reach still somewhat confined; Valley Creek influence	

Reach 4	
Boundaries: Valley Creek to Finley Creek	19.0 to 30.7
Habitat survey: South Valley Creek Road downstream	23.2 to 24.8
Fish sampling station (150 m): South Valley Creek road	23.2
Comments: reach unconfined; Finley Creek influence	

Reach 5	
Boundaries: Finley Creek to K canal	30.7 to 41.8
Habitat survey: Teresa Adams Road downstream	36.7 to 38.3
Fish sampling station (150 m): behind Clinkenbeard ranch, Sec 7	36.8
Comments: reach has hatchery influence and dewatered section	

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

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

MISSION CREEK

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

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

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

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

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

POST CREEK

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

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

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

Reach 4

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

CROW CREEK

Reach 1

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

LITTLE BITTERROOT RIVER

Reach 1

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

Reach 2

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

	Stream km
Reach 3	
Boundaries: Hot Springs Creek to Sullivan Creek	44.1 to 55.7
Habitat survey: Section 29/20 road upstream	45.9 to 47.5
Fish sampling station (150 m): Section 29/30 road	45.9
Comments: Sullivan Creek is another sediment source	
Reach 4	
Boundaries: Sullivan Creek to Camas A Canal	55.7 to 76.0
Habitat survey: Section 22 crossroads upstream	61.3 to 62.9
Fish sampling station (150 m): Section 22 crossroads	61.3
Comments: large marsh in reach; canyon above Bassoo Creek	
Reach 5	
Boundaries: Camas A Canal to Reservation boundary	76.0 to 82.1
Habitat survey: canyon area Section 9 upstream	77.2 to 78.8
Fish sampling station (150 m): canyon area Section 9	77.2
Comments: reach has trout-accommodating habitat	

HABITAT SURVEY FORMS

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

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

Stream Features On Back

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

Pools: III, II, I

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

CHANNEL STABILITY EVALUATION

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

Size Composition of Bottom Materials (Total to 100%)

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

TOTAL SCORE __________

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

APPENDIX F

Habitat weighting used for tributary IFIM analysis, weighted usable area (WAU) output and estimated streamflows

TRIBUTARY IFIM

HABITAT WEIGHTING

Jocko Segment 1

Habitat survey percent occurrence (P.O.): pools(p)- 2%
riffles(R)- 10%
runs(RN)- 85.5%
pocket water(PW)- 2.5%

Transect 1
- -Split channel with the tail of a pool in the left (facing upstream) channel and a shallow riffle in the right channel.
- -Weight: 2% for pool + 10% for riffle = 12%.

Transect 2
- -Run with pocket water near right bank.
- -Weight: 85.5% for run + 2.5% for pocket water = 88%.

Jocko Segment 2

Habitat survey P.O.:

P	1%
R	7.5%
RN	91.5%
PW	0%

Transect 1
- -Run with pool near rip-rapped right bank. Run is deeper with finer substrate than transect 3, and is therefore less typical of the segment.
- -Weight: 1% for pool + 9% for run = 10%

Transect 2
- -Riffle with quiet water near near left bank.
- -Weight: 7.5% for riffle + 27.5% for pool/run = 35%.

Transect 3
- -Run typical of entire channelized area.
- -Weight: 55% for run = 55%.

Jocko Segment 3

Habitat survey P.O.:

P	- 2.5%
R	- 2.5%
RN	- 95%
PW	- 0%

Transect 1
-Typical run with centered flow. Represents area in segment 3 below J Canal diversion.
-Weight: 40% for run = 40%.

Transect 2
-Pool on bend.
-Weight: 2% for pool = 2%

Transect 3
-Riffle/run with known spawning site near left bank.
-Weight: 3% for riffle + 3% for run = 6%.

Transect 4
-Run with cover on right bank. Represents area in segment 3 above J Canal diversion.
-Weight: 50% for run = 50%.

Transect 5
-Run/pool along rip-rapped left bank.
-Weight: 2% for run/pool = 2%.

Jocko Segment 4

All weighting was divided between transects 1 through 6 and 7 through 12 based on changes in soils, bank slope, and density of riparian vegetation. Most of the features described include a split channel or side channel. Approximately 4,000 ft of side channel was measured during the one-mile habitat survey.

Habitat survey P.O.: P - 3%
R - 10%
RN - 87%
PW - 0%

Transect 1
-Split channel with deeper run in main channel near right bank and known spawning area in smaller channel.
-Weight: 15% for split-channel run = 15%.

Transect 2
-Riffle/run with grass-covered banks.
-Weight: 4% for run + 2% for riffle = 6%.

Transect 3
-Run/pool with undercut left bank and known spawning area for brown trout.
-Weight: 1% for pool + 9% for run = 10%.

Transect 4

-Run in rip-rapped section with larger substrate.
-Weight: 2% for run = 2%.

Transect 5

-Main channel is run/pool; side channel is shallow riffle.
-Weight: 14% for run = 14%.

Transect 6

-Riffle with small pool.
-Weight: 3% for riffle = 3%.

Transect 7

-Typical riffle/run with right bank having good cover and left bank having poor.
-Weight: 4% for run + 2% for riffle = 6%.

Transect 8

-Riffle/run with flow evenly distributed and quiet water near the right bank.
-Weight: 4% for run + 2% for riffle = 6%.

Transect 9

-Split channel with good debris cover; riffle in right channel, and run in left channel.
-Weight: 18% for run + 1% for riffle = 19%.

Transect 10

-High quality pool with backwater near left bank.
-Weight: 2% for pool = 2%

Transect 11

-Run with gradually sloping right bank and steep left bank overgrown by knapweed.
-Weight: 9% for run = 9%.

Transect 12

-Run/pool below a split channel. Most of the flow is near the left bank and cover is good on both banks.
-Weight: 8% for run + pool = 8%.

Jocko Segment 5

Habitat survey P.O.:	P	- 2.5%
	R	- 5%
	RN	- 57.5%
	PW	- 35%

Transect 1

-Typical riffle/pocket water, especially of channelized area.

-Weight: 1% for riffle + 14% pocket water = 15%.

Transect 2

-Typical riffle/pocket water, especially of channelized area.

-Weight: 15% for pocket water = 15%

Transect 3

-Run with pool near left bank.

-Weight: 1% for pool + 19% for run = 20%

Transect 4

-Riffle/run with pool near left bank and pocket water.

-Weight: 1% for pool + 2% for riffle + 13% for run = 15%.

Transect 5

-Typical shallow riffle with pocket water.

-Weight: 2% for riffle + 8% pocket water = 10%.

Transect 6

-Run/riffle with pocket water; some debris cover.

-Weight: 14% for run + 1% pocket water = 15%.

Transect 7

-Run with pool nearer left bank.

-Weight: 9% for run + 1% for pool = 10%.

Jocko Segment 6

Habitat survey P.O.: P - 2%
R - 7.5%
RN - 90.5%
PW - 0%

Transect 1

-Riffle with pocket water.

-Weight: 10% for riffle = 10%.

Transect 2

-Run with pocket water

-Weight: 10% for run = 10%.

Transect 3

-Riffle run with narrow channel and undercut banks.

-Weight: 15% for run = 15%.

Transect 4
-Run/pocket water formed by boulders; banks sloped back.
-Weight: 30% for run = 30%

Transect 5
-Run/pool on bend; banks sloped back.
-Weight: 2% for pool + 18% for run = 20%.

Transect 6
-Riffle with pocket water; undercut left bank.
-Weight: 15% for run = 15%.

Jocko Segment 7

Habitat survey P.O.: P - 5%
R - 0%
RN - 80%
PW - 15%

Transect 1
-Riffle with pool and pocket water.
-Weight: 2.5% for pool + 7.5% for pocket water = 10%.

Transect 2
-Typical run with pocket water.
-Weight: 22.5% for run + 2.5% for Pocket water = 25%.

Transect 3
-Run with undercut right bank.
-Weight: 20% for run = 20%

Transect 4
-Run with pocket water and undercut right bank.
-Weight: 20% for run + 5% for pocket water = 25%.

Transect 5
-Riffle/run with deeper pool near undercut right bank.
-Weight: 7.5% for run + 2.5% for pool = 10%

Transect 6
-Riffle/run with pocket water and backwater near right bank.
-Weight: 10% for run = 10%

Jocko Segment 8

Based upon linear distance measured on an aerial photograph (1981), the upper steep area of reach 8 represents 36% of the total distance; the lower flatter area, 64%. This segment was not among the original habitat survey segments.

Transect 1
- Tail of plunge pool. good representation of infrequent pools in lower, flatter 64%.
- Weight: 20% of 64% = 13%.

Transect 2
- Flat run very typical of lower 64%.
- Weight: 40% of 64% = 26%.

Transect 3
- Riffle/run also very typical of lower area.
- Weight: 39% of 64% = 25%.

Transect 4
- Steep riffle with heavy bank cover in upper 36%.
- Weight: 30% of 36% = 11%.

Transect 5
- Run/pool on corner with overhanging vegetation.
- Weight: 30% of 36% = 11%.

Transect 6
- Pocket water very typical of upper 36%.
- Weight: 40% of 36% = 14%

Mission Segment 1

Habitat survey P.O.:	P	- 7.5%
(Mission 1 & 2 combined)	R	- 7.5%
	RN	- 85%
	PW	- 0%

Transect 1
- Run with channel splitting just below. Known rainbow trout spawning area.
- Weight: 10% for run = 10%.

Transect 2
- Run with pool near right bank overhung by vegetation.
- Weight: 12% for run + 3% for pool = 15%.

Transect 3
- Run with pool created by tree sloughed into creek. This transect changed between high and low flows when the tree swung downstream to lie parallel along the right bank.
- Weight: 7% for run + 3% for pool = 10%.

Transect 4
- Typical run.
- Weight: 15% for run = 15%.

Transect 5
- Deep riffle/run near left bank with slack water near right bank.
- Weight: 1% for riffle + 9% for run = 10%.

Transect 6
- Typical riffle.
- Weight: 7% for riffle = 7%.

Transect 7
- Typical pocket water - rare according to habitat survey.
- Weight: 7% from run category = 7%.

Transect 8
- Run with boulders and bedrock near right bank.
- Weight: 13% for run = 13%.

Transect 9
- Deeper run with large substrate.
- Weight: 13% for run = 13%.

Mission Segment 2

The transects placed at runs are equally good representations of all types of runs within this segment. Therefore, each of the six run transects was weighted one sixth of the 84% allocated for runs according to habitat survey results.

Habitat survey P.O.:	P	- 6.7%
(Mission 3, 4, & 5 combined)	R	- 8.3%
	RN	- 85%
	PW	- 0%

Transect 1
- Run typical of lower silted area.
- Weight: 14% for run = 14%.

Transect 2

-Deeper run from lower area with undercut banks.
-Weight: 14% for run = 14%.

Transect 3

-Run/pool on corner.
-Weight: 3% for pool = 3%.

Transect 4

-Riffle at WETP site typical of middle section.
-Weight: 5% for riffle = 5%.

Transect 5

-Riffle/pocket water typical of upper section.
-Weight: 3% for riffle = 3%.

Transect 6

-Run/pocket water; banks not undercut.
-Weight: 14% for run = 14%.

Transect 7

-Run with banks slightly undercut.
-Weight: 14% for run = 14%.

Transect 8

-Run with banks deeply undercut.
-Weight: 14% for run = 14%.

Transect 9

-Plunge pool which has held spawning cutthroat trout.
-Weight: 4% for pool = 4%.

Transect 10

-Shallow riffle.
-Weight: 1% for riffle = 1%.

Transect 11

-Deep run with undercut banks.
-Weight: 14% for run = 14%.

Post Segment 1

Transects 1, 2, and 3 best represent a relatively short, wide section of Post Creek. Transects 4, 5, and 6 are typical of the longest stretch of this IFIM segment.

Habitat survey P.O.:	P	- 1.3%
(Post 1 & 2 combined)	R	- 7.5%
	RN	- 90%
	PW	- 1.2%

Transect 1
- -Rectangular-shaped, weir-like run with silt bottom.
- -Weight: 12% for run = 12%.

Transect 2
- -Run with deep area near right bank.
- -Weight: 9% for run + 1% for pool = 10%.

Transect 3
- -Wide riffle.
- -Weight: 8% for riffle = 8%.

Transect 4
- -Run in an area with trees along the banks.
- -Weight: 10% for run = 10%.

Transect 5
- -Run where mats of vegetation form instream during summer. Banks are heavily grazed.
- -Weight: 15% for run = 15%.

Transect 6
- -Another run with vegetation mats on the streambed and grazing on the banks.
- -Weight: 15% for run = 15%.

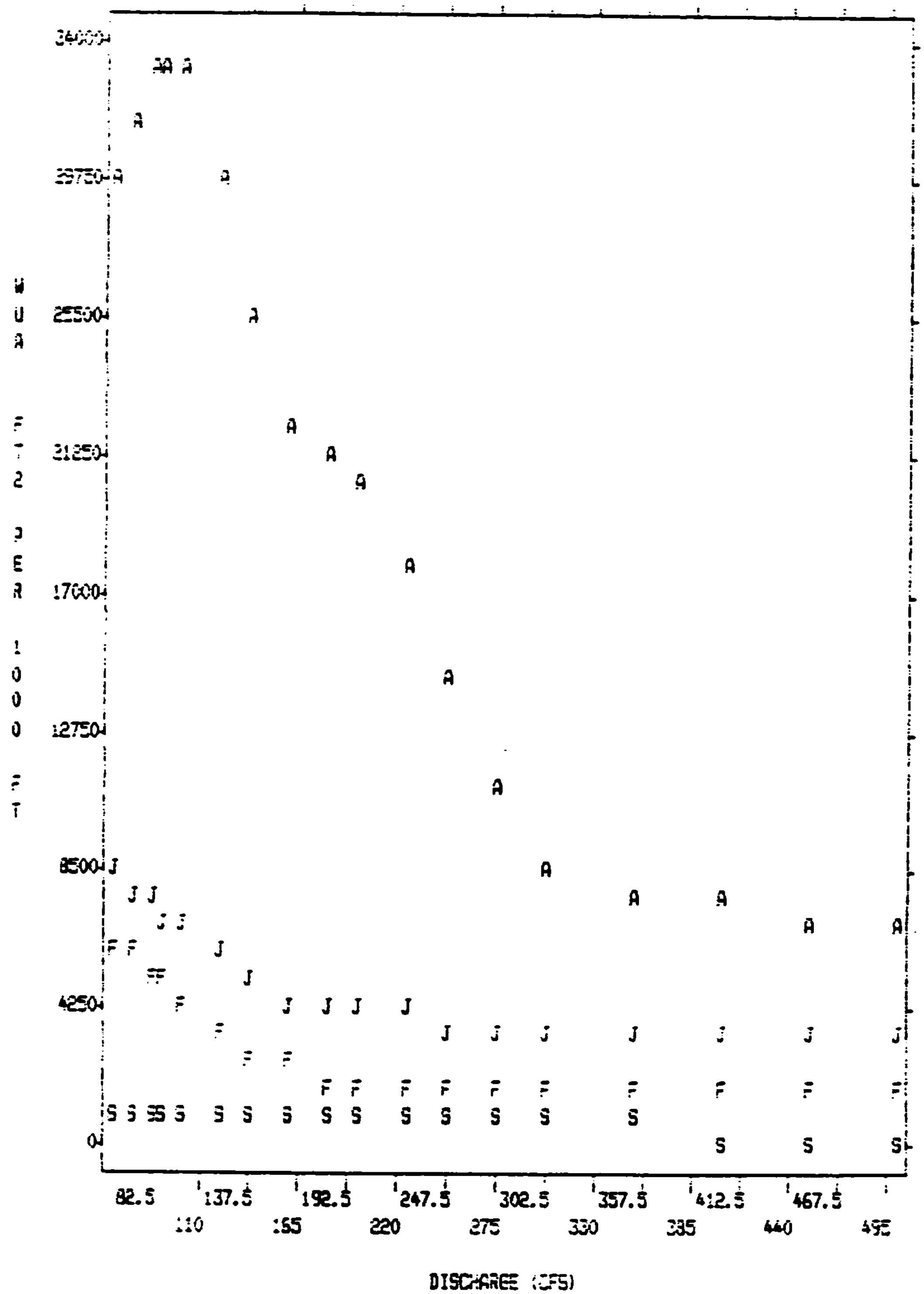
Transect 7
- -Run with pocketwater/pool near right bank.
- -Weight: 9% for run + 1% for pool = 10%.

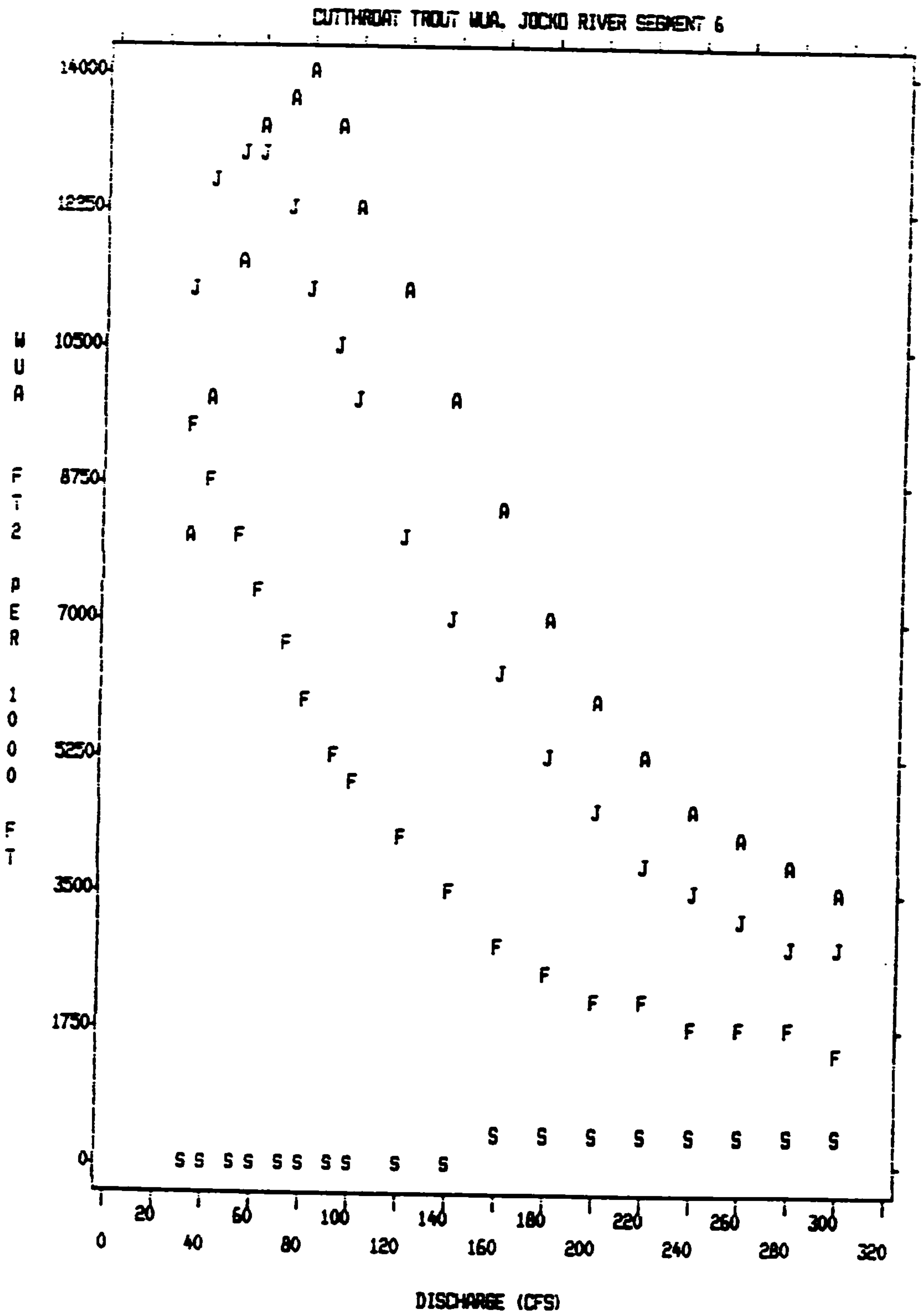
Transect 8
- -Run/riffle with trees lining banks.
- -Weight: 10% for run = 10%.

Transect 9
- -Run with larger substrate.
- -Weight: 10% for run = 10%.

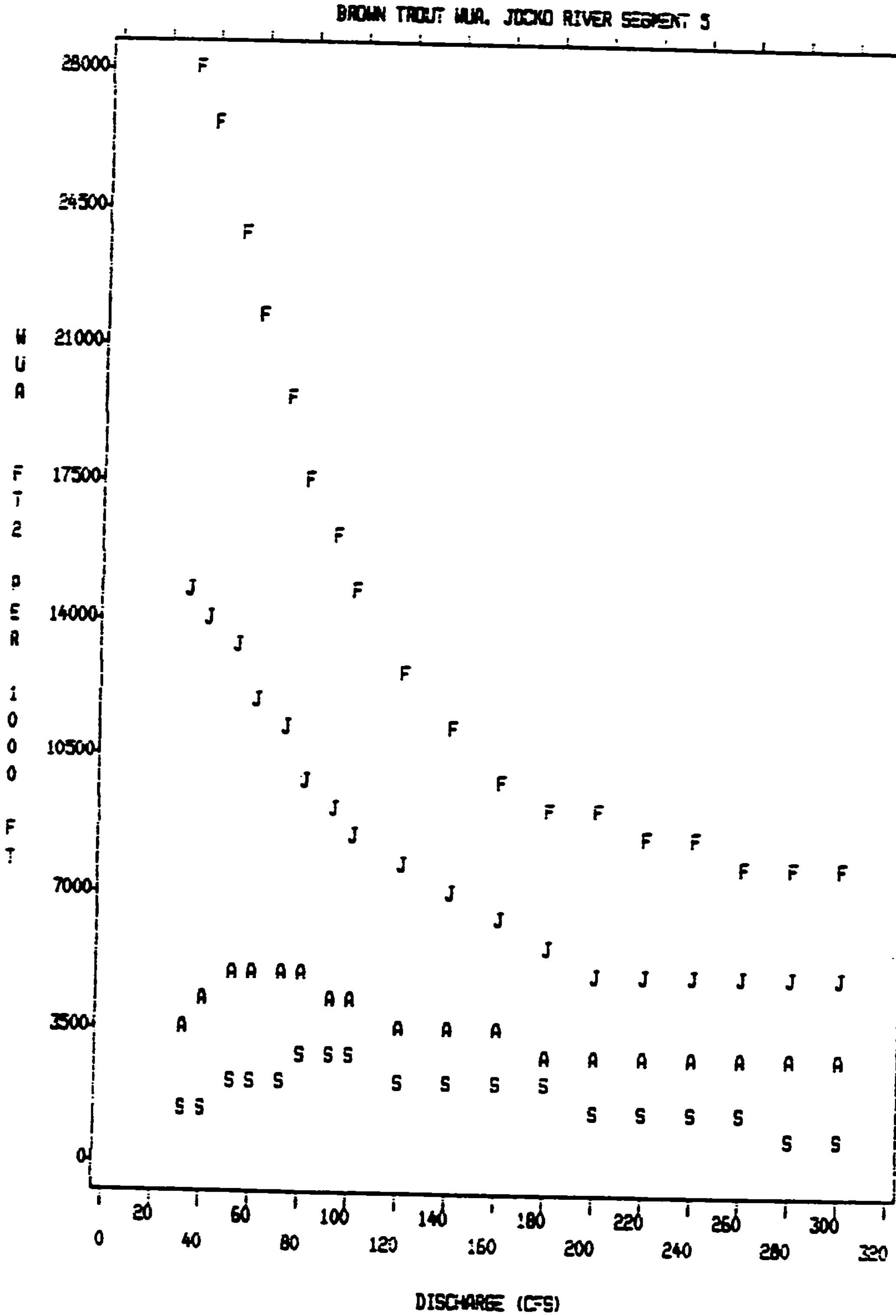
Weighted Usable Area
WAU

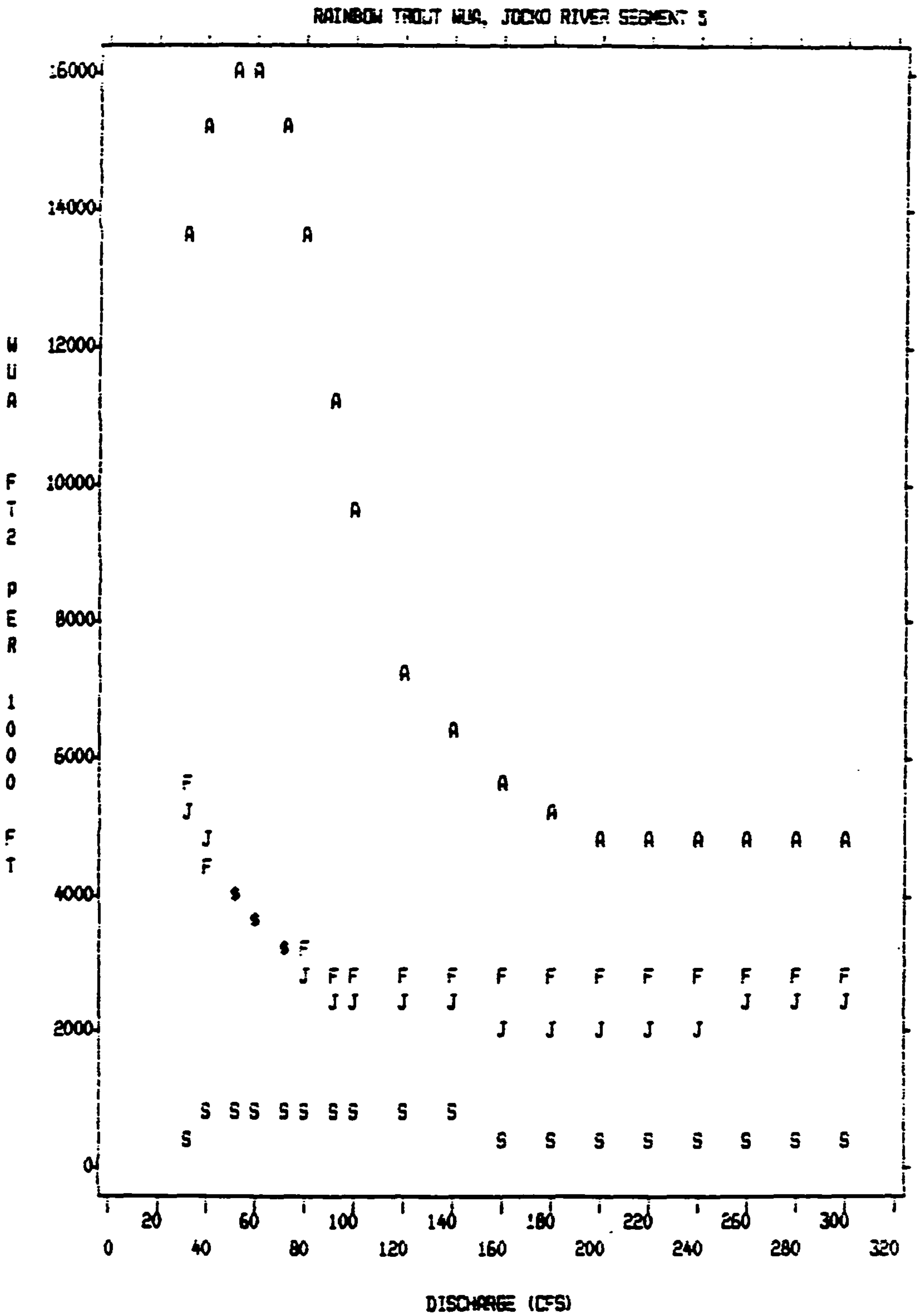
RAINBOW TROUT WUA, JOCKO RIVER SEGMENT 1



