INSTREAM FLOWS NEEDED FOR SUCCESSFUL MIGRATION SPAWNING & REARING OF RAINBOW AND WESTSLOPE CUTTHROAT TROUT IN SELECTED TRIBUTARIES OF THE

KOOTENAI RIVER

Final Report 1986

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Final Report 1986

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ACKNOWLEDGEMENTS

EXECUTIVE SUMMARY

This study was conducted by Montana Department of Fish, Wildlife and Parks in contractual agreement with Bonneville Power Administration and addresses measure 804(a)(9) of the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program. Objectives were to determine instream flow needs in Kootenai River tributaries to maintain successful fish migration, spawning and rearing habitat of game fish, evaluate existing resident and rearing fish populations, and compile hydrologic and fishery information required to secure legal reservation of water for the fishery resource.

The Kootenai River fishery is threatened by microhydro and other water use development which reduce tributary habitat critical for maintaining a healthy spawning and rearing environment. The wetted perimeter method was used to estimate flows required to provide the maximum amount of spawning, rearing and food production area to maintain present fish populations in 20 tributaries to the Kootenai River and two to the Clark Fork River. Migrant passage flows were determined using the same method based on a discharge - average depth relationship at four (usually five or more) riffle transects. This information will provide the basis to reserve water through application to the Montana Department of Natural Resources and Conservation.

Electrofishing in stream reaches where instream flow measurements were made indicates the relative recruit production value of the various streams. Of all reservoir tributaries investigated, Bristow Creek contained the greatest number of trout (Salmo spp. $\geq$75mm) per km(1,179 $\pm$143). Quartz Creek, containing an estimated 853 $\pm$438 Salmo spp. ($\geq$75 mm) per km, ranked highest among the main stem Kootenai River tributaries. The location of some sampling sections within low stability channels near the tributary mouths may have resulted in underestimates of fish populations further upstream. Westslope cutthroat trout comprised a greater percentage of the Salmo population in reservoir tributaries than appeared in Kootenai River tributary samples.

Migrant Salmo spp. utilizing Bristow and Quartz creeks during spring were captured and released through a bi-directional fish trap. Schnabel's multiple census estimate was used to quantify the total migrant populations. An estimated 285 adult fish (range 224 to 336, P>0.95) migrated into Bristow Creek to spawn. Quartz Creek was used by an estimated 280 migrants (range 177 to 444). The timing of the run corresponded with increasing water temperatures in both creeks. The Quartz Creek run, predominantly rainbow trout, corresponded with peak flows, whereas Bristow Creek migrants, mainly westslope cutthroat trout, entered the creek during declining flows.

Fluvial bull trout enter spawning areas in Grave, Quartz, and Pipe creeks during fall. A total of 24 large adult bull trout were captured and released while migrating into Quartz Creek. Adults are highly visible while resting in pools and passing over riffles and are vulnerable to predation and poaching. Debris and log jams may pose critical passage problems during low autumn flows.

Kokanee salmon migrated during fall to spawn in the Tobacco River and its major tributaries, Fortine and Grave creeks, as well as the Fisher River and Libby Creek below Libby Dam No estimate of kokanee recruitment from these tributaries exists. Most kokanee reproduction occurs in Kootenai River tributaries in Canada.

Log and debris jams are obstacles to migrant fish in Barron, Bobtail, Bristow, Deep, Fivemile, Pinkham, Pipe and Quartz creeks. Periodic debris removal may be needed to maintain access to spawning gravels. Partial blockage is desirable to provide cover, and allow pool formation and gravel deposition. A total fish barrier composed of rock at the mouth of Barron Creek should be modified to allow migrant passage during spring.

Sediment pollution and channel instability caused by man's activities in the Kootenai watershed continue to threaten the health of the fishery resource.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

In recognition of the harmful effects of hydropower develop-
ment on fishery habitat, the Northwest Power Planning Council
(1982) under the direction of the Northwest Power Act of 1980,
developed a plan "... to protect, mitigate and enhance fish and
wildlife, including related spawning grounds and habitat, on the
Columbia River and its tributaries." The program was designed to
deal comprehensively with the Columbia drainage system; the
Kootenai River is the second largest tributary. This final report
is the culmination of research funded by the Bonneville Power
Administration and performed by the Montana Department of Fish,
Wildlife and Parks to address measure 804(a)(9) of the Northwest
Power Planning Council's Columbia River Basin Fish and Wildlife
Program.

The tributaries to the Kootenai River and Libby Reservoir
provide critical spawning and rearing habitat for fluvial and
adfluvial fish populations which produce one of western Montana's
most popular sport fisheries. The Kootenai watershed is a high
water-yield drainage and tributaries have been targeted for
microhydro and irrigation development, both of which could reduce
available habitat required to maintain the fishery resource.
Fisheries production in tributary streams is directly proportional
to the amount of insect production, bank cover, and fish spawning
and rearing habitat, which in turn are proportional to the amount
of wetted riffle areas. When discharge declines, stream flow
recedes from the banks and riffle areas, reducing available food,
and resting and rearing habitat. Thus, the wetted perimeter-
discharge relationship is an important parameter in the assessment
of fisheries needs (Leathe and Nelson 1986). It is important that
instream flow requirements of game fish species be determined so
that fisheries needs can be balanced with those required for power
and irrigation facilities.

When completion of Libby Dam on the Kootenai River formed
Libby Reservoir (Lake Koocanusa), the initial fish management plan
was to establish spawning runs of adflwial westslope cutthroat
and other game fish in suitable tributary streams (May et al.
1983). Similarly, the fishery below the dam was to be managed for
increased fish size and to maintain critical spawning and rearing
habitat in tributary streams (May and Huston 1983). Popular game
fish include westslope cutthroat trout, <u>Salmo clarki lewisi</u>;
rainbow trout, <u>Salmo gairdneri</u>; 'bull trout, <u>Salvelinus confluentis</u>
(inland Dolly Varden); kokanee salmon, <u>Oncorhynchus nerka</u>; north-
ern mountain whitefish, <u>Prosopium williamsoni</u>; and the burbot,
<u>Lota lota</u>   The westslope cutthroat trout and bull trout are
considered species of special concern in Montana because of their
limited distribution in the state and reduced presence within
their original native range.

Section 210 of the Public Utility Regulatory Policies Act, passed by congress in 1978, created a strong incentive for developing small hydropower facilities (less than 5 megawatts) in the Pacific Northwest by assuring a high market price for energy from qualifying facilities. In response, applications to the Federal Energy Regulatory Commission (FERC) for small hydro facilities increased in the northwest. In July 1986, the Montana Public Service Commission lowered the rate power companies were required to pay for energy from small hydroelectric facilities, making development less attractive. For this reason, many of the original FERC applications for microhydro development in the Kootenai River tributaries were withdrawn or allowed to expire. However, in 1986, four small hydroelectric projects were pending in the Kootenai Drainage of Montana and another small scale generator was recently installed. Further microhydro development is anticipated when the region's energy surplus declines and cost-benefit ratios improve, thereby making construction of new projects once again economically attractive. Development of housing subdivisions, irrigated farmland and mining have also increased competition for water-use on important spawning and rearing tributaries (May and Huston 1983).

This project began in August, 1986, with the following objectives:

1) Determine instream flows required to ensure successful migration, spawning and rearing of salmonids in selected tributaries to the Kootenai River (Callahan, Granite, Libby, Quartz and Wolf creeks, and the Fisher River) and tributaries to Libby Reservoir (Barron, Big, Bristow, Deep, Fivemile and Grave creeks, and the Tobacco River).

2) Evaluate existing resident and rearing fish populations in the tributary reaches where the instream flow measurements were made, and assess potential barriers to migrant spawners.

3) Compile available hydrologic and fishery information required to secure legal reservation of instream flows on Kootenai River tributaries identified as containing important or sensitive fishery habitat.

STUDY AREA

The Kootenai River, the second largest tributary to the Columbia -River, originates in Kootenai National Park near Banff, British Columbia. The river enters Montana near Rexford, Montana, flows southward through the Purcell and Salish mountains and enters the reservoir created by Libby Dam. Below the dam at Libby, Montana, the river turns northwest along the Cabinet Mountain range and crosses the Idaho border near Troy, Montana. The Kootenai is approximately 780 km long and flows into the Columbia River at Castlegar, B.C.

The drainage basin is characterized by north to northwest trending mountain ranges composed of faulted and folded crustal blocks of metamorphosed sedimentary rocks of the Precambrian Belt Series and minor basaltic intrusions. The area is typified by rugged, steep mountain slopes and narrow valleys. As much as 90 percent of the Kootenai basin is coniferous forest; a small amount (about 2%) is agricultural land used mainly for pasture and forage production (Bonde and Bush 1982).

Of the approximately 49,987 km^2 in the Kootenai drainage, runoff from 5,761.7 km^2 enters the Kootenai from the thirteen tributaries under investigation (Figure 1). Seven Kootenai tributaries (3,289.8 km) and two tributaries to the Clark Fork drainage (155.1 km^2) investigated by May (1982) were reanalyzed, Further tributary descriptions are included in their respective sections of this report.

The tributaries are characteristically high gradient mountain streams with bed material consisting of various mixtures of sand, gravel, rubble, boulders and differing amounts of clay and silt, predominantly of glacio-lacustrine origin Fine materials, due to their instability during periods of high stream discharge, are continually abraded and redeposited as gravel bars, forming braided channels with alternating riffles and pools.

Siltation and dewatering are major threats to the aquatic habitat in the tributaries. Siltation has been increased by timber harvest, mining, poor agricultural practices, and road con- struction A high percentage of fine material in the streambed, unless removed from the gravels by dominant discharge flows, can be deleterious to the spawning habitat, and egg and fry survival (Peters 1962).

Stream flow in unregulated tributaries generally peaks in May and June after the onset of snow melt, then declines to low flows from November through March Natural low flows during autumn and winter months combined with surface, anchor and frazil ice, as well as channel scouring during ice-out in spring can be especial- ly damaging to fish and fish habitat. For this reason, water withdrawals during this time nay have a greater impact on the already stressed fish populations. Decreasing flous during summer
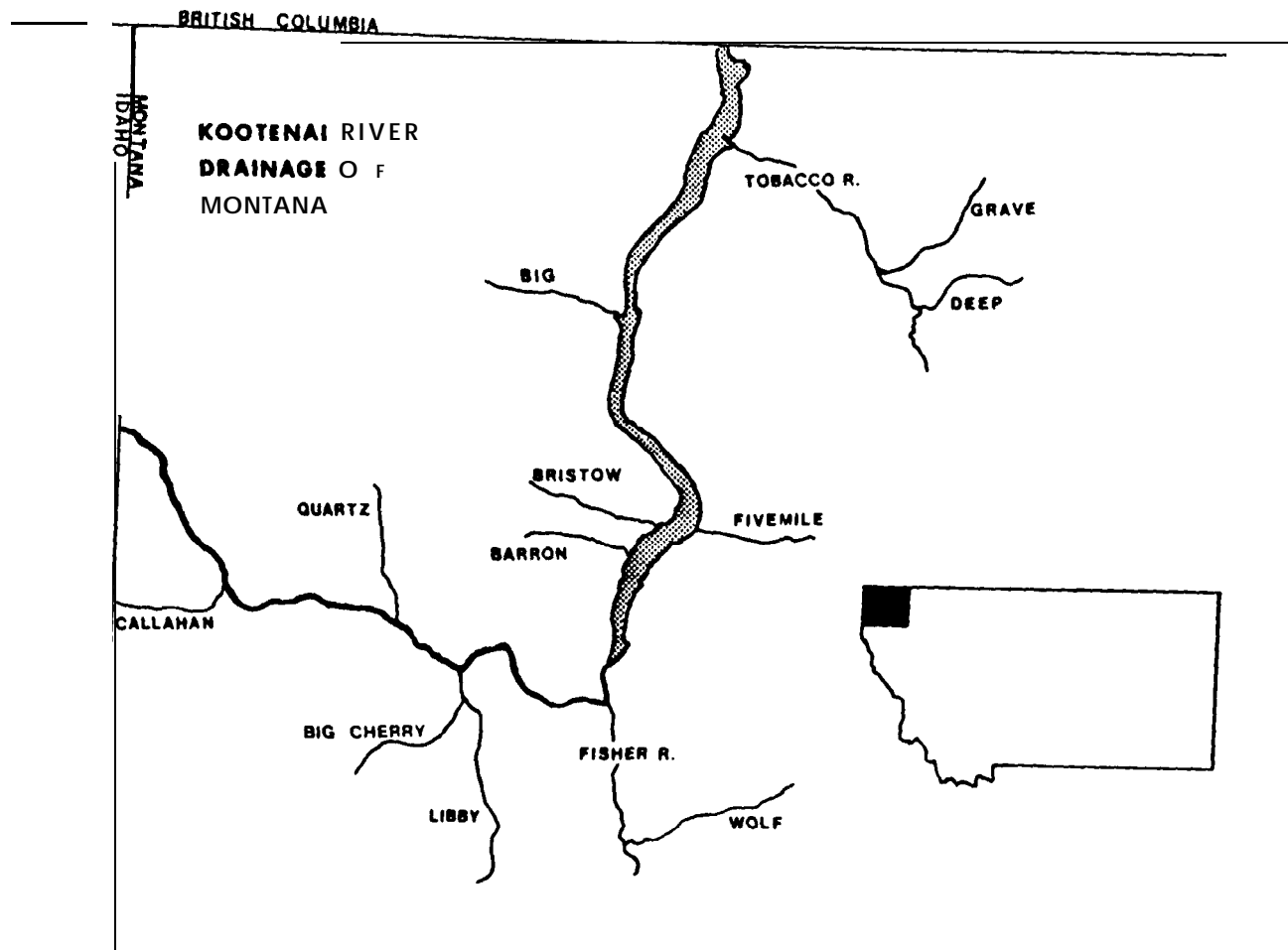
Fiqurc **1.** Relative location of study tributaries to Libby Reservoir and the Kootcnai River.

increase water temperature and reduce the amount of cover avail-
able to rearing young. Extremely low flows may strand adults and
young recruits in rapidly warming pools. Therefore, if trout
populations are to be maintained at present levels, it is neces-
saryto discontinue water removal when flows fall below the recom-
mended flow.

METHODS

Instream Flow Recommendations

The wetted perimeter method described by Nelson (1980) was used to determine instream flows needed to maintain existing fish populations and provide adequate passage for spawning migrants. A minimum of four (usually five or more) permanent transects were established across representative riffles in each tributary. Discharge in cubic feet per second (cfs) was measured at low, medium and high stream discharge using a Teledyne Gurley Type AA or Pigmy water velocity meter, depending on water depth (Type AA for water >l ft and Pigmy for water <l ft deep). Water velocities were measured at approximately 20 or more stations positioned along each transect. Measurements were made at a standard depth (0.6 total depth) at each station. At stations deeper than 2.5 ft, calculations were based on the average of velocities measured at 0.2 and 0.8 of measured depth. The product of area and water velocity produced stream discharge within each width-depth "cell" along the transect. The sum of discharge in all cells equals total stream discharge.

Water stage and transect profile elevations were determined relative to an established bench mark with a level and stadia rod (Nelson 1984).

Three or more stage-discharge coordinates were linearly regressed on a logarithmic scale to develop a stage-discharge relationship for each riffle transect. Channel profile measurements combined with predicted water stage heights at selected stream discharges yielded accurate estimates of wetted perimeter, that portion of streambed in contact with water (Figure 2). Inflection points, identified from a plot of the curvilinear relationship between discharge and wetted perimeter, and criteria developed by Nelson (1980) were used for recommending stream flows required for maintenance of the fishery. Water depths, over critical riffle features, predicted by the wetted perimeter program (WETP) were used in conjunction with fish passage criteria (Table 1) to derive minimum passage flows for migrants.

The IFG1 method was not used for comparison with the wetted perimeter method because it involves the use of the Manning equation and a roughness coefficient which are difficult to apply to high-gradient turbulent streams.

Hydrologic Characteristics

For ungauged streams, mean annual discharge was estimated from a multiple regression equation derived by Parrett and Hull (1985). The following log-linear form, based on 47 stream-flow measuring

WETTED PERIMETER
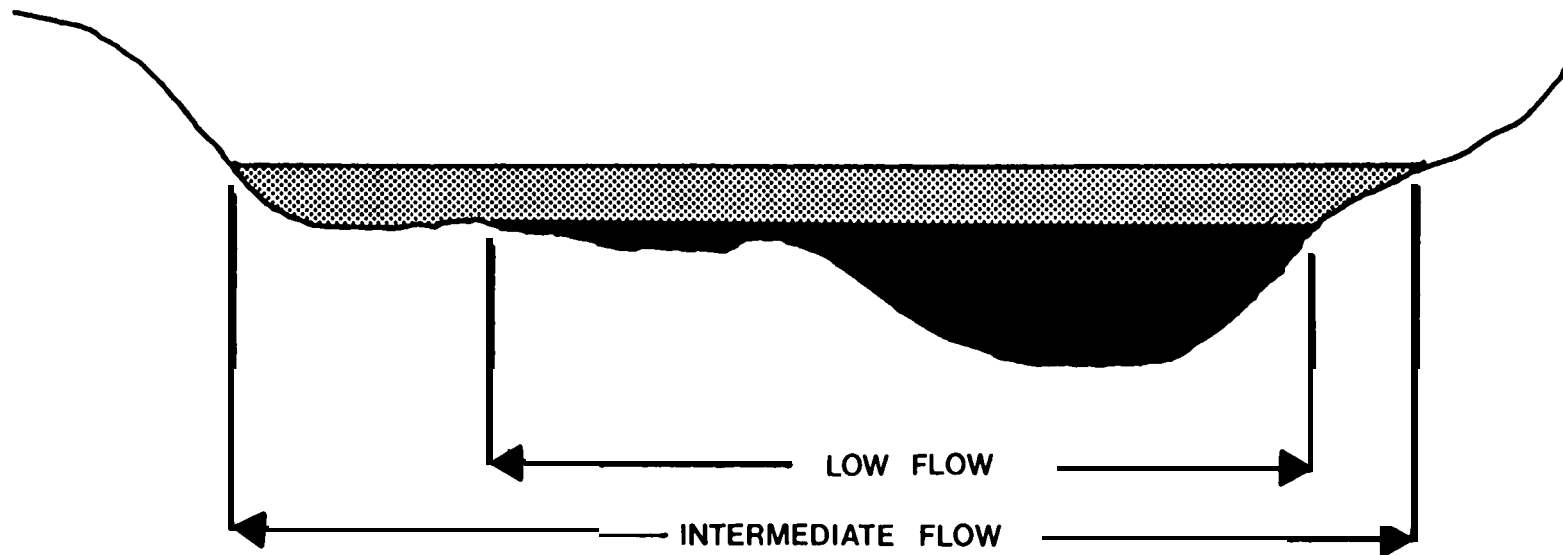
Figure 2. A diagram of wetted perimeter. The distance along the contour of the streambed in direct contact with the water declines rapidly as stream discharge is depleted.

Table 1. Trout passage criteria from Wesche and Rechard (1980).

Species	Source	Minimum depth (ft)	Average depth (ft)	where developed
Large trout >20 in.	Thompson 1972	0.6		Oregon
Other trout <20 in.	Thompson 1972	0.4		Oregon
Trout streams >20 ft. wide	Colorado Div. of Wildlife 1976	---	*0.5-0.6	Colorado
Trout streams 10-20 ft. wide	Colorado Div. of Wildlife 1976	--	*0.2-0.4	Colorado

* Across riffles

sites and gauging stations in northwest Montana, has an r^2=0.944 and a standard error of 33 percent (pL0.95):

$$Q_A = 0.0165 \ A^{0.974} \ P^{1.159}$$

Where: Q_A = mean annual discharge (cfs)
A = drainage area (mi^2)
and P = mean annual precipitation
(from U.S. Soil Conservation Service 1977)

Tributary drainage areas (A) were determined using standard USGS topographic maps (1 in = 1 mi scale) and an electronic planimeter. Drainage area was measure repeatedly until the results compared within 0.01 percent (mi^2) and the mean of successive trials was converted to km^2. The precipitation portion of the equation (P) was based on average annual precipitation from 1941 through 1970 in each watershed (U.S. Soil Conservation Service 1977). Mean annual discharge and eightieth percentile exceedence flow hydrographs were developed for all gauged streams based on a minimum of 10 years of daily readings compiled by the USGS Water Resources Division, Helena, Montana. Annual hydrographs for ungauged streams were estimated by comparing available discharge measurements to concurrent measurements at gauged streams exhibiting the same general hydrologic setting as the site in question (Parrett and Hull 1985). Flow recommendations, based on the results of the wetted perimeter analyses, were compared with base flows derived from existing data to determine applicable minimum flow limits throughout the year.

Water Stage Gauging

Standard staff gauges were installed in protected areas on Bristow, Deep and Quartz creeks in April 1986. Discharge measurements made at various low, medium and high flows were correlated with water heights read from the staff gauges to develop a log-linear stage-discharge relationship. Stage readings were later transformed to discharge (cfs) based on an algorithm unique to each gauge and associated stream profile.

Population Estimates

Fish population estimates were intentionally performed during late summer and fall to avoid the capture of _Salmo_ spp. during their spawning run and to target resident and pre-emigrant fish. The timing of the estimate reduces the chance of violating the assumption of a closed population and produces results more comparable from year to year. Electrofishing population estimates were reported in number of fish per km based on surveyed sections in all tributary creeks. A 2,000-ft section was surveyed on the Tobacco River and a 15,820-ft section was electrofished on the Fisher River.

The electrofishing method used depended on the discharge of the stream. Estimates on small tributaries ($\leq$ 20 cfs) were made using a two-sample method explained by Seber (1973). Each sample consisted of an intensive electrofishing effort within a 100-m to 300-m section of stream, isolated from the remaining reach by block nets or natural stream features. A three-person crew (2 netters, 1 shocker) using a Coffelt BP-1C gas-powered backpack electrofishing unit, attempted to capture every fish within the measured stream section on each pass. Captured fish were measured and weighed, then retained in a mesh box for the duration of the experiment. A three-sample estimate of population size and variance was calculated using equations 7.23, 7.24, and 7.30 in Seber (1973) when the following criteria were not met in two passes:

$\hat{p} \geq 0.50$ and $\hat{N} \geq 50$, or

$\hat{p} \geq 0.60$ and $\hat{N} \leq 50$

where: $\hat{p}$ = probability of capture

and $\hat{N}$ = the fish population estimate

The probability of capture ($\hat{p}$) was calculated as:

$$\hat{p} = \frac{n_1 - n_2}{n_1}$$

The population size ($\hat{N}$) and variance ($\hat{V}[\hat{N}]$) for two-sample estimates were calculated as follows:

$$\hat{N} = \frac{n_1^2}{n_1 - n_2}$$

$$\hat{V}[\hat{N}] = \frac{n_1^2 \, n_2^2 \, (n_1 + n_2)}{(n_1 - n_2)^4}$$

Where: n_1 = the number of fish ≥ 75 mm, TL in the first Sample,

and n_2 = the number of fish, 75 mm, TL in the second sample.

Fish populations in tributaries with discharges in excess of 20 cfs were estimated with the mark-recapture method presented by Seber (1973). On smaller tributaries, a mark-recapture effort was made using the Coffelt backpack electrofishing unit described earlier. For larger tributaries (≥ 35 cfs), we used a bank shocking unit or a drift shocking boat containing a Coffelt variable voltage pulsator - 3E electroshocker energized by a Homelite gas-powered generator. The resident population was sampled within a

representative section of stream 300-600 meters in length depending on tributary size. Block nets or natural barriers were used to isolate the measured section. Individual fish were marked with a pelvic, anal or caudal fin punch and released throughout the electrofishing section and allowed to redistribute for a minimum of 72 hours prior to the recapture run.

Population size $(\hat{N})$ and variance $(\hat{V}[\hat{N}])$ for mark-recapture estimates were calculated according to (1973).

$$i = \frac{(M+1)(C+1)}{(R+1)} - 1$$

$$\hat{V}[\hat{N}] = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

Where: M = number of marked fish
C = number of fish in the recapture sample
and R = number of marked fish recaptured.

Fish were analyzed by subgroups based on 5-mm length-frequency histograms and capture efficiency curves. A minimum total fish length of ≥ 75 mm was used for estimates in which all length groups were pooled. Smaller fish were included in estimates where capture efficiency indicated acceptable accuracy in lower length categories. Subgroup estimates were summed to obtain a total population estimate,

Migrant Trapping

Two bidirectional fish traps were installed approximately 1 km upstream from the mouth of Bristow and Quartz creeks to capture migrants traveling both up and downstream. Individual traps were 122 'by 122 by 70 cm welded metal frames surrounded on all sides and bottom with 12 mm hardware cloth mesh. An X-shaped arrangement of poultry-mesh leads with 2.54 cm openings, supported by metal fence posts driven into the streambed, guided fish toward the throat of the traps. Escape was made difficult by a V-shaped baffle extending inward at the front of the trap to a 5.8 cm-wide, vertical slot in the interior. A trap door in the wooden top and minimal internal reenforcement provided easy access to the catch with a dip net. A water scope was used to assure that all fish were removed from the traps. The trap leads were designed to release if water and debris strained the trap structure (Figure 3). Leads were brushed free of debris up to twice dail and

11
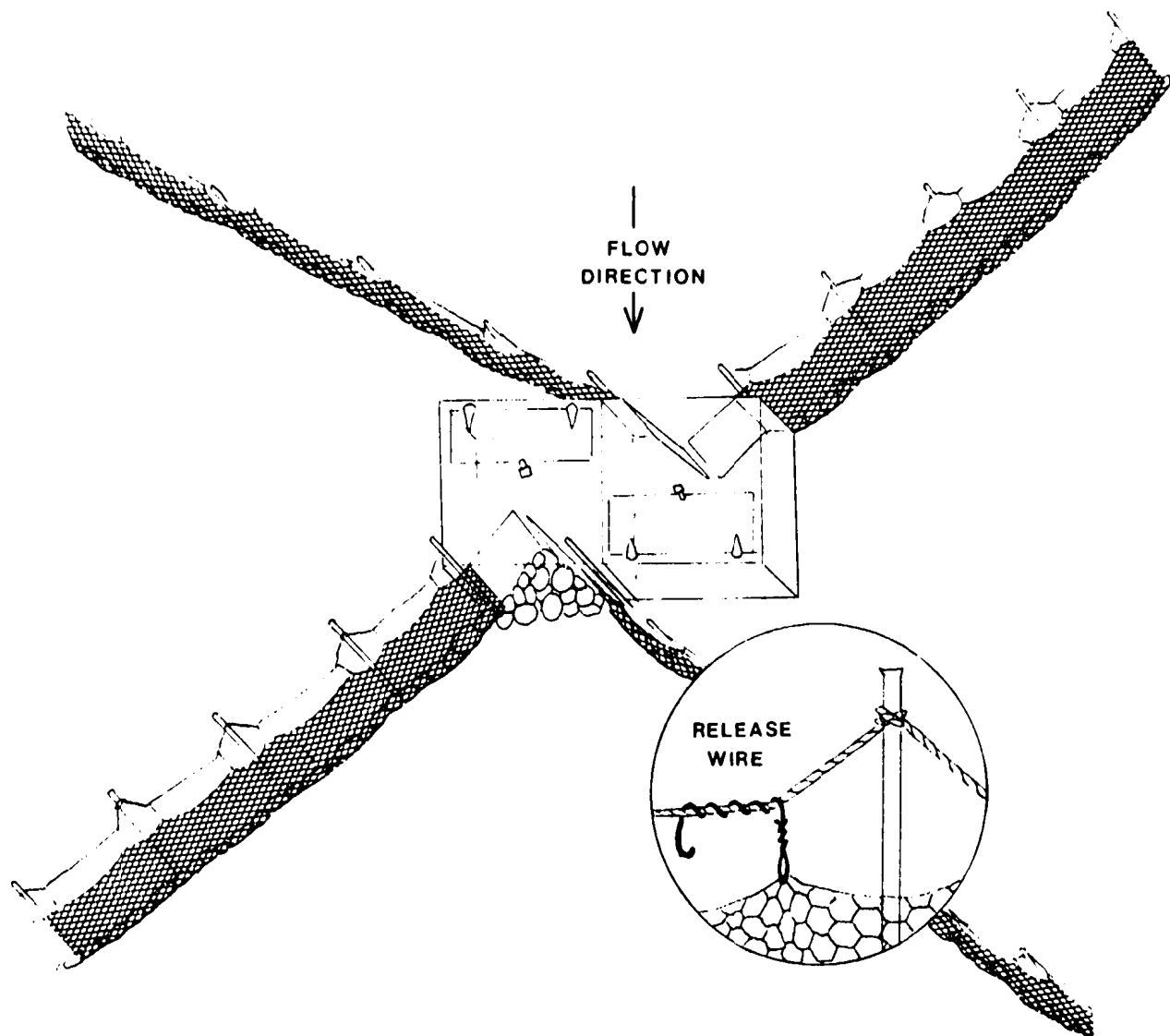
Figure 3. A diagram of the bi-directional fish trapping structure installed in Bristow and Quartz creeks. Release wires were designed to drop the trap leads if water and debris strained the trap structure.

checked with the water scope to maintain trapping efficiency during spring runoff. Catches were standardized to catch-per-day assuming catch rate was constant. Stream discharge and maximum-minimum water temperatures were recorded in conjunction with fish catch.

The migrant populations were approximated to the maximum likelihood estimate using Schnabel's multiple census formula modified by Chapman (Ricker 1975):

$$\hat{N} = \sum \frac{(C_t M_t)}{R+1}$$

Where: M_t = the number of marked fish ≥ 180 mm at large at time t,

C_t = the number of fish ≥ 180 mm captured at time t,

and R = the number of marked recaptures.

Approximate limits of confidence $(p \geq 0.95)$ for this formula were obtained by considering $\sum R$ as a Poisson variable (Ricker 1977).

Spawning Surveys

Redds were recorded by survey personnel in Bristow, Grave and Quartz creeks after the spawning run was completed. Redds were listed as definite, probable or possible using criteria described by Shepard et al. (1982). Only those redds classified as "definite" or "probable" were included in the final count.

RESULTS AND DISCUSSION

Stream descriptions, population estimates and hydrologic information required for recommending instream flows are presented by stream in two groups: 1) tributaries to Libby reservoir and 2) tributaries to the Kootenai River. Instream flow recommendations by May (1982) were reanalyzed by an updated WETP program and are summarized at the end of this report.

LIBBY RESERVOIR TRIBUTARIES

Streams entering Libby Reservoir supplement the reservoir fishery through recruitment of the progeny of migrant fish which ascend the tributaries to spawn. These tributaries supply inflowing nutrients from the surrounding watershed and food items such as benthic drift and forage fish. Fish production in the reservoir, therefore, depends greatly on the health of its tributary streams.

Barron Creek

Description

Stream reach: Barron Creek from its confluence with the western shore of Libby Reservoir (T32N, R29W, Sec. 27) to the headwaters (T32N, R30W, Sec. 22) (Figure 4).

Stream Length: 10.9 km. Total drainage area: 42.37 km^2. Gradient: 39.6 m/km.

Source and Land Use

Barron Creek **originates** on the southeast slope of the Purcell Mountains and flows east for approximately 11 km into the western shore of Libby Reservoir. Most of the drainage is in the Kootenai National Forest. All or a portion of five sections of land within the drainage are owned by Champion **International.** Timber production is the primary land use in the drainage.

Flows

Little flow data have been collected on Barron Creek except for sporadic measurements taken by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Miscellaneous measurements were compiled to construct an estimated annual hydrograph for water availability (Figure 5). Estimated mean annual discharge is 14.2 cfs.

14

BARRON CREEK

SEDIMENT POINT SOURCE
LOO jam
BEAVER ACTIVITY
TRANSECT LOCATION
POTENTIAL FISH BARRIOR
FISH TRAP
FISH BARRIOR
ELECTROFISHINO SECTION

20   21   22

FDR
RD.

LAKE
KOOCANUSA

BA NFIELD   MTN. URAL CR.

Figure 4.   A map of Barron Creek showing the location of transects and other
points of interest.

Potential Environmental Problems

Timber harvesting could increase sediment loading to the system and alter peak flows, causing channel stability problems and damage to fishery habitat.

Original spawning habitat downstream of a rock barrier located within the zone of reservoir surface fluctuation has been inundated. Historical reservoir water elevations are 'below the height of the rock barrier during the spring spawning period, eliminating Barron Creek as a potential source of rainbow and westslope cutthroat trout recruits to the reservoir. The rock barrier could be modified into a step-like cascade which would allow for migrant passage.

FISH POPULATIONS

Resident Fish

The results of a two-pass population assessment conducted within a 108-m blocked-off section of stream revealed that the game fish population in Barron Creek presently consists of eastern brook trout (Appendix Al) and relatively smaller numbers of westslope cutthroat trout and rainbow-cutthroat hybrids (Table 2).

FLOW RECOMMENDATIONS

Five permanent transects were established in riffle areas located approximately 1 km upstream from the mouth (T32N, R29W, Sec. 21, SE-l/4). The WETP program was calibrated to stage and discharge measurements made at flows of 1.6, 3.1, 17.7 and 46.4 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 1 and 2 cfs, respectively (Figure 6). Based on an evaluation of the existing fishery, results of the wetted perimeter analysis and estimated water availability, a discharge of 2 cfs is recommended for the low flow period from July 1 through March 31.

The average depth at the five riffle transects exceeds 0.5 ft, the minimum depth estimated for trout passage, at a flow of approximately 12.5 cfs (Table 3). Therefore, a flow of 12.5 cfs is recommended for the period from April 1 through June 30 to ensure &passage of spring spawners above the barrier and a possible future spawning run from the reservoir enhanced by barrier removal.

Table 2. The results of a two-pass **population** assessment conducted
in Barron Creek (T32N, R29W, Sec. 21) during July, 1985.
Discharge approximately **1.9** cfs.

	Total Number Captured	Estimated Number Fish $\geq$**75** mm per km
eastern brook trout	153	1,537 **±139**
Salmo spp.[a]	6	83 **±55**

[a] Species composition: WCT=67%, **HYB=33%**

Figure 5. An estimated hydrograph for Barron Creek based on
a comparison of 21 concurrent flow measurements made
at the Tobacco River USGS stage-discharge gauging
station, and miscellaneous measurements.
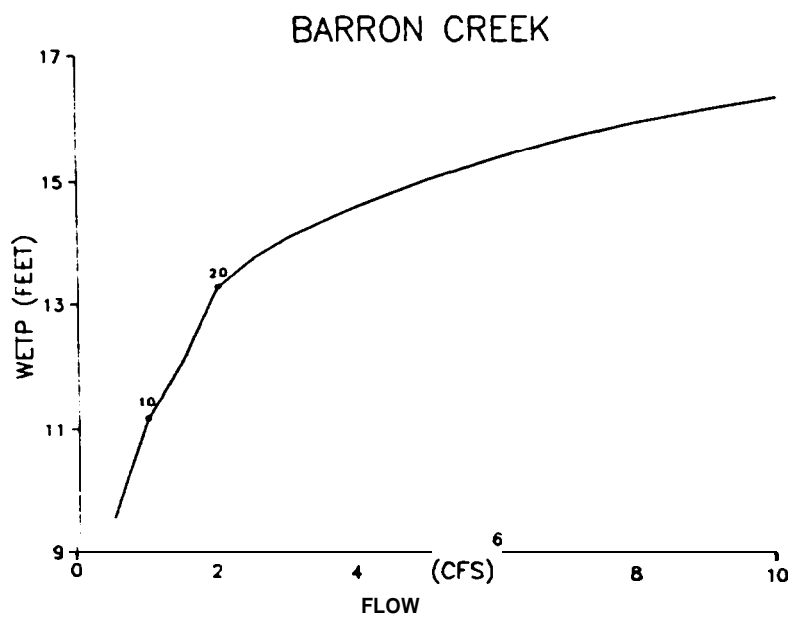
Figure 6. The wetted perimeter-discharge relationship for five
riffle transects on Barron Creek 1985-1986.

Table 3. Average depth at five riffle transects on Barron Creek at
selected flows of interest.

Flow (cfs)	Average depth (ft)				
	CS1	cs2	cs3	cs4	cs5
1.0	.17	.37	.16	.10	.15
2.0	.29	.56	.28	.23	.23
12.5	.60	.94	**.60**	.52	.71

Big Creek

Description

Stream reach: Big Creek from its confluence with the western shore of Libby Reservoir (T35N, R24W, Sec. 3) upstream to the junction of the north and south forks of Big Creek (T35N, R3OW, Sec. 28) (Figure 7).

Stream Length: 11.7 km. Total drainage area: 360.1 km^2. Gradient, mouth to north and south forks: 19.8 m per km.

Source and Land Use

Big Creek originates on the east slopes of the Purcell Mountains in two major forks which join from the north and south, then flows east for 11.7 km to the western shore of Libby Reservoir. The entire Big Creek drainage is located in the Kootenai National Forest. Timber production is the primary land use in the drainage.

Flows

The U.S. Geological Survey, Water Resources Division maintained a water-stage recorder in T35N, R29W, Sec. 33 from October 1972 through September 1981 (USGS 1973-1982). Daily discharge measurements during this period are summarized in an annual hydrograph (Figure 8). Mean annual discharge is 119 cfs. Infrequent measurements were also made by personnel of the Kootenai National Forest.

Potential Environmental Problems

Big Creek has been targeted for small scale hydroelectric development. Although applications for power resource construction were later withdrawn, interest in future development is anticipated as surplus power in the region decreases and cost-benefit ratios improve, making hydropower facilities once again economically attractive.

Increased sediment loads and higher peak flows resulting from timber production could reduce recruitment to the reservoir from the Big Creek drainage.

NORTH FORK

BIG CREEK

LOST HORSE MTN. | BOULDER LAKES
PARSNIP MTN.

31   32   33

FDR
RD.