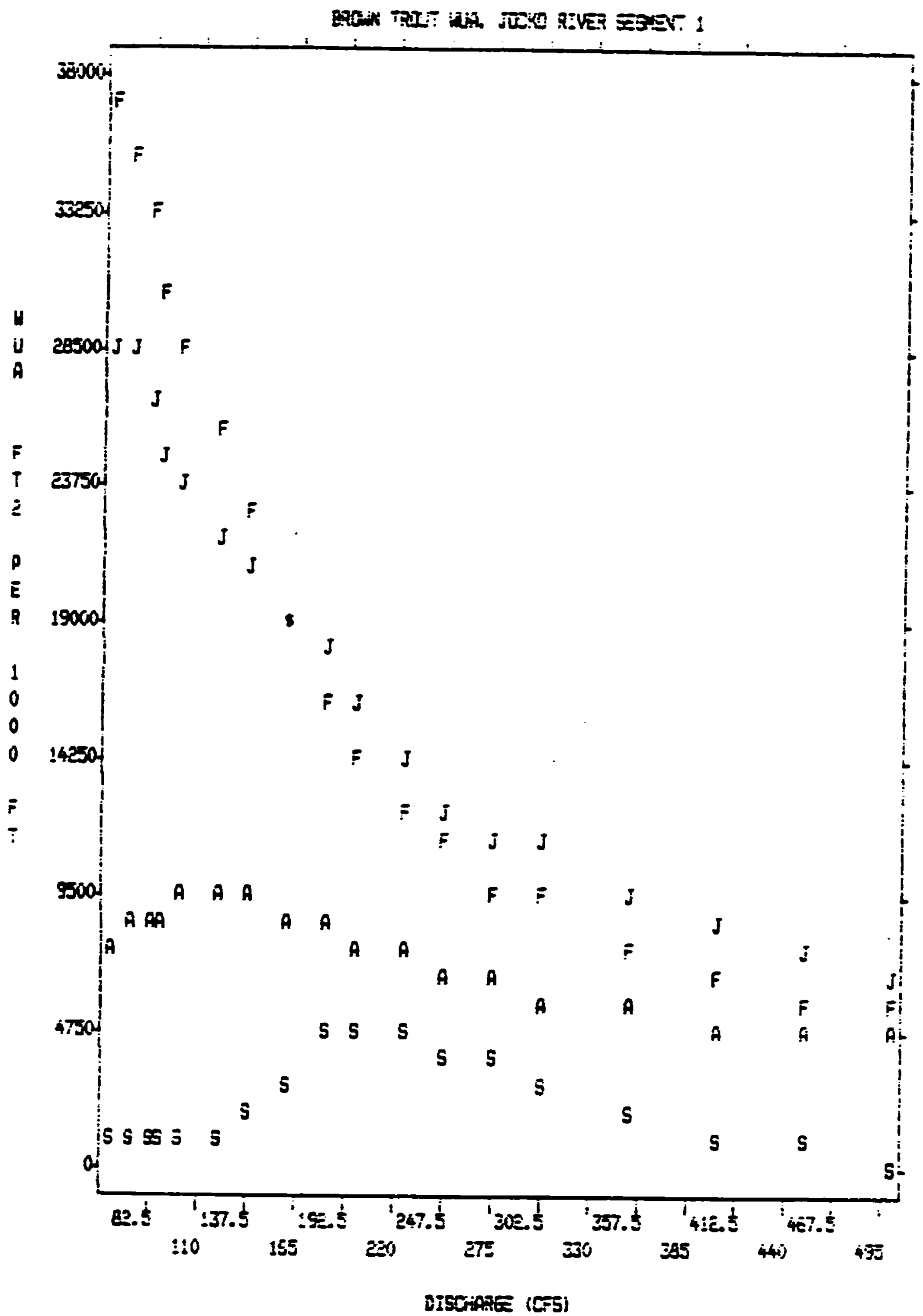


CUTTHROAT TROUT WUA, JOCKO RIVER SEGMENT 6
WUA FT2 PER 1000 FT
14000
12250
10500
8750
7000
5250
3500
1750
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
DISCHARGE (CFS)

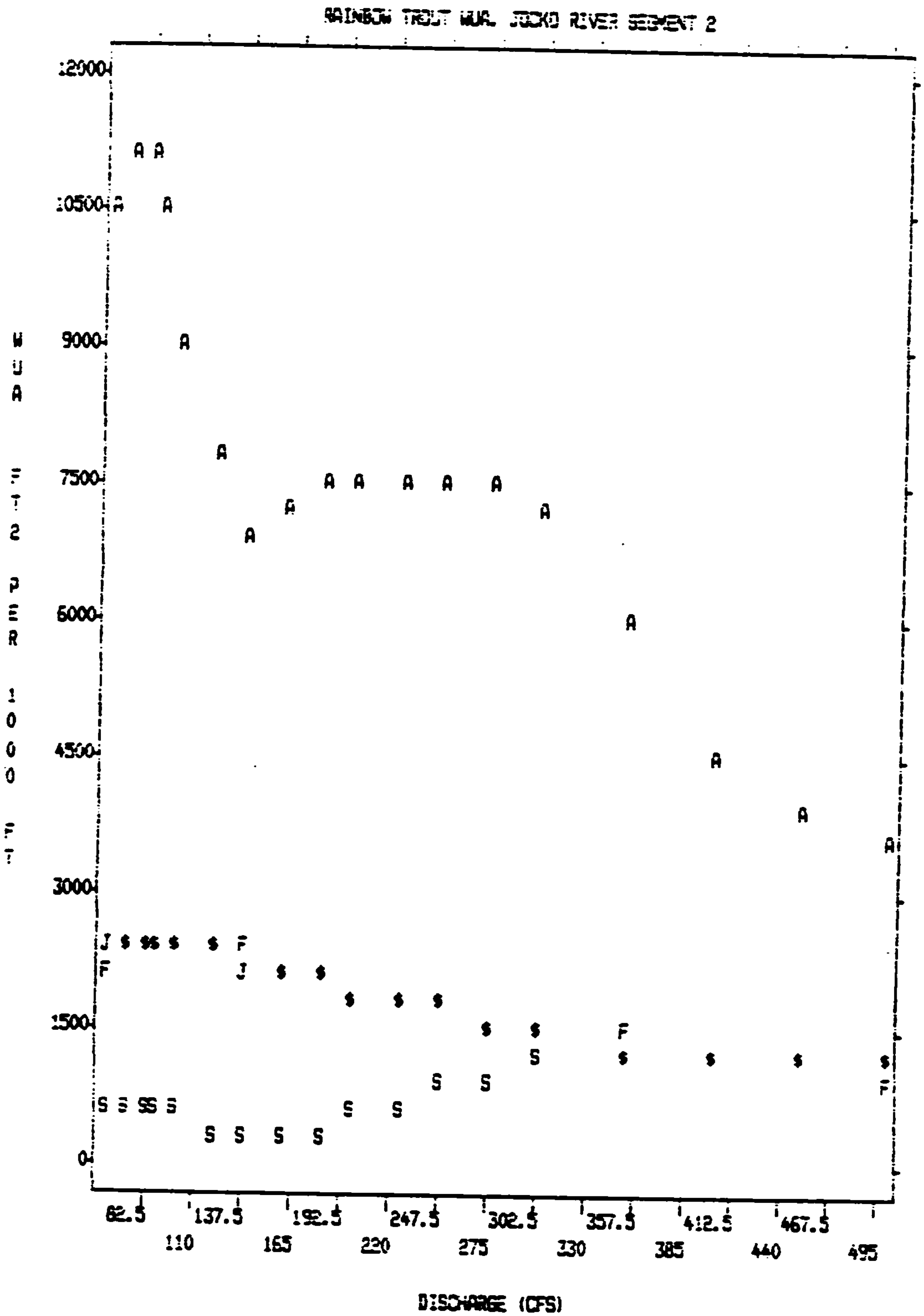

BROWN TROUT WUA, JOCKO RIVER SEGMENT 5
WUA FT2 PER 1000 FT
28000
24500
21000
17500
14000
10500
7000
3500
0
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320
DISCHARGE (CFS)

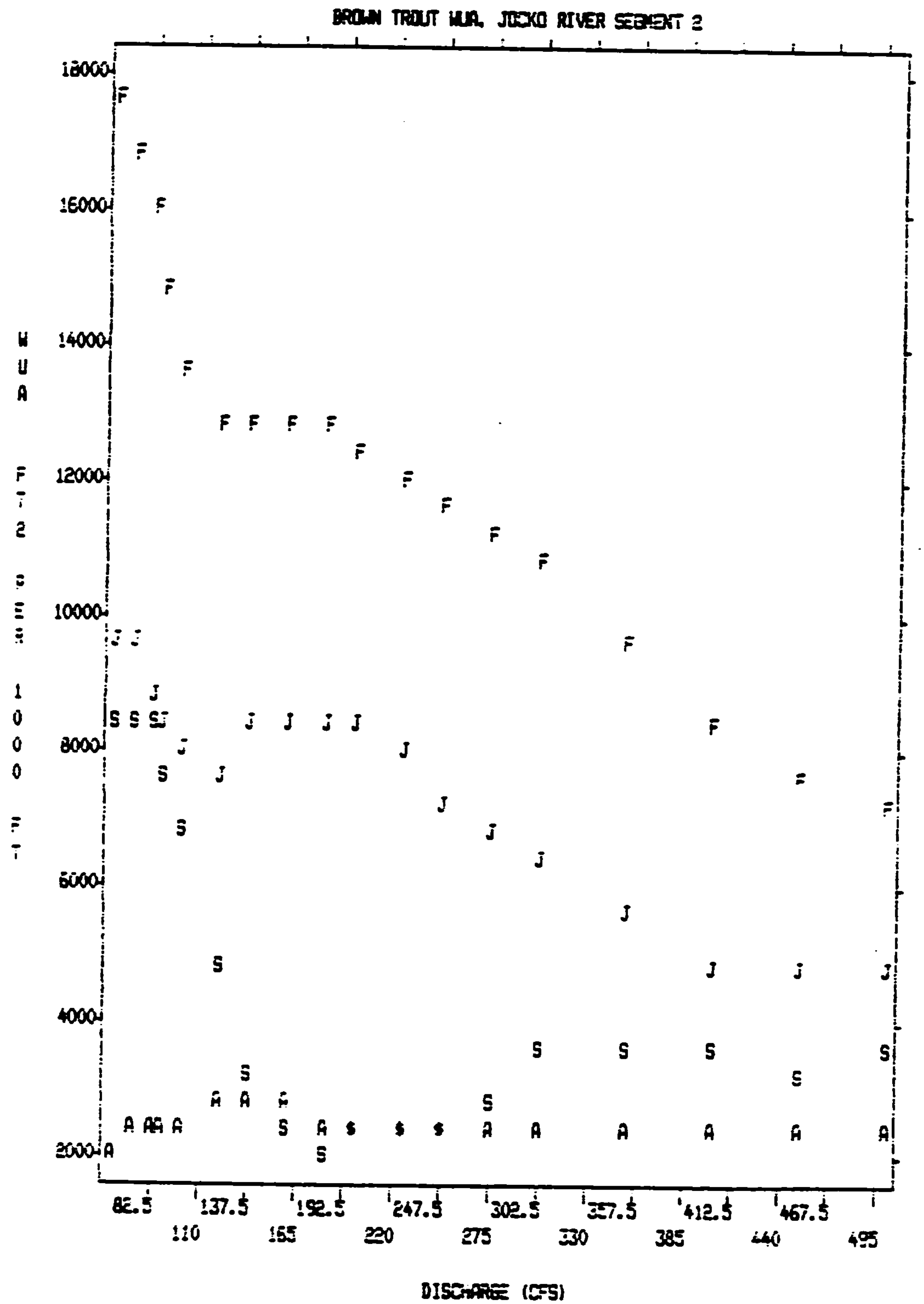


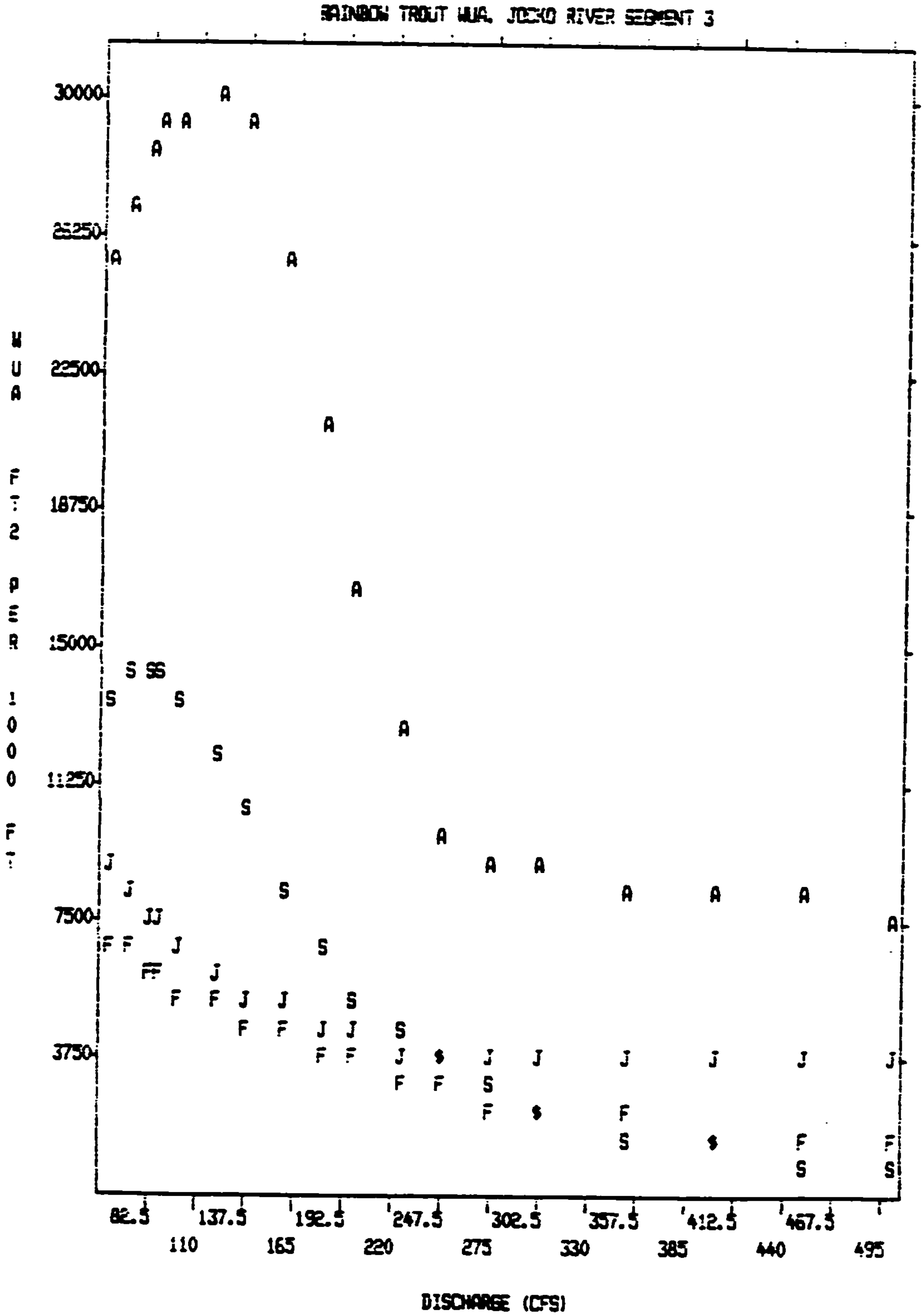
RAINBOW TROUT WUA, JOCKO RIVER SEGMENT 5
WUA FT2 PER 1000 FT
DISCHARGE (CFS)

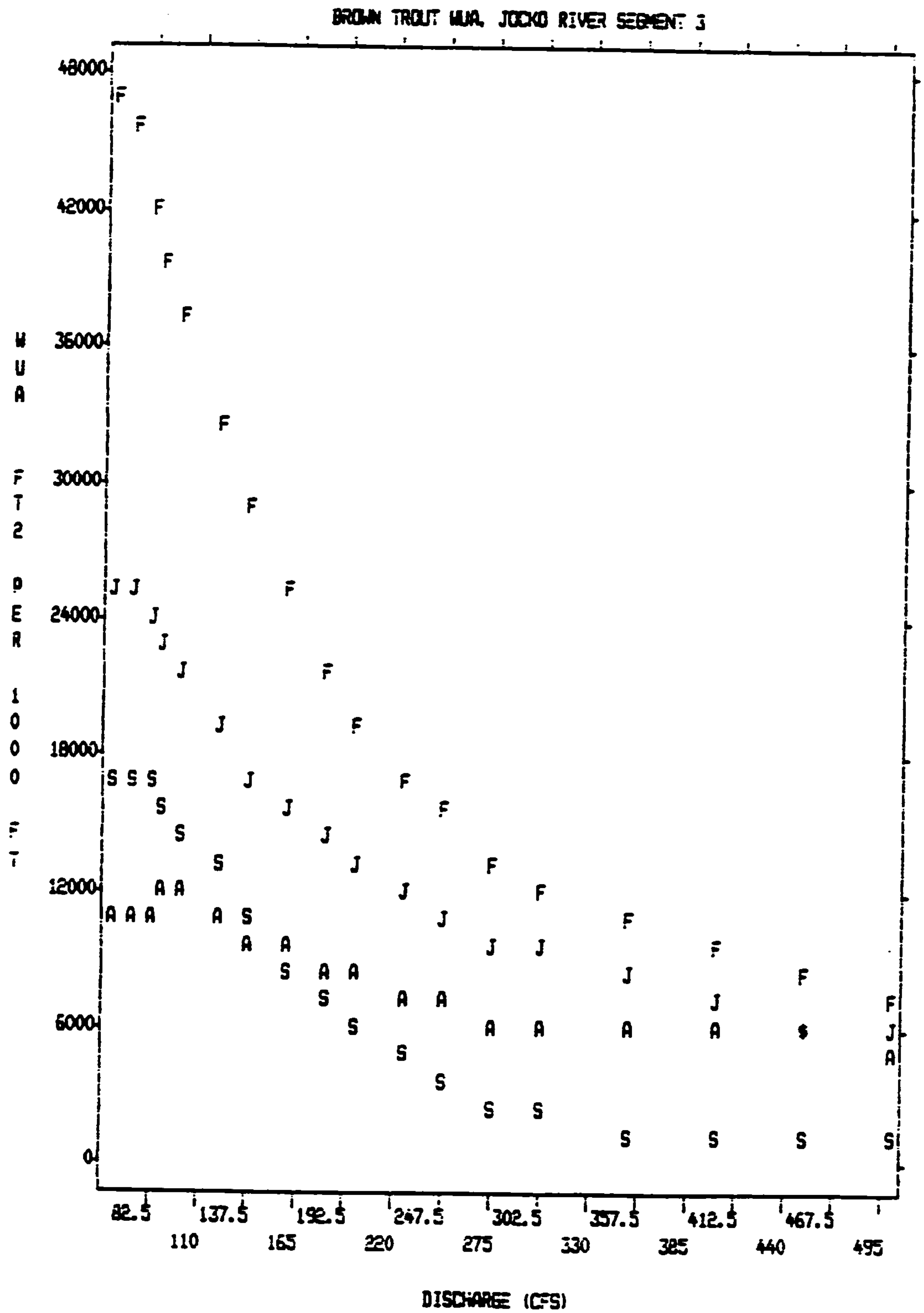


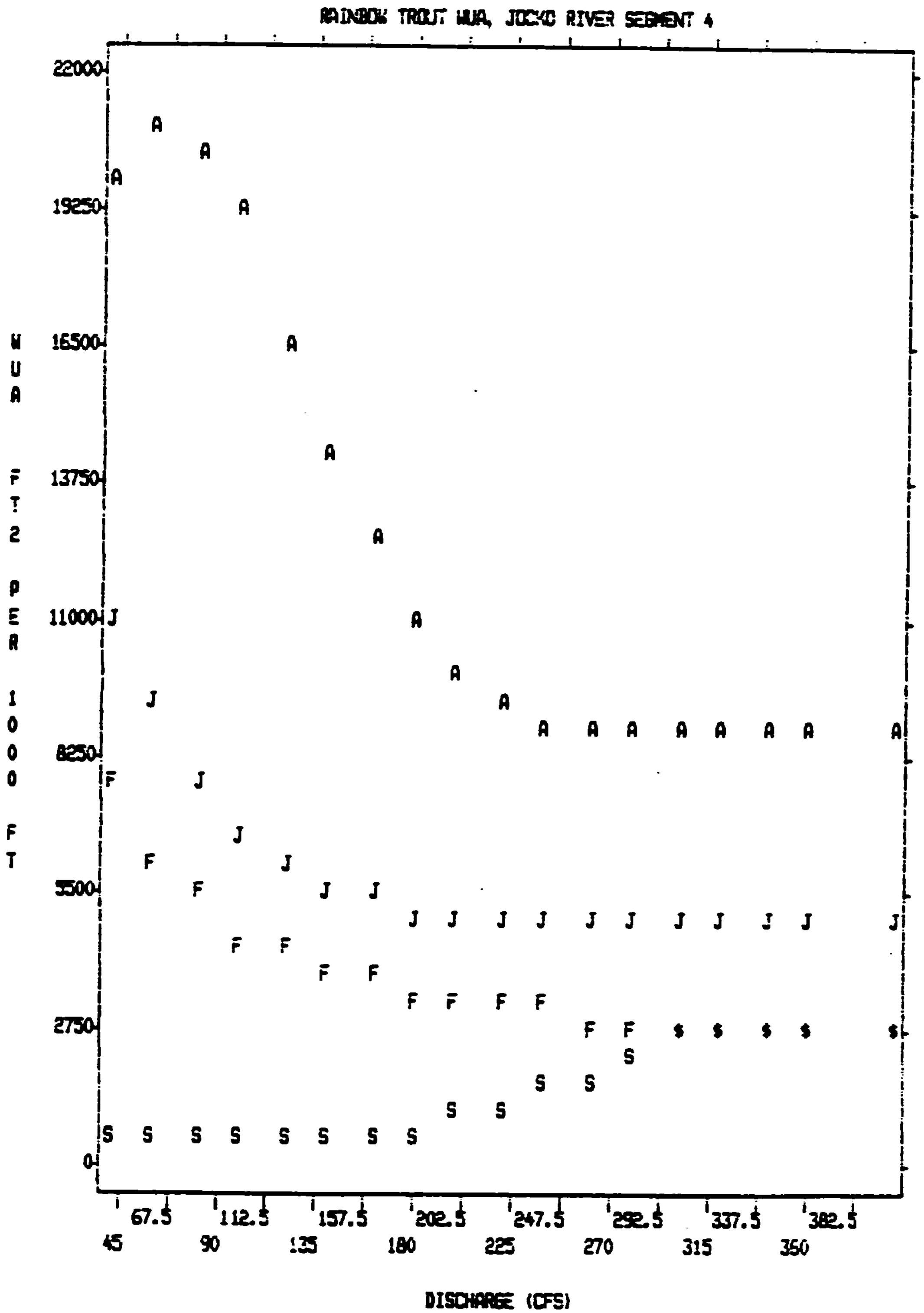
BROWN TROUT WUA, JOCKO RIVER SEGMENT 1
WUA FT2 PER 1000 FT
38000
33250
28500
23750
19000
14250
9500
4750
0
82.5
137.5
192.5
247.5
302.5
357.5
412.5
467.5
110
165
220
275
330
385
440
495
DISCHARGE (CFS)

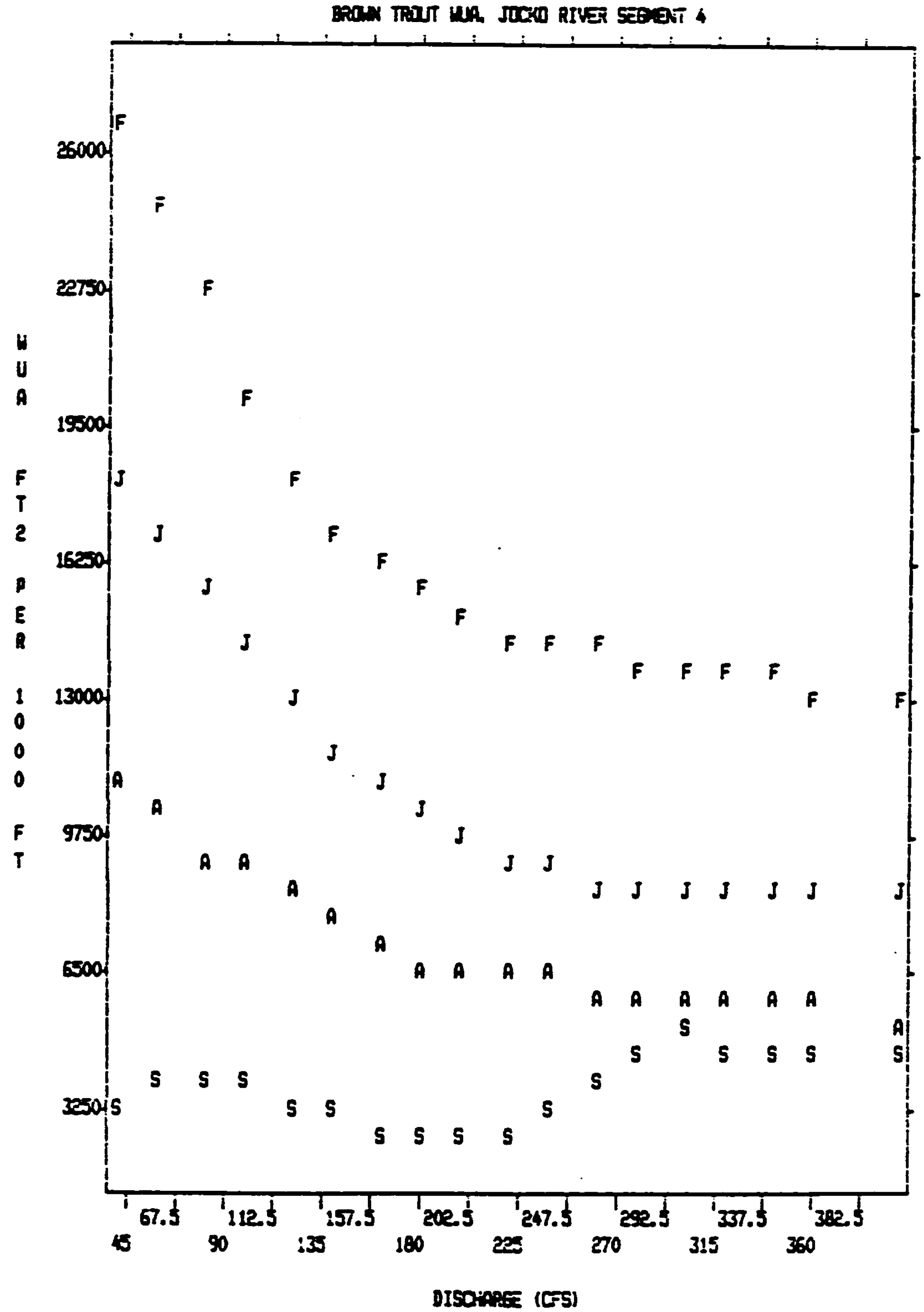

RAINBOW TROUT WUA, JOCKO RIVER SEGMENT 2
WUA FT2 PER 1000 FT
12000
10500
9000
7500
6000
4500
3000
1500
0
82.5
110
137.5
165
192.5
220
247.5
275
302.5
330
357.5
385
412.5
440
467.5
495
DISCHARGE (CFS)