SOUTH FORK

LAKE
KOOCANUSA

SEDIMENT POINT SOURCE
LOG JAM
BEAVER ACTIVITY
TRANSECT LOCATION
POTENTIAL FISH BARRIOR
FISH TRAP
FISH BARRIOR
ELECTROFISHING SECTION
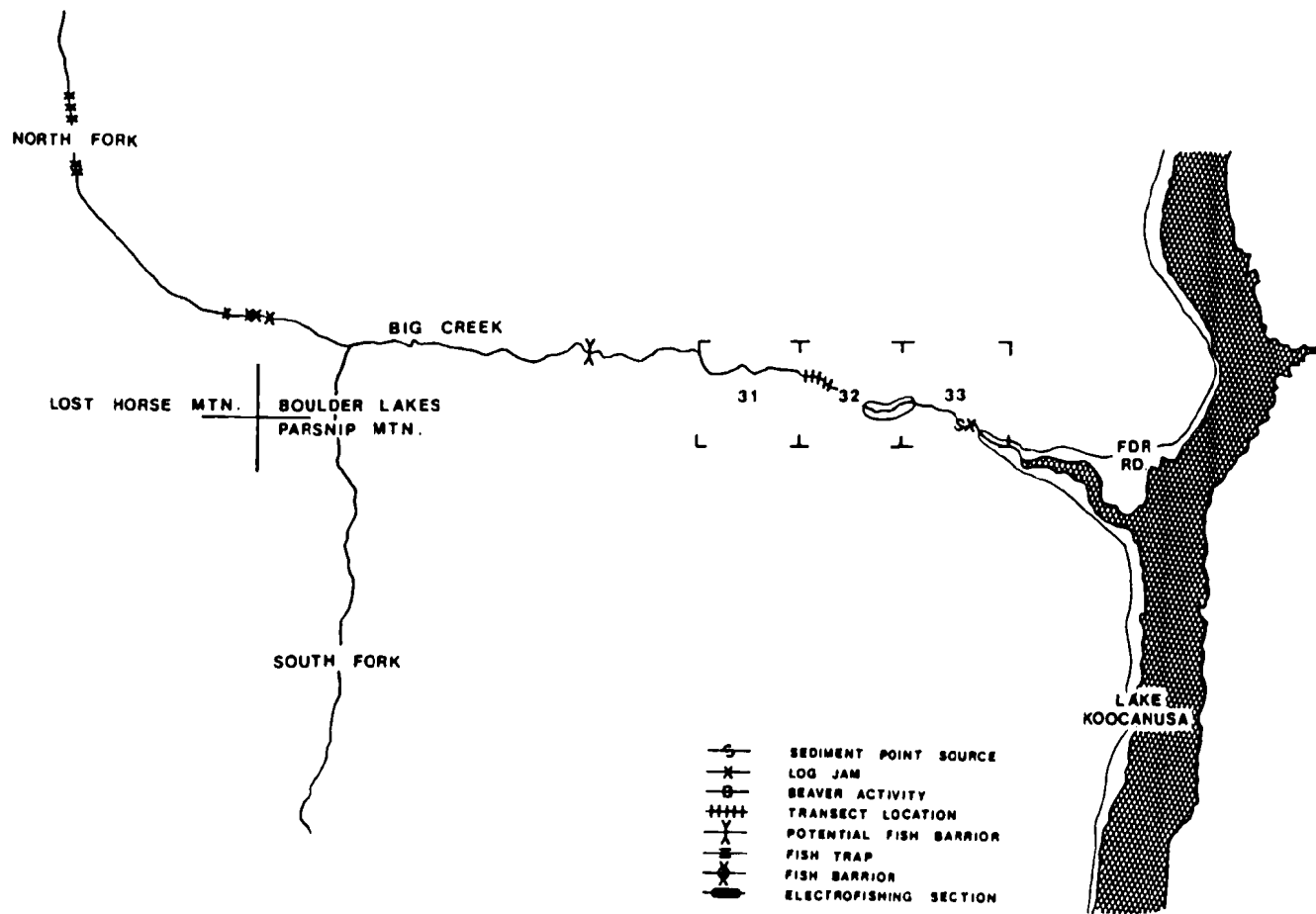
Figure 7. A map of Big Creek showing the location of transects and other
points of interest.

FISH POPULATIONS

Resident and Pre-emigrant Fish

A mark-recapture population estimate was made on a representative 120-m section chosen for its location between two natural constrictions in the stream. Results revealed that game fish in Big Creek include westslope cutthroat trout, rainbow trout, rainbow-cutthroat hybrids, bull trout, eastern brook trout, mountain whitefish, and burbot (Table 4). Based on a length-frequency histogram (Appendix A2) and a capture efficiency curve (Appendix A3), the _Salmo_ spp. population is best described in two groups:

> Fish >85 mm through 140 mm TL
> and Fish >140 mm through 255 mm TL.

FLOW RECOMMENDATIONS

Five permanent transects were established on riffle areas located approximately 2.5 km upstream of the Forest Development Road (T35N, R29W, Sec. 32, NE-l/4). The WETP program was calibrated to stage and discharge measurements at flows of 36.3, 42.7 and 311.0 cfs. The lower and upper inflection points in a plot of the wetted perimeter-Discharge relationship occur at flows of 19 and 32.5 cfs, respectively (Figure 9). Based on an evaluation of the existing fishery, results of the wetted perimeter analysis and water availability, a discharge of 19 cfs is recommended for the low flow period from July 16 through March 31,

An average depth of 0.5 ft, required for successful passage of spawning migrants, is not reached in all transects until flows equal or exceed 37.5 cfs (Table 5). A flow of 37.5 cfs is therefore recommended for the period from April 1 through July 15 to ensure migrant passage and protect spawning redds from dewatering. Recommendations have been set for half-month intervals based on historical water availability (Table 6). Recommended flows amount to 45.6 percent of the mean annual discharge on record.

BIG CREEK
discharge
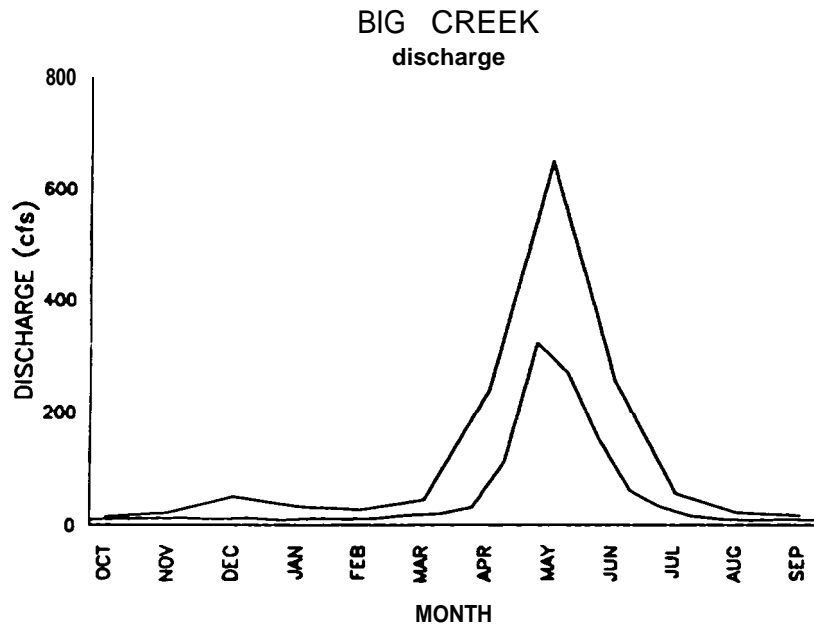
Figure 8. Mean monthly flows (top line) and eightieth
percentile exceedence flows (bottom line)
based on 10 years of daily stage records for
Big Creek (USGS).
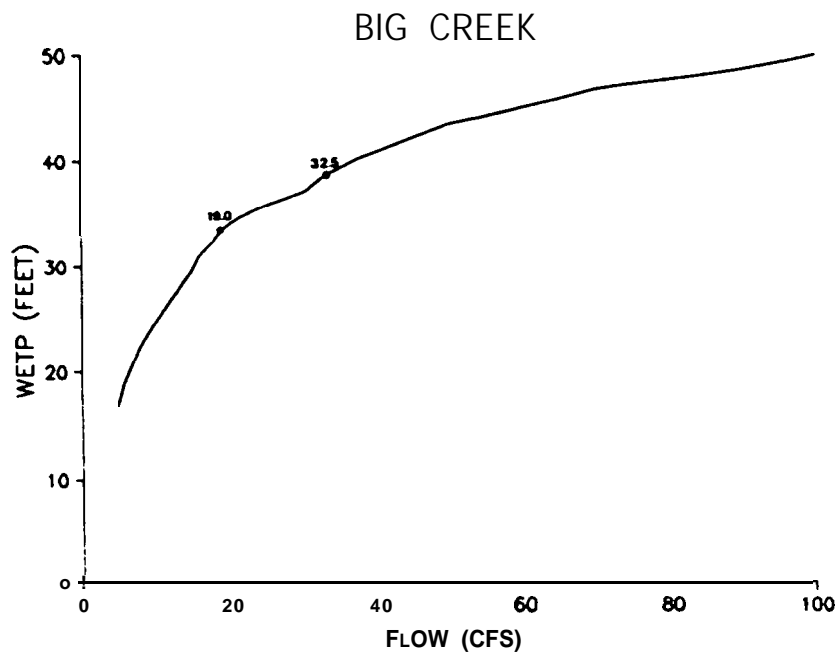
BIG CREEK

Figure 9. The wetted perimeter-discharge relationship for
five riffle transects on Big Creek 1985-1986.

Table 4. Results of mark-recapture estimate conducted on Big Creek
(T35N, ,R29W, Sec. 32) during August 1986. Discharge 37.5
cfs.

Length Categories	Total Number Captured	Estimated number per 1km
salmo spp.[a]		
>85-140 mm	92	594 ±291
>140-255 mm	54	225 297
TOTAL		819 ±388

[a] Species canposition: RB=63.4%, WCT=16.8%, HYB=19.8%

Table 5. Average depth in five riffle transects on Big Creek at
selected flows of interest.

Flow (cfs)	Average depth (ft)				
	CS1	CS2	Cs3	cs4	CS5
19.0	.33	.50	.55	.76	.49
32.5	.47	.72	.70	.82	.64
37.5	.50	.77	.74	.88	.66

Table 6. Recommended minimum flows for Big Creek and historical
water availability records based on ten years of daily
records (USGS).

Period of Water Year	Recommended Flows	80% Exceedence Flows	Mean Flows	Acre Feet
OCT 1 - OCT 15	19.0	**9.5**	15.1	449.1
OCT 16 - OCT 31	19.0	10.9	15.1	479.1
NOV 1 - NOV 15	19.0	11.4	22.0	654.4
NOV 16 - NOV 30	19.0	12.3	22.0	654.4
DEC 1 - DEC 15	19.0	10.5	49.9	1484.3
DEC 16 - DEC 31	19.0	12.4	49.9	1583.2
JAN 1 - JAN 15	19.0	9.3	32.7	972.7
JAN 16 - JAN 31	19.0	11.5	32.7	1037.5
FEB 1 - FEB 15	19.0	10.5	26.9	800.1
FEB 16 - FEB 28	19.0	11.9	26.9	640.1
MAR 1 - MAR 15	19.0	17.3	44.3	1317.7
MAR 16 - MAR 31	19.0	19.0	44.3	1405.6
APR 1 - APR 15	37.5	30.9	238.2	7085.3
APR 16 - APR 30	**110.0**	111.9	238.2	7085.3
MAY 1 - MAY 15	**324.0**[a]	324.3	648.6	19292.6
MAY 16 - MAY 31	269:0	268.9	648.6	20578.8
JUN 1 - JUN 15	151.0	150.9	255.5	7600.0
JUN 16 - JUN 30	60.0	60.3	255.5	7600.0
JUL 1 - JUL 15	37.5	32.3	55.7	1656.8
JUL 16 - JuL 31	19.0	16.0	55.7	1767.2
AUG 1 - AUG 15	19.0	10.6	22.0	654.4
AUG 16 - AUG 31	19.0	8.5	22.0	698.0
SEP 1 - SEP 15	19.0	9.5	16.9	502.7
SEP 16 - SEP 30	19.0	9.3	16.9	502.7
				86134.3

[a] A dominant discharge flow (the approximated bank full flow
presently undefined) should be maintained for 24 hours during
this period.

Bristow Creek

Description

Stream reach: Bristow Creek from its confluence with the western shore of Libby Reservoir **(T32N, R29W,** Sec. 5) to the source **(T32N, R30W,** Sec. 2) (Figure **10).**

Stream length: 11.6 km. Total drainage area: 60.3 **km^2.** Gradient: 43.8 **m** per km.

Source **and Land** Use

Bristow Creek originates at the north and south forks on the eastern slope of the Purcell Mountains and flows east for **11.6** km into the western shore of Libby Reservoir. Except for a small strip of land owned by Champion International located in two sections of the Bristow Creek, the entire drainage is in the Kootenai National Forest. Timber production is the primary land use **in** the drainage.

Flows

Little flow information has been collected on Bristow Creek except for infrequent measurements taken by personnel of the Kootenai National Forest and the U.S. Geological Survey **1974-1975.** Miscellaneous measurements were compiled to construct an estimated hydrograph for water availability (Figure **11).** Estimated mean annual discharge is 18.2 cfs.
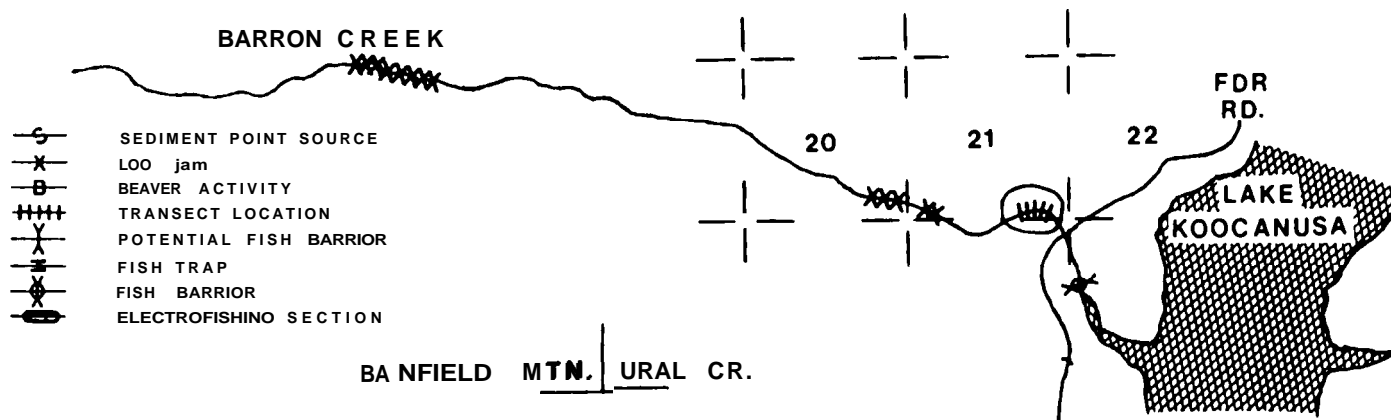
Potential Environmental Problems

Timber harvest in the Bristow Creek drainage has resulted in increased peak flows, causing instability in some portions of the creek. The Kootenai National Forest has selectively cut high-risk trees in the **riparian zone** to reduce sediment loading associated with root wad dislocation and to retain stream bank cover and stability. Barrier removal has also beenconductedto maintain access for migrant spawners

Planned timber sales in the drainage will probably increase sediment and decrease stream stability and could potentially limit fish production in the stream.

CAMP CREEK

NORTH FORK

SOUTH FORK

HICKEY CREEK

EVERETT CREEK

9 10 11

BRISTOW CREEK

SEDIMENT POINT SOURCE
LOG JAM
BEAVER ACTIVITY
TRANSECT LOCATION
POTENTIAL FISH BARRIOR
FISH TRAP
FISH BARRIOR
ELECTROFISHING SECTION

FDR RD.

LAKE KOOCANUSA

BANFIELD MTN. URAL CR.
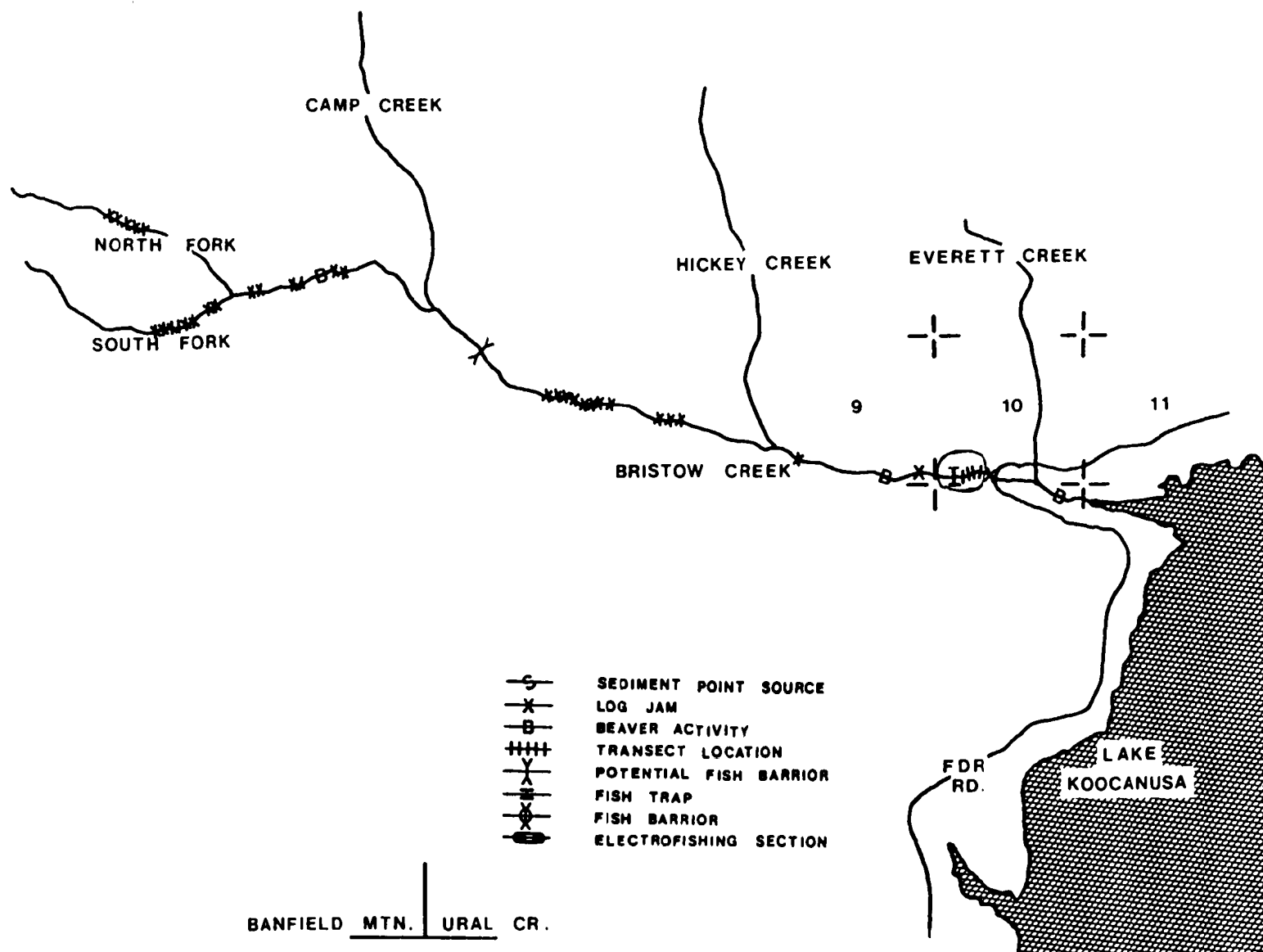
Figure 10. A map of Bristow Creek showing the location of transects and other points of interest.