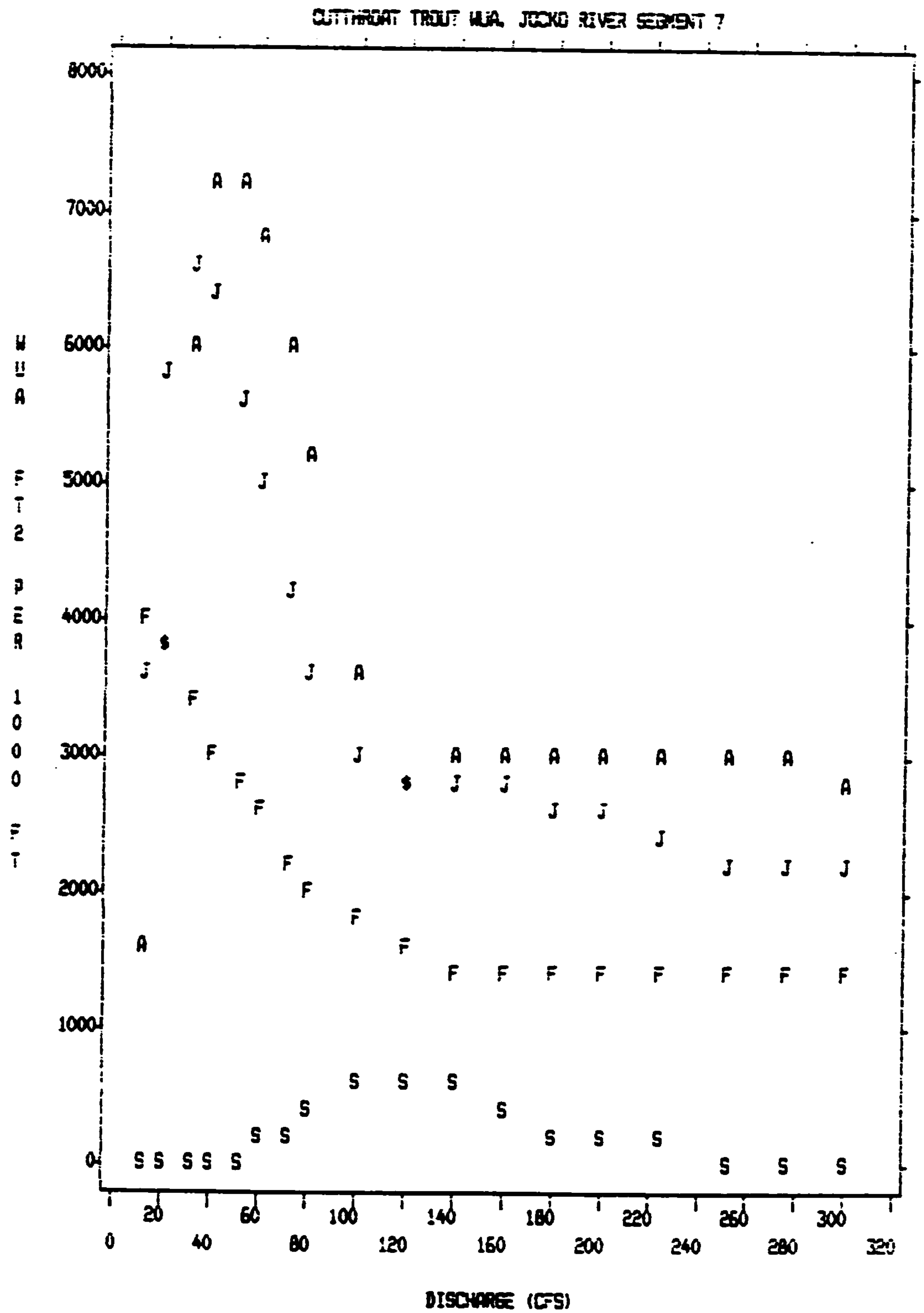

BROWN TROUT WUA, JOCKO RIVER SEGMENT 2
WUA FT2 PER 1000 FT
18000
16000
14000
12000
10000
8000
6000
4000
2000
82.5
110
137.5
165
192.5
220
247.5
275
302.5
330
357.5
385
412.5
440
467.5
495
DISCHARGE (CFS)

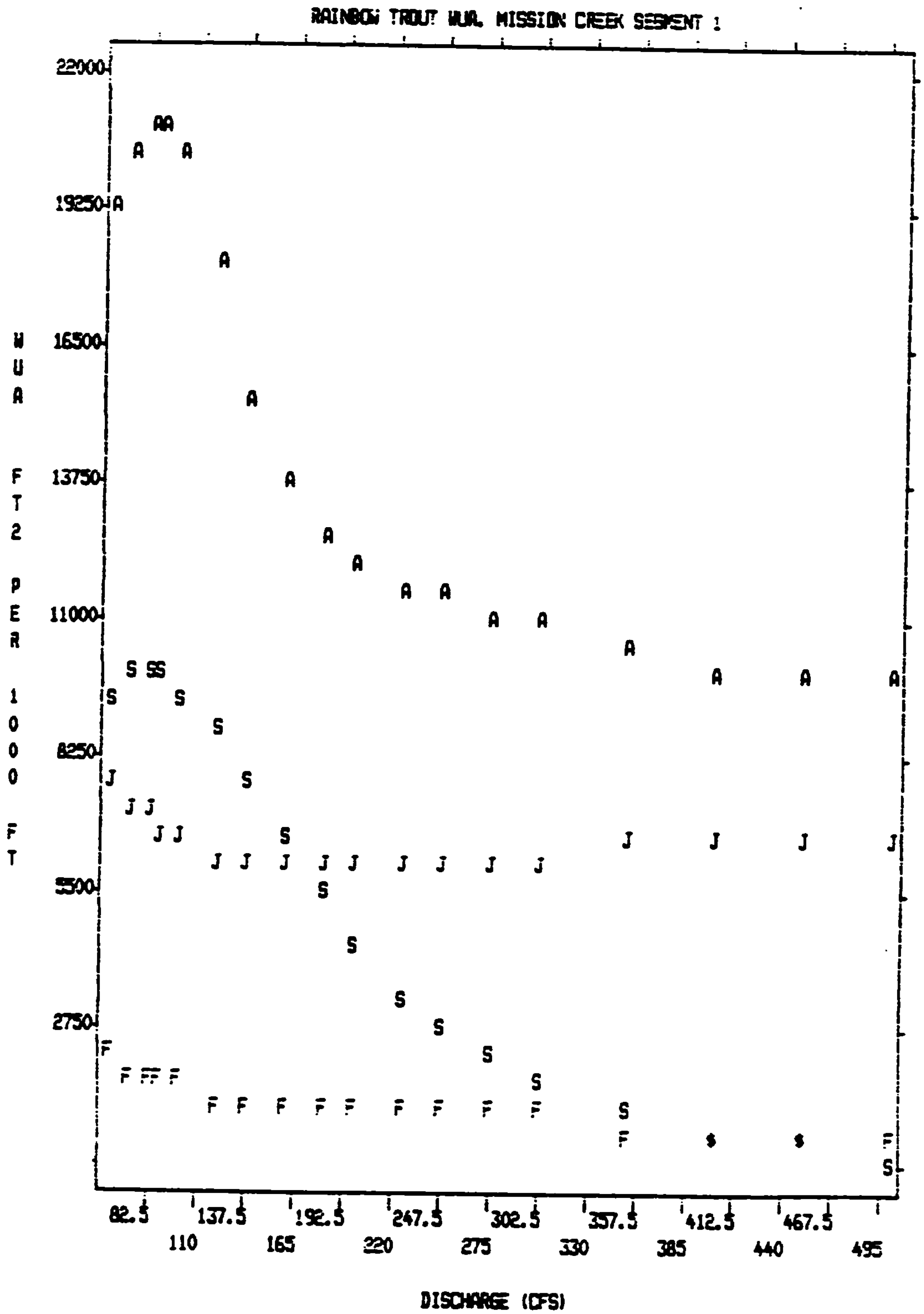

RAINBOW TROUT WUA, JOCKO RIVER SEGMENT 3
WUA FT2 PER 1000 FT
30000
26250
22500
18750
15000
11250
7500
3750
82.5
110
137.5
165
192.5
220
247.5
275
302.5
330
357.5
385
412.5
440
467.5
495
DISCHARGE (CFS)

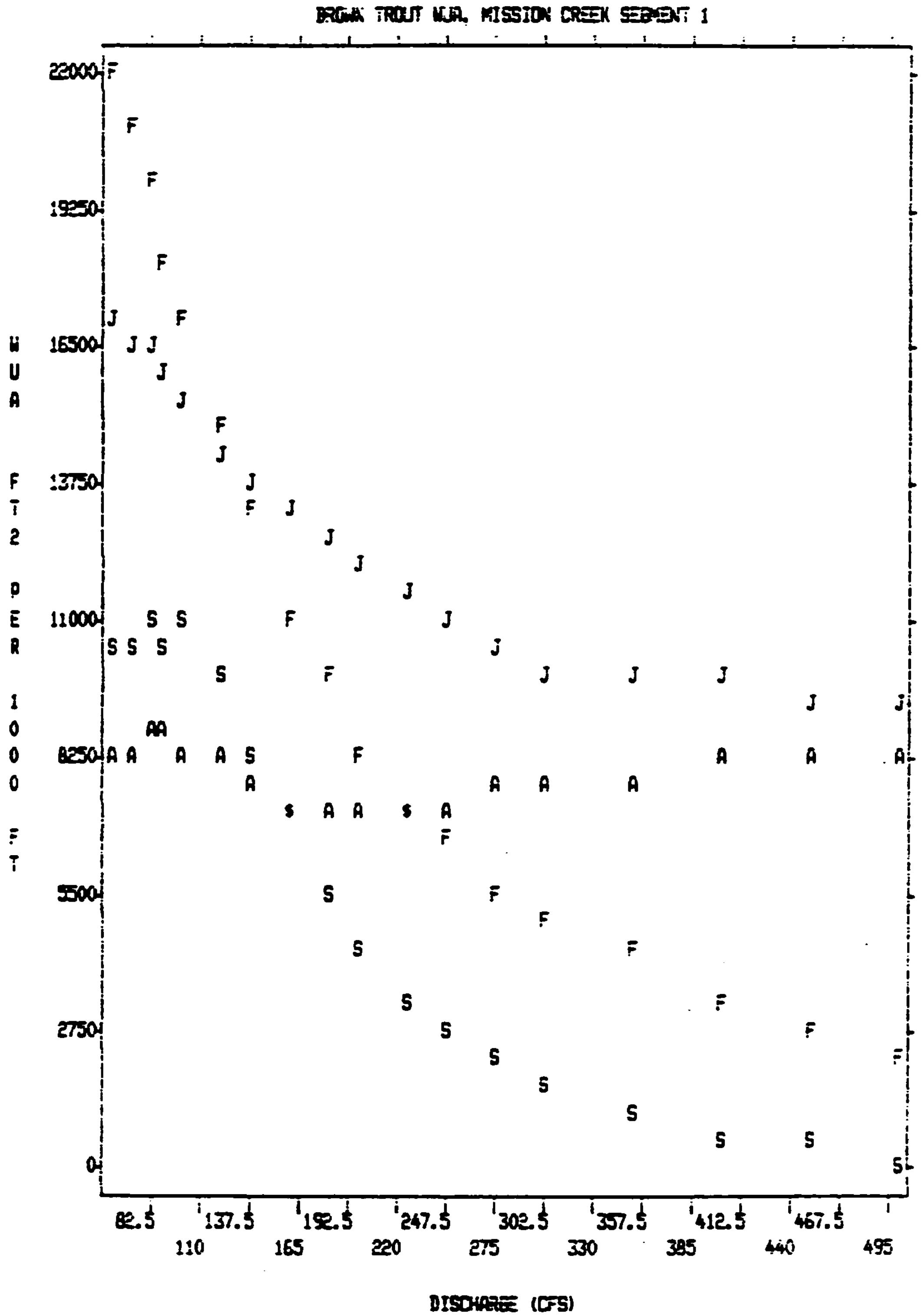

BROWN TROUT WUA, JOCKO RIVER SEGMENT 3
WUA FT2 PER 1000 FT
48000
42000
36000
30000
24000
18000
12000
6000
0
82.5
110
137.5
165
192.5
220
247.5
275
302.5
330
357.5
385
412.5
440
467.5
495
DISCHARGE (CFS)

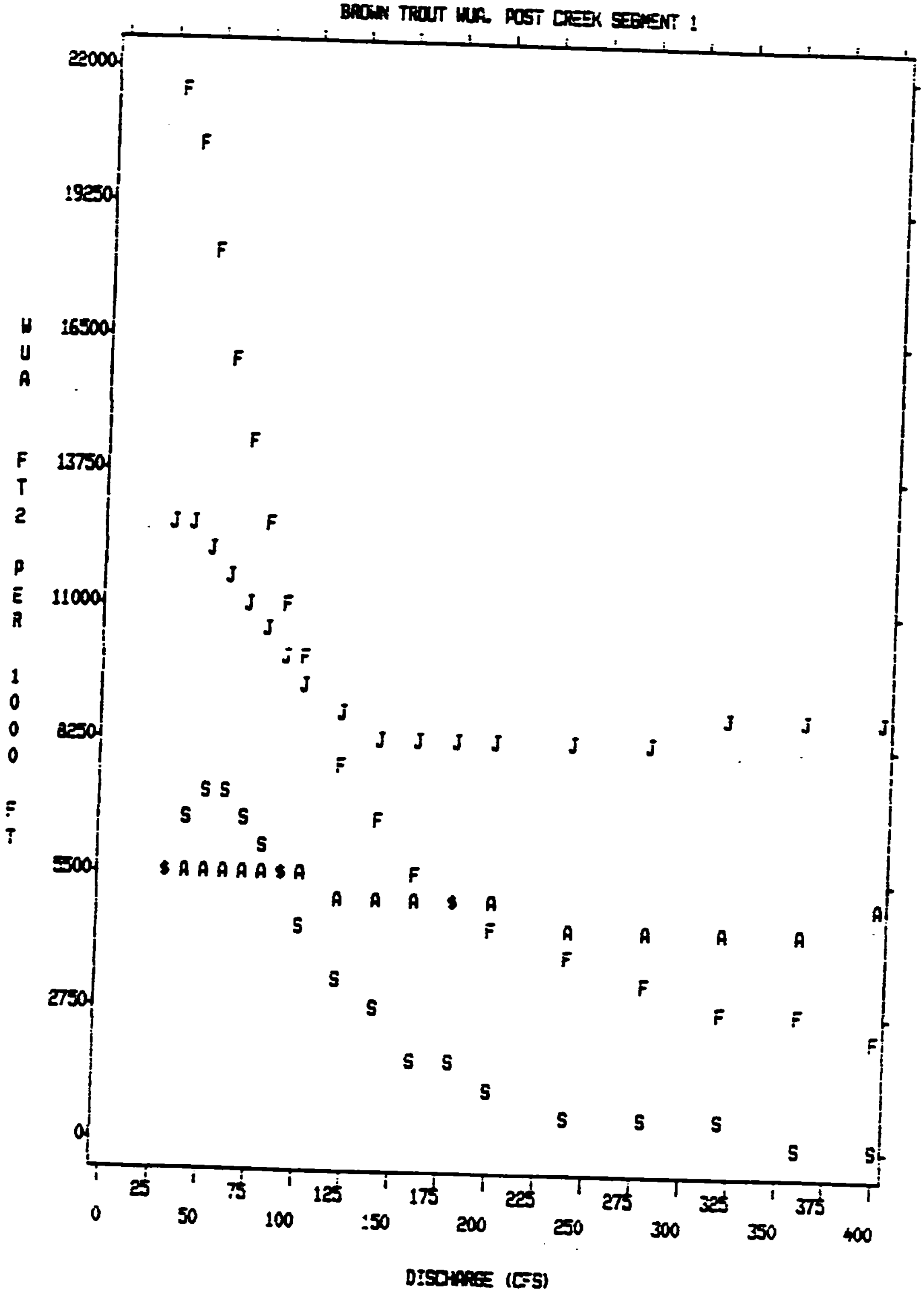

RAINBOW TROUT WUA, JOCKO RIVER SEGMENT 4
WUA FT2 PER 1000 FT
22000
19250
16500
13750
11000
8250
5500
2750
0
67.5
112.5
157.5
202.5
247.5
292.5
337.5
382.5
45
90
135
180
225
270
315
360
DISCHARGE (CFS)

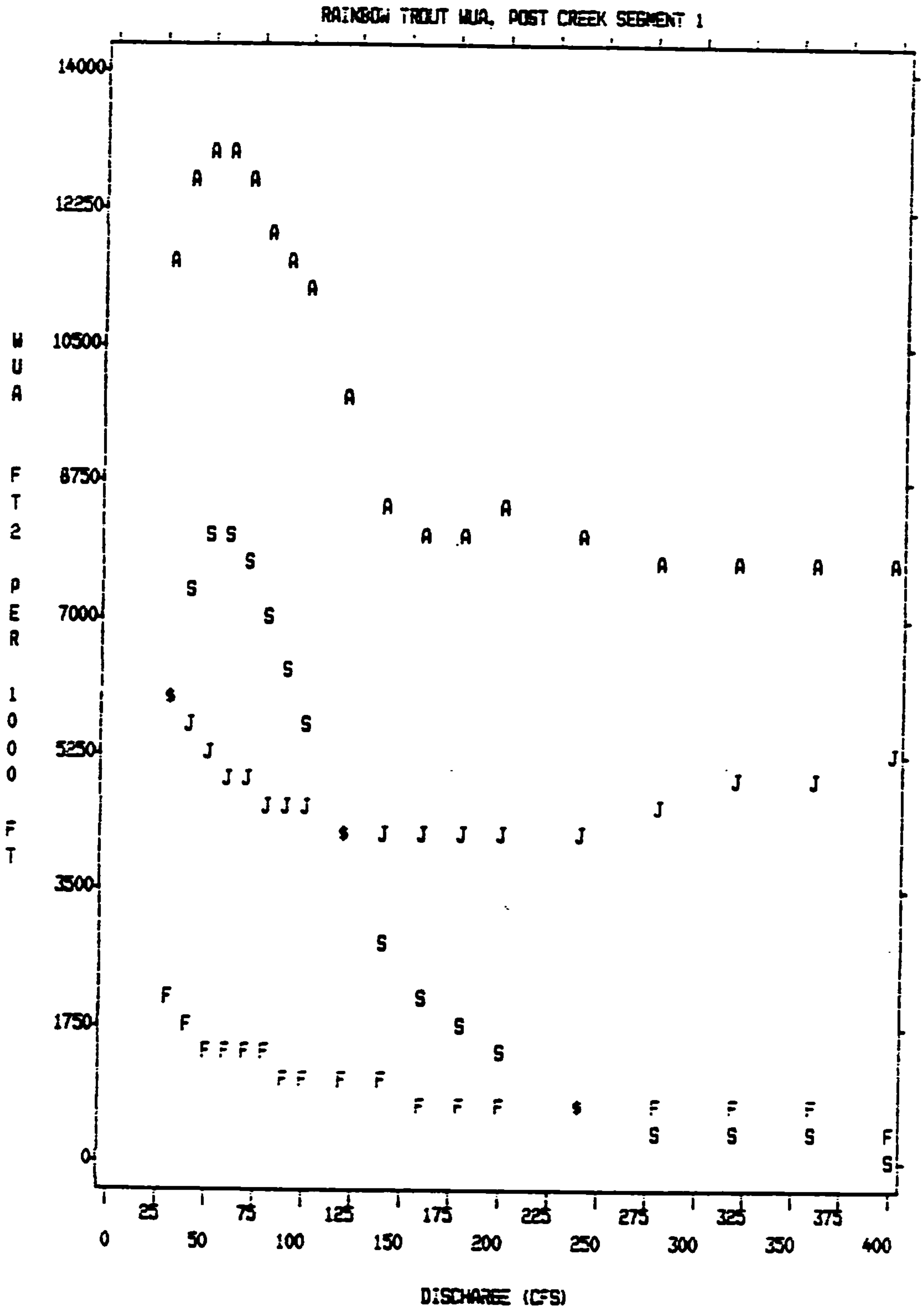

BROWN TROUT WUA, JOCKO RIVER SEGMENT 4
WUA FT2 PER 1000 FT
26000
22750
19500
16250
13000
9750
6500
3250
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
360
382.5
DISCHARGE (CFS)


CUTTHROAT TROUT WUA, JOCKO RIVER SEGMENT 7
WUA FT2 PER 1000 FT
DISCHARGE (CFS)

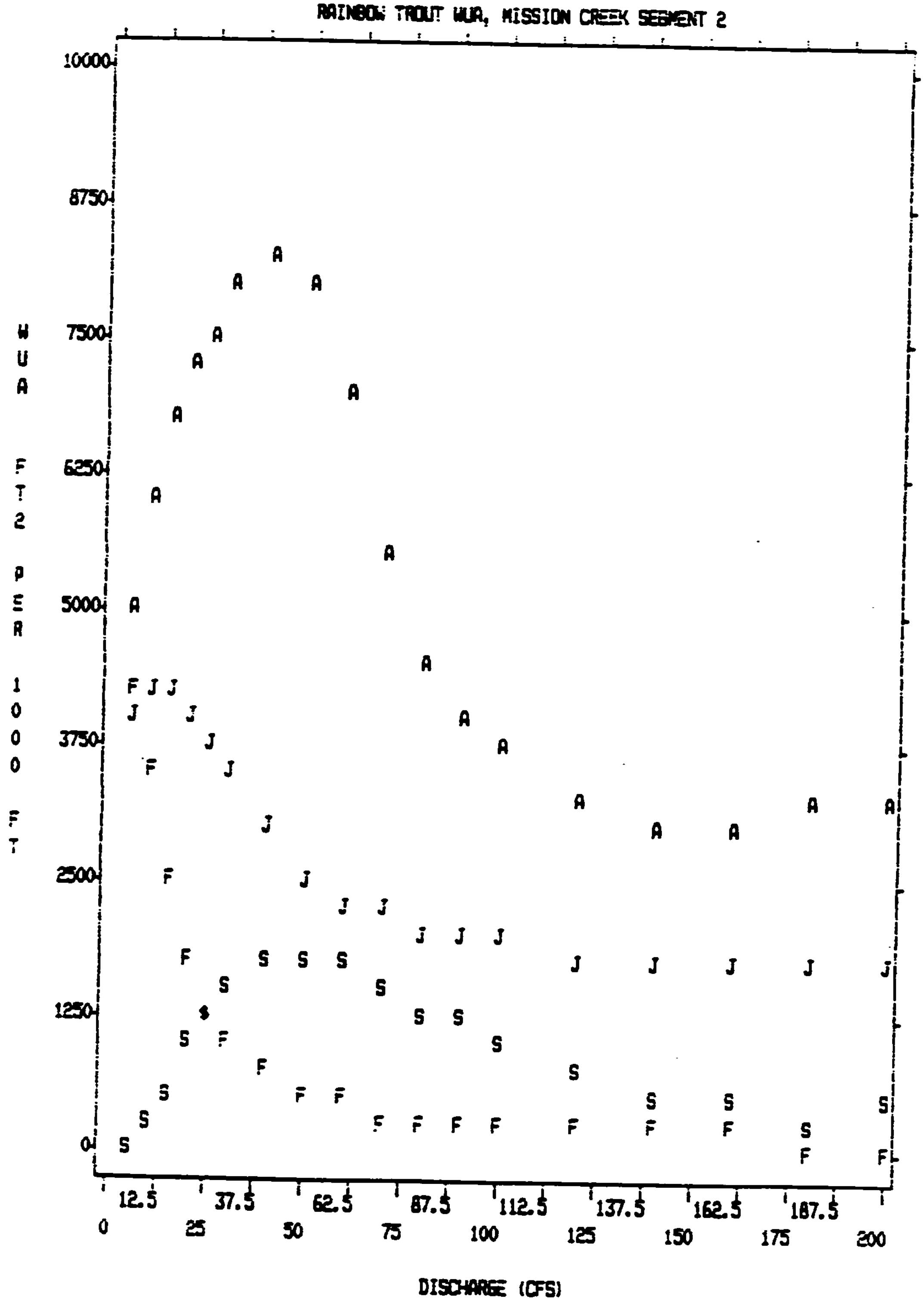

RAINBOW TROUT WUA, MISSION CREEK SEGMENT 1
W U A FT2 PER 1000 FT
22000
19250
16500
13750
11000
8250
5500
2750
82.5
110
137.5
165
192.5
220
247.5
275
302.5
330
357.5
385
412.5
440
467.5
495
DISCHARGE (CFS)


BROWN TROUT WUA, MISSION CREEK SEGMENT 1
W U A F T 2 P E R 1 0 0 0 F T
22000
19250
16500
13750
11000
8250
5500
2750
0
82.5
110
137.5
165
192.5
220
247.5
275
302.5
330
357.5
385
412.5
440
467.5
495
DISCHARGE (CFS)

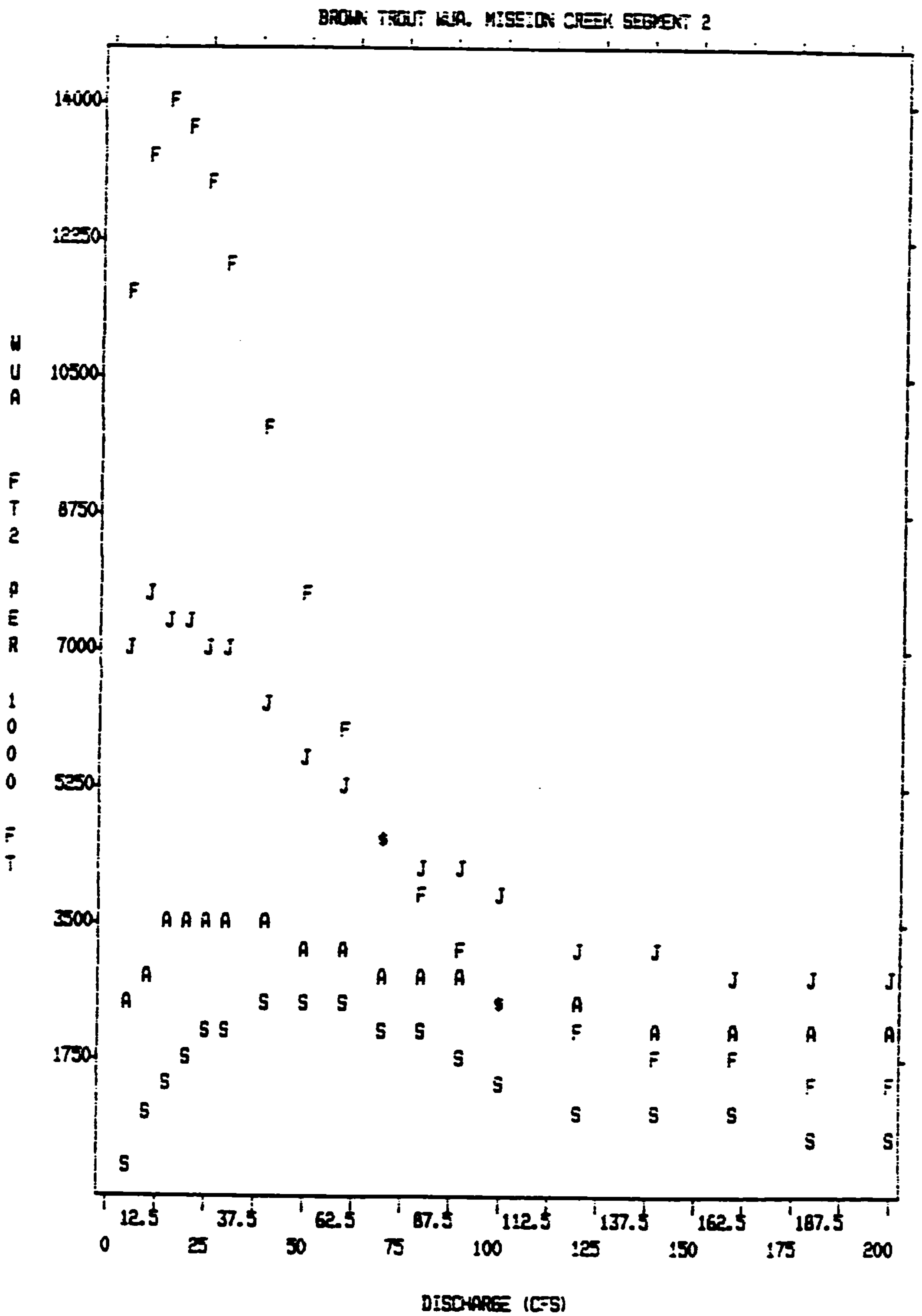

BROWN TROUT WUA, POST CREEK SEGMENT 1
W U A FT2 PER 1000 FT
22000
19250
16500
13750
11000
8250
5500
2750
0
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
DISCHARGE (CFS)

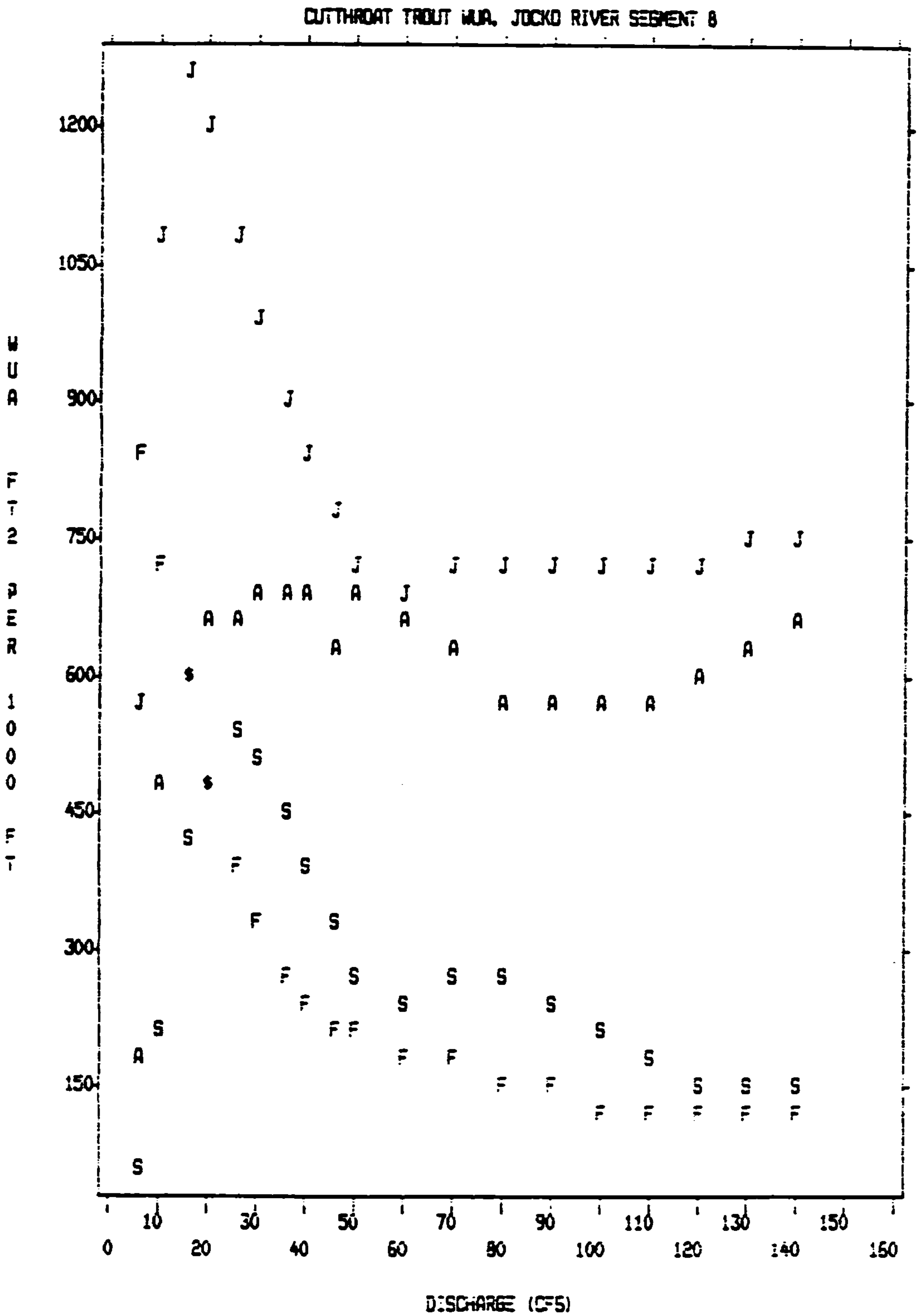


RAINBOW TROUT WUA, POST CREEK SEGMENT 1
14000
12250
10500
8750
7000
5250
3500
1750
0
WUA FT2 PER 1000 FT
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
DISCHARGE (CFS)



RAINBOW TROUT WUA, MISSION CREEK SEGMENT 2
WUA FT2 PER 1000 FT
10000
8750
7500
6250
5000
3750
2500
1250
0
12.5
37.5
62.5
87.5
112.5
137.5
162.5
187.5
0
25
50
75
100
125
150
175
200
DISCHARGE (CFS)


BROWN TROUT WUA, MISSION CREEK SEGMENT 2
WUA FT2 PER 1000 FT
14000
12250
10500
8750
7000
5250
3500
1750
12.5
37.5
62.5
87.5
112.5
137.5
162.5
187.5
0
25
50
75
100
125
150
175
200
DISCHARGE (CFS)



CUTTHROAT TROUT WUA, JOCKO RIVER SEGMENT 8
WUA FT2 PER 1000 FT
1200
1050
900
750
600
450
300
150
10 30 50 70 90 110 130 150
0 20 40 60 80 100 120 140 160
DISCHARGE (CFS)

Estimated tributary streamflows
using basin characteristics
regression equations

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Mission Creek at St. Ignatius, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	23 (17-31)	23 (18-30)	21 (16-28)	20 (15-27)	20 (16-26)	23 (18-30)
70	32 (25-42)	36 (28-46)	31 (24-40)	26 (20-33)	26 (20-32)	30 (24-38)
50	41 (32-52)	46 (36-58)	39 (31-50)	32 (25-40)	30 (24-37)	37 (29-47)
10	74 (57-95)	85 (67-110)	75 (59-97)	60 (47-78)	54 (42-70)	66 (51-87)

%	APR	MAY	JUN	JUL	AUG	SEP
90	27 (21-34)	100 (77-130)	160 (120-200)	66 (47-91)	29 (19-42)	23 (16-33)
70	47 (38-58)	170 (130-210)	250 (200-310)	110 (84-140)	42 (30-59)	30 (22-42)
50	75 (59-95)	240 (190-310)	360 (290-430)	150 (120-200)	57 (42-78)	40 (30-54)
10	190 (140-250)	470 (380-580)	630 (530-750)	330 (270-400)	93 (72-120)	68 (54-85)

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Post Creek bl. Post "F" Canal nr. Charlo, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	24 (18-33)	25 (19-33)	22 (17-29)	22 (16-29)	21 (16-27)	25 (19-31)
70	35 (27-45)	39 (30-50)	33 (26-42)	27 (21-34)	26 (21-33)	31 (25-40)
50	43 (34-55)	48 (38-61)	41 (32-52)	33 (26-42)	31 (25-39)	38 (30-48)
10	74 (58-95)	86 (68-110)	76 (60-98)	62 (48-80)	53 (41-69)	68 (52-89)

%	APR	MAY	JUN	JUL	AUG	SEP
90	30 (24-38)	120 (88-150)	170 (130-220)	70 (50-97)	30 (20-44)	25 (17-36)
70	52 (42-65)	190 (150-240)	270 (220-330)	120 (92-160)	45 (32-63)	32 (23-45)
50	84 (66-110)	270 (210-340)	380 (320-460)	170 (130-210)	62 (45-85)	43 (32-59)
10	210 (160-280)	510 (410-630)	670 (560-810)	350 (290-430)	100 (70-130)	73 (58-92)

THE CONFEDERATED SALISH AND KOOTENAI TRIBES OF THE FLATHEAD RESERVATION

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M E M O R A N D U M

Date: June 23, 1988

To: Joseph Dos Santos, Fisheries Biologist, BPA Lower Flathead Fisheries Study

From: Kenn D. Cartier, Hydrologist, CS&KT Water Res. Program

Subject: Estimated streamflows using basin characteristics regression equations.

As requested, the Water Resources Program (WRP) has computed streamflow estimates for the eleven stream reaches examined by the BPA-CSKT Lower Flathead Fisheries Study (BPA-CSKT) on Flathead River tributaries. The attached streamflow estimates were derived using a family of regional regression equations developed jointly by the US Geological Survey (USGS) and WRP.

STUDY SITES:

The BPA-CSKT stream reaches listed in downstream order are as follows:

1) Mission Creek - Mission Reservoir to Post Creek,
2) Post Creek - McDonald Lake Road to mouth,
3) Mission Creek - Post Creek to mouth,
4) Middle Fork Jocko River - Tabor Feeder Canal to mouth,
5) Jocko River - Middle Fork Jocko to North Fork Jocko,
6) Jocko River - North Fork Jocko to Jocko "K" Canal,
7) Jocko River - Jocko "K" Canal to Finley Creek,
8) Jocko River - Finley Creek to Valley Creek,
9) Jocko River - Valley Creek to Highway 200 crossing,
10) Jocko River - Highway 200 crossing to Spring Canyon,
11) Jocko River - Spring Canyon to mouth.

The attached streamflow estimates were developed using map measurements collected at eleven stream sites. These sites and corresponding stream reaches are as follows:

A) Mission Creek at St. Ignatius - reach 1,
B) Post Creek below Post "F" Canal near Charlo - reach 2,
C) Post Creek at Highway 93 near Charlo - reach 2,
D) Mission Creek at Nat. Bison Range nr Moiese - reach 3,
E) Middle Fork Jocko River at mouth nr Arlee - reach 4,
F) Jocko River ab. North Fork Jocko nr Arlee - reach 5,
G) Jocko River ab. Jocko "K" Canal nr Arlee - reach 6,
H) Jocko River bl. Jocko "K" Canal nr Arlee - reach 7,
I) Jocko River bl. Finley Creek nr Arlee - reach 8,
J) Jocko River at Ravalli - reach 9.
K) Jocko River at Dixon - reach 10 & 11.

DESCRIPTION OF ANALYTICAL TECHNIQUE:

The regression equations used in this analysis were developed from measurements collected at 59 USGS gaging stations located in western Montana within the Columbia River basin as well as the adjacent eastern side of the Rocky Mountains (personal communication, Charles Parrett, USGS). Twelve stations were located within the Flathead Reservation. The stations were selected to have at least five years of daily flow record, although some stations did not have complete record for all months. The streamflow statistics used for the regression analysis were computed from the period of record and no attempt was made to translate the record to a common base period.

Basin characteristics data were measured by WRP personnel using USGS topographic maps and MOSS Geographic Information System (GIS) on the CSKT Prime minicomputer. Measurements were taken following the same techniques employed by Parrett for the development of the regression equations. Six parameters (drainage area, drainage area above 6000 ft, basin perimeter, mean basin elevation, basin relief, and mean basin slope) were measured from 1:24,000 scale maps. One parameter (mean basin precipitation) was measured from a 1:100,000 scale map.

The equations were developed in the power form with basin parameters or channel width used as the input variable and streamflow as the output variable, such that the basin characteristics equations have the general form:

$$Q_{Mp} = k\ (A)^{a}\ (BSL)^{bsl}\ (PE)^{pe}\ (E6)^{e6}\ (E)^{e}\ (R)^{r}\ (P)^{p}$$

where:

Q_{Mp} = streamflow at a specified month and exceedence probability in cubic feet per second,
k = coefficient of the equation,
A = drainage area in miles,
a = exponent for drainage area,
BSL = dimensionless mean basin slope,
bsl = exponent for basin slope,
PE = basin perimeter in miles,
pe = exponent for basin perimeter,
E6 = percent of drainage area above 6000 ft. elevation plus 1,
e6 = exponent for basin above 6000 ft. index,
E = mean basin elevation in thousands of feet,
e = exponent for mean basin elevation,
R = maximum basin relief in thousands of feet,
r = exponent for basin relief,
P = mean annual precipitation in inches,
and p = exponent for precipitation.

A family of equations was developed for each month of the year containing an equation corresponding to flows at the following mean-daily exceedence probabilities: .90, .70, .50, and . The exceedence statistics are for the probability of occurrence of a mean-daily flow in the specified month. I must emphasize that these statistics are not for the distribution of mean-monthly flows, but instead for the distribution of mean-daily flows by month.

The regression equations were developed through step-wise regression analysis using the least-squares method. The analysis was allowed to progress so that the most significant variable(s) was incorporated in the equation based on the F-statistic. In order to assure consistency within a specific month, the equations were also developed so that the same variable(s) was used for all of the equations within a single month.

Standard errors were computed for each month and exceedence probability. In general, the equations have larger standard errors for lower streamflows (larger exceedence probability) within a month. The equations had the largest standard errors during the months of July through September and the lowest errors during February through May. The log-transformed standard errors ranged between 0.18 and 0.38 log-cycles (43 to 103 %).

The attached tables contain the estimated value from the regression equations and the range of values for one standard deviation from the estimated value.

LIMITATIONS OF TECHNIQUES:

The "basin parameters" equations used for this analysis contained from two to four independent variables, with drainage area and basin perimeter being the most significant variables. These equations are similar in form to empirical streamflow equations which have been employed in a wide range of geographic areas for the past several decades. The technique is well accepted by hydrologists and has been used in numerous engineering, land management, and other undertakings (Omang et al, 1986; Parrett et al, 1984).

Based on previous experience in Montana, the accuracy of the "basin parameter" equations is most uncertain for sites affected by substantial groundwater - surface water interaction. In particular, the equations have the lowest accuracy for stream reaches located over extensive valley-fill material. The present "state-of-the-art" methodology for developing "basin parameter" equations does not include a commonly accepted variable which accounts for complex groundwater influence on the hydrograph.

REFERENCES:

Omang, R.J., Parrett, C. and Hull, J.A., 1986, Methods for Estimating Magnitude and Frequency of Floods in Montana based on Data through 1983, USGS Water-Resources Investigations 86-4027, 85 p.

Parrett, C., and Hull, J.A., 1984, Streamflow Characteristics of Mountain Streams in Western Montana: USGS Open-File Report 84-244, 74 p.

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Post Creek at Highway 93 nr. St. Ignatius, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	29 (21-39)	28 (22-37)	25 (19-33)	23 (17-31)	22 (17-28)	27 (21-34)
70	38 (30-50)	41 (32-53)	35 (28-45)	28 (22-36)	28 (22-35)	33 (27-42)
50	46 (36-58)	48 (38-61)	42 (33-53)	34 (27-44)	32 (26-40)	41 (32-51)
10	73 (57-94)	78 (61-99)	71 (55-91)	64 (50-83)	53 (41-63)	75 (57-98)

%	APR	MAY	JUN	JUL	AUG	SEP
90	37 (29-46)	120 (89-150)	140 (110-180)	56 (40-78)	25 (17-36)	22 (15-31)
70	67 (54-83)	200 (160-260)	230 (190-290)	100 (78-130)	39 (28-55)	30 (21-41)
50	110 (86-140)	290 (230-370)	340 (280-410)	140 (110-180)	57 (42-77)	41 (30-55)
10	280 (210-370)	570 (460-700)	620 (520-740)	290 (230-350)	94 (73-120)	67 (53-84)

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Mission Creek at National Bison Range nr. Moiese, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	67 (49-91)	67 (51-88)	58 (44-76)	52 (39-70)	50 (39-64)	63 (49-80)
70	83 (64-110)	86 (67-110)	75 (59-95)	61 (48-77)	63 (50-80)	78 (62-98)
50	90 (71-110)	91 (71-120)	83 (65-110)	75 (59-95)	73 (58-91)	95 (76-120)
10	120 (97-160)	130 (100-160)	130 (100-170)	140 (110-180)	123 (92-150)	190 (150-250)

%	APR	MAY	JUN	JUL	AUG	SEP
90	89 (71-110)	220 (170-290)	200 (160-260)	92 (66-130)	45 (31-66)	43 (38-62)
70	170 (140-210)	430 (330-550)	360 (290-440)	180 (140-240)	75 (54-110)	62 (44-86)
50	290 (220-360)	620 (480-780)	520 (430-630)	240 (190-310)	110 (80-150)	82 (60-110)
10	750 (560-990)	1210 (900-1490)	1020 (850-1220)	490 (390-600)	180 (140-230)	120 (98-160)

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Middle Fork Jocko River at mouth nr. Arlee, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	3.9 (2.9-5.3)	3.9 (3.0-5.1)	3.4 (2.6-4.5)	3.0 (2.2-4.0)	3.3 (2.6-4.2)	3.8 (3.0-4.8)
70	5.7 (4.4-7.4)	6.3 (4.9-8.1)	5.3 (4.2-6.8)	4.5 (3.6-5.8)	4.7 (3.7-5.9)	5.2 (4.2-6.6)
50	8.1 (6.4-10)	9.0 (7.1-11)	7.4 (5.8-9.4)	6.0 (4.7-7.7)	5.6 (4.5-6.9)	6.3 (5.0-8.0)
10	23 (18-29)	19 (15-25)	15 (12-19)	11 (8.8-15)	11 (8.4-14)	12 (8.8-15)

%	APR	MAY	JUN	JUL	AUG	SEP
90	6.1 (4.8-7.6)	19 (15-25)	39 (30-50)	15 (11-21)	7.6 (5.2-11)	5.4 (3.7-7.8)
70	10 (8.1-13)	32 (25-41)	58 (47-71)	22 (17-29)	10 (7.1-14)	7.2 (5.2- 10)
50	16 (13-21)	50 (39-63)	85 (70-100)	32 (25-41)	13 (9.4-18)	9.0 (6.6-12)
10	40 (30-52)	120 (90-150)	160 (130-190)	74 (60-91)	23 (18-29)	18 (14-22)

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Jocko River ab. North Fork Jocko nr. Arlee, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	31 (22-42)	32 (24-42)	29 (22-38)	26 (20-35)	27 (21-35)	33 (26-42)
70	42 (32-54)	45 (35-58)	39 (31-50)	34 (27-43)	36 (29-45)	43 (34-55)
50	51 (40-64)	54 (43-69)	49 (39-63)	44 (34-56)	43 (34-54)	53 (42-67)
10	93 (73-120)	90 (77-120)	93 (72-120)	83 (65-110)	81 (63-110)	100 (79-140)

%	APR	MAY	JUN	JUL	AUG	SEP
90	44 (35-55)	160 (120-200)	210 (160-270)	60 (43-83)	30 (20-44)	25 (17-36)
70	73 (59-91)	280 (220-360)	350 (290-430)	** (76-130)	44 (31-61)	33 (24-46)
50	110 (89-140)	410 (320-520)	500 (420-610)	140 (110-180)	58 (43-80)	42 (31-57)
10	310 (230-400)	800 (650-990)	940 (790-1130)	300 (240-370)	97 (75-130)	70 (56-89)

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Jocko River ab. Jocko "K" Canal nr. Arlee, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	39 (28-53)	41 (31-53)	37 (28-48)	34 (26-46)	35 (27-45)	42 (33-54)
70	53 (41-68)	57 (44-73)	50 (39-63)	43 (34-55)	46 (37-59)	56 (44-70)
50	63 (49-80)	68 (53-86)	62 (49-79)	55 (44-70)	55 (44-68)	68 (54-86)
10	110 (86-140)	120 (95-150)	120 (91-150)	110 (82-140)	100 (80-130)	130 (100-170)

%	APR	MAY	JUN	JUL	AUG	SEP
90	58 (46-73)	210 (160-270)	250 (200-330)	100 (73-140)	51 (35-75)	43 (30-62)
70	98 (79-120)	370 (290-480)	430 (350-530)	170 (130-220)	74 (53-100)	57 (41-80)
50	150 (120-190)	530 (420-680)	620 (510-750)	240 (180-300)	98 (72-130)	71 (53-96)
10	410 (310-540)	1000 (810-1240)	1150 (960-1380)	510 (410-630)	160 (120-210)	110 (90-140)

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Jocko River bl. Big Knife Creek nr. Arlee, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	43 (32-59)	46 (35-60)	41 (31-54)	39 (29-52)	40 (31-51)	48 (37-61)
70	59 (45-76)	63 (49-81)	56 (44-71)	48 (38-62)	51 (41-65)	62 (50-79)
50	70 (55-89)	76 (59-96)	69 (55-88)	62 (49-78)	61 (49-76)	77 (61-97)
10	120 (94-150)	130 (110-170)	130 (100-170)	120 (92-150)	120 (89-150)	150 (110-200)

%	APR	MAY	JUN	JUL	AUG	SEP
90	62 (49-78)	220 (170-290)	270 (210-350)	110 (76-150)	53 (36-77)	44 (31-64)
70	110 (84-130)	400 (310-510)	470 (380-570)	180 (140-230)	77 (55-110)	59 (43-83)
50	160 (130-210)	570 (450-720)	670 (550-810)	250 (190-320)	100 (75-140)	74 (55-100)
10	440 (330-580)	1070 (870-1320)	1240 (1030-1480)	540 (430-660)	170 (130-210)	120 (94-150)

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Jocko River bl. Finley Creek nr. Arlee, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	62 (45-84)	65 (50-86)	59 (45-77)	56 (42-74)	56 (44-72)	69 (54-87)
70	82 (63-110)	88 (68-110)	78 (61-99)	68 (53-86)	73 (58-91)	89 (71-110)
50	94 (74-120)	100 (79-130)	94 (74-120)	86 (68-110)	86 (69-110)	110 (88-140)
10	150 (120-190)	170 (140-220)	170 (140-220)	160 (130-210)	160 (120-210)	220 (170-290)

%	APR	MAY	JUN	JUL	AUG	SEP
90	82 (65-100)	260 (200-340)	310 (240-400)	150 (110-210)	78 (54-110)	69 (47-99)
70	140 (110-180)	490 (390-630)	540 (440-660)	270 (200-350)	120 (83-160)	92 (66-130)
50	220 (180-280)	710 (560-900)	780 (640-940)	370 (280-470)	160 (110-210)	110 (85-150)
10	610 (460-810)	1340 (1090-1650)	1460 (1220-1750)	780 (640-970)	250 (190-320)	170 (140-220)

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Jocko River at Ravalli, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	88 (65-120)	94 (72-120)	85 (65-110)	80 (60-110)	80 (63-100)	99 (78-130)
70	120 (89-150)	120 (95-160)	110 (85-140)	95 (75-120)	100 (82-130)	130 (100-160)
50	130 (100-160)	140 (110-170)	130 (100-160)	120 (95-150)	120 (99-150)	160 (130-200)
10	190 (150-250)	220 (170-280)	230 (180-300)	230 (180-300)	230 (180-300)	320 (240-420)

%	APR	MAY	JUN	JUL	AUG	SEP
90	110 (84-130)	300 (230-390)	340 (260-430)	200 (140-270)	100 (69-150)	91 (63-130)
70	190 (150-240)	590 (460-750)	600 (490-730)	350 (260-450)	150 (110-210)	120 (88-170)
50	300 (240-380)	840 (660-1070)	870 (720-1050)	470 (370-600)	200 (150-280)	150 (110-210)
10	830 (620-1090)	1620 (1320-2000)	1660 (1300-1900)	*** (810-1230)	320 (250-420)	220 (180-280)

DISCHARGE ESTIMATES USING BASIN CHARACTERISTICS
FOR: Jocko River at Dixon, MT.