BRISTOW CREEK
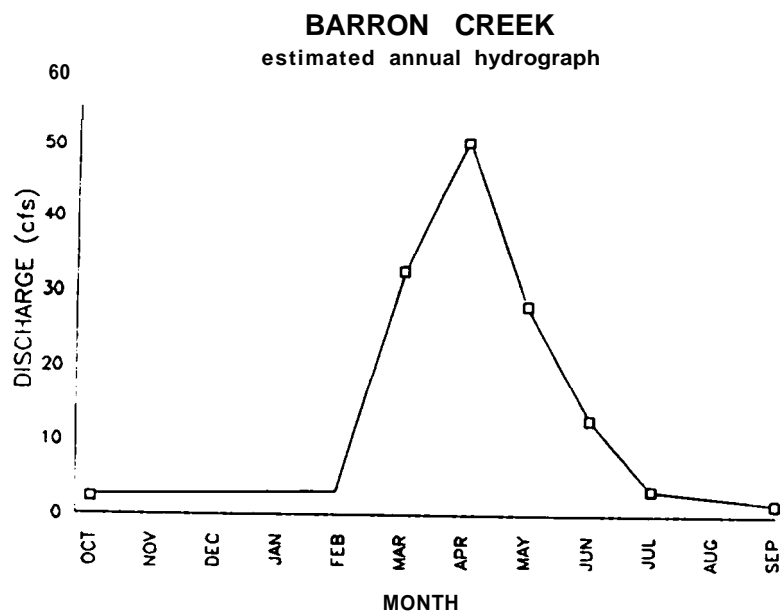## estimated annual hydrograph

Figure 11. An estimated annual hydrograph for Bristow Creek based on a comparison of six concurrent flow measurements made at the Tobacco River USGS stage-discharge gauging station, and 39 miscellaneous discharge measurements.

FISH POPULATIONS

Resident and Pre-emigrant Fish

Results of a two-pass population estimate on a 112-m block-netted section of stream disclosed that game fish in Bristow Creek were predominantly Salmo spp. (Appendix A4) and relatively smaller numbers of eastern brook trout (Table 7).

Migrant Trapping

A bi-directional trap structure was installed approximately 1.5 km above the mouth in Bristow Creek (T32N, R29W, Sec.10) to capture migrants traveling both up and downstream. Traps were monitored simultaneously during the period from April 7, 1986 through August 1, 1986. The first capture took place on May 12, 1986. The number of upstream migrants captured in Bristow Creek totaled 161 Salmo spp., whereas 136 spent migrants were captured while exiting the creek. The maximum likelihood estimate of the total migrant population, calculated using Schnable's Multiple Census Formula (Ricker 1975), amounted to 285 fish, with a range of 224-336 ($p \geq 0.95$, Poisson). Species composition was RB=9.5%, WCT=66.9% and HYB=23.6%.

The length-frequency histogram upstream for migrants nearly mirrors that for downstream migrants, indicating that the assumption of a closed population above the double trap structure was not violated (Figure 12). Mortality due to fishing was assumed to be equal among marked and unmarked fish; however, no fish tags have as yet been returned. At no time during the spawning run were both the upstream trap leads and downstream leads breached simultaneously. There is however a possibility that some fish may have escaped being trapped by leaping over or passing under the leads; bias was considered to be negligible since both marked and unmarked fish presumably have equal chance of escape.

The timing of the spawning run was well defined and short-lived, beginning on Way 12, 1986 and ending on June 29, 1986. The onset of upstream migration corresponds with declining discharge and rising water temperatures (Figure 13). The length of time marked individuals remained at large in Bristow Creek after passing the trap structure averaged 19 days with a range of 8 to 34 days at large.

Table 7. The results of a two-pass population assessment conducted in Bristow Creek (T32N, R29W, Sec. 10) during July 1985. Discharge approximately 6.6 cfs.

	Total Number Captured	Estimated Number Fish $\geq$75 mm per km
<u>salmo</u> spp.[a]	153	1,179 $\pm$143
eastern brook trout	5	[b]

[a] Species composition: RB=4%, WCT=50%, HYB=46%

[b] $\hat{p}$=0.33 insufficient for estimate

31
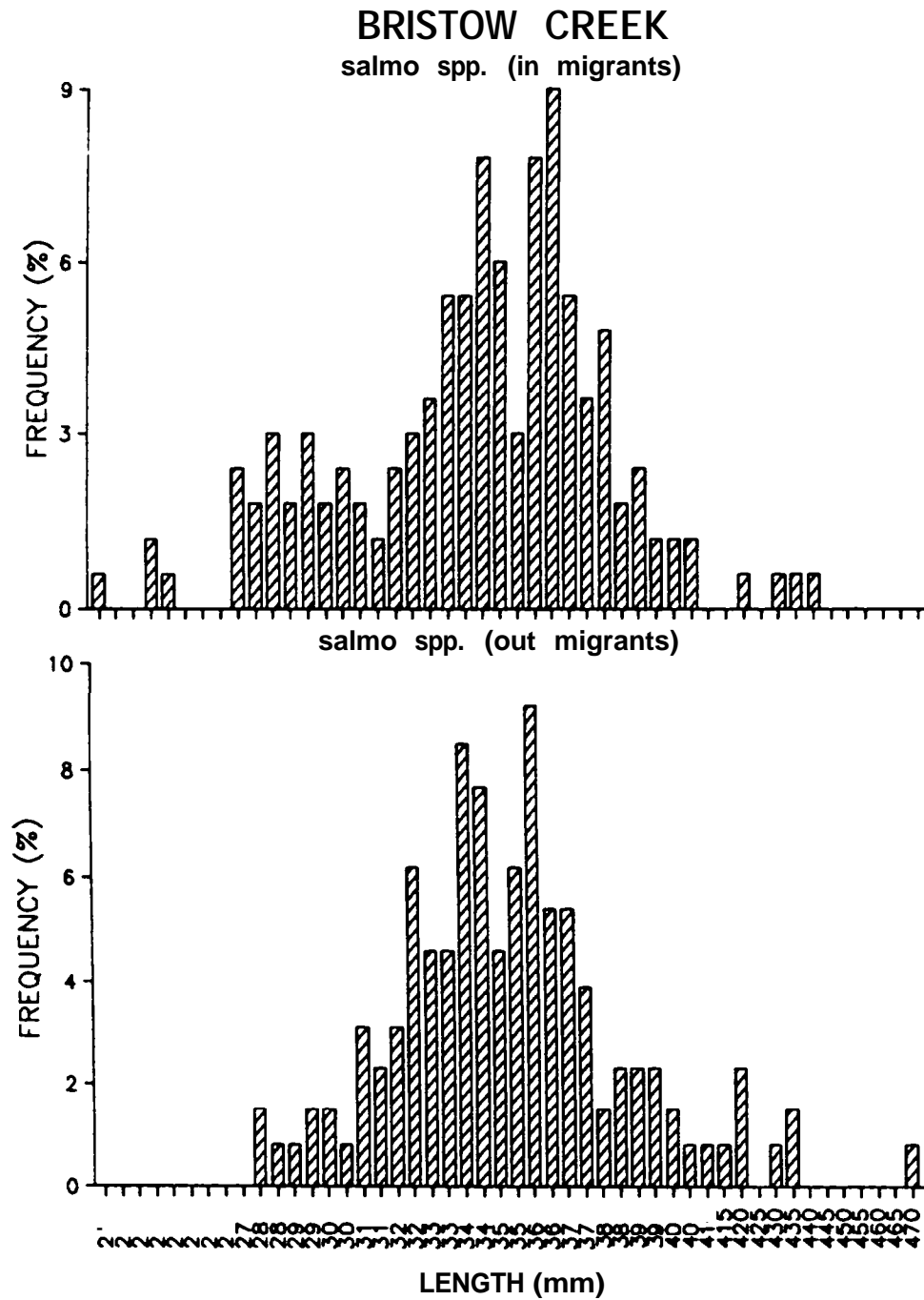
Figure 12. Length-frequency histograms of <u>Salmo</u> spp.
captured while migrating into (top) and out
of Bristcw Creek (bottom) during the spring
spawning run 1986.

BRISTOW MIGRANT TRAPS
catch over time
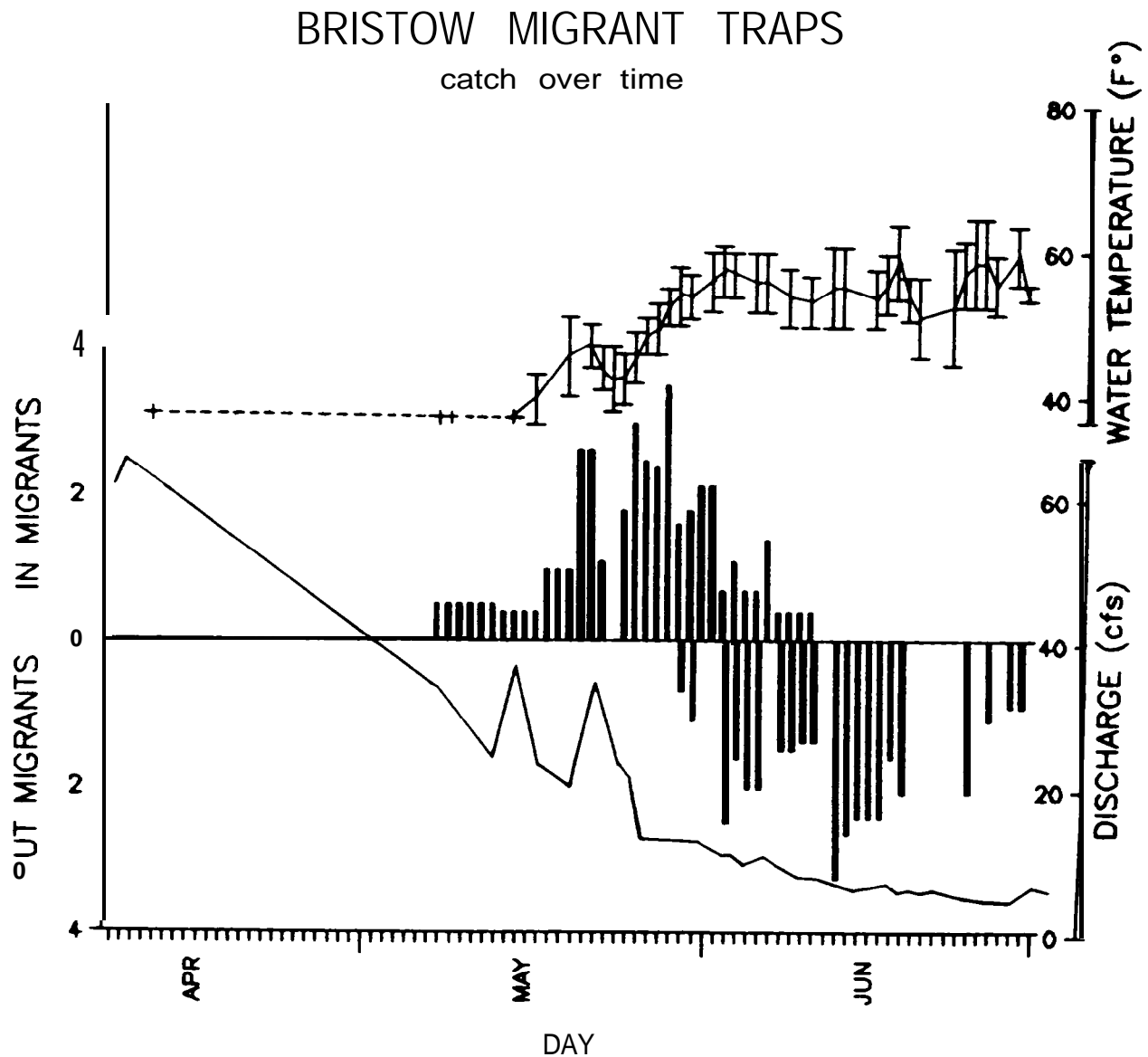
Figure 13. Catch derection and distribution over time of migrating _Salmo_ spp. capured at the Bristow Creek trapping structure during spring 1986 (vertical bars, middle), and associated water temperatures (range and mean top) and stream discharge (bottom). (Note: logarithmic scale)

Spawning Redd Survey

Redds observed by field personnel were placed into the following categories:

	Above trap site	Below trap site
Definite	44	1
Probable	39	**3**
Possible	19	**3**

A comparison of estimated spawners (utilizing that portion of Bristow Creek above the trap structure) to the number of redds classified as definite and probable produced an estimate of approximately 3 fish per redd with a range of 2.7 to 4.0. The sex ratio of individual fish captured in the trap was 1:2 (males to females).

FLOW RECOMMENDATIONS

Five permanent transects were established on riffle areas located approximately 1.5 km upstream from the mouth (T32N, R29W, Sec. 10, SW-l/4). The WETP program was calibrated to stage and discharge measurements at flows of 0.7, 8.5, 11.4, 28.1, 37.2, 47.9, 50.4, and 64.7 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 5 and 12 cfs, respectively (Figure 14). Based on an evaluation of the existing fishery, results of the wetted perimeter analysis and estimated water availability, a discharge of 12 cfs is recommended for the low flow period from July 16 through March 31. Stream discharge was observed to flow subgravel in some areas causing visible stream discharge to fall below the recommended flow, indicating that the fishery environment is below optimum during portions of some water years.

An average depth of 0.5 ft required for successful passage of spawning migrants is not reached until flows equal or exceed 13 cfs (Table 8). A minimum passage flow of 13 cfs is therefore recommended for the period from April 1 through July 15 to ensure migrant passage and protect redds from dewaterirrg.

BRISTOW CREEK

Figure 14.   The wetted perimeter-discharge relationship for five riffle transects on Bristow Creek 1985-1986.

Table 8.   Average **depth** at five riffle cross-sections on Bristow
Creek at selected flows of interest.

Flow	Average depth (ft)				
(cfs)	CS1	cs2	cs3	cs4	cs5
5	.65	.49	1.18	.36	.73
13	.79	.61	1.26	.50	.75

Deep Creek

Description

Stream reach : **Deep Creek** from its confluence with **Fortine** Creek **(T35N, R26W,** Sec. 25) to the spring **creeks(T35N, R25W,** Sec. 29, **SE-1/4)** and from the spring creeks to the source **(T35N, R24W,** Sec. **17)** (Figure **15).**

Stream length: 16.2 km. Total drainage area: 55.4 **km^2.** Gradient, mouth to the springs: 20.8 **m** per km, springs to the source: 64.9 **m** per km.

Deep Creek originates on the western slope of the Whitefish Range and flows west-southwest for 16.2 km to its confluence with **Fortine** Creek near **Fortine,** Montana. Portions of six sections within the Deep Creek drainage are privately owned. Of these sections, a segment of one belongs **to Burlington** Northern. The remainder of the watershed is in the Kootenai National Forest. Timber production is the primary land **use** in the drainage, although there is a considerable portion of arable land used for pasture and forage production

Flows

A crest-stage gauge has been operated by the U.S. Geological Survey from 1959 to present. **(T35N, R25W, Sec.** 30, **SW-1/4).** The gauge measures annual maximum discharge. Infrequent data have also been collected by Montana Department of Fish, Wildlife and Parks. Miscellaneous data were compiled to construct an estimated hydrograph for water availability (Figure 16).

Potential Environmental Problems

Water appropriations listed for Deep Creek amount to **31.09** cfs not including amounts allocated for livestock which are based on stock type and herd size (Index of Claims, State Water Rights, Helena, Montana). Estimated mean annual discharge is 16.7 cfs. If all water users exercise their water rights to the fullest extent, the stream will be dewatered during most of the water year. It is not known, however, what percentage of the existing appropriations are valid or presently in use.

Livestock access, unrestrained in pasture lands bordering the creek in the lower 3 km of Deep Creek, has accelerated bank erosion and sediment loading.

Saw mill waste and leachates are entering Deep Creek near its confluence with Fortine Creek.