%	OCT	NOV	DEC	JAN	FEB	MAR
90	97 (71-130)	100 (79-140)	93 (71-120)	88 (66-120)	88 (63-110)	110 (86-140)
70	130 (97-160)	130 (100-170)	120 (93-150)	100 (82-130)	110 (89-140)	140 (110-180)
50	140 (110-180)	150 (120-190)	140 (110-180)	130 (100-170)	130 (110-170)	170 (140-220)
10	200 (160-260)	240 (190-300)	250 (200-320)	250 (200-320)	250 (190-320)	350 (270-460)

%	APR	MAY	JUN	JUL	AUG	SEP
90	110 (88-140)	300 (230-400)	340 (270-440)	210 (150-300)	110 (74-160)	99 (69-140)
70	200 (160-250)	600 (470-770)	610 (500-750)	380 (290-490)	170 (120-230)	130 (96-190)
50	320 (250-410)	870 (680-1100)	890 (730-1070)	510 (400-660)	220 (160-300)	170 (120-220)
10	880 (660-1160)	1670 (1360-2070)	1630 (1410-2030)	1000 (800-1340)	350 (270-450)	240 (190-300)

APPENDIX G

Selected habitat parameters
on tributaries to the
lower Flathead River.

Table G1. Selected habitat parameters measured on tributaries to the lower Flathead River.

Stream and reach	Survey date	Flow (m^3/second)	Hydraulics: Wetted width (m)	Channel width (m)	Average depth (cm)	Feature (%Pool/riffle/run/pocket-water)	Bed material: Texture (%-f,g,c,bo,be)[b]	Bed material: Compaction (n,l,m,h)[a]	Bank material: Texture (%-f,g,c,bo,be,)[b]	Stability (e,g,f,p)[c]	Channel cover (%-canopy/overhang/instream)	U S F S rating (e,g,f,p)[c]
Jocko River												
R-1	1 Aug 1983	7.5	21	24	51	0/10/88/2	42/25/21/12/0	m	50/25/18/7/0	f	5/4/8	g
R-2	10 Aug 1983	8.7	20	26	39	0/7/93/0	28/34/28/10/0	l	47/25/25/3/0	g	5/5/1	g
R-3	11 Aug 1983	6.9	20	25	51	3/2/95/0	43/30/23/4/0	l	80/16/4/0/0	g	6/5/2	g
R-4	9 Aug 1983	4.2	19	47	43	0/10/90/0	37/40/23/0/0	l	52/30/18/0/0	f	3/5/3	f
R-5	8 Aug 1983	0.1	11	18	20	3/5/57/35	22/22/26/30/0	h	34/23/28/15/0	g	13/9/2	g
R-6	3 Aug 1983	5.0	17	20	44	0/8/92/0	30/17/25/28/0	h	37/15/20/28/0	g	3/2/2	g
R-7	2 Aug 1983	3.9	12	14	55	5/0/80/15	43/18/15/24/0	h	85/8/4/3/0	g	36/18/15	g
Mission Creek												
R-1	1 Sept 1983	6.8	14	25	59	5/10/95/0	50/35/12/4/0	l	66/22/10/2/0	p	4/3/100	f
R-2	23 Aug 1983	5.1	18	22	65	10/15/75/0	63/24/13/0/0	l	73/18/7/2/0	p	4/4/77	p
R-3	22 June 1983	0.5	7	12	37	13/18/69/0	47/47/5/1/0	m	58/38/3/1/0	f	8/5/4	f
R-4	27 June 1983	1.4	8	10	37	5/5/90/0	38/40/21/1/0	m	63/28/6/3/0	f	9/6/5	g
R-5	15 Aug 1983	3.0	11	17	40	3/0/97/0	33/28/32/7/0	h	68/18/13/1/0	p	24/10/6	f
Post Creek												
R-1	22 Aug 1983	3.1	16	16	53	3/12/83/2	64/25/9/2/0	l	85/13/1/1/0	g	9/10/80	f
R-2	18 Aug 1983	0.6	10	10	51	0/3/97/0	58/38/3/1/0	l	92/8/0/0/0	g	5/5/100	f
R-3	17 Aug 1983	0.1	7	16	20	2/10/88/0	35/20/32/13/0	h	87/6/6/1/0	f	12/22/3	f
R-4												
Crow Creek												
R-1	16 Aug 1983	2.4	9	15	30	8/22/67/3	50/17/23/10/0	m	74/8/14/4/0	p	6/5/35	f
Little Bitterroot River												
R-1	11 July 1983	0.1	10	13	30	3/20/77/0	32/17/25/23/3	h	67/7/6/4/16	f	1/1/100	f
R-2	13 July 1983	0.1	7	9	36	0/0/100/0	99/1/0/0/0	h	100/0/0/0/0	p	1/1/100	f
R-3	7 July 1983	0.3	6	7	40	0/0/100/0	100/0/0/0/0	l	100/0/0/0/0	f	17/23/100	f
R-4	5 July 1983	0.003	16	27	83	0/0/100/0	100/0/0/0/0	n	100/0/0/0/0	e	47/69/100	g
R-5	6 July 1983	0.3	7	10	22	5/18/77/0	37/10/38/15/0	h	77/8/8/7/0	e	31/14/19	g

[a] n = nil, l = low, m = moderate, h = high

[b] f = fines, g = gravel, c = cobble, bo = boulder, be = bedrock

[c] e = excellent, g = good, f = fair, p = poor

APPENDIX H

Substrate characteristics of the Jocko River and Mission, Post and Crow Creeks.

Table H1. Predicted rainbow trout (Rb) embryo survival in spawning areas of the lower Flathead River tributaries related to combinations of substrates smaller than 0.85 and 9.5 mm based upon studies by Irving and Bjorn (1984).

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

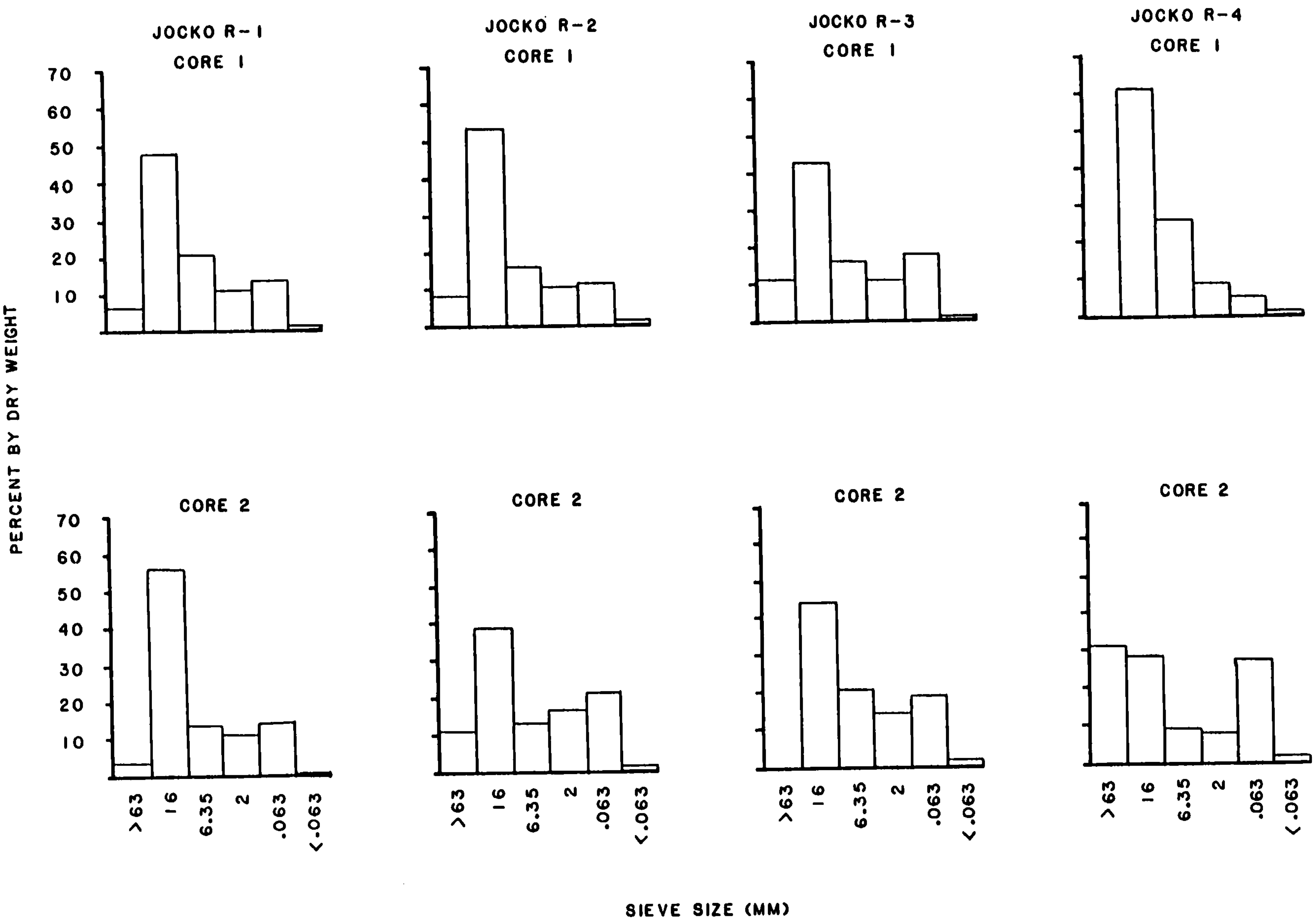


Figure H1. Substrate composition of gravels collected from brown and rainbow trout spawning areas in the Jocko River during the spring, 1985.

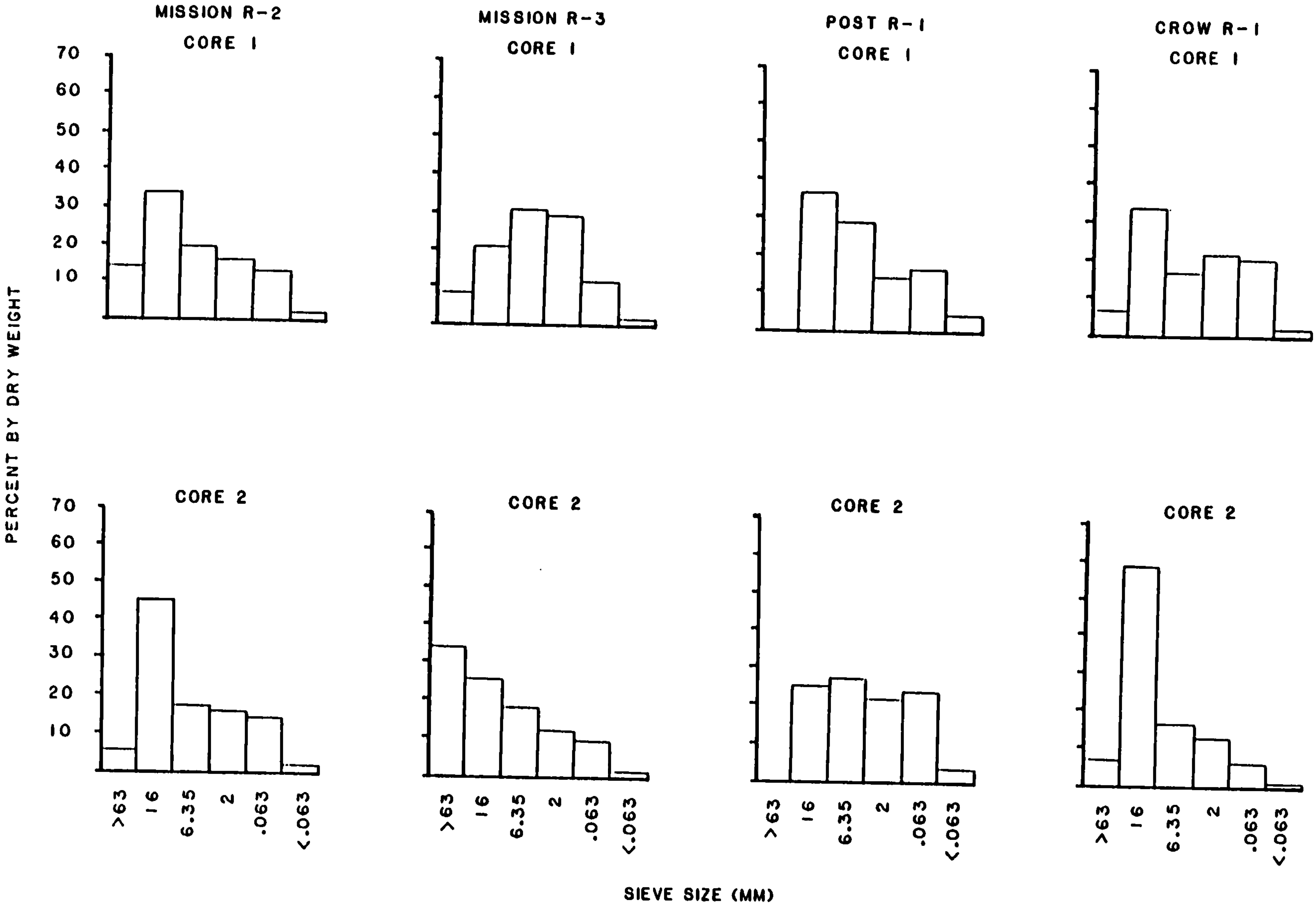


Figure H2. Substrate composition of gravels collected from brown and rainbow trout spawning areas in Mission, Post and Crow Creeks during spring 1985.

APPENDIX I

Water temperatures recorded near the mouths of four major tributaries to the lower Flathead River using 90 - day thermographs.

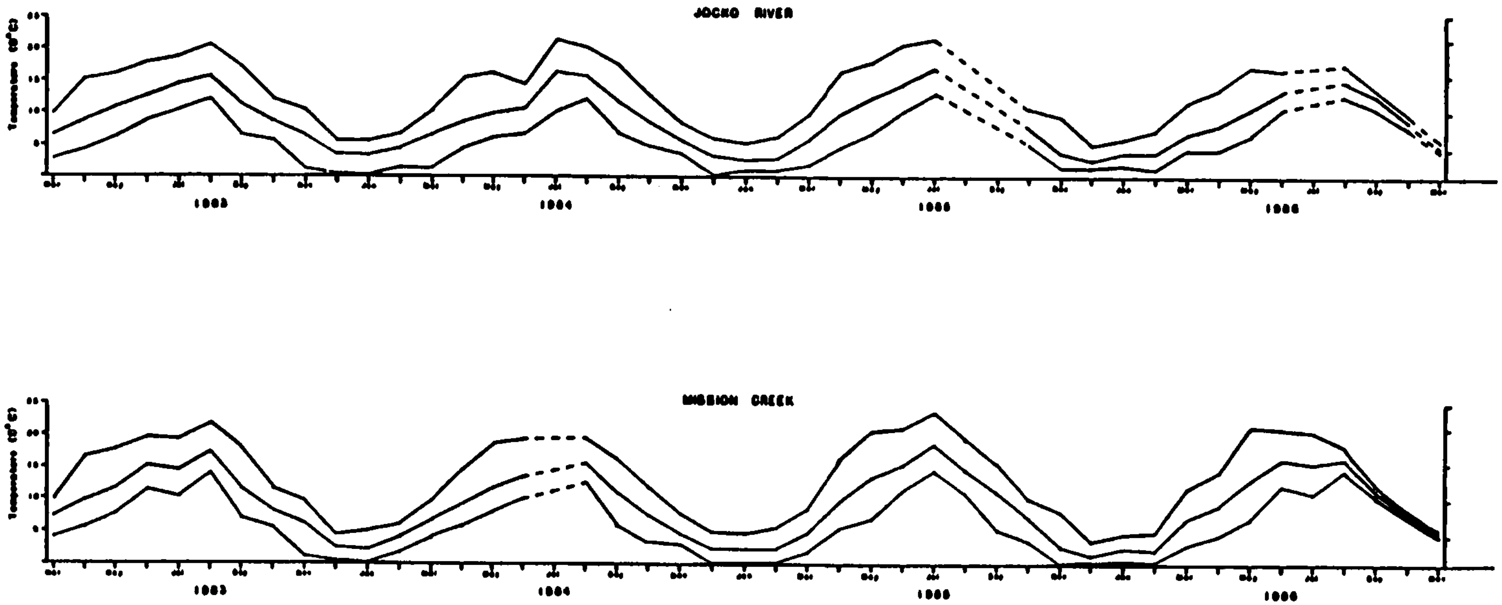


Figure I1. Average monthly minimum, mean, and maximum water temperatures recorded at near the mouths of the Jocko River and Mission Creek, 1983 - 1986.

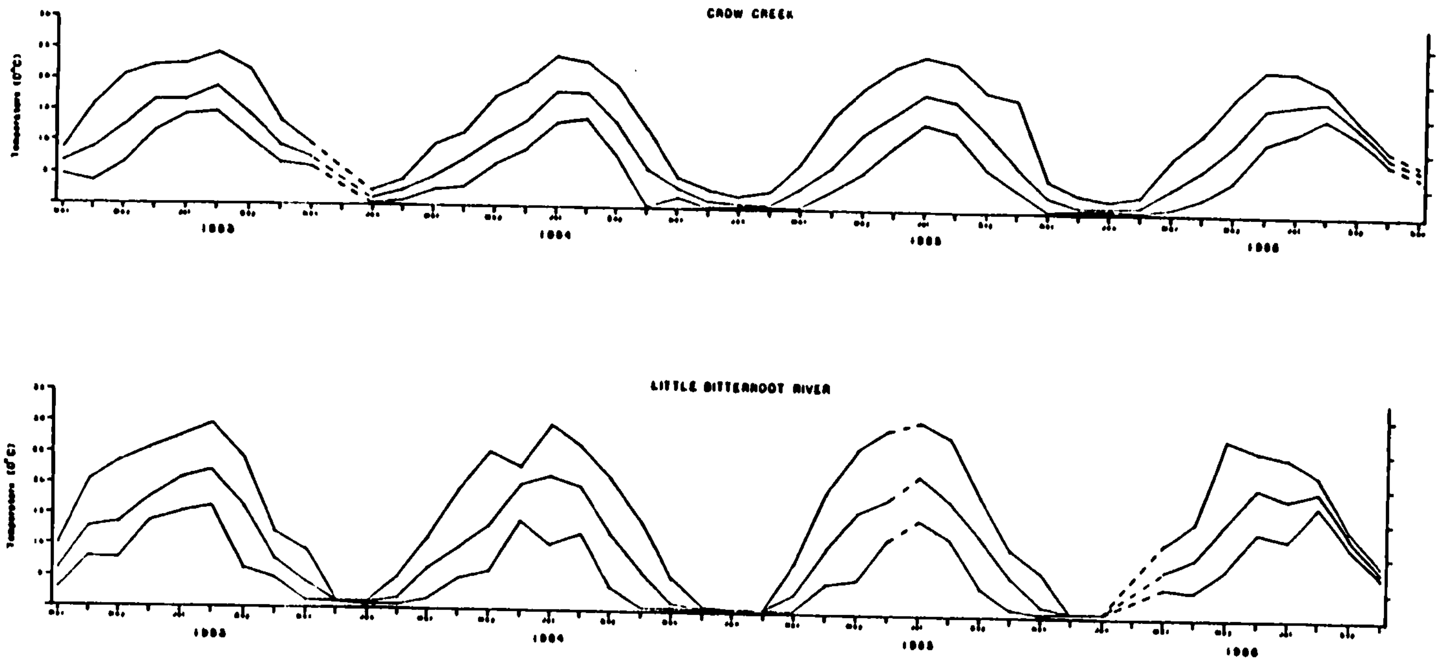


Figure I2. Average monthly minimum, mean, and maximum water temperatures recorded at near the mouths of the Crow Creek and Little Bitterroot River, 1983 - 1986.

APPENDIX J

Population estimates for trout and northern pike at stock assessment stations on five tributaries to the lower Flathead River.

JOCKO RIVER

Record#	REACH	SEASON	SPECIES	CPUE	POPEST	CONFINTER	IN_100_SQM
1	1	f83	LL	1.8	0	0	0.0
2	1	f84	LL	0.5	0	0	0.0
3	1	f85	LL	3.3	0	0	0.0
4	1	f83	rb	0.4	0	0	0.0
5	1	f84	rb	2.7	0	0	0.0
6	1	f85	rb	2.1	0	0	0.0
7	2	f83	LL	5.0	11	6	0.3
8	2	f84	LL	10.0	76	45	2.4
9	2	f85	LL	15.9	171	80	3.0
10	2	f83	rb	15.0	51	27	1.6
11	2	f84	rb	13.0	199	145	6.3
12	2	f85	rb	11.7	260	189	4.7
13	3	f83	LL	6.0	12	7	0.4
14	3	f84	LL	18.8	220	119	7.6
15	3	f85	LL	20.9	0	0	0.0
16	3	f83	rb	4.0	12	8	0.4
17	3	f84	rb	1.6	0	0	0.0
18	3	f85	rb	6.4	98	71	1.9
19	4	f83	LL	20.8	120	53	4.4
20	4	f84	LL	33.7	457	181	16.0
21	4	f85	LL	78.1	2961	1275	61.4
22	4	f83	eb	0.8	0	0	0.0
23	4	f84	eb	3.8	0	0	0.0
24	4	f85	eb	16.6	199	80	4.1
25	4	f83	rb	2.4	0	0	0.0
26	4	f84	rb	3.0	19	14	0.7
27	4	f85	rb	1.1	0	0	0.0
28	5	f84	DV	0.4	0	0	0.0
29	5	f83	LL	1.2	0	0	0.0
30	5	f84	LL	4.7	0	0	0.0
31	5	f85	LL	6.6	0	0	0.0
32	5	f84	ct	0.4	0	0	0.0
33	5	f83	eb	5.8	0	0	0.0
34	5	f84	eb	12.1	43	20	2.4
35	5	f85	eb	11.4	0	0	0.0
36	5	f84	rb	0.4	0	0	0.0
37	5	f85	rb	0.6	0	0	0.0
38	6	f83	DV	3.0	7	2	0.3
39	6	f84	DV	3.1	0	0	0.0
40	6	f83	ct	6.0	47	34	1.9
41	6	f84	ct	6.7	29	21	1.2
42	6	f84	rb	0.4	0	0	0.0
43	7	f83	DV	1.0	0	0	0.0
44	7	f84	DV	1.4	4	4	0.3
45	7	f83	ct	7.7	38	19	2.9
46	7	f84	ct	14.5	54	17	4.0
47	7	f83	eb	4.0	16	16	1.2
48	7	f84	eb	4.3	15	9	1.1

Note: f85 estimates are based upon 300 m stations; all others on 150 m stations.

MISSION CREEK

Record#	REACH	SEASON	SPECIES	CPUE	POPEST	CONFINTER	IN_100_SQM
1	1	f83	rb	0.4	0	0	0.0
2	2	f83	LL	0.8	0	0	0.0
3	2	f83	rb	6.0	31	22	1.3
4	2	f84	rb	3.7	0	0	0.0
5	2	f85	rb	14.9	77	26	1.8
6	3	f83	eb	62.5	583	195	45.2
7	3	f84	eb	52.1	661	203	50.0
8	3	f85	eb	61.1	959	150	42.2
9	3	f83	rb	94.0	735	187	57.0
10	3	f84	rb	68.2	1198	388	90.8
11	3	f85	rb	110.5	1657	188	73.0
12	4	f83	eb	66.8	247	69	27.9
13	4	f84	eb	65.1	362	68	40.2
14	4	f83	rb	23.5	84	32	9.5
15	4	f84	rb	42.9	187	35	20.8
16	5	f83	eb	44.0	213	59	20.3
17	5	f84	eb	34.4	407	139	32.7
18	5	f83	rb	16.8	114	60	10.9
19	5	f84	rb	14.3	147	73	11.8

POST CREEK

Record#	REACH	SEASON	SPECIES	CPUE	POPEST	CONFINTER	IN_100_SQM
1	1	f85	LL	1.3	4	4	0.1
2	1	f83	eb	1.0	0	0	0.0
3	1	f85	eb	0.6	1	0	0.1
4	1	f83	rb	13.5	112	81	4.5
5	1	f84	rb	8.6	19	9	0.7
6	1	f85	rb	23.9	204	84	3.9
7	2	f83	LL	0.4	0	0	0.0
8	2	f84	LL	4.4	17	12	1.3
9	2	f83	eb	1.6	3	2	0.2
10	2	f84	eb	0.4	0	0	0.0
11	2	f83	rb	66.4	320	73	25.7
12	2	f84	rb	40.4	405	205	30.7
13	3	f83	LL	1.3	0	0	0.0
14	3	f83	eb	60.7	0	0	0.0
15	3	f84	eb	75.7	266	36	28.1
16	3	f83	rb	4.7	0	0	0.0
17	3	f84	rb	11.3	39	12	4.1
18	4	f84	DV	0.3	0	0	0.0
19	4	f83	ct	0.6	0	0	0.0
20	4	f83	eb	14.3	0	0	0.0
21	4	f84	eb	21.4	239	93	15.2
22	4	f83	rb	37.7	0	0	0.0
23	4	f84	rb	60.2	304	42	19.3

CROW CREEK

Record#	REACH	SEASON	SPECIES	CPUE	POPEST	CONFINTER	IN_100_SQM
1	1	f83	LL	0.3	0	0	0.0
2	1	f84	LL	0.7	0	0	0.0
3	1	f85	LL	2.5	0	0	0.0
4	1	f83	rb	9.2	67	48	4.6
5	1	f84	rb	8.5	19	15	2.3
6	1	f85	rb	4.5	0	0	0.0

Note: f85 estimates based upon 300 m stations, all others on 150 m stations.

LITTLE BITTERROOT RIVER

Record#	REACH	SEASON	SPECIES	CPUE	POPEST	CONFINTER	IN_100_SQM
1	3	f83	nb	5.1	9	7	1.1
2	3	f84	nb	1.5	0	0	0.0
3	4	f83	nb	3.0	0	0	0.0
4	5	f83	ct	7.8	35	17	1.6
5	5	f84	ct	20.0	108	31	8.9
6	5	f83	eb	48.8	357	116	16.5
7	5	f84	eb	87.4	713	149	58.7
8	5	f83	rb	2.1	12	8	0.6

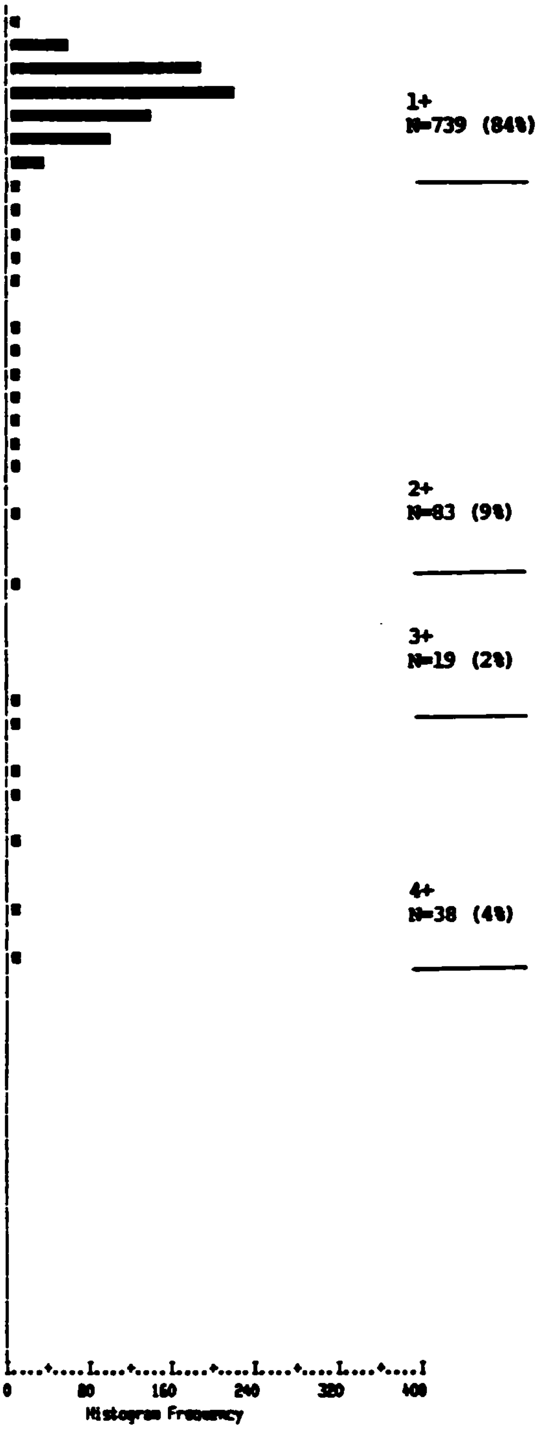
APPENDIX K

Length-frequency histograms for trout and northern pike captured during sampling from 1983 to 1986.

Brown trout from Jocko River reaches 1-5

LENGTH

Count	Midpoint
5	65.00
58	75.00
186	85.00
214	95.00
132	105.00
98	115.00
35	125.00
11	135.00
4	145.00
5	155.00
6	165.00
9	175.00
2	185.00
9	195.00
6	205.00
6	215.00
5	225.00
6	235.00
4	245.00
4	255.00
3	265.00
4	275.00
3	285.00
3	295.00
4	305.00
3	315.00
2	325.00
3	335.00
3	345.00
4	355.00
4	365.00
2	375.00
4	385.00
5	395.00
3	405.00
6	415.00
1	425.00
3	435.00
4	445.00
2	455.00
5	465.00
3	475.00
0	485.00
1	495.00
0	505.00
0	515.00
0	525.00
0	535.00
1	545.00
0	555.00
1	565.00
1	575.00
0	585.00
0	595.00
0	605.00
0	615.00
0	625.00
1	632.00



LENGTH

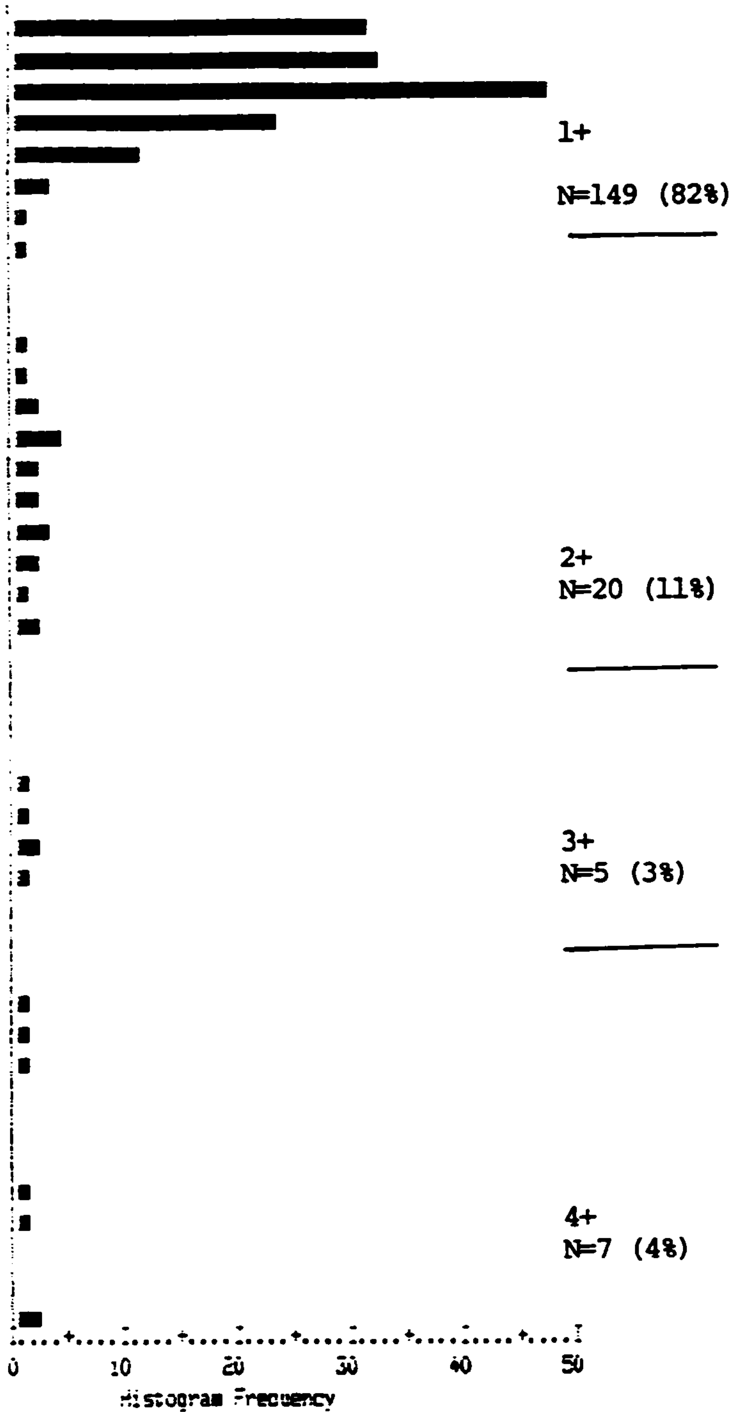
Mean	129.726	Std Err	2.968	Median	98.000
Mode	98.000	Std Dev	88.244	Variance	7786.980
Kurtosis	7.210	S E Kurt	.164	Skewness	2.741
S E Skew	.082	Range	570.000	Minimum	62.000
Maximum	632.000	Sum	114678.000		

Valid Cases 884 Missing Cases 0

Rainbow trout from Jocko River reaches 1-5

LENGTH

Count	Midpoint
31	65.00
32	75.00
47	85.00
23	95.00
11	105.00
3	115.00
1	125.00
1	135.00
0	145.00
0	155.00
1	165.00
1	175.00
2	185.00
4	195.00
2	205.00
2	215.00
3	225.00
2	235.00
1	245.00
2	255.00
0	265.00
0	275.00
0	285.00
0	295.00
1	305.00
1	315.00
2	325.00
1	335.00
0	345.00
0	355.00
0	365.00
1	375.00
1	385.00
1	395.00
0	405.00
0	415.00
0	425.00
1	435.00
1	445.00
0	455.00
0	465.00
2	475.00



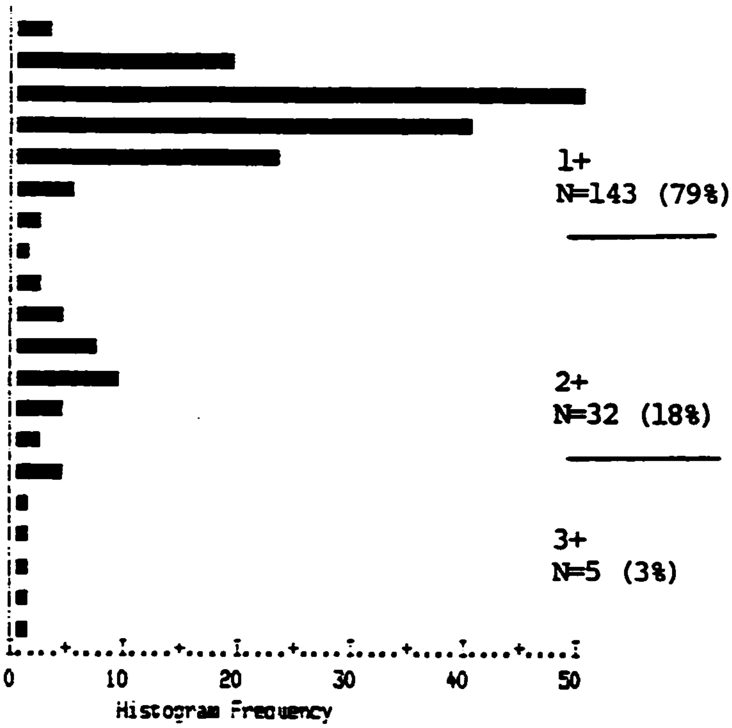
Mean	113.447	Std Err	6.022	Median	85.000
Mode	57.000	Std Dev	83.005	Variance	6889.315
Kurtosis	5.487	S E Kurt	.351	Skewness	2.366
S E Skew	.176	Range	420.000	Minimum	53.000
Maximum	473.000	Sum	21555.000		

Valid Cases 190 Missing Cases 0 K2

Brook trout from Jocko River reaches 1-5

LENGTH

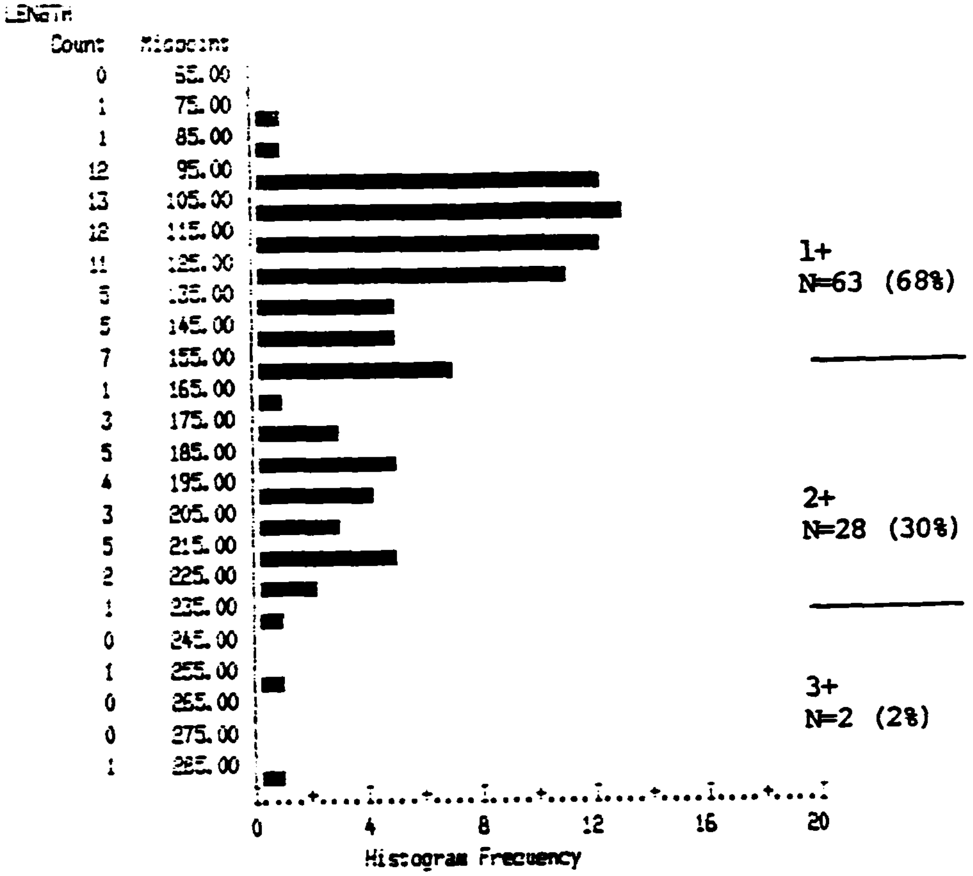
Count	Midpoint
3	65.00
19	75.00
50	85.00
40	95.00
23	105.00
5	115.00
2	125.00
1	135.00
2	145.00
4	155.00
7	165.00
9	175.00
4	185.00
2	195.00
4	205.00
1	215.00
1	225.00
1	235.00
1	245.00
1	255.00



Mean	109.194	Std Err	3.039	Median	93.000
Mode	80.000	Std Dev	40.778	Variance	1662.839
Kurtosis	1.696	S E Kurt	.360	Skewness	1.597
S E Skew	.181	Range	195.000	Minimum	65.000
Maximum	260.000	Sum	19655.000		

Valid Cases 180 Missing Cases 0

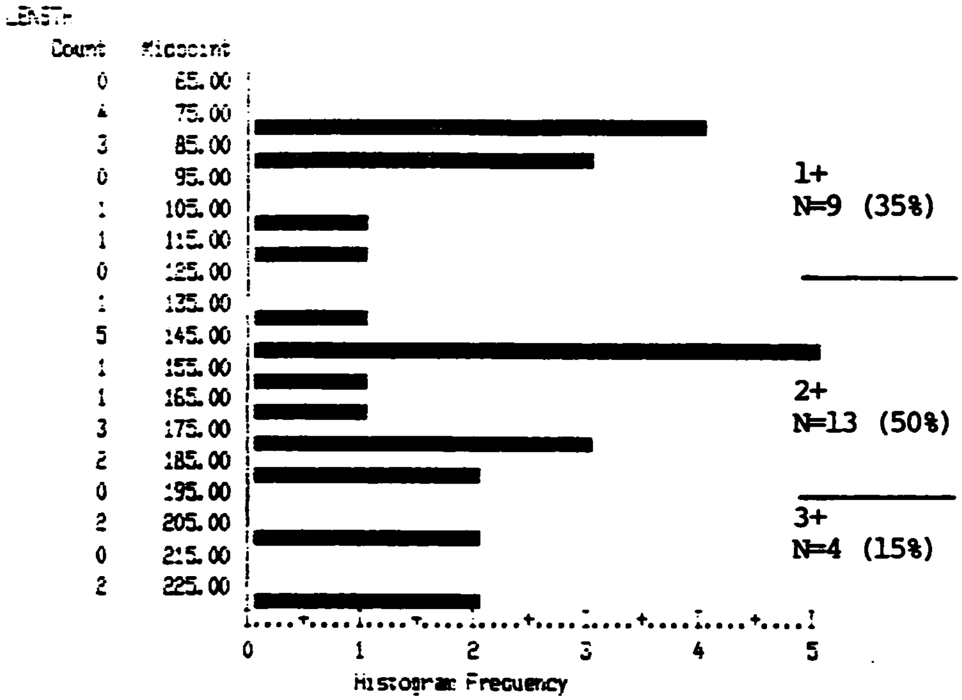
Cutthroat trout from Jocko River reaches 6&7



Mean	141.699	Std Err	4.636	Median	125.000
Mode	90.000	Std Dev	44.708	Variance	1998.821
Kurtosis	.174	S E Kurt	.495	Skewness	.920
S E Skew	.250	Range	214.000	Minimum	73.000
Maximum	287.000	Sum	13178.000		

Valid Cases 93 Missing Cases 0

Brook trout from Jocko River reaches 6&7



LENGTH

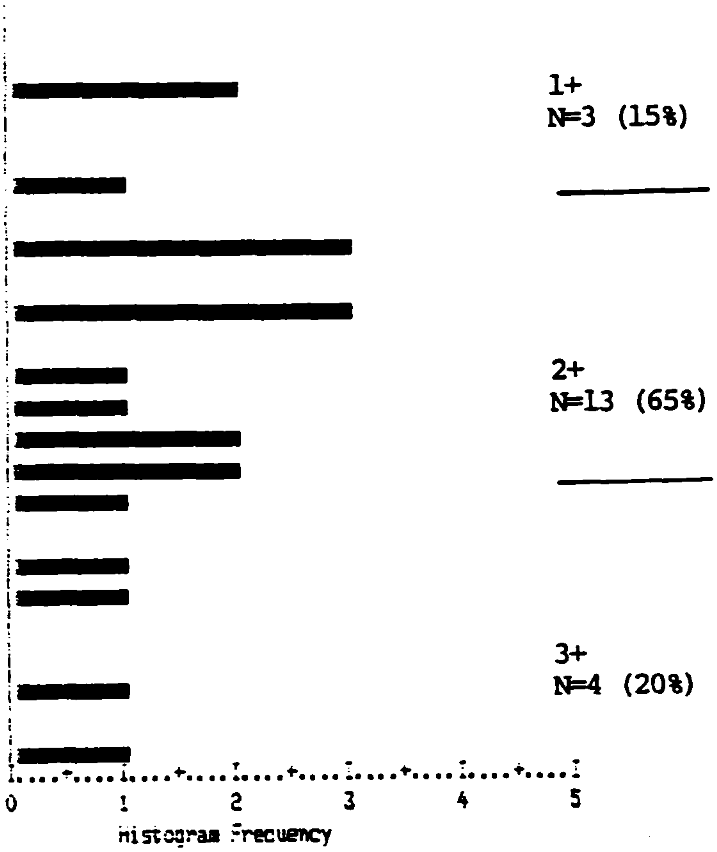
Mean	141.077	Std Err	9.755	Median	145.500
Mode	140.000	Std Dev	49.742	Variance	2474.314
Kurtosis	-1.104	S E Kurt	.887	Skewness	-.012
S E Skew	.456	Range	155.000	Minimum	70.000
Maximum	225.000	Sum	3668.000		

Valid Cases 26 Missing Cases 0

Bull trout from Jocko River reaches 6&7

LENGTH

Count	Midpoint
0	65.00
0	75.00
2	85.00
0	95.00
0	105.00
1	115.00
0	125.00
3	135.00
0	145.00
3	155.00
0	165.00
1	175.00
1	185.00
2	195.00
2	205.00
1	215.00
0	225.00
1	235.00
1	245.00
0	255.00
0	265.00
1	275.00
0	285.00
1	295.00



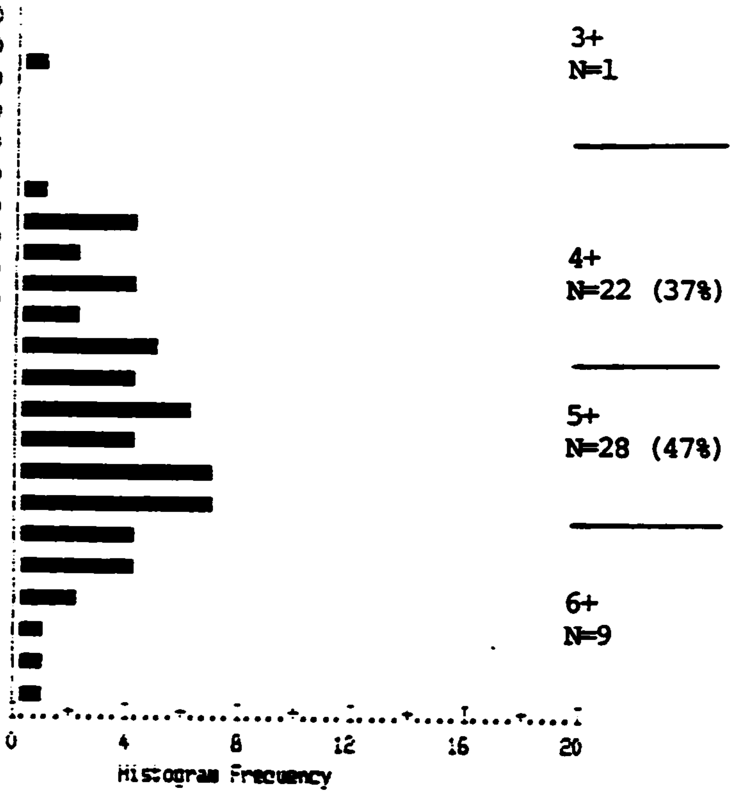
Mean	176.050	Std Err	12.744	Median	176.500
Mode	84.000	Std Dev	56.991	Variance	3247.945
Kurtosis	-.361	S E Kurt	.992	Skewness	.258
S E Skew	.512	Range	208.000	Minimum	84.000
Maximum	292.000	Sum	3521.000		

Valid Cases 20 Missing Cases 0

Rainbow trout from Jocko Weir

LENGTH

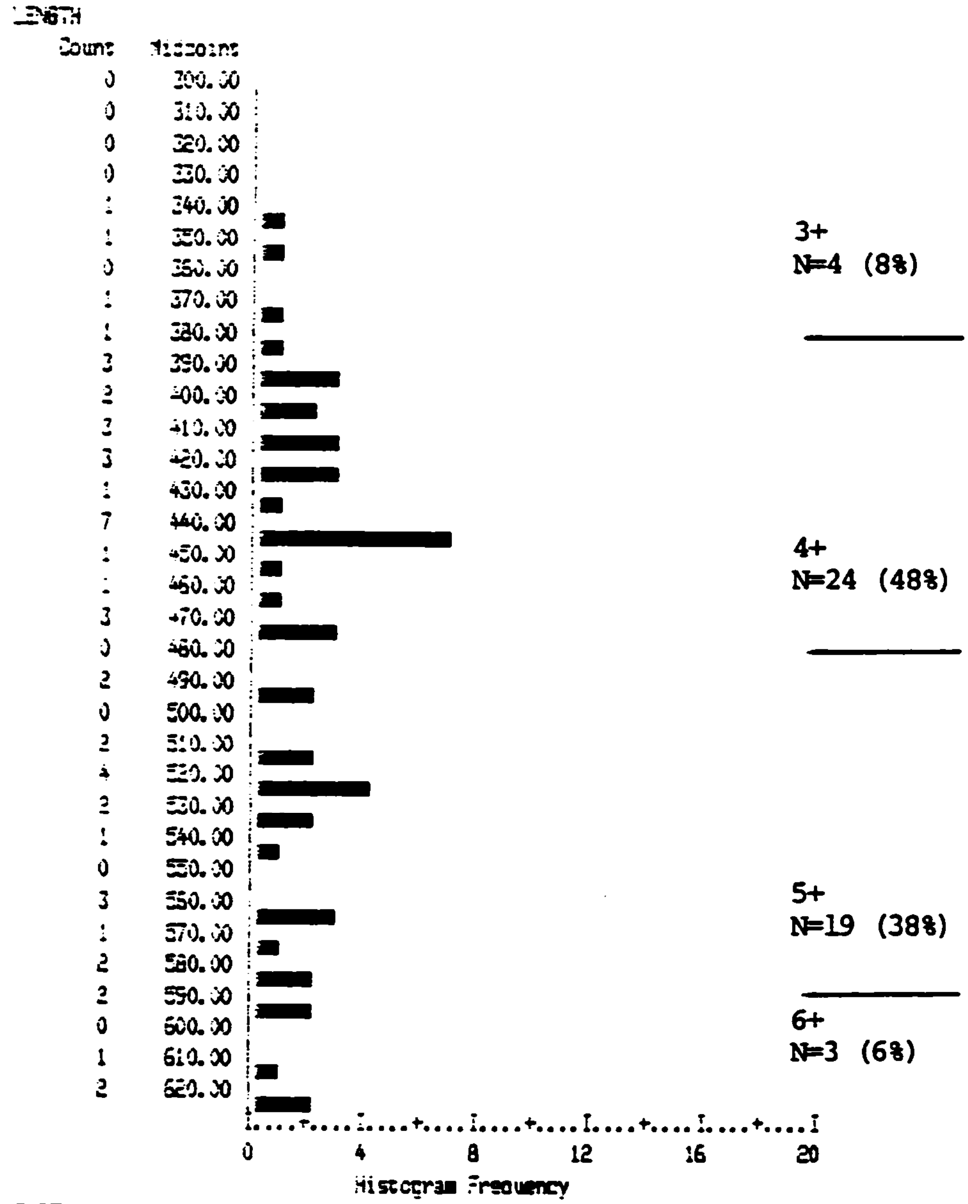
Count	Midpoint
0	300.00
1	310.00
0	320.00
0	330.00
0	340.00
1	350.00
4	360.00
2	370.00
4	380.00
2	390.00
5	400.00
4	410.00
6	420.00
4	430.00
7	440.00
7	450.00
4	460.00
4	470.00
2	480.00
1	490.00
1	500.00
1	508.00



Mean	422.550	Std Err	5.260	Median	427.000
Mode	451.000	Std Dev	40.746	Variance	1660.218
Kurtosis	-.213	S E Kurt	.608	Skewness	-.285
S E Skew	.309	Range	195.000	Minimum	313.000
Maximum	508.000	Sum	25353.000		

Valid Cases 60 Missing Cases 0

Brown trout from Jocko Weir



LENGTH

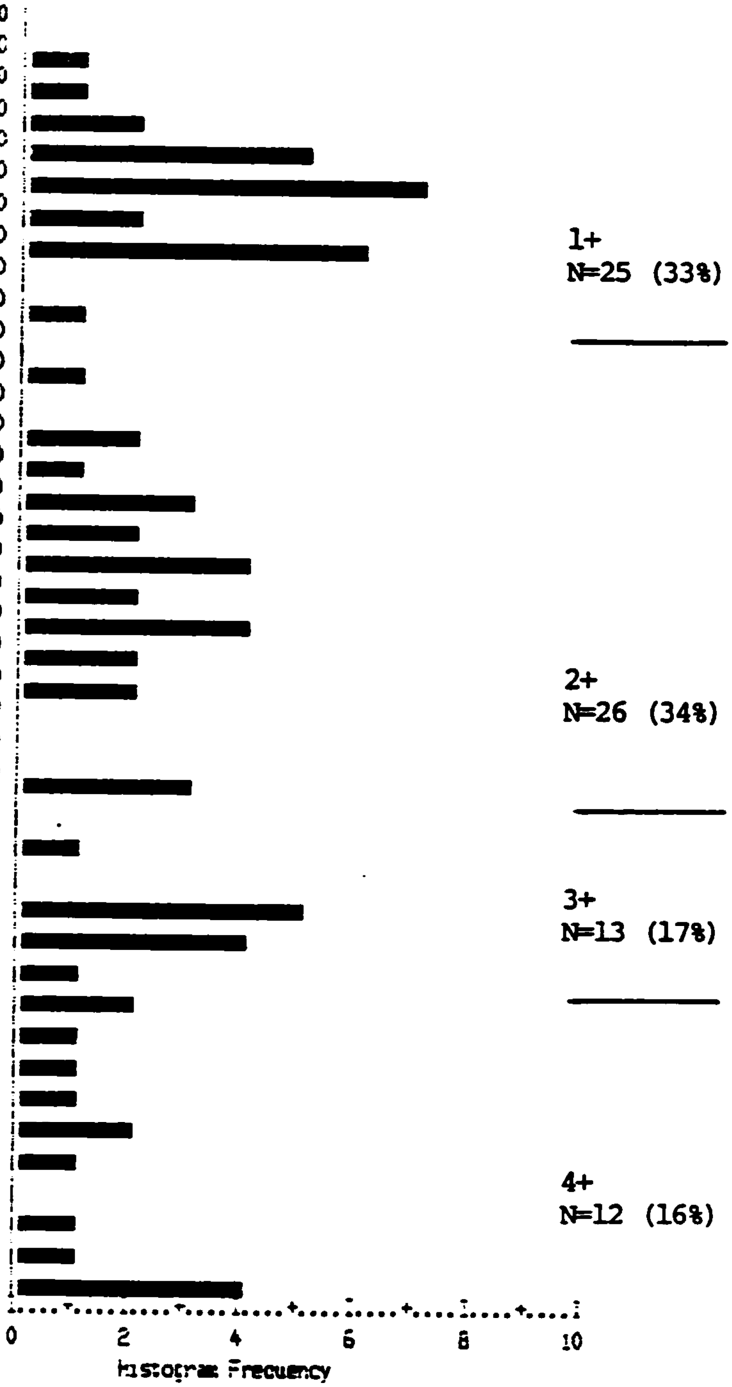
Mean	475.100	Std Err	10.686	Median	466.000
Mode	416.000	Std Dev	75.559	Variance	5709.235
Kurtosis	-.378	S E Kurt	.662	Skewness	.231
S E Skew	.337	Range	283.000	Minimum	337.000
Maximum	620.000	Sum	23755.000		