DEEP CREEK

30 29

SPRINGS

FORTINE | MOUNT MARSTON

SEDIMENT POINT SOURCE
LOG JAM
BEAVER ACTIVITY
TRANSECT LOCATION
POTENTIAL FISH BARRIOR
FISH TRAP
FISH BARRIOR
ELECTROFISHING SECTION
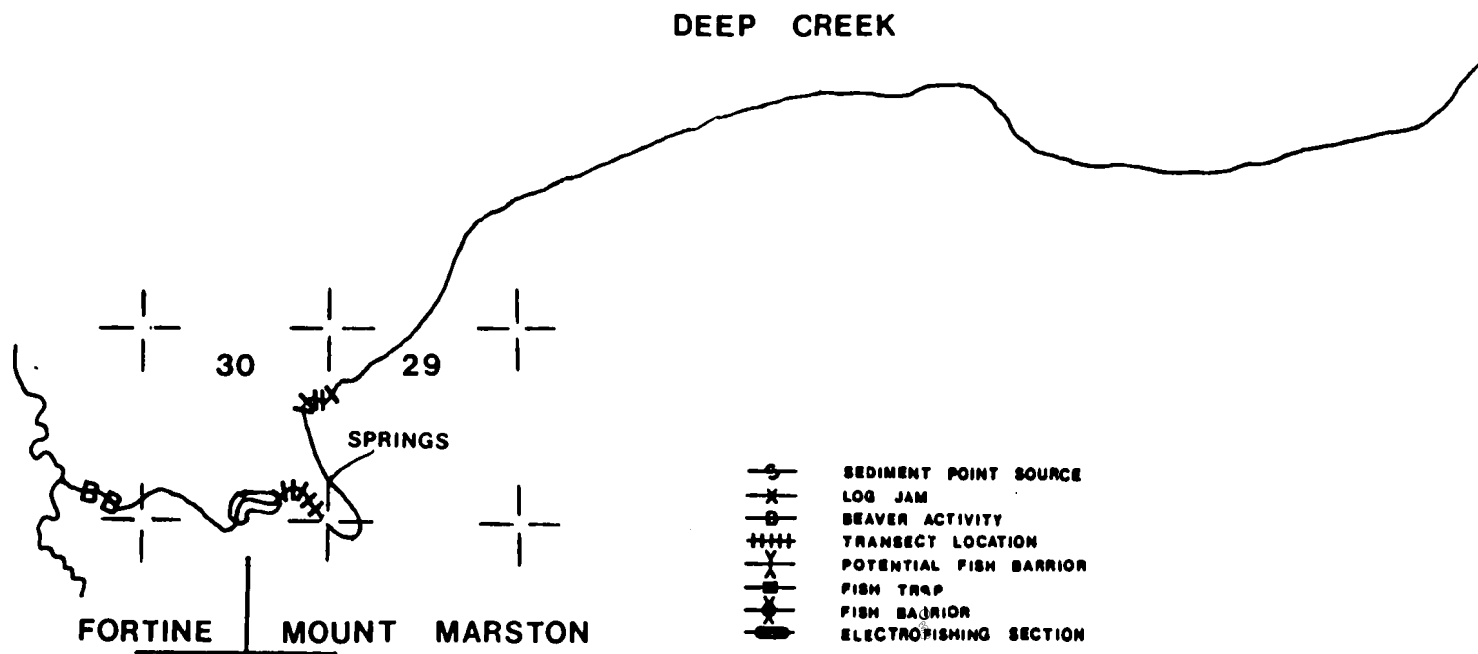
Figure 15. A map of Deep Creek showing the location of transects and other points of interest.
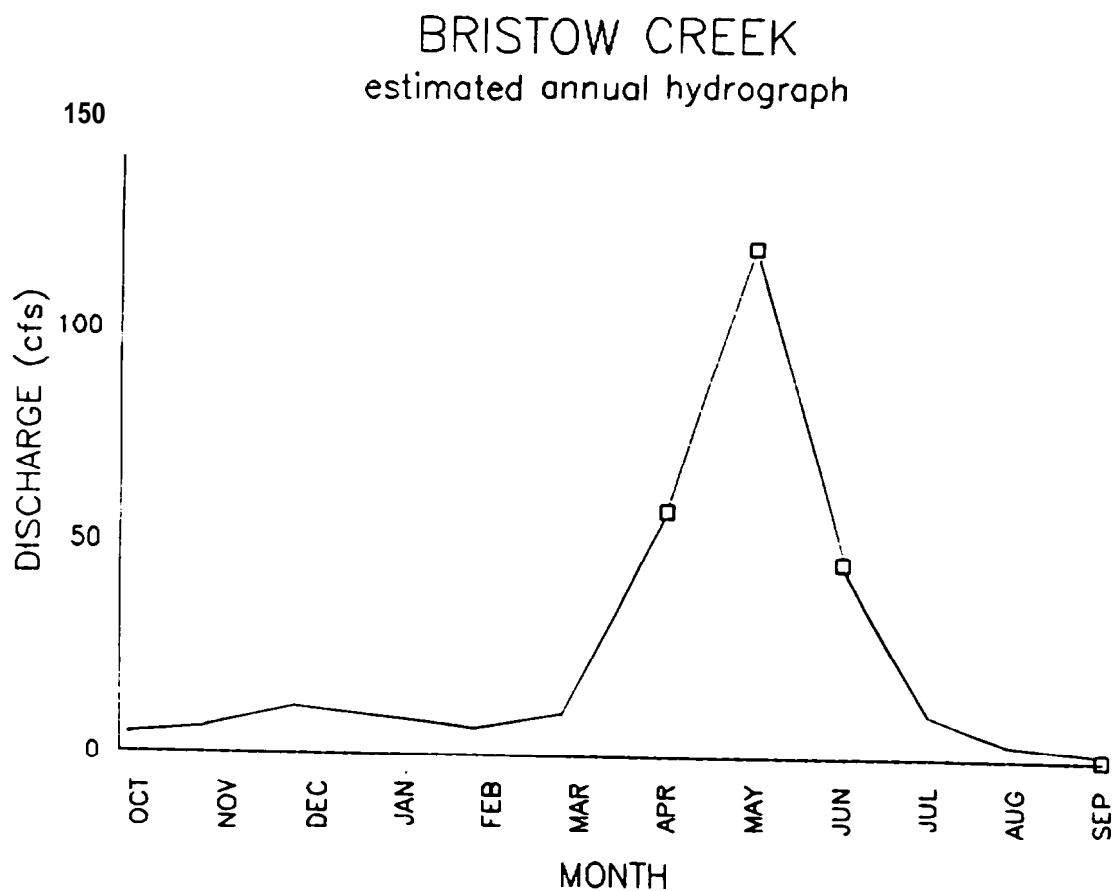
DEEP CREEK
estimated annual hydrograph
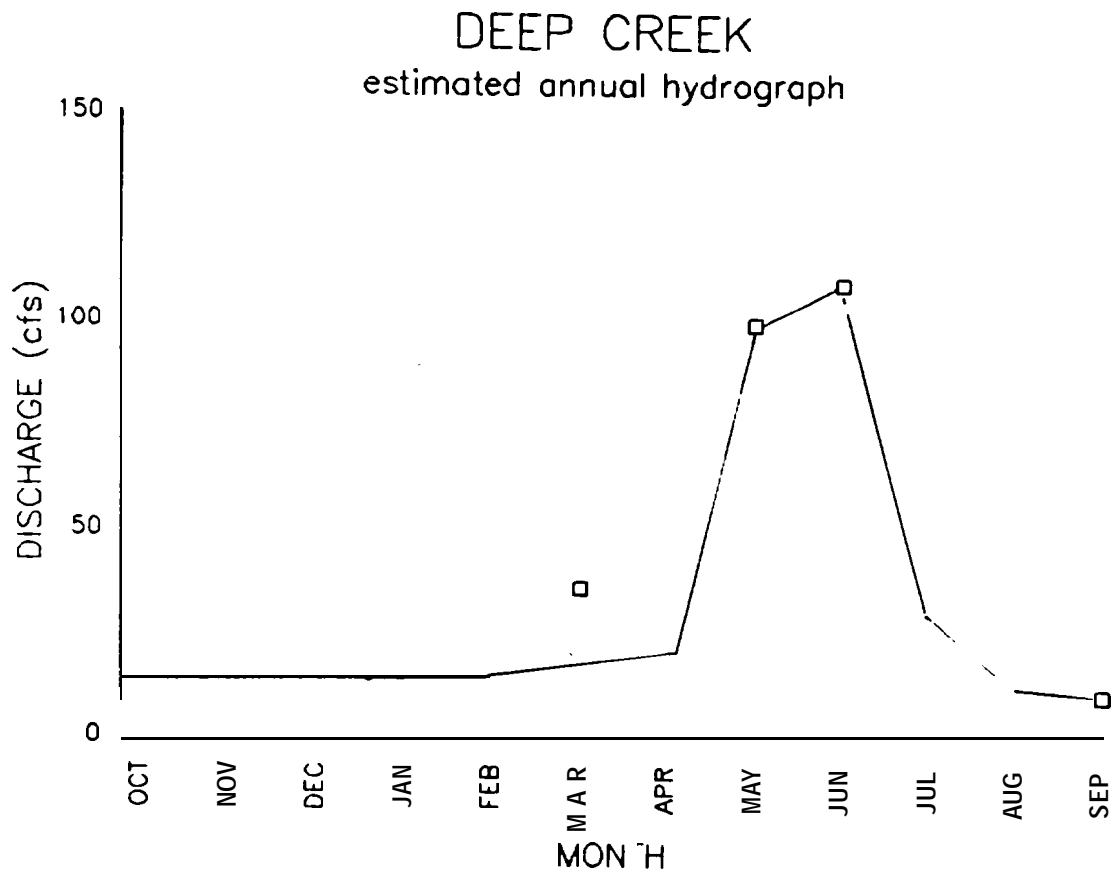
Figure 16. An estimated annual hydrograph for lower Deep Creek based on a comparison of 20 concurrent flow measurements made at the Tobacco River USGS stage-di charge gauging station; 24 years of USGS annual maximum discharge data, and miscellaneous flow measurements.

Deep Creek has been targeted for microhydro development. Although the original application was later withdrawn, future development is anticipated when the region's power surplus declines and improved cost-benefit ratios make development of hydroelectric projects more attractive.

FISH POPULATIONS

Resident and Pre-emigrant Fish

Results of a two-pass population estimate on a 109.7-meter blocknetted section of stream disclosed that game fish in Deep Creek were predominantly Salmo spp. and relatively smaller numbers of eastern brook trout (Table 9). Length-frequency histograms show modal lengths (Appendix A5 and A6).

FLOW RECOMMENDATIONS

Five permanent transects were established on riffle areas located approximately 1 km upstream from the mouth (R35N, R25W, Sec. 30, SE-1/4). The WETP program was calibrated to stage and discharge measurements at flows of 17.6, 23.0, and 101.7 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 3.0 and 8.0 cfs, respectively (Figure 17). Based on an evaluation of the existing fishery, results of the wettedperimeter analysis, and estimated water availability, a discharge of 8 cfs is recommended for the low flow period from July 1 through March 31. This segment of Deep Creek is unique in that approximately 40 percent of the flow enters lower Deep Creek from a series of springs in section 29.

Five additional transects and a stage gauge were installed upstream of the entry point of the spring creeks (upper). The WETP program was calibrated at flows of 2.5, 14.0, and 64.0 cfs. Lower and upper inflection points occur at flows of 4.0 and 12.0, respectively (Figure 18). Adischarge of 4.0 is recommended for that portion of Deep Creek upstream of the spring streams located in the SW1/4, of the SW1/4, Sec. 29 during the low flow period from July 1 throughMarch 3. Flows calculated from water stage measured during the period from May 16, 1986 through August 1986 ranged from 87.8 to 2.5 cfs andaveraged16.0 cfs (Figure 19).

An average depth of 0.5 ft is met at all transects at a discharge of 30 cfs. A minimum fish passage flow of 30 cfs is therefore recommended for the period of April 1 through June 30 to ensure successful passage of migrant spawners (Table 10).

Table 9. The results of a two-pass population assessment conducted
on Deep Creek **(T35N, R25W,** Sec. 30) during September
1985.   Discharge 17.6 cfs.

	Total Number Captured	EstimatedNumber Fish $\geq$**75** mm per km
<u>Salmo</u> **spp.**[a]	63	611 **+155**
eastern brook trout	60	301 **+32**

[a] Species composition: RB=7.9%, WCT=76.2%, HYB=15.9%
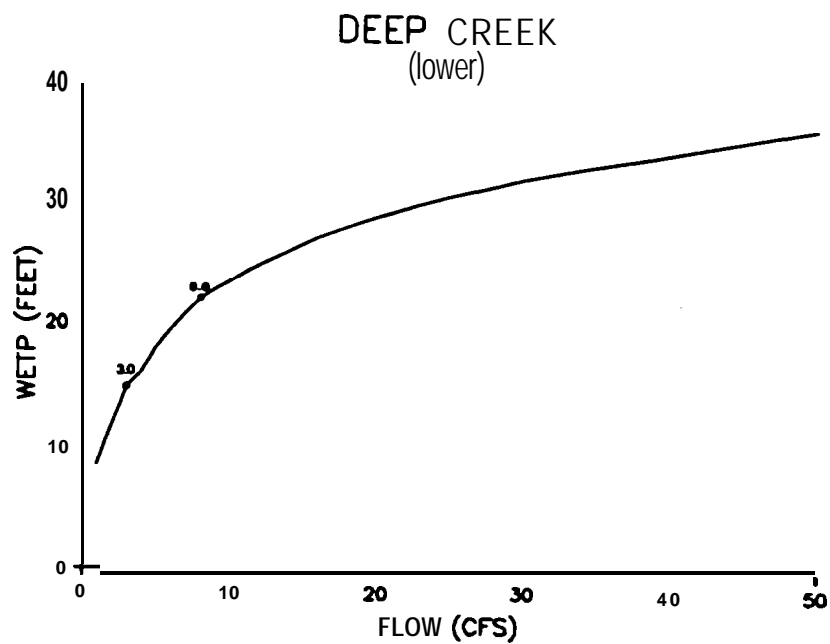
DEEP CREEK
(lower)

Figure 17.   The wetted perimeter-discharge relationship for
             five riffle transects on lower Deep Creek 1985-1986.
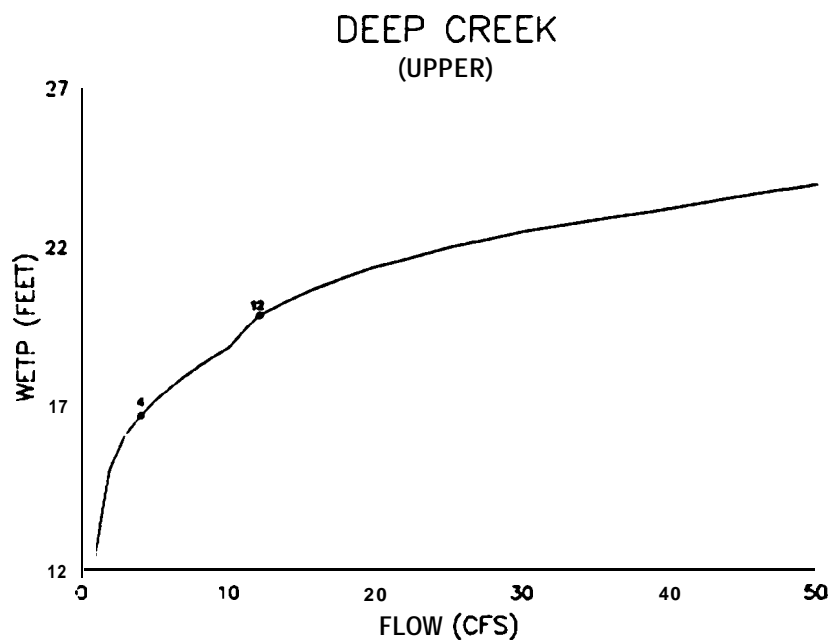
DEEP CREEK
(UPPER)

Figure 18.   The wetted perimeter-discharge relationship for
             five riffle transects on upper Deep Creek 1986.

DEEP CREEK
discharge
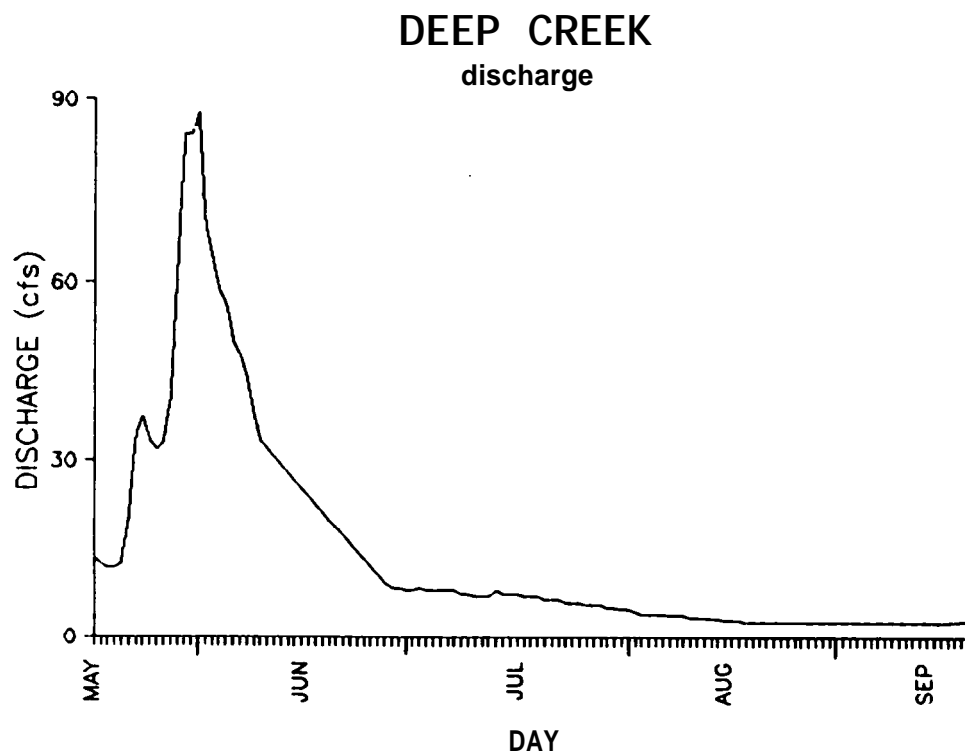
Figure 19.   Stream discharge derived from stage gauge data for
             upper Deep Creek, May 16 – September 21, 1986.

Table 10. The average depth for 10 riffle cross-sections in Deep
Creek at selected flows of interest.

Discharge (cfs) Transect group	Average depth (ft)				
Lower	CSl	cs2	cs3	cs4	cs5
3	.17	.18	.22	.13	.25
8	.34	.26	.31	.20	.38
30	.71	.54	.59	.61	.73
Upper	CS6	cs7	CS8	**CS9**	CSlO
4	.24	.24	.21	.99	.73
12	.33	.40	.39	1.24	1.02
30	.54	.63	.61	1.48	1.32

Fivmile Creek

Description

Stream reach: Fivemile Creek from its confluence with the eastern shore of Libby Reservoir (T32N, R28W, Sec. 18) to the junction of the south fork of Fivemile Creek (T32N, R27W, Sec. 19) (Figure 20).

Stream Length: 8.4 km.   Total drainage area: 75 km^2. Gradient: 9.7 m per km.

Source and Land Use

Fivemile Creek originates on the western slopes of the Salish Mountains and flows west for approximately 11.6 km to Libby Reservoir. Other than one narrow strip of privately owned stream bottom and another owned by Champion International, the entire drainage is in the Kootenai National Forest. Timber production is the primary land use in the watershed.

Flows

Little flow data have been obtained on Fivemile Creek except for sporadic measurements taken by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 14.1 cfs.

Potential Environmental Problems

Timber harvesting could increase sediment loading and peak flows, causing channel instability and damage to fish habitat.

FISH POPULATIONS

Resident and Pre-emigrant Fish

A two-pass population assessment on a 112.8-m blocknetted section of stream ascertained that most game fish in Fivemile Creek are <u>Salmo</u> spp. and relatively fewer numbers of eastern brook trout (Table 11). Length-frequency histograms present modal lengths (Appendix A7 and A8).

FLOW RECOMMENDATIONS

Five permanent transects were established on riffle areas located approximately 0.5 km upstream from the mouth (T32N, R28W, Sec. 17, NW-l/4. The WETP program was calibrated to stage and

LAKE
KOOCANUSA

HWY
37

17   16   15

FIVEMILE CREEK

SOUTH FORK

SEDIMENT POINT SOURCE
LOG JAM
BEAVER ACTIVITY
TRANSECT LOCATION
POTENTIAL FISH BARRIOR
FISH TRAP
FISH BARRIOR
ELECTROFISHING SECTION

VALCOUR GULCH   DAVIS MTN.
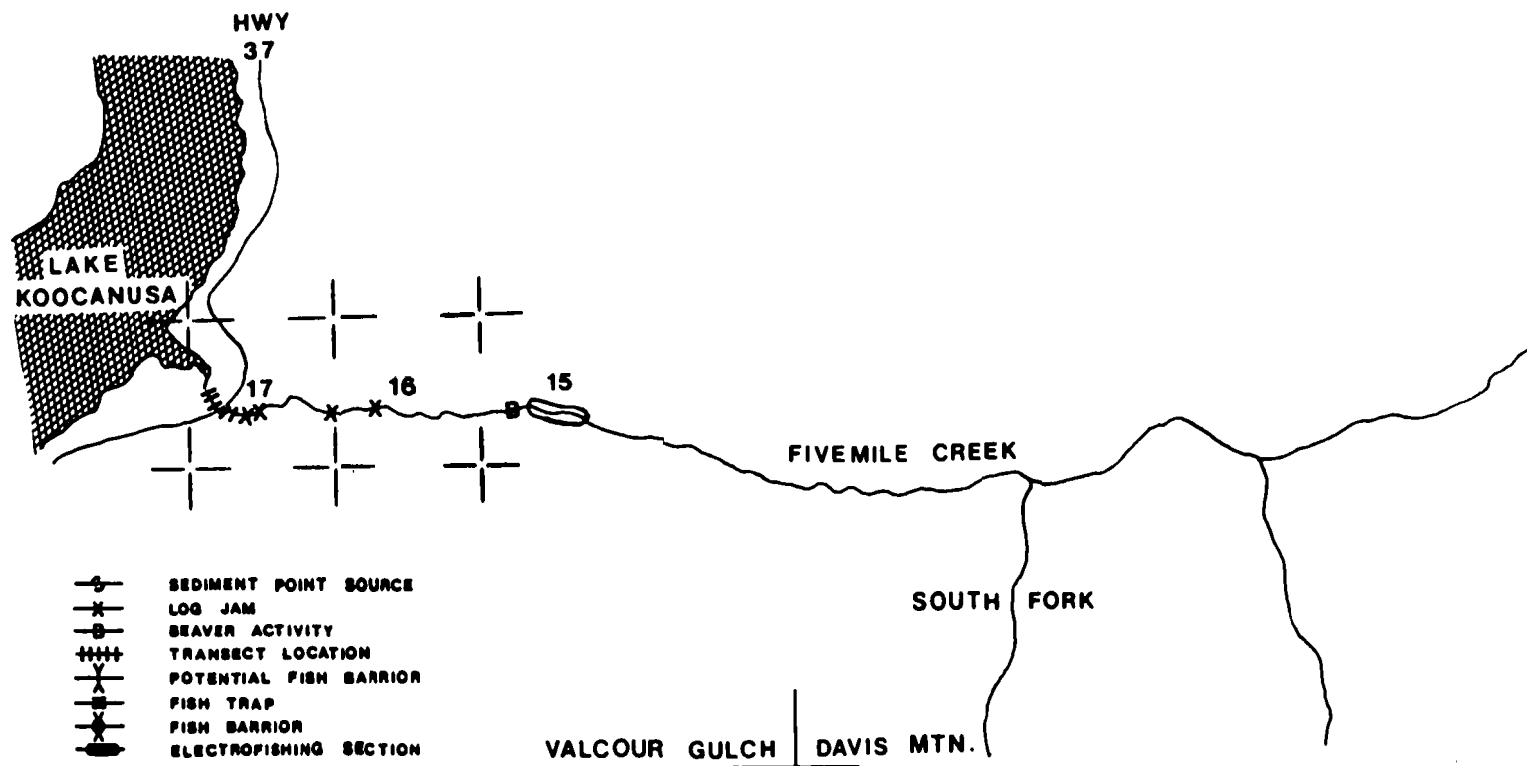
Figure 20. A map of Fivemile Creek showing the location of transects and other
points of interest.

Table 11. The results of a two-pass population assessment con-
ducted on Fivemile Creek (T32N, R28W, Sec. 24) during
July 1985. No discharge on record.

	Total Number Captured	Estimated Number Fish $\geq$ **75** mm per km
<u>Salmo</u> spp.[a]	112	465 **±128**
eastern brook trout	43	243 **±160**

[a] Species composition: RB=83.0%, WCT=10.7%, HYB=6.3%

discharge measurements at flows of 2.6, 7.1, 31.6 and 33.7 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 2.0 and 4.0 cfs respectively (Figure 21). Based on an evaluation of the present fishery, results of the wetted perimeter analysis, and estimated water availability, a discharge of 4 cfs is recommended for the low flow period from July 16 through March 31. Natural flows were observed to decline to below the recommended flow, and at times, in some areas, water flows subsurface, indicating that conditions in Fivemile Creek are below optimum during portions of some water years.

An average depth of 0.5 ft, required for successful passage of spawning migrants, is not reached until flows equal or exceed 20.0 cfs (Table 12). A flow of 20.0 cfs is therefore recommended for the period from April 1 through July 15 to ensure migrant passage and protect spawning redds from dewatering.

Grave Creek

Description

Stream reach: Grave Creek from its confluence with the Tobacco River (T35N, R26W, Sec. 15) to Foundation Creek (T37N, R24W, Sec. 29) (Figure 22).

Stream Length: 28.3 km. Total drainage area: 191.9 km^2. Gradient, 18.5 m per km.

Source and Land Use

Grave Creek begins on the western slopes of the Whitefish Mountain Range and flows for 28.3 km southwest to the Tobacco River. Approximately 14 percent of the lower portion of the watershed is privately owned; the remainder of the drainage is in the Kootenai National Forest. Timber production is the primary land use on the National Forest. Privately owned land is mainly arable, much of which has been put to pasture and forage production.

Flows

A water stage recording station was maintained by the U.S. Geological Survey, Water Resources Division during the 1923 and 1924 water years. Although the records are incomplete and of short duration, monthly means were used to develop an estimated annual hydrograph based on best available data (Figure 23). Estimated mean annual discharge is 88.9 cfs.
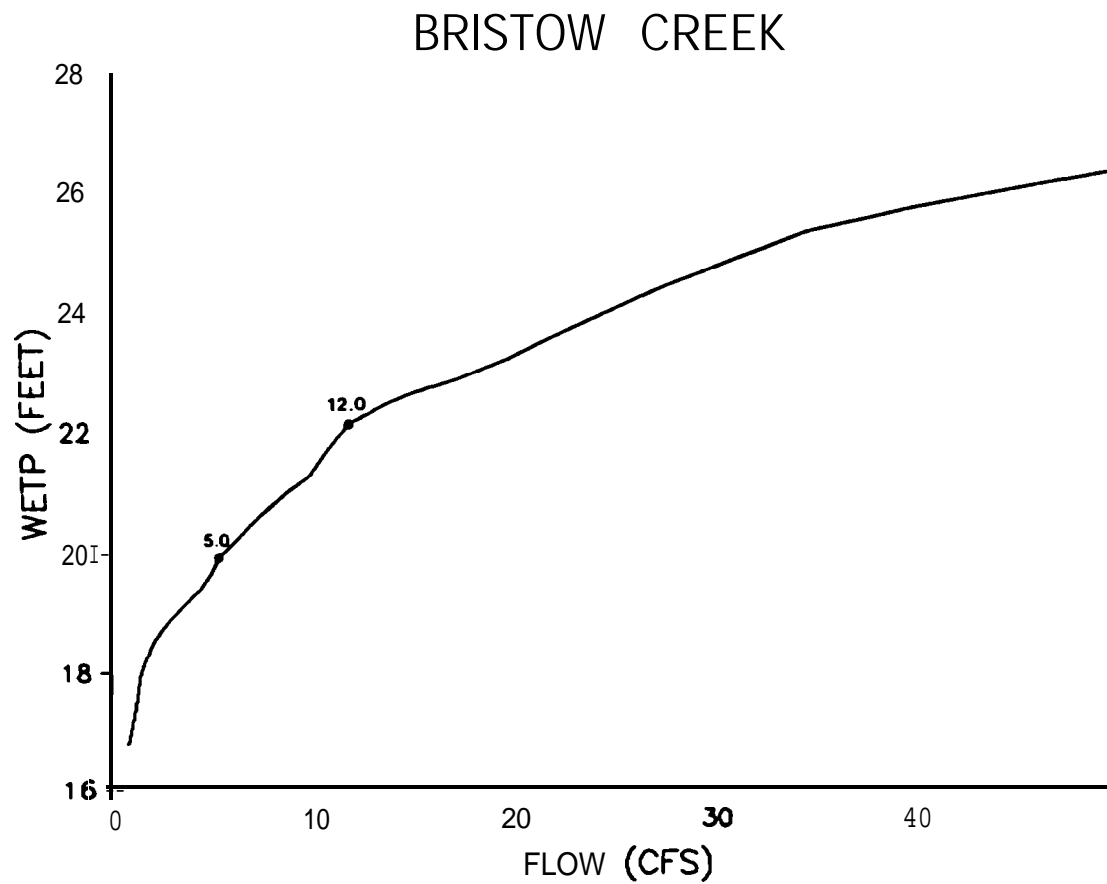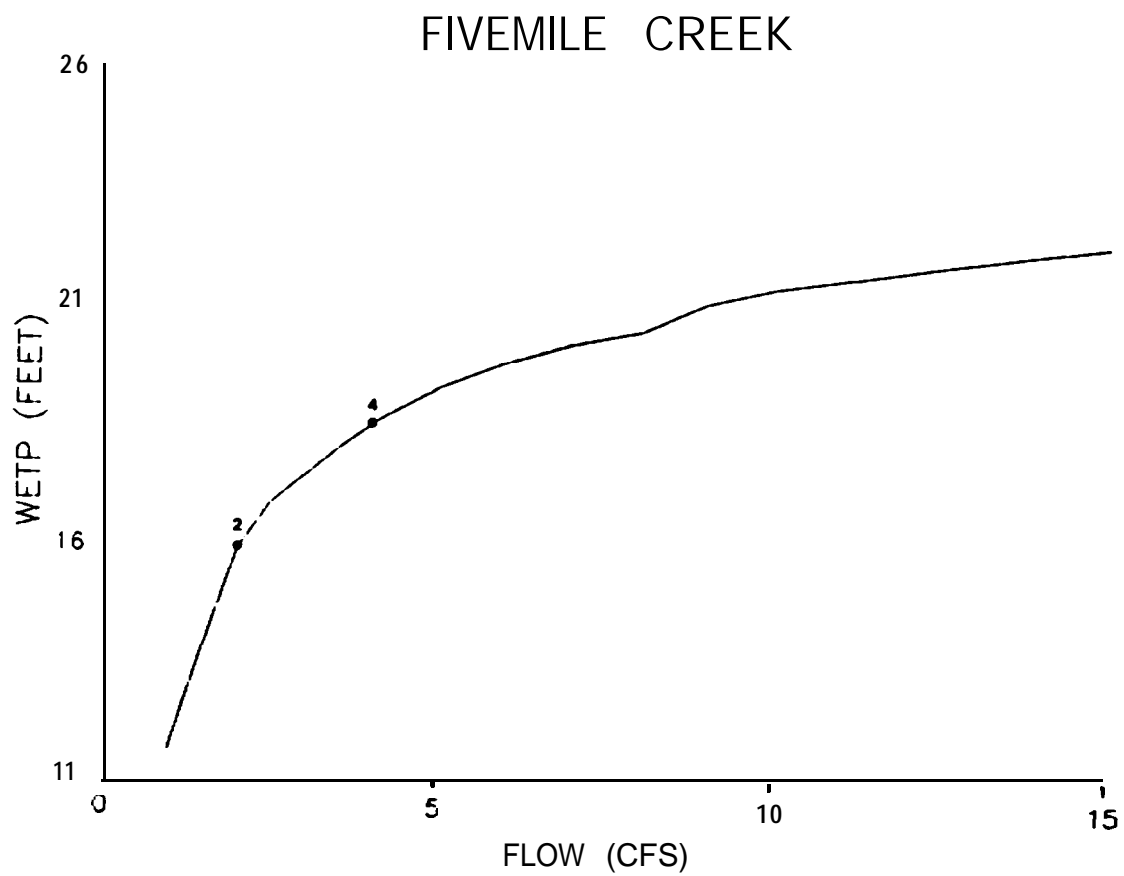
FIVEMILE CREEK

Figure 21. The wetted perimeter-discharge relationship for
five riffle transects on Fivemile Creek 1985-1986.

Table 12. Average depth at five riffle transects in Fivemile
          Creek at selected flows of interest.

Flow	Average depth (ft)				
(cfs)	CSl	cs2	Cs3	cs4	cs5
2.0	.31	.28	.22	.14	.41
4.0	.40	.36	.34	.19	.52
20.0	.67	.69	.79	.52	.77

FORTINE

GRAVE CREEK

TOBACCO RIVER

HWY
93

14

FORTINE CREEK

SEDIMENT POINT SOURCE
LOG JAM
BEAVER ACTIVITY
TRANSECT LOCATION
POTENTIAL FISH BARRIER
FISH TRAP
FISH BARRIER
ELECTROFISHING SECTION

MOUNT ⊃ ASTON
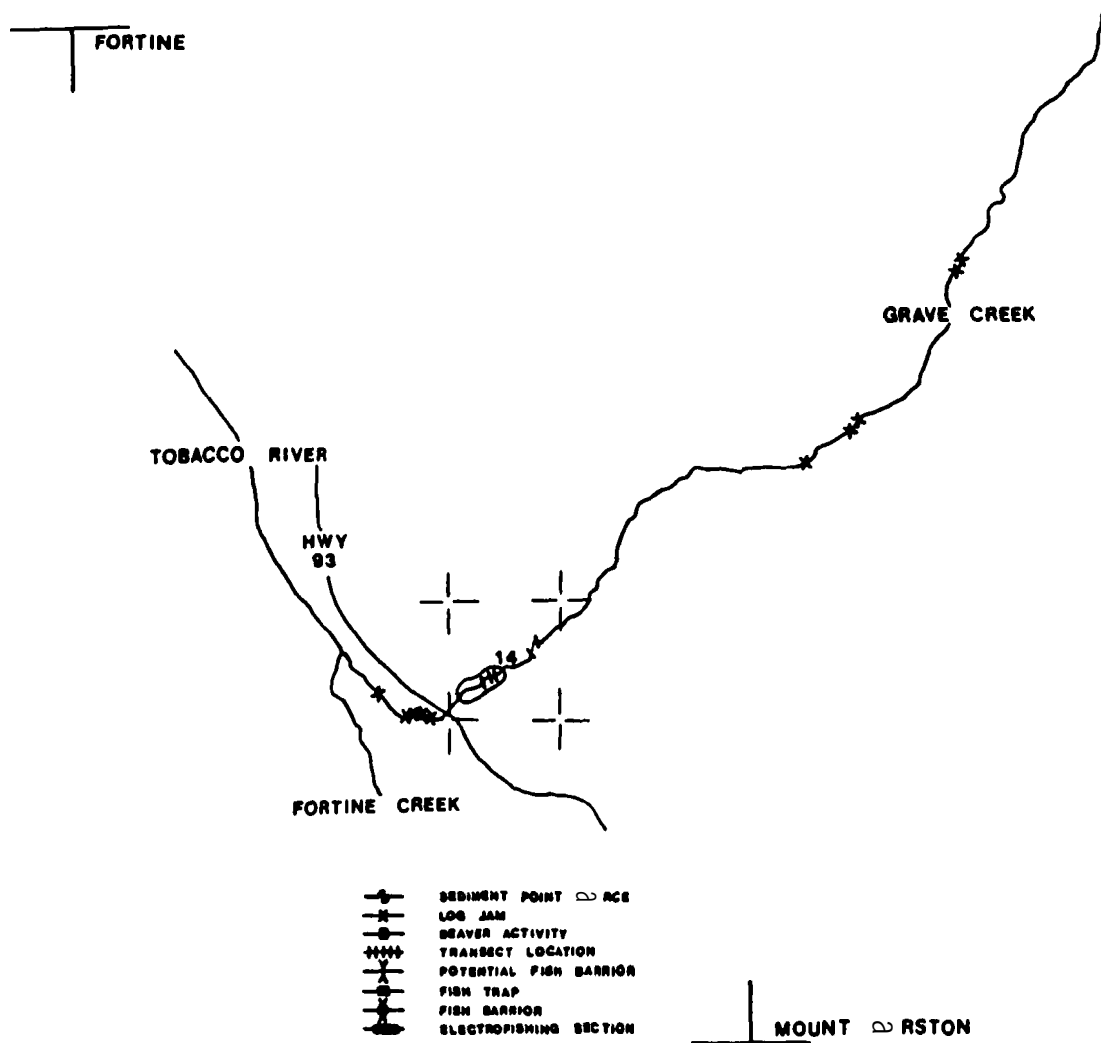
Figure 22. A map of Grave Creek showing the location of transects and other points of interest.

Potential Environmental Problems

Water appropriations listed for Grave Creek total 80.8 cfs not including amounts allocated for livestock which are issued on the basis of stock type and herd size (Index of Claims, State Water Rights, Helena, Montana). If all water users exercise their water rights to the fullest extent, the stream would be dewatered during mostofthe water year. It is unknown, however, what number of claims are valid or presently in use.

Livestock access to Grave Creek is unrestricted in many pasture lands bordering the lower 6 km of the stream. Bank erosion and sediment loading has apparently been accelerated by grazing and forage production.

Timber harvest and associated road building could also increase sediment loading and peak flows, causing channel instability and damage to fish habitat.

Source tributaries (Blue Sky, Clarence, Stahl and Williams creeks) have been targeted for microhydro development. Although original applications on the former three creeks were subsequently withdrawn, the application on Williams Creek is still pending and future development is anticipated in the drainage when the region's power surplus declines and cost-benefit ratios improve, making hydroelectric projects more attractive to developers.

FISHPOPULATIONS

Resident Pre-emigrant and Migrant Fish

A mark-recapture population estimate was conducted on a repre-sentative 324.9-m section chosen for its location between natural constrictions in the stream. Game fish captured were predominated by _Salmo_ spp and a relatively smaller population of eastern brook trout (Table 13). Length-frequency histograms present modal lengths (Appendix A9 and Al0). Based on recaptures and catch efficiency results (Appendix All), all length groups were pooled. One male kokanee salmon and a mountain whitefish were also included in the catch. Two other ripe kokanee observed in a pool escaped our electrofishing effort.

Grave Creek is a major producer of bull trout recruits to Libby Reservoir. Since 1983, personnel of the Montana Department of Fish, Wildlife and Parks have conducted annual bull trout redd

Table 13. Results of a mark-recapture estimate conducted on Grave
          Creek (T35N, R26W, Sec. 14, SE-l/4) during September
          1986.   Discharge 42.8 cfs.