Valid Cases 50 Missing Cases 0

Rainbow trout from Mission Creek reaches 1&2

LENGTH

Count	Midpoint
0	65.00
1	75.00
1	85.00
2	95.00
5	105.00
7	115.00
2	125.00
6	135.00
0	145.00
1	155.00
0	165.00
1	175.00
0	185.00
2	195.00
1	205.00
3	215.00
2	225.00
4	235.00
2	245.00
4	255.00
2	265.00
2	275.00
0	285.00
0	295.00
3	305.00
0	315.00
1	325.00
0	335.00
5	345.00
4	355.00
1	365.00
2	375.00
1	385.00
1	395.00
1	405.00
2	415.00
1	425.00
0	435.00
1	445.00
1	455.00
4	465.00



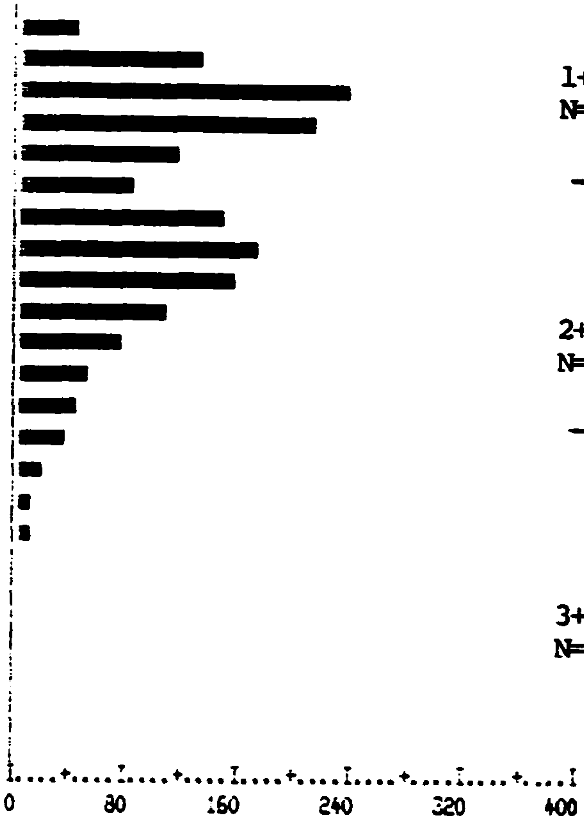
Mean	245.447	Std Err	13.524	Median	242.000
Mode	357.000	Std Dev	117.902	Variance	13900.891
Kurtosis	-1.153	S E Kurt	.545	Skewness	.257
S E Skew	.276	Range	391.000	Minimum	79.000
Maximum	470.000	Sum	18654.000		

Valid Cases 76 Missing Cases 0 K9

Brook trout from Mission Creek reaches 3-5

LENGTH

Count	Midpoint
35	55.00
123	75.00
224	85.00
208	95.00
114	105.00
81	115.00
146	125.00
167	135.00
152	145.00
105	155.00
72	165.00
51	175.00
41	185.00
28	195.00
16	205.00
10	215.00
7	225.00
2	235.00
3	245.00
2	255.00
2	265.00
2	275.00
0	285.00
1	294.00



1+
N=801 (50%)

2+
N=762 (47%)

3+
N=45 (3%)

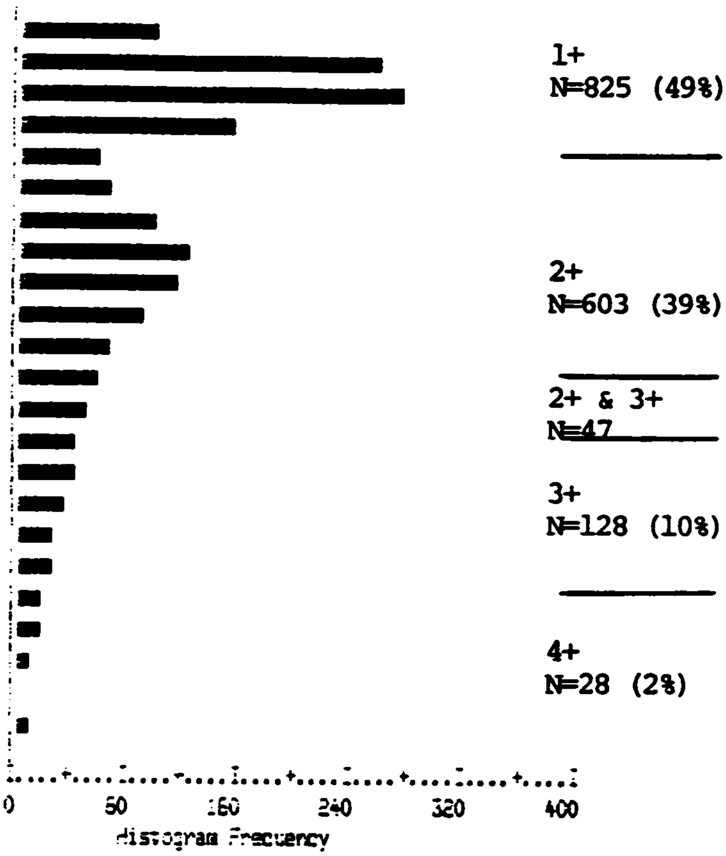
Mean	121.158	Std Err	.922	Median	120.000
Moce	30.000	Std Dev	37.022	Variance	1370.500
Kurtosis	.483	S E Kurt	.122	Skewness	.745
S E Skew	.061	Range	242.000	Minimum	52.000
Maximum	294.000	Sum	195185.000		

Valid Cases 1611 Missing Cases 0

Rainbow trout from Mission Creek reaches 3-5

LENGTH

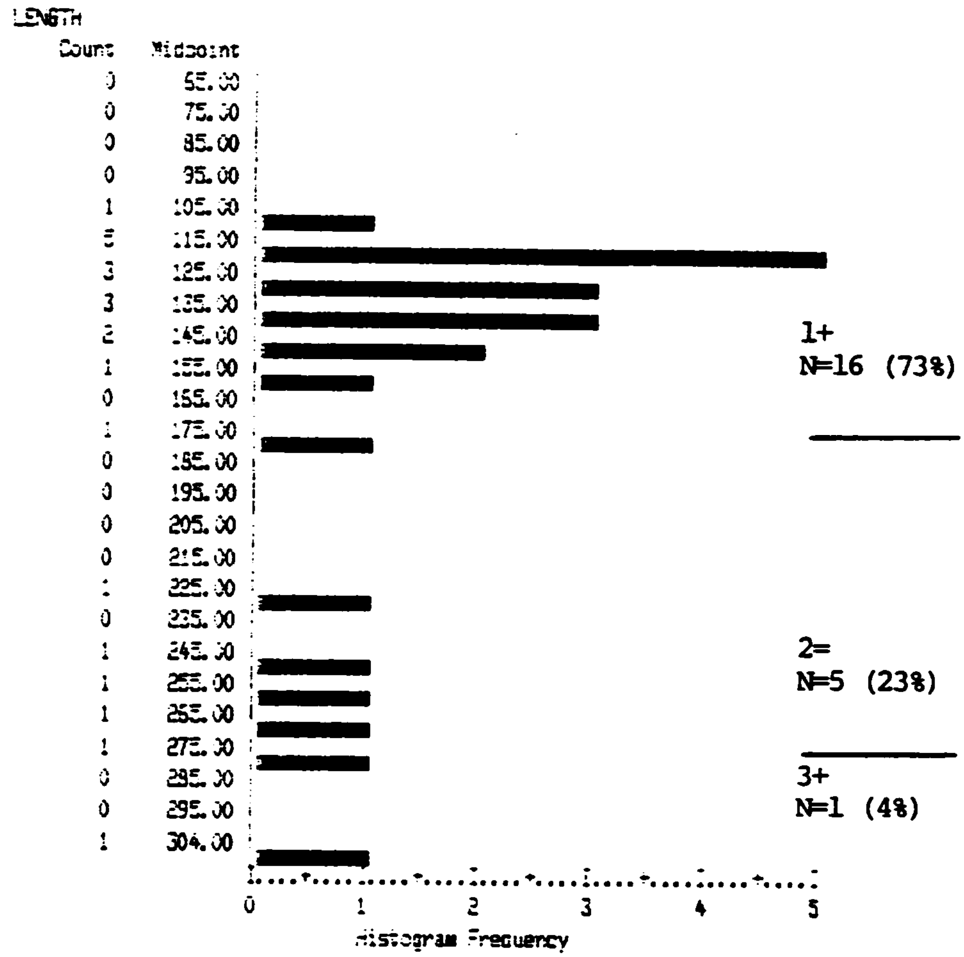
Count	Midpoint
96	65.00
256	75.00
269	85.00
149	95.00
50	105.00
57	115.00
95	125.00
122	135.00
113	145.00
88	155.00
65	165.00
52	175.00
51	185.00
43	195.00
39	205.00
33	215.00
25	225.00
20	235.00
14	245.00
13	255.00
7	265.00
3	275.00
4	285.00
1	295.00



Mean	122.481	Std Err	1.201	Median	111.000
Mode	75.000	Std Dev	49.368	Variance	2437.165
Kurtosis	.021	S E Kurt	.119	Skewness	.876
S E Skew	.060	Range	251.000	Minimum	49.000
Maximum	300.000	Sum	206993.000		

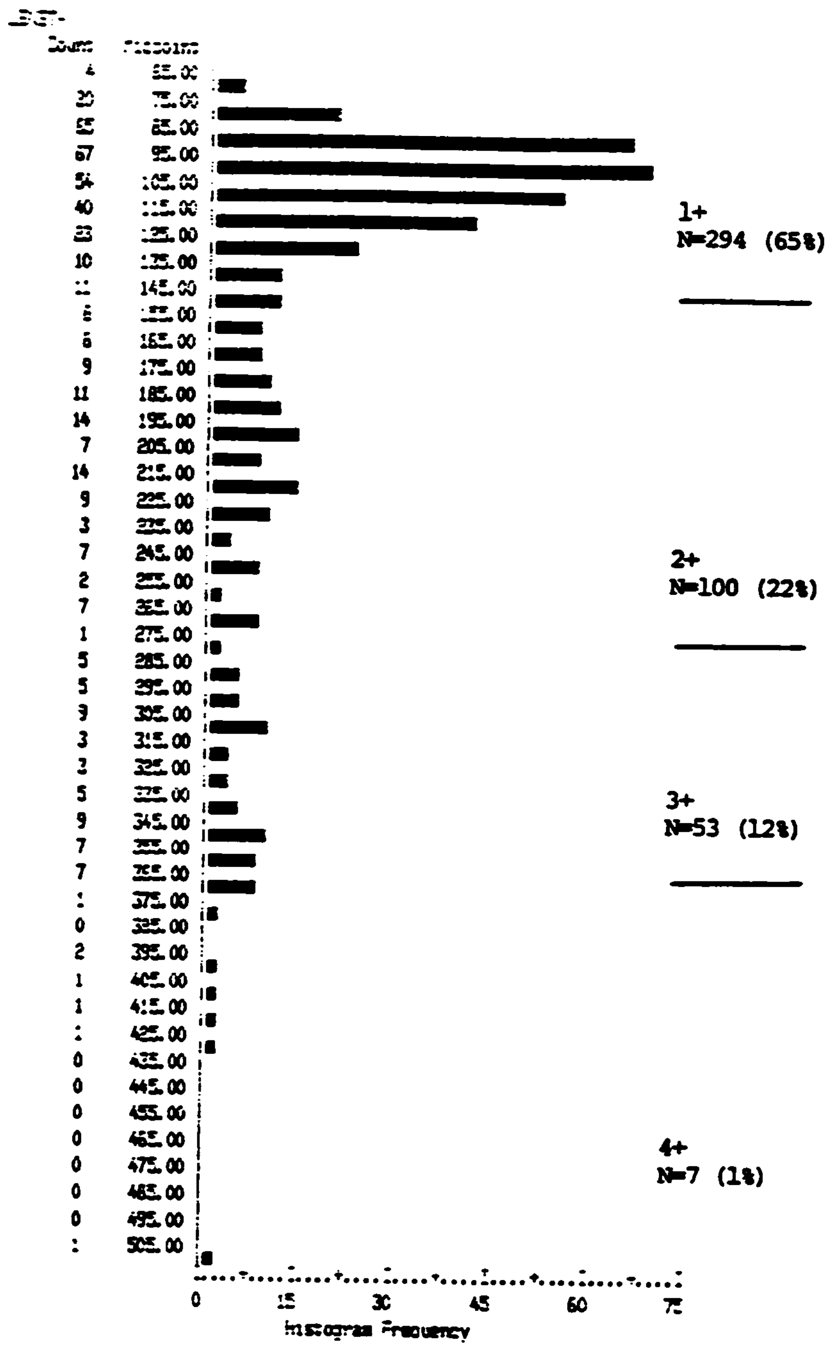
Valid Cases 1690 Missing Cases 0

Brown trout from Post Creek reaches 1&2



Mean	165.273	Std Err	13.620	Median	135.000
Mode	114.000	Std Dev	63.882	Variance	4080.874
Kurtosis	-.370	S E Kurt	.953	Skewness	1.083
S E Skew	.491	Range	199.000	Minimum	105.000
Maximum	304.000	Sum	3636.000		

Valid Cases 22 Missing Cases 0



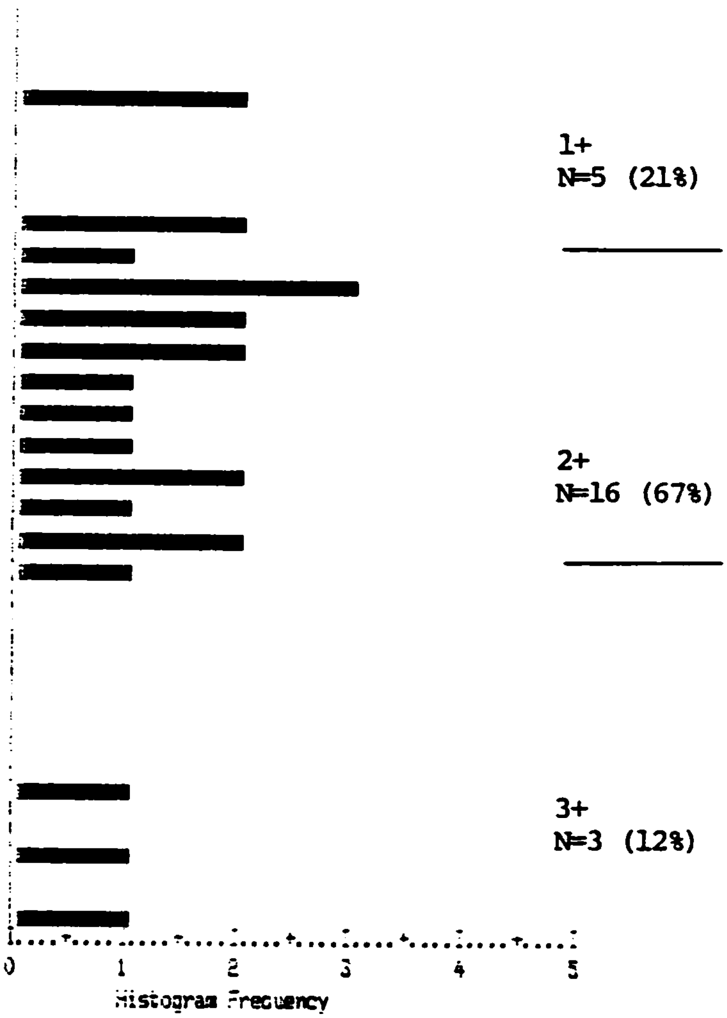
Mean	154.537	Std Err	4.066	Median	1[illegible].000
Mode	97.000	Std Dev	86.635	Variance	7505.666
Kurtosis	.871	S E Kurt	.229	Skewness	1.343
S E Skew	.115	Range	442.000	Minimum	63.000
Maximum	505.000	Sum	70[illegible].000		

Valid Cases 454 Missing Cases 0

Brook trout from Post Creek reaches 1&2

LENGTH

Count	Midpoint
0	65.00
0	75.00
2	85.00
0	95.00
0	105.00
0	115.00
2	125.00
1	135.00
3	145.00
2	155.00
2	165.00
1	175.00
1	185.00
1	195.00
2	205.00
1	215.00
2	225.00
1	235.00
0	245.00
0	255.00
0	265.00
0	275.00
0	285.00
0	295.00
1	305.00
0	315.00
1	325.00
0	335.00
1	345.00



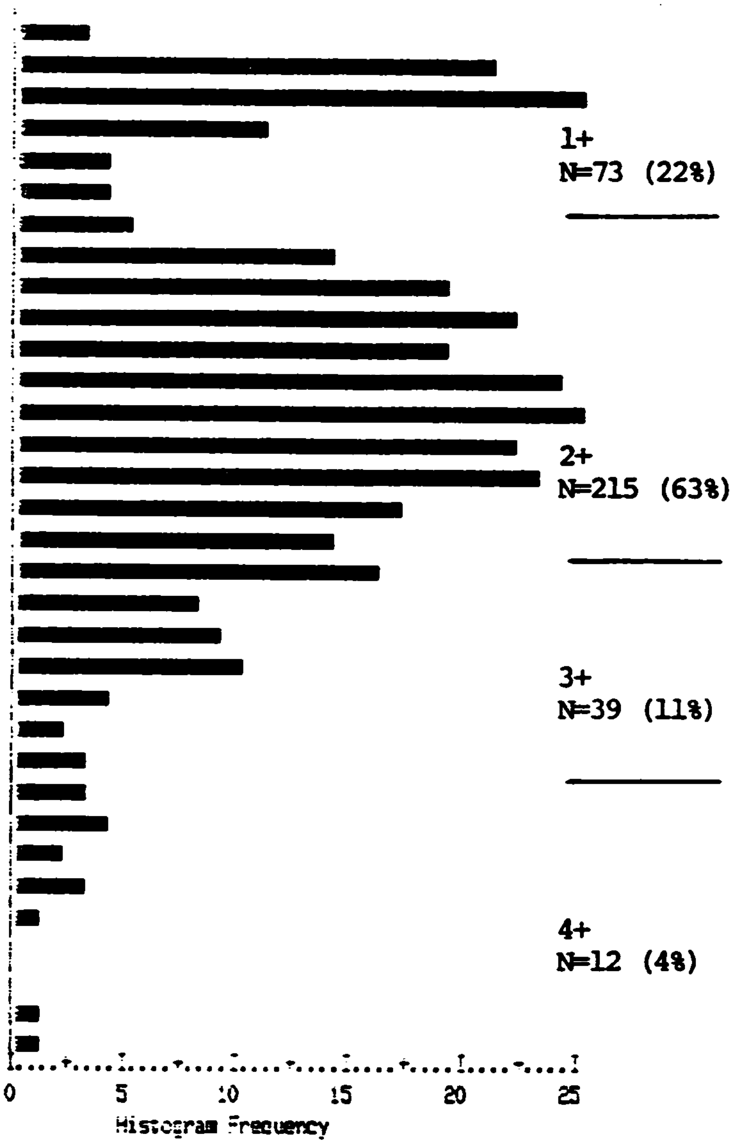
Mean	186.375	Std Err	13.805	Median	163.000
Mode	122.000	Std Dev	67.629	Variance	4573.723
Kurtosis	.677	S E Kurt	.918	Skewness	.912
S E Skew	.472	Range	265.000	Minimum	85.000
Maximum	350.000	Sum	4473.000		

Valid Cases 24 Missing Cases 0

Rainbow trout from Post Creek reaches 3&4

LENGTH

Count	Midpoint
3	65.00
21	75.00
25	85.00
11	95.00
4	105.00
4	115.00
5	125.00
14	135.00
13	145.00
22	155.00
19	165.00
24	175.00
25	185.00
22	195.00
23	205.00
17	215.00
14	225.00
15	235.00
8	245.00
9	255.00
10	265.00
4	275.00
2	285.00
3	295.00
3	305.00
4	315.00
2	325.00
3	335.00
1	345.00
0	355.00
0	365.00
1	375.00
1	381.00

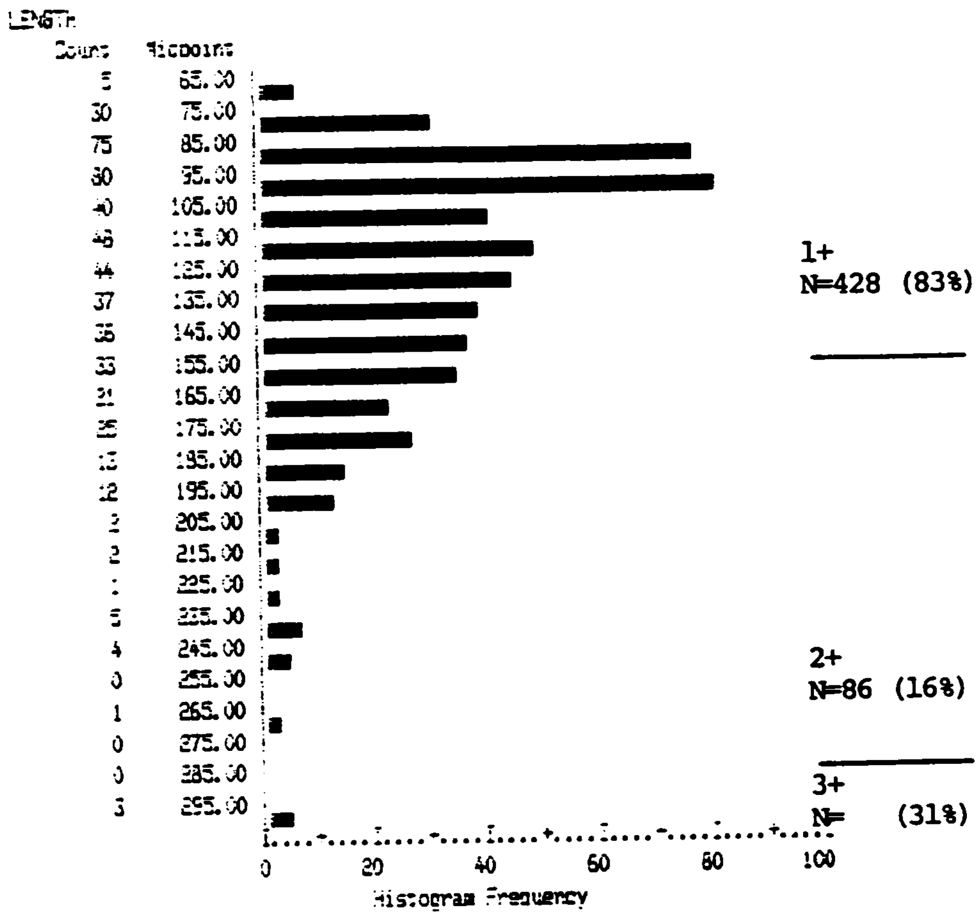


LENGTH

Mean	177.440	Std Err	3.506	Median	178.000
Mode	203.000	Std Dev	64.551	Variance	4166.866
Kurtosis	-.091	S E Kurt	.264	Skewness	.276
S E Skew	.132	Range	319.000	Minimum	62.000
Maximum	381.000	Sum	60152.000		

Valid Cases 339 Missing Cases 0

Brook trout from Post Creek reaches 3&4



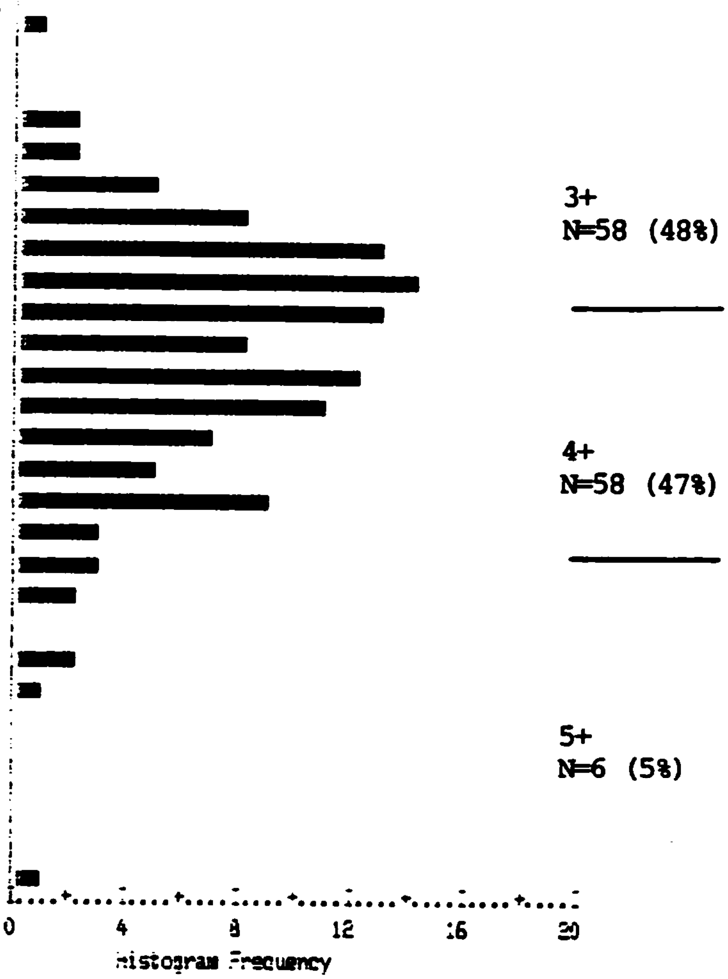
Mean	123.373	Std Err	1.744	Median	115.000
Mode	94.000	Std Dev	39.647	Variance	1571.909
Kurtosis	1.790	S E Kurt	.214	Skewness	1.162
S E Skew	.107	Range	238.000	Minimum	60.000
Maximum	298.000	Sum	63784.000		