	Total Number Captured	Estimated Number Fish $\geq$75 mm per 1 km
<u>Salmo</u> spp.4	83	428 $\pm$151
eastern brook trout	22	142 $\pm$105

a/ **Species** composition: RB=73.5%, WCT=7.2%, HYB=19.3%

GRAVE CREEK
estimated annual hydrograph
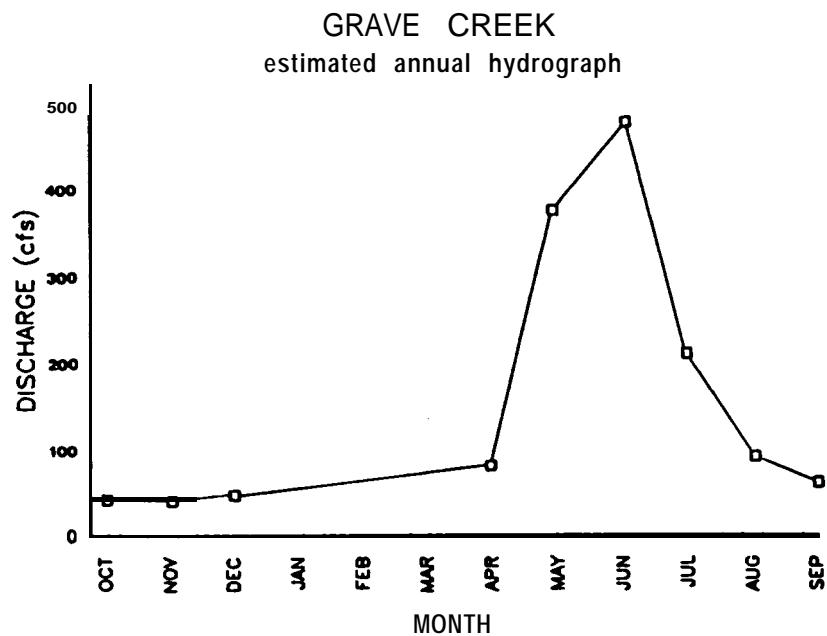
Figure 23.   An estimated annual hydrograph for Grave Creek based
on UAGS daily stage-discharge measurements during
previous water years, and miscellaneousmeasurements.
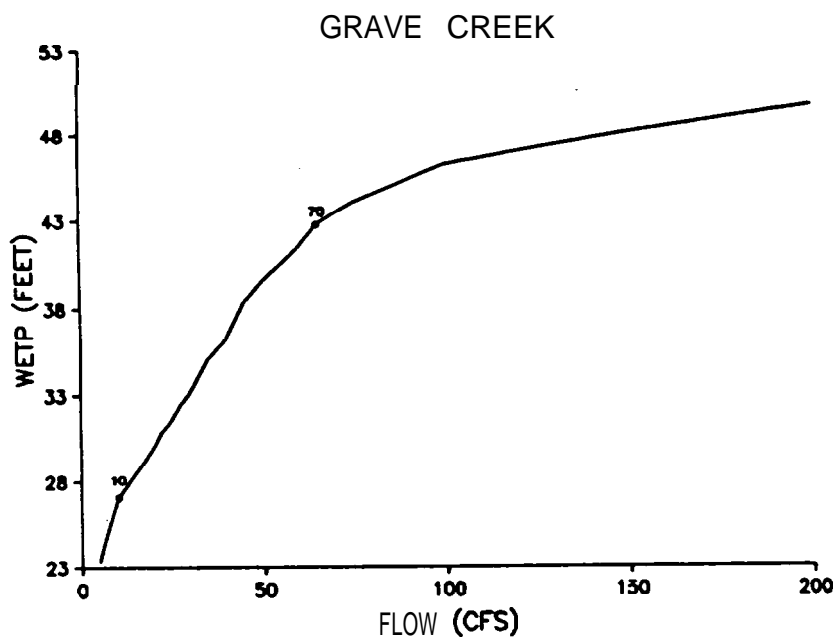
GRAVE CREEK

Figure 24.   The wetted perimeter-discharge relationship for five
riffle transects on Grave Creek 1985-1986.

surveys on Grave Creek and its major tributaries. Redds were located in Grave and Clarence creeks. Results are as follows:

		Grave Creek	Clarence Creek
1983	definite	40	31
	probable	8	6
1984	definite	22	12
	probable	1	0
1985	definite	24	3
	probable	9	2

FLOW RECOMMENDATIONS

Five permanent transects were established on riffle areas located approximately 1km upstream from the Highway 93 bridge (T35N, R26w, sec. 14, S-l/2). The WETP program was calibrated to stage and discharge measurements at flows of 73.0, 97.9, and 188.5 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 10 and 70 cfs, respectively (Figure 24). Based on an evaluation of the existing fishery, results of the wetted perimeter analysis and estimated water availability, a minimum discharge of 70 cfsis recommended for the low flow period from July 16 through March 31.

An average depth of 0.5 ft required for successful passage of spawning migrants is not reached until flows equal or exceed 70 cfs (Table 14). Aminimumpassage flow of 70 cfs is therefore recommended for the period from April 1 through July 15 to assure migrant passage and protect spawning redds from dewatering.

Tobacco River

Description

Stream reach: Tobacco River from the mouth on the eastern shore of Libby Reservoir (T36N, R27W, Sec. 8) to the confluence of Fortine and Grave Creek (T35N, R26W, Sec 15) (Figure 25).

Stream length: 24 km. Total drainage area: 1,135.2 km^2. Gradient: 6.3 m per km.

Source and Land Use

The Tobacco River forms at the junction of its two major tributaries, Fortine and Grave creeks. Fortine Creek begins on the east slopes of the Salish mountains and flows north for 45.1 km to its junction with Grave Creek. Grave Creek forms on the western slopes of the Whitefish Mountains and flows southwest for 28.3 km to the Tobacco River. Approximately 24 percent of the Tobacco Drainage is privately owned; the remainder is in the

Table 14. Average depth in five riffle transects on Grave Creek
at selected flows of interest.

Flow	Average depth (ft)				
(cfs)	CS1	cs2	cs3	cs4	CS5
10.0	.50	.30	.36	.43	.28
70.0	.83	.51	.81	.85	.59
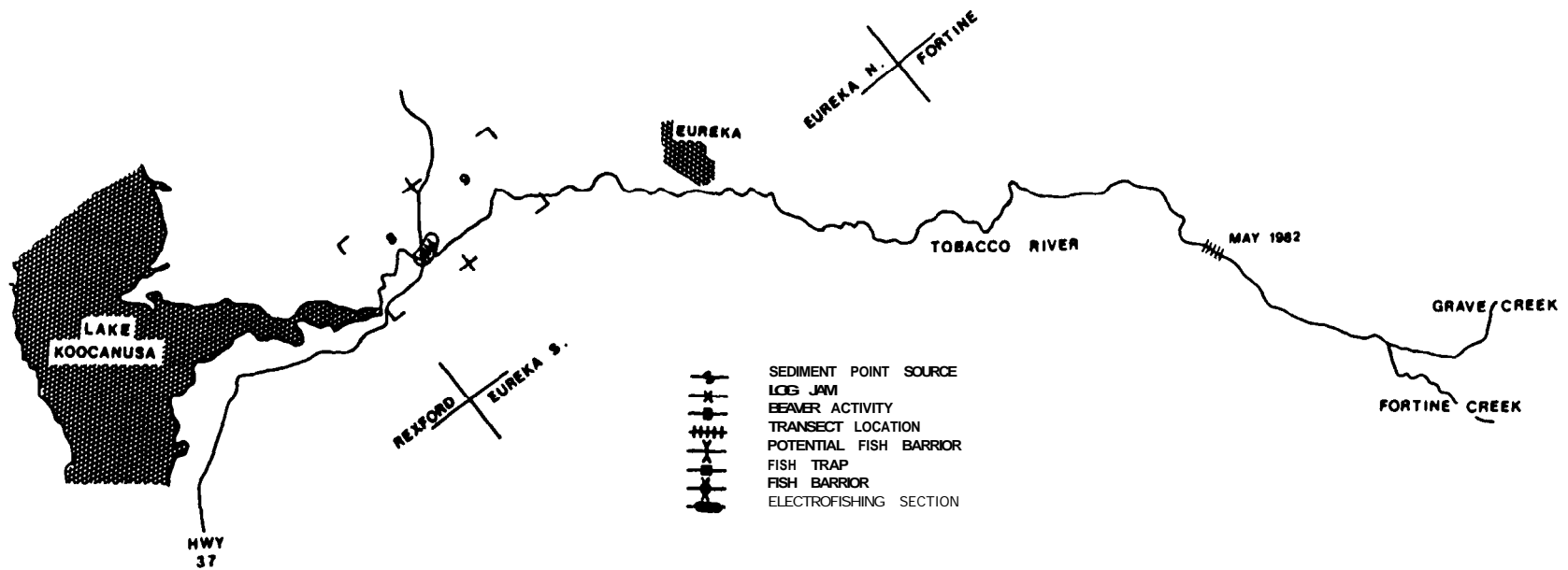
Figure 25. A map of the Tobacco River showing the location of transects and points of interest.

Kootenai National Forest. Timber production is the primary land use in the watershed. The lower drainage contains extensive arable lands in pasture and forage production.

Flows

A continuously recording stage-discharge station was maintained by the U.S. Geological Survey, Water Resources Division from October 1958 through September 1965 and from October 1967 through September 1985 (T36N, R27W, Sec. 9). Monthly mean flows based on 28 years of daily stage measurements and associated eightieth percentile exceedence flows are summarized in Figure 26. Mean annual discharge is 268.7 cfs. A wetted perimeter analysis was performed by the Montana Department of Fish, Wildlife and Parks approximately 1.6 km upstream from the mouth of Therriault Creek (T35N, R26W, Sec. 4) (May 1982).

Potential Environmental Problems

Water appropriations listed for the Tobacco River total 201.8 cfs, amounting to 75 percent of the 28-year mean annual discharge of 268.70 cfs (Index of Claims, State Water Rights, Helena, Montana). This total does not include water allotments for livestock nor water allocations on source tributaries which are apparently over-appropriated (see Grave and Deep creeks). If all water users exercise their water rights to the fullest extent, the Tobacco River could potentially become dewatered. It is not known, however, what percentage of existing claims are valid or presently in use. Future water rights will increase the potential for dewatering.

Source tributaries (Blue Sky, Clarence, Deep, Stahl, and Williams creeks) have been targeted for microhydro development. Although the former four applications were later withdrawn, the application on Williams Creek is still pending and future development in the drainage is anticipated when the region's power surplus declines and cost-benefit ratios improve making hydroelectric projects once again more attractive to developers. The watershed will be impacted by hydroelectric projects if they are installed, reducing habitat for migrant and rearing fish populations.

Sediment pollution from timber harvest and associated road building, and agricultural practices will continue to be a problem in the future. Sediment loading is most severe in Fortine Creek.

TOBACCO RIVER

discharge

Figure 26.   Mean monthly flows (top line) and eightieth
             percentile exceedence flows (bottom line) based
             on 28 years of daily stage records for the
             Tobacco River (USGS).

FISH POPULATIONS

Resident and Pre-emigrant Fish

A mark-recapture population estimate was conducted during September, 1985 in a representative 609.6-m section of stream chosen for its location between two shallow riffle areas encompassing the study transects (T36N, R27W, Sec., 8). Came fish were predominantly Salmo spp. (species composition: RB=96.6%, WCT=1.7%, HYB=1.7%). A total of 60 Salmo spp. were captured, producing an estimate of **156 ±62** fish (**≥75** mm) per km. A length-frequency histogram reveals modal lengths (Appendix A12). Based on recaptures and a catch efficiency curve (Appendix A13), all length categories were pooled. Relatively smaller numbers of bull trout (1) and mountain whitefish (10) were also captured. Discharge corresponding with the electrofishing survey was 89.4 cfs.

Migrant Fish

A point estimate based on a mark-recapture study of the spring spawning run disclosed that an estimated 5,937 rainbow and 516 westslope cutthroat trout utilized Tobacco River as a spawning area in 1976 (May and Huston 1980). May (1982) stated, "... the Tobacco River is the most important spawning and rearing drainage in the Montana portion of the Lake Koocanusa system."

The Tobacco River supports the largest spawning run of kokanee salmon of all U.S. Kootenai River tributaries. The 1985 immigration was estimated at 3,000 to 5,000 spawners, based on aerial survey (Personal Communication, Paul Hamlin, MDFWP). Spawning kokanee are harvested by sportsmen during the annual salmon snagging season

FLOW RECOMMENDATIONS

Five permanent transects were established in a series of five riffle areas of the Tobacco River upstream from the Highway 37 bridge (T36N, R27W, Sec. 8). The WETP program was calibrated to stage and discharge measurements at flows of 101.1, 170.0, and 45L0 cfs. The lower and upper inflection points in a plot of the wettedperimeter-discharge relationshipoccurredat70 and 120 cfs, respectively (Figure 27). Based on a reanalysis of data compiled on the Tobacco River by May 1982 at a station approximately 1.6 km upstream from the mouth of Therriault Creek, inflection points occurred at 65 and 95 cfs (Figure 28).

An average depth of 0.5 ft required for fish passage is met in all riffle transects when the flow equals or exceeds 32 cfs in the lowe portion of the Tobacco River (Table 15). Since the minimum flow recommendation for all periods of the year exceeds the minimum depth limit for successful passage, migration should not
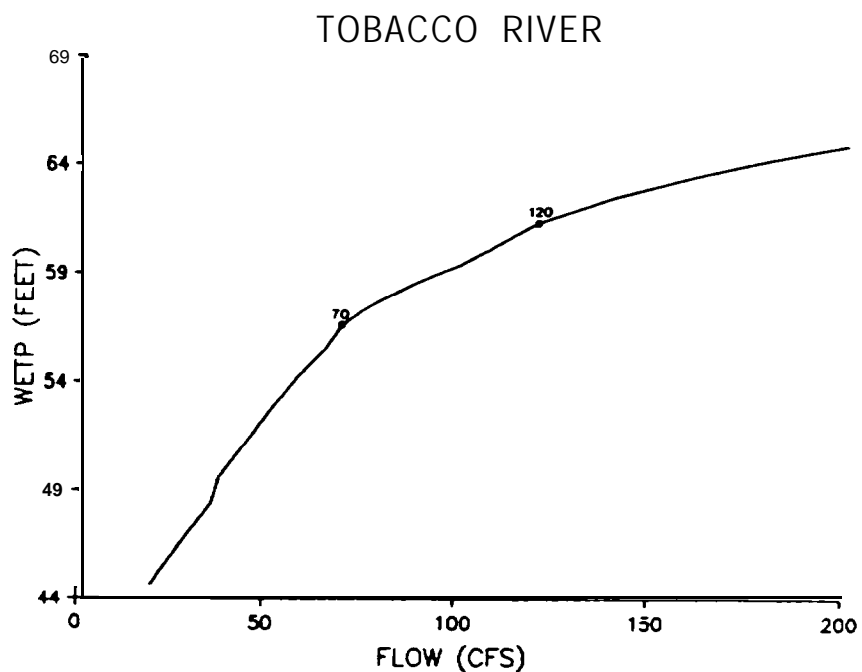
TOBACCO RIVER

Figure 27.   The wetted perimeter-discharge relationship for
five riffle transects on the Tobacco River 1985-1986.
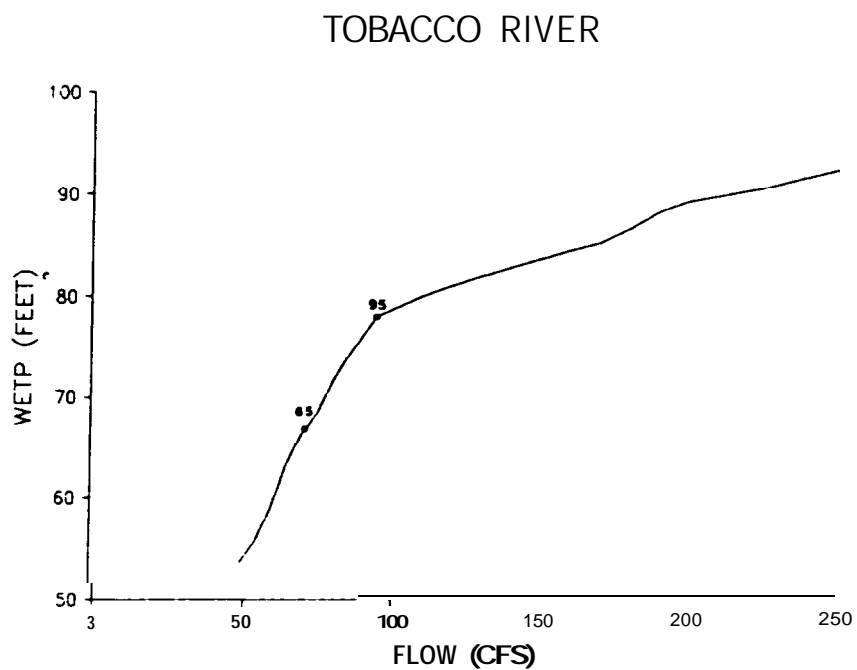
TOBACCO RIVER

Figure 28.   The wetted perimeter-discharge relationship for
five riffle transects on the Tobacco River May 1982).

Table 15. Average depth for five riffle transects in the Tobacco
           River at selected flows of interest,

Flow	Average depth (ft)				
(cfs)	CS1	cs2	cs3	cs4	cs5
32	.59	.67	1.02	.50	1.15
70	.80	.89	1.01	.74	1.46
120	1.05	1.09	1.16	1.02	1.72

be inhibited if instream flow recommendations are instituted as stated. A depth of 0.5 ft is not reached at all upper transects until flows equal or exceed 110 cfs (Table 16). A fish passage flow of 110 cfs is-recommended for the period from April 1 through July 15.

The results of both studies were combined for an overall recommendation for the Tobacco River (Table 17). Recommended flows amount to 47.1 percent of the mean annual discharge on record.

Table 16. The average depth for five riffle cross-sections in
           upper Tobacco River at selected flows of interest May
           1982).

Flow	Average depth (ft)				
(cfs)	CS1	cs2	cs3	cs4	cs5
65	.35	**.79**	**.91**	**.56**	**.45**
95	.46	.66	.81	.69	.49
110	.51	.70	.87	.73	.54

Table 17. Recommended minimum flows for the Tobacco River and historical water availability records based on 28 years of daily records (USGS).

Period of Water Year	Recomnended Flows	80% Exceedence Flows	Mean Flows	Acre Feet	Median Flows[b]
OCT 1 - OCT 15	95.0	76.6	115.1	3423.6	102.0
OCT 16 - OCT 31	95.0	81.0	115.1	3651.9	102.0
NOV 1 - NOV 15	95.0	86.3	124.5	3703.3	104.0
NOV 16- NOV 30	95.0	82.5	124.5	3703.3	104.0
DEC 1 - DEC 15	95.0	80.5	108.2	3218.4	99.0
DEC 16 - DEC 31	95.0	69.8	108.2	3433.0	99.0
JAN 1 - JAN 15	95.0	65.7	101.5	3019.1	95.0
JAN 16 - JAN 31	95.0	71.6	101.5	3220.4	95.0
FEB 31 - EEB 15	95.0	65.5	104.9	3120.3	96.0
FEB 16 - FEB 28	95.0	75.8	104.9	2496.2	96.0
MAR 1 - MAR 15	95.0	78.5	147.4	4384.4	115.0
MAR 16 - MAR 31	95.0	88.8	147.4	4676.7	115.0
APR 1 - APR 15	110.0	130.6	383.9	11417.1	228.0
APR 16 - APR 30	110.0	215.2	383.9	11417.1	355.0
MAY 1 - MAY 15[a]	200.0	414.5	801.5	23840.6	696.0
MAY 16 - MAY 31	400.0	603.7	801.5	25430.0	916.0
JUN 1 - JUN 15	400.0	598.3	773.8	23016.7	908.0
JUN 16 - JUN 30	200.0	380.0	773.8	23016.7	666.0
JUL 1 - JUL 15	110.0	201.8	318.6	9476.8	450.0
JUL 16 - JUL 31	95.0	112.8	318.6	10109.5	231.0
AUG 1 - AUG 15	95.0	88.9	129.8	3860.9	128.0
AUG 16 - AUG 31	95.0	72.7	129.8	4118.3	128.0
SEP 1 - SEP 15	95.0	78.8	115.4	3432.6	104.0
SEP 16 - SEP 30	95.0	80.0	115.4	3432.6	104.0
				194538.8	

[a] A dominant discharge flow (approximated bankful discharge presently undefined) should be maintained for 24 hours during this period.

[b] Derived from a nine-year period of record (between 1965 and 1973) for the USGS gauge near Eureka (4.5 km upstream from mouth) (May 1982).

Tributariestothe main stem Kootenai River below Libby Dam provide a great majority of recruits to the river fishery. In addition, the tributaries supply nutrients and food items such as benthic drift and prey fish populations. The following is a discussion of some of the tributaries identified as high priority spawning and rearing streams

Big Cherry Creek

Description

Big Cherry Creek (this reach is also listed as Granite Creek on some maps) from the mouth on Libby Creek (T30N, R31W, Sec. 14) to the confluence of Granite and Big Cherry creeks (T29N, R31W, Sec. 2) (Figure 29).