Valid Cases 517 Missing Cases 0

Rainbow trout from Mission Weir

LENGTH

Count	Midpoint
1	300.00
0	310.00
0	320.00
2	330.00
2	340.00
5	350.00
8	360.00
13	370.00
14	380.00
13	390.00
8	400.00
12	410.00
11	420.00
7	430.00
5	440.00
9	450.00
3	460.00
3	470.00
2	480.00
0	490.00
2	500.00
1	510.00
0	520.00
0	530.00
0	540.00
0	550.00
0	560.00
1	570.00



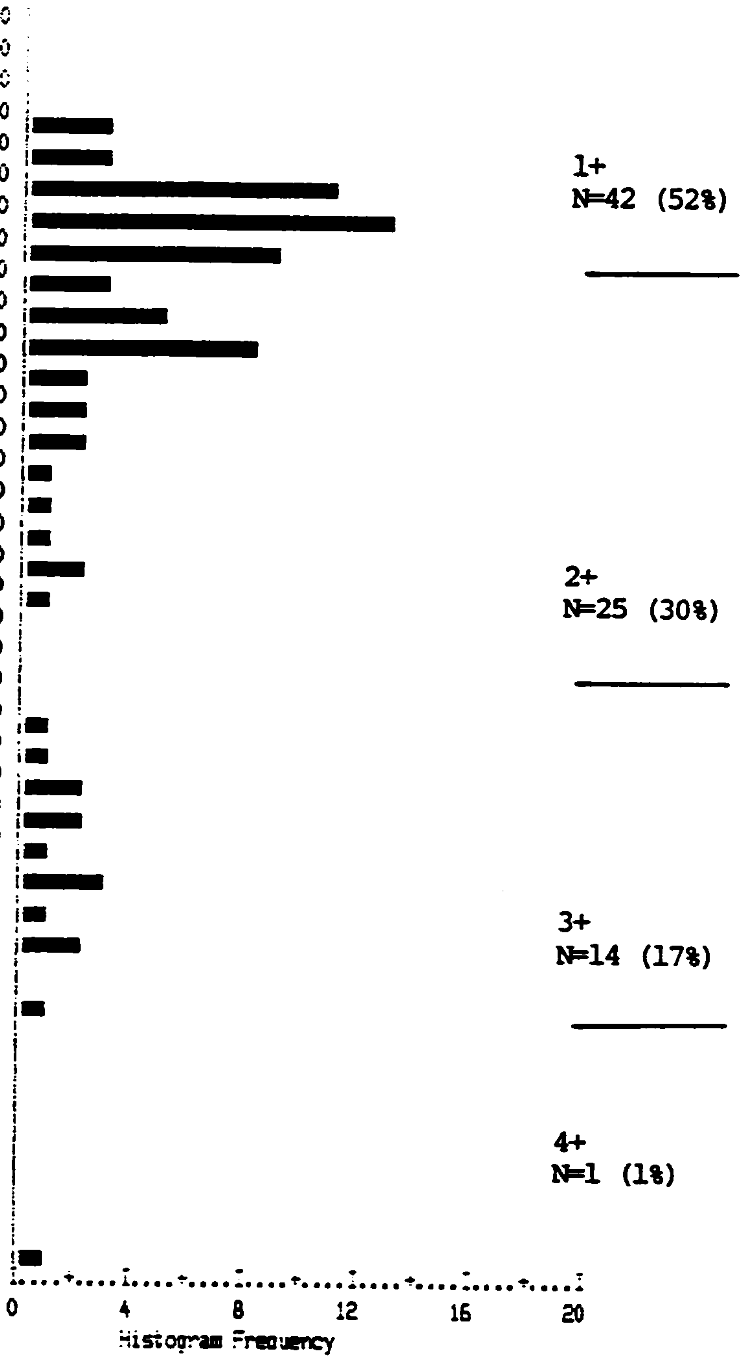
Mean	403.556	Std Err	3.821	Median	400.000
Mode	365.000	Std Dev	42.207	Variance	1781.451
Kurtosis	1.551	S E Kurt	.435	Skewness	.746
S E Skew	.219	Range	277.000	Minimum	297.000
Maximum	574.000	Sum	49246.000		

Valid Cases 122 Missing Cases 0

Rainbow trout from Crow Creek reach 1

LENGTH

Count	Midpoint
0	65.00
0	75.00
0	85.00
3	95.00
3	105.00
11	115.00
13	125.00
9	135.00
3	145.00
5	155.00
8	165.00
2	175.00
2	185.00
2	195.00
1	205.00
1	215.00
1	225.00
2	235.00
1	245.00
0	255.00
0	265.00
0	275.00
1	285.00
1	295.00
2	305.00
2	315.00
1	325.00
3	335.00
1	345.00
2	355.00
0	365.00
1	375.00
0	385.00
0	395.00
0	405.00
0	415.00
0	425.00
0	435.00
0	445.00
1	455.00



LENGTH

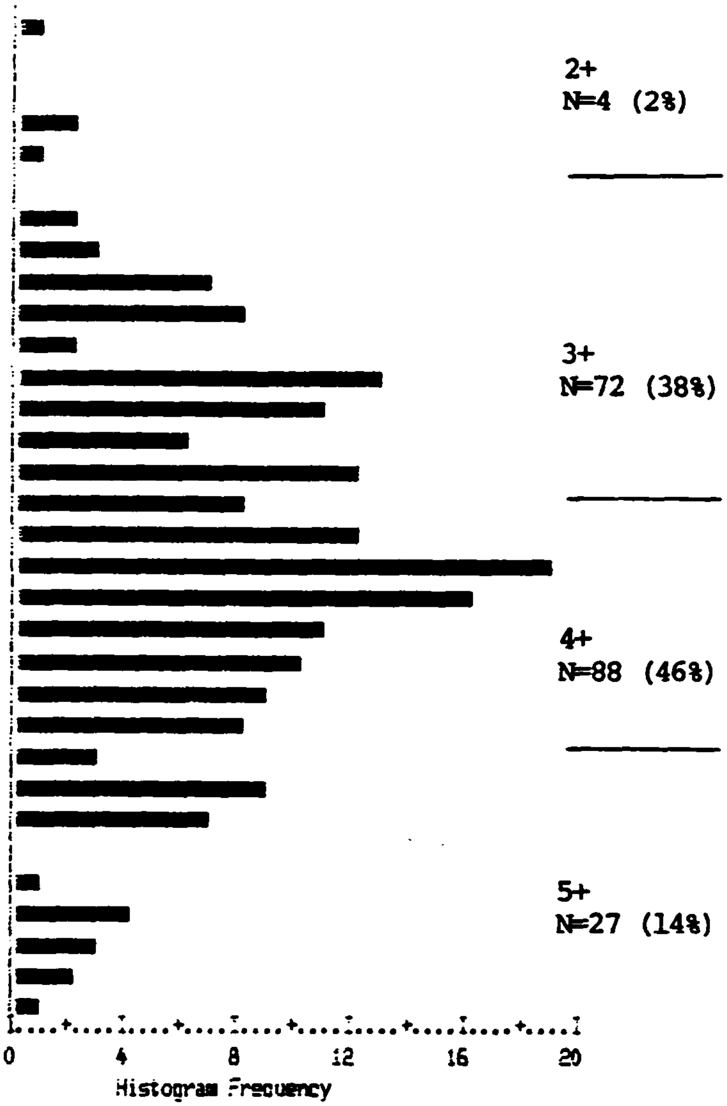
Mean	179.146	Std Err	9.107	Median	146.500
Mode	125.000	Std Dev	82.469	Variance	6801.213
Kurtosis	.999	S E Kurt	.526	Skewness	1.382
S E Skew	.266	Range	367.000	Minimum	91.000
Maximum	458.000	Sum	14690.000		

Valid Cases 82 Missing Cases 0

Rainbow trout spawners from Crow Creek

LENGTH

Count	Midpoint
1	205.00
0	215.00
0	225.00
2	235.00
1	245.00
0	255.00
2	265.00
3	275.00
7	285.00
8	295.00
2	305.00
13	315.00
11	325.00
6	335.00
12	345.00
8	355.00
12	365.00
19	375.00
16	385.00
11	395.00
10	405.00
9	415.00
8	425.00
3	435.00
9	445.00
7	455.00
0	465.00
1	475.00
4	485.00
3	495.00
2	505.00
1	512.00

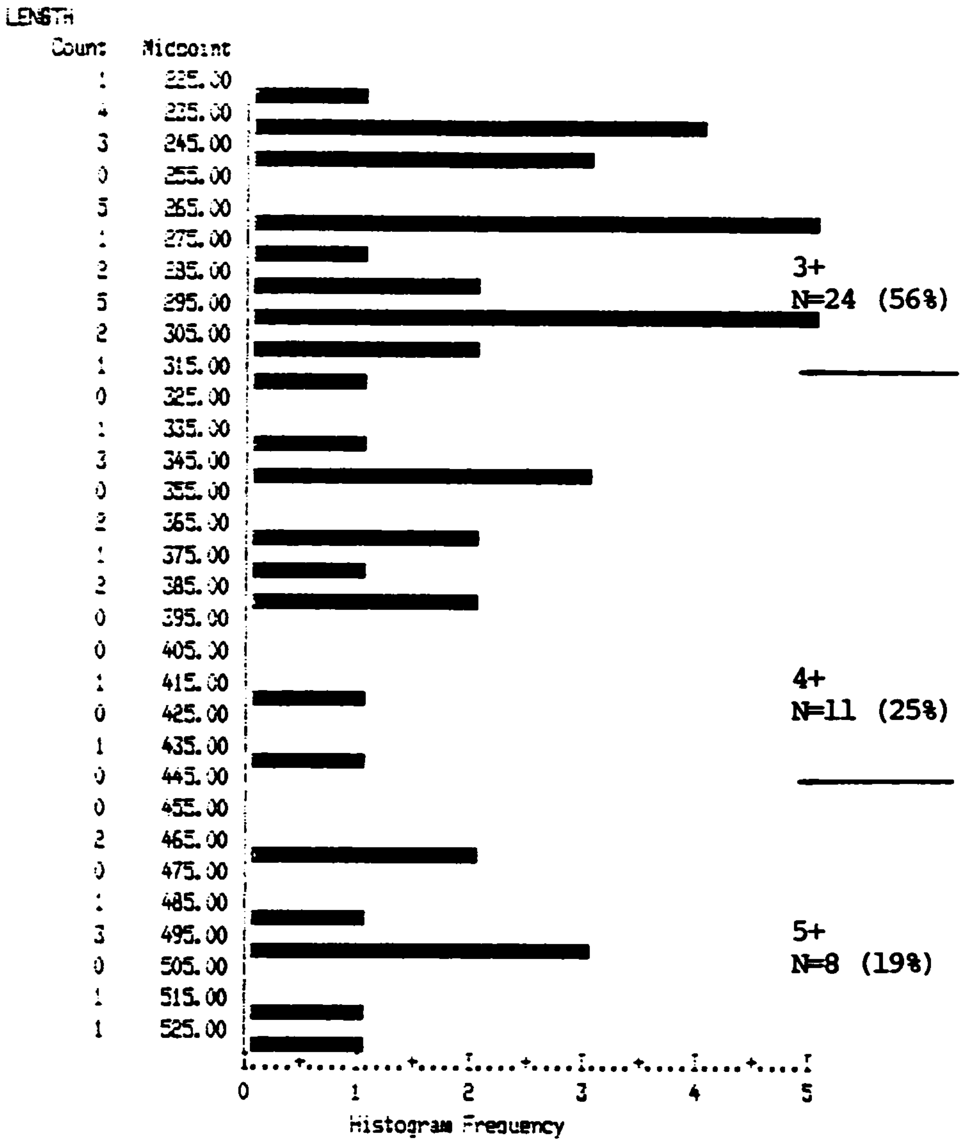


LENGTH

Mean	370.403	Std Err	4.253	Median	374.000
Mode	375.000	Std Dev	58.760	Variance	3455.147
Kurtosis	-.146	S E Kurt	.350	Skewness	.027
S E Skew	.176	Range	312.000	Minimum	200.000
Maximum	512.000	Sum	70747.000		

Valid Cases 191 Missing Cases 0

Brown trout spawners from Crow Creek



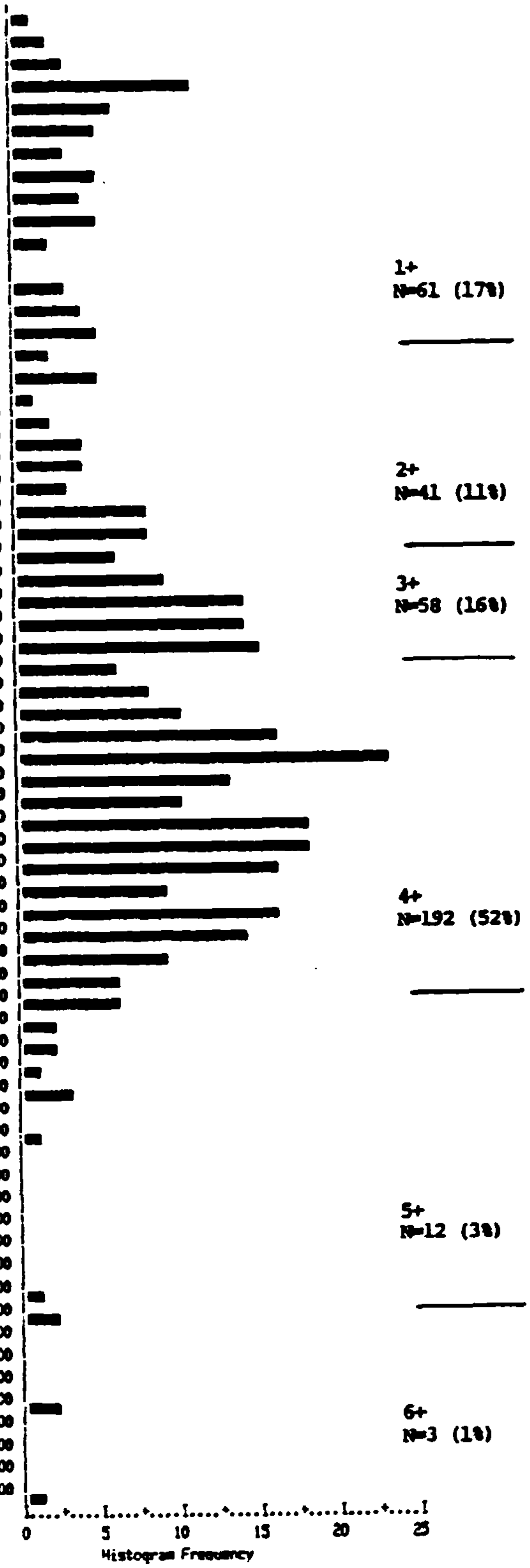
Mean	336.721	Std Err	13.949	Median	301.000
Mode	267.000	Std Dev	91.472	Variance	8367.111
Kurtosis	-.585	S E Kurt	.709	Skewness	.746
S E Skew	.361	Range	310.000	Minimum	220.000
Maximum	530.000	Sum	14479.000		

Valid Cases 43 Missing Cases 0

Northern pike from the Little Bitterroot River

LENGTH

Count	Midpoint
1	145.00
2	155.00
3	165.00
11	175.00
6	185.00
5	195.00
3	205.00
5	215.00
4	225.00
5	235.00
2	245.00
0	255.00
3	265.00
4	275.00
5	285.00
2	295.00
5	305.00
1	315.00
2	325.00
4	335.00
4	345.00
3	355.00
8	365.00
8	375.00
6	385.00
9	395.00
14	405.00
14	415.00
15	425.00
6	435.00
8	445.00
10	455.00
16	465.00
23	475.00
13	485.00
10	495.00
18	505.00
18	515.00
16	525.00
9	535.00
16	545.00
14	555.00
9	565.00
6	575.00
6	585.00
2	595.00
2	605.00
1	615.00
3	625.00
0	635.00
1	645.00
0	655.00
0	665.00
0	675.00
0	685.00
0	695.00
0	705.00
1	715.00
2	725.00
0	735.00
0	745.00
0	755.00
2	765.00
0	775.00
0	785.00
0	795.00
1	805.00



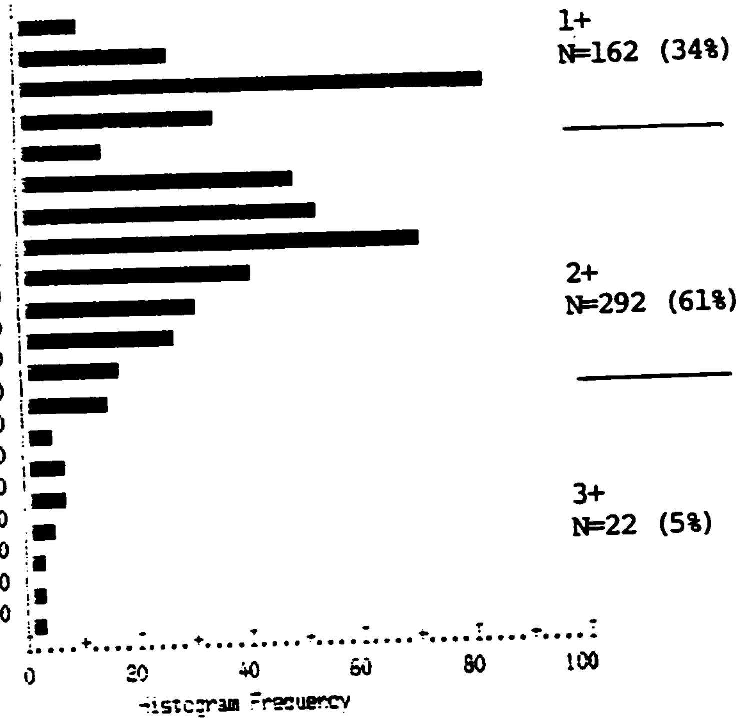
Mean	433.883	Std Err	6.464	Median	462.000
Mode	425.000	Std Dev	123.841	Variance	15336.535
Kurtosis	.075	S E Kurt	.254	Skewness	-.505
S E Skew	.127	Range	665.000	Minimum	140.000
Maximum	805.000	Sum	159235.000		

Valid Cases 367 Missing Cases 0

Brook trout from the Little Bitterroot River reach 5, fall

LENGTH

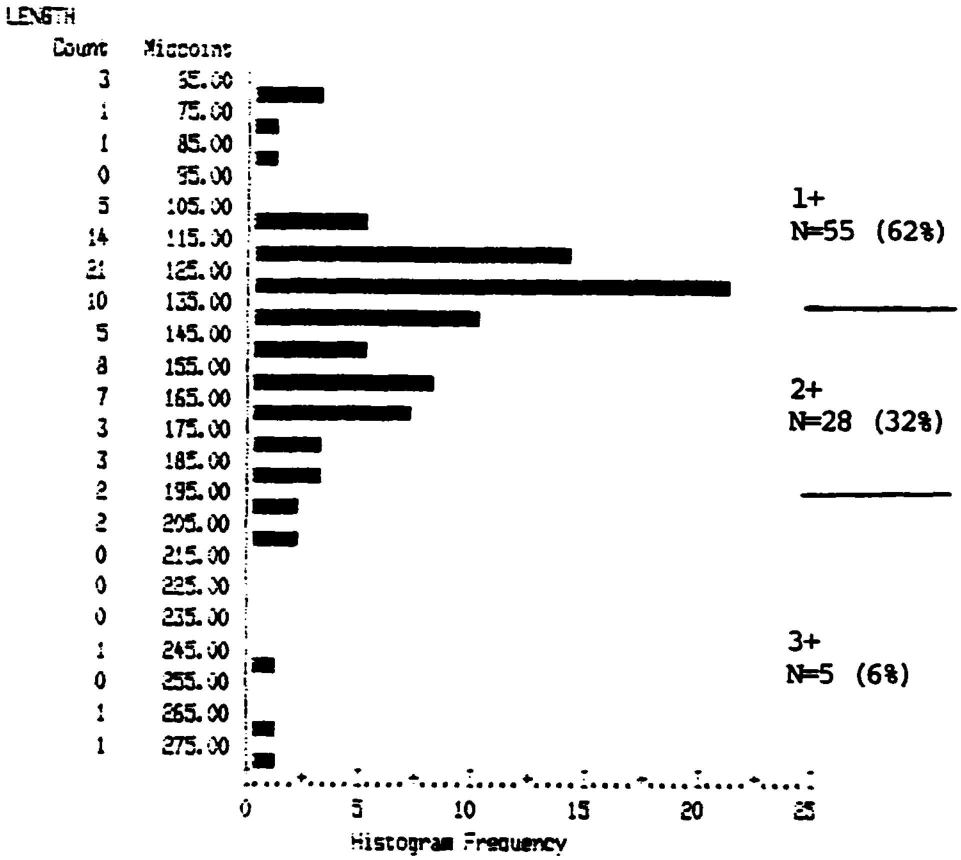
Count	Midpoint
9	65.00
25	75.00
81	85.00
33	95.00
14	105.00
48	115.00
52	125.00
69	135.00
39	145.00
30	155.00
25	165.00
16	175.00
13	185.00
4	195.00
6	205.00
5	215.00
3	225.00
1	235.00
2	245.00
1	255.00



Mean	124.779	Std Err	1.652	Median	125.000
Mode	85.000	Std Dev	36.050	Variance	1299.621
Kurtosis	.268	S E Kurt	.223	Skewness	.604
S E Skew	.112	Range	196.000	Minimum	54.000
Maximum	250.000	Sum	59395.000		

Valid Cases 476 Missing Cases 0

Cutthroat trout from the Little Bitterroot River, fall



Mean	138.398	Std Err	3.989	Median	128.500
Mode	114.000	Std Dev	37.419	Variance	1400.156
Kurtosis	2.614	S E Kurt	.508	Skewness	1.076
S E Skew	.257	Range	215.000	Minimum	60.000
Maximum	275.000	Sum	12179.000		

Valid Cases 88 Missing Cases 0

APPENDIX L

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

Record#	TAG_NO	TAG_DATE	SPECIES	TAG_LENGTH	TAG_STREAM	TAG_KM	CAP_DATE	CAP_LENGTH	CAP_STREAM	CAP_KM	TIME_INTER	DISTANC_KM	GROWTH_MM
1	2595	10/22/84	rb	376	C	5	04/17/85	382	C	2	177	3	6
2	4115	11/20/85	rb	396	C	5	03/20/86	392	M	6	120	37	0
3	1225	06/15/83	LL	403	F	10	08/27/83	999	J	14	73	45	999
4	1226	06/15/83	LL	567	F	10	08/20/84	575	J	2	432	33	8
5	1350	09/26/83	LL	336	F	105	08/08/84	381	J	14	317	78	45
6	1504	10/25/83	LL	470	F	45	10/24/84	523	J	2	365	6	53
7	1597	04/02/84	LL	430	F	105	08/08/84	999	J	14	128	78	999
8	1606	04/02/84	LL	474	F	105	09/09/85	559	J	20	525	84	85
9	1618	04/04/84	LL	271	F	71	09/05/85	412	J	19	519	49	141
10	1633	04/10/84	LL	497	F	74	08/20/84	508	J	2	132	35	11
11	1637	04/10/84	LL	444	F	74	08/26/84	449	J	2	138	35	5
12	1643	04/11/84	LL	289	F	71	10/11/85	353	J	2	549	32	64
13	1659	04/15/84	LL	621	F	45	08/13/84	620	J	2	120	6	0
14	1702	04/22/84	LL	553	F	45	08/02/85	565	J	2	467	6	12
15	1727	04/23/84	LL	383	F	42	04/29/84	386	J	2	6	3	3
16	1332	07/19/83	rb	360	F	13	03/22/84	372	M	6	247	38	12
17	3041	09/24/85	rb	390	F	74	03/06/86	385	M	6	163	35	0
18	2611	10/24/84	LL	440	J	2	11/18/84	447	J	23	25	21	7
19	2877	09/24/85	LL	416	J	2	10/26/85	999	J	13	31	11	999
20	2218	09/07/83	rb	282	J	1	03/30/84	999	M	24	205	29	999
21	2378	03/21/84	rb	405	J	2	05/27/84	381	J	38	67	36	0
22	2469	04/17/84	rb	435	J	2	05/19/85	432	CF	45	397	88	0
23	2590	10/04/84	rb	372	J	3	02/25/85	380	M	6	144	13	8
24	2009	03/27/83	NP	522	L	60	06/11/83	999	L	55	76	5	999
25	2054	04/21/83	NP	554	L	60	06/11/83	999	L	55	51	5	999
26	2050	04/21/83	NP	467	L	60	06/11/83	999	L	55	51	5	999
27	2047	04/21/83	NP	622	L	60	06/11/83	710	L	55	51	5	88
28	2068	04/25/83	NP	542	L	60	06/11/83	999	L	55	47	5	999
29	2203	06/27/83	NP	418	L	2	02/28/86	999	F	45	976	29	999
30	2202	06/28/83	NP	764	L	4	07/27/83	999	F	71	34	5	999
31	2483	04/27/84	NP	538	L	46	04/02/85	568	L	45	340	68	30
32	2483	04/27/84	NP	538	L	46	10/19/84	571	L	12	175	34	33
33	2814	05/15/85	NP	360	L	2	11/06/85	594	F	65	175	67	234
34	2360	03/16/84	rb	410	M	6	03/27/85	417	M	6	376	99	7
35	2362	03/18/84	rb	405	M	6	05/27/84	432	F	99	70	99	27
36	2390	03/27/84	rb	499	M	6	03/28/85	504	M	6	366	99	5
37	2420	04/04/84	rb	371	M	6	07/04/84	999	CF	45	91	92	999
38	2556	09/20/84	rb	449	M	6	03/21/85	452	M	6	182	99	3
39	2817	05/22/85	rb	392	M	6	06/16/85	392	M	9	25	3	0
40	4161	03/25/86	rb	367	M	6	05/23/86	356	M	7	59	1	0
41	2311	11/16/83	eb	245	P	7	03/21/84	245	P	14	126	7	0
42	2304	11/16/83	rb	379	P	7	03/13/84	356	P	8	118	1	0
43	8136	10/23/84	rb	225	P	17	05/18/85	229	PF	99	207	7	4

APPENDIX M

Regression of total length (mm)
vs weight (g) for all northern pike
captured from the Little Bitterroot River

Northern pike from the Little Bitterroot River