Stream length: 6.8 km. Total drainage area: 221.6 km^2. Gradient, Big Cherry Creek from Libby Creek to the confluence of Granite and Big Cherry Creek: 11.6 m per km.

Source and Land Use

Big Cherry Creek arises on the east face of the Cabinet Mountains in two major streams, Granite and Big Cherry creeks. Discharge from both streams combine and flow 6.8 km to merge with Libby Creek. Approximately 8 percent of the watershed is privately owned; the remainder is in the Kootenai National Forest. The headwaters drain portions of the Cabinet Mountain Wilderness. Timber production and mining are the primary land uses in the drainage.

Flows

A continuous stage recording station was maintained on Granite Creek by the U.S. Geological Survey from January through December 1933, August 1936 through November 1943, and August 1960 through October 1969. Mean monthly discharge and eightieth percentile exceedence flows for Granite Creek are presented in Figure 30. Little flow information exists for Big Cherry Creek which delivers a significant volume of water to the study area.

Potential Environmental Problems

Timber harvesting, mining and construction activities (especially surrounding the lower 5 km of the stream) in the watershed have increased sediment loading and peak flows resulting in channel stability problems and damage to the fish habitat.
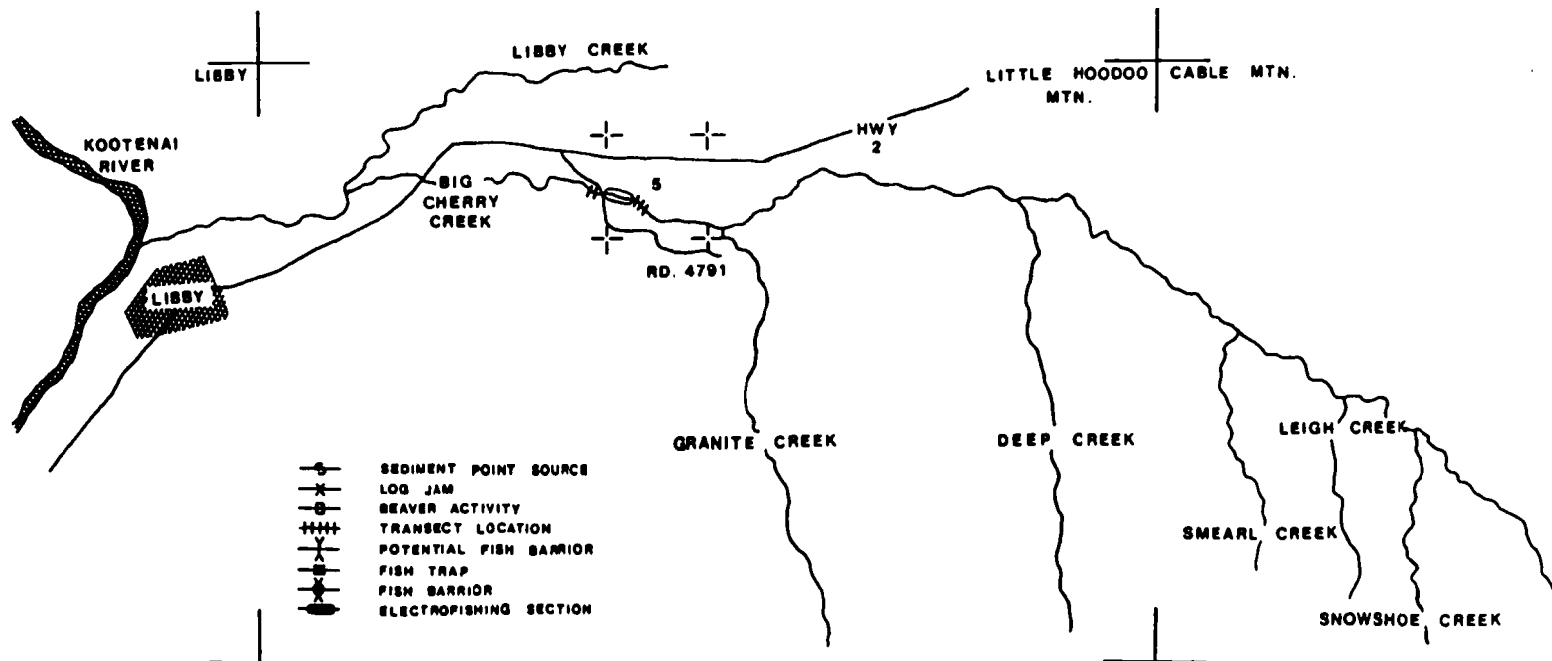
Figure 29. A map of Big Cherry Creek showing the location of transects and other points of interest.
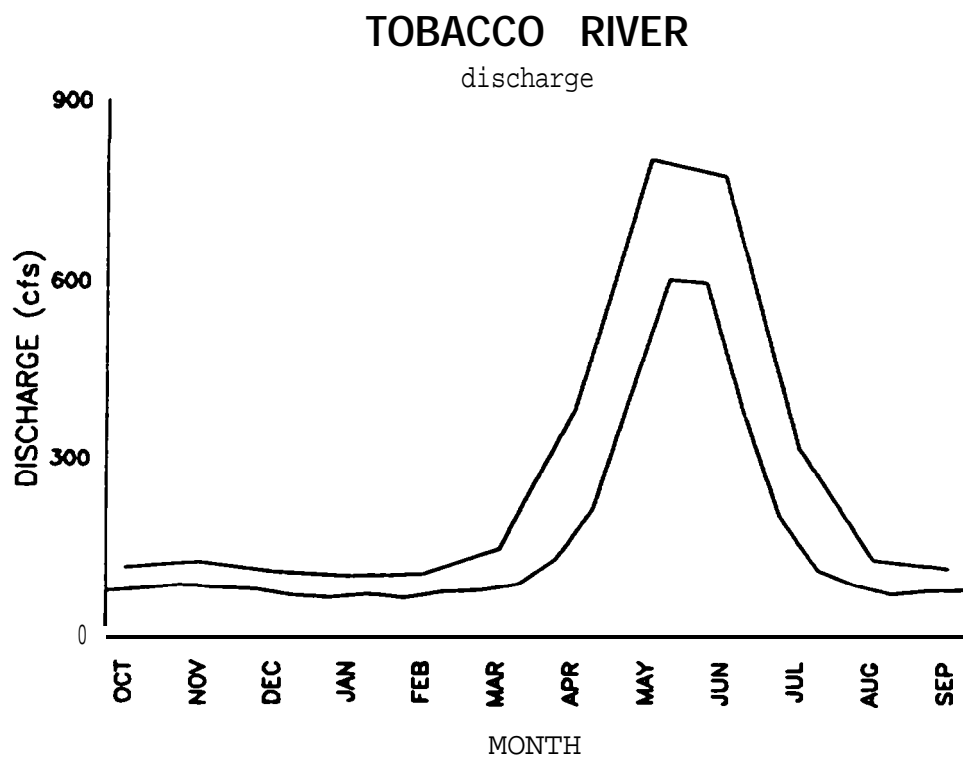
GRANITE CREEK
discharge
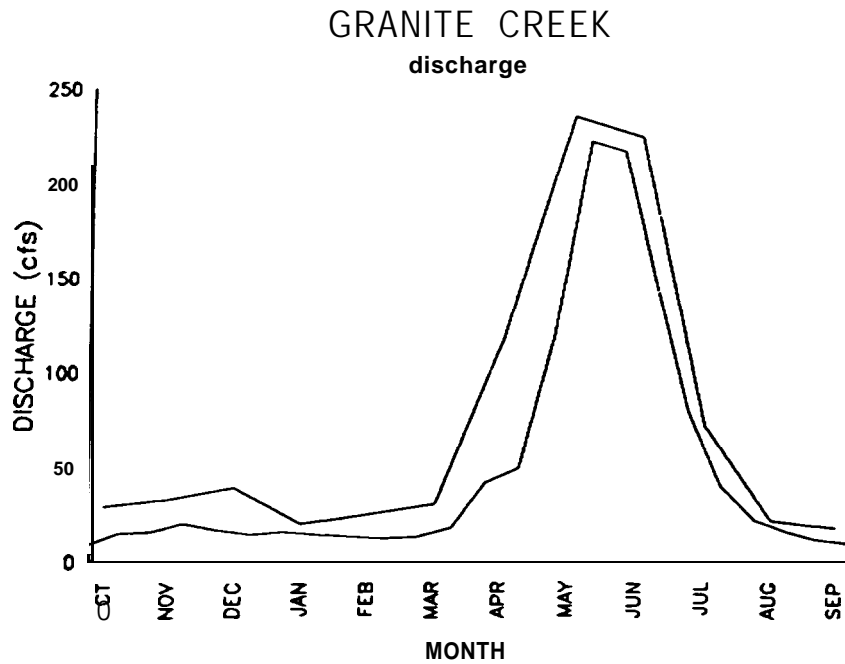
Figure 30. Mean monthly flows (top line) and eightieth percentile exceedence flows bottom line) based on ten years of daily stage records for Granite Creek (USGS). (Big Cherry Creek probably has similar hydrologic conditions.)
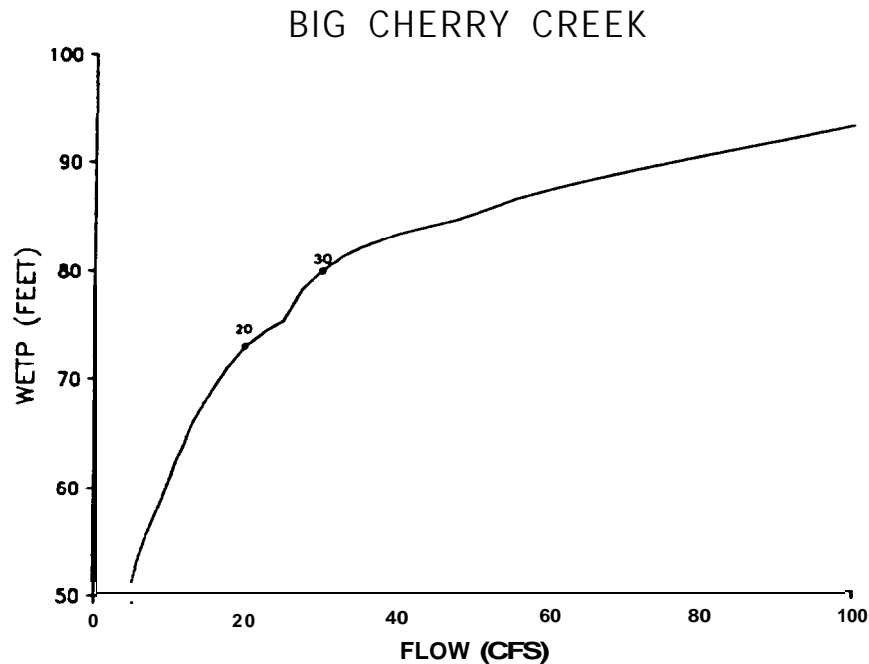
BIG CHERRY CREEK

Figure 3. The wetted perimeter-dischargerelationship for four riffle transects on Big Cherry Creek below the confluence of Granite and Big Cherry creeks 1985-1986.

Water appropriations for domestic use and mining total 33.14 cfs for Granite Creek alone. If water users exercise their water rights to the fullest extent, water in the reach below the confluence of Granite and Big Cherry Creeks could potentially reach extremely low levels, impacting available fish habitat. It is unknown, however, what portion of existing claims are valid or presently is use.

Pollution from an abandoned mine on Snowshoe Creek is limiting productivity in Showshoe and Big Cherry Creeks (May 1982).

FISH POPULATIONS

A mark-recapture population survey was conducted during August, 1986, in a 304.8-m section of stream chosen for its habitat characteristics which are representative of much of the stream and its location between two shallow riffle areas (T30N, R3lW, Sec. 35). Game fish were composed primarily of rainbow trout(75), yielding an estimate of 87$\pm$604 fish $\geq$75 mm per km, and relatively fewer numbers of eastern brook trout (4). The sparse population in this reach, characterized by channel instability, resulted in a limited sample size. A length-frequency histogram shows modal length of rainbow trout captured (Appendix Al4). Associated discharge was 24.3 cfs.

FLOW RECOMMENDATIONS

Five permanent transects were established in riffle areas in Big Cherry Creek from approximately 0.4 to 1.6 km downstream of the confluence of Granite and Big Cherry Creeks (T30N, R31W, Sec. 35). One transect was dropped due to channel morphology changes which occurred during the study period. Therefore, flow considerations were based on four transects. The WETP program was calibrated to stage and discharge measurements at flows of 20.8, 24.2, 274.2 and 444.2 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 20 and 30 cfs, respectively (Figure 31). Based on existing fish populations, results of the wetted perimeter analysis and estimated water availability a flow of 20 cfs is recommended for the low flow period from July through March 31. Since flow characteristics change significantly above the confluence of Granite and Big Cherry creeks, further research is recommended to clarify discharge requirements in the two major water sources. Combined flows should equal or exceed minimum recommendations set for the lower reach of the stream.

An average depth of 0.5 ft is not reached in all transects until the flow equals or exceeds 50 cfs (Table 18). A passage flow of 50 cfs is therefore recommended from April 1 through June 30 to ensure successful migration of fish during the spring spawning run.

Table 18. The average depth for four riffle cross-sections on Big
           Cherry Creek at selected flows of interest.

Flow	Average depth (ft)			
(cfs)	Cs2	Cs3	Cs4	Cs5
20	1.51	.53	.37	.42
30	1.32	.66	.42	.51
50	1.49	.85	.50	.63

Callahan Creek

Description

Stream reaches: Lower Callahan Creek from the mouth on the Kootenai River near Troy, Montana (T3lN, R34W, Sec. 13) to a 2.4-m falls and 7.62-m long cataract believed to be a barrier to migrant fish (T31N, R34W, Sec. 21). And Upper Callahan Creek from the falls to the source (T60N, R2E, Sec 34) in Idaho. Callahan Creek crosses the Montana Idaho border at T31N, R34W, Sec. 23) (Figure 32).

Stream length: mouth to falls, 8 km; falls to source, 12.8 km. Total drainage: 211.7 km^2. Gradient: mouth to falls, 24.9; falls to source, 29.6 m per km.

Source and Land Use

Callahan Creek originates on the eastern slopes of the West Cabinet Mountains and flows east for 20.8 km to the Kootenai River. Other than a few parcels of privately owned land and land belonging to Champion International in eight sections of the drainage, the entire watershed is in the Kootenai National Forest. The lower approximately 2 km flows through the southern portion of the city of Troy, Montana. Upstream, the creek is bordered by National Forest land except for a narrow strip at the Snowstorm Mine, which is privately owned.

Flows

The U.S. Geological Survey, Water Resources Division maintained a continuously recording stage-discharge station for July through June 1911 and October and April through June 1912 (T31N, R34W, Sec. 13). Although records do not include continuous data for the entire water years, a hydrograph was constructed based on best available data (Figure 33). Estimated mean annual discharge is 136.4 cfs.

POTENTIAL ENVIRONMENTAL PROBLEMS

Many steep slopes within the Callahan drainage are composed of fine materials easily erodable by timber harvest activities and associated road building. A potential exists for sediment loading. Channel stability is poor in areas above and below the deeply incised canyon area.

Remnants of past mining endeavors remain in the stream below the Snowstorm mine site.
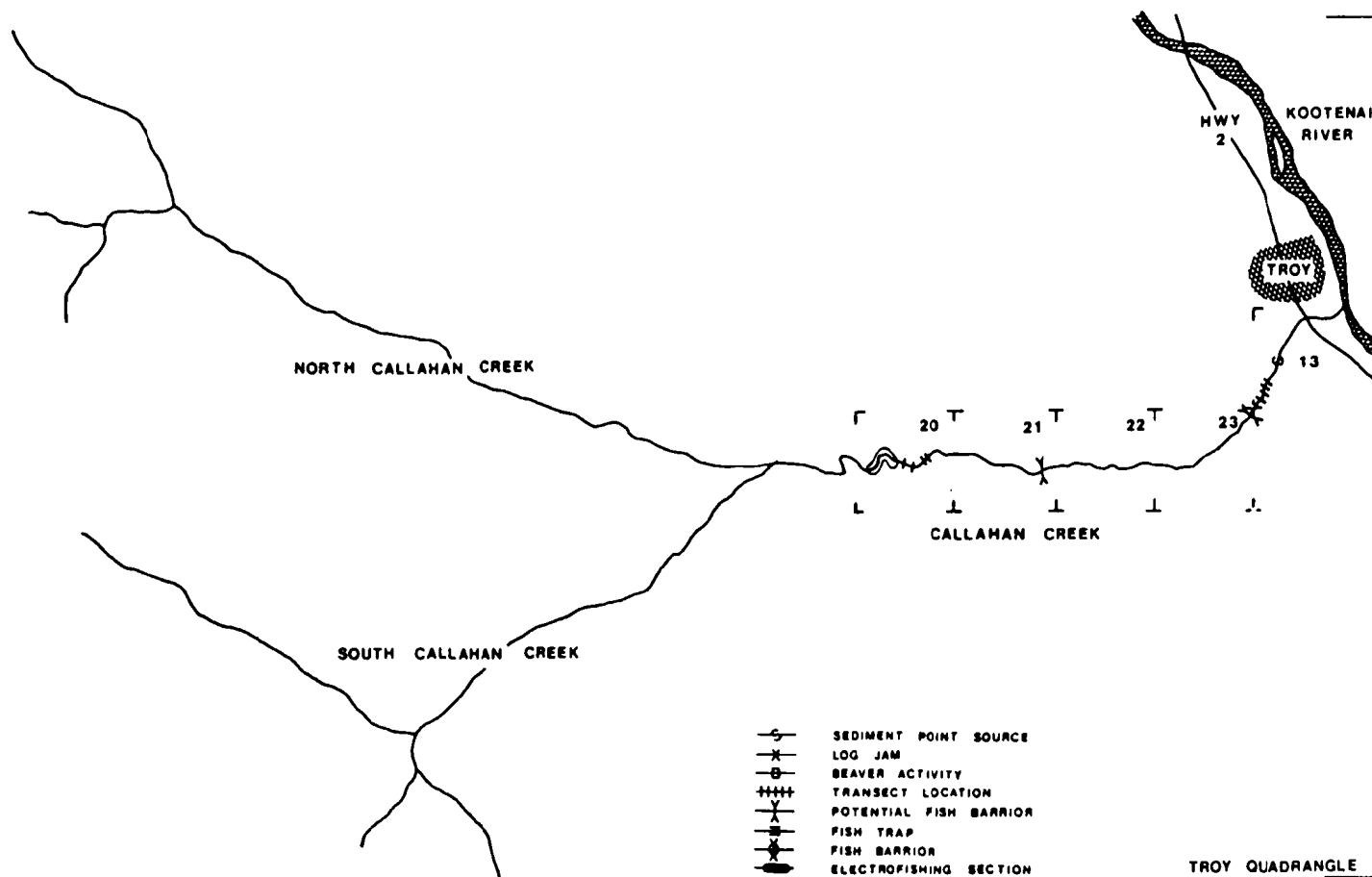
Figure 32. A map of Callahan Creek showing the location of transects and other points of interest.

CALLAHAN CREEK
estimated annual hydrograph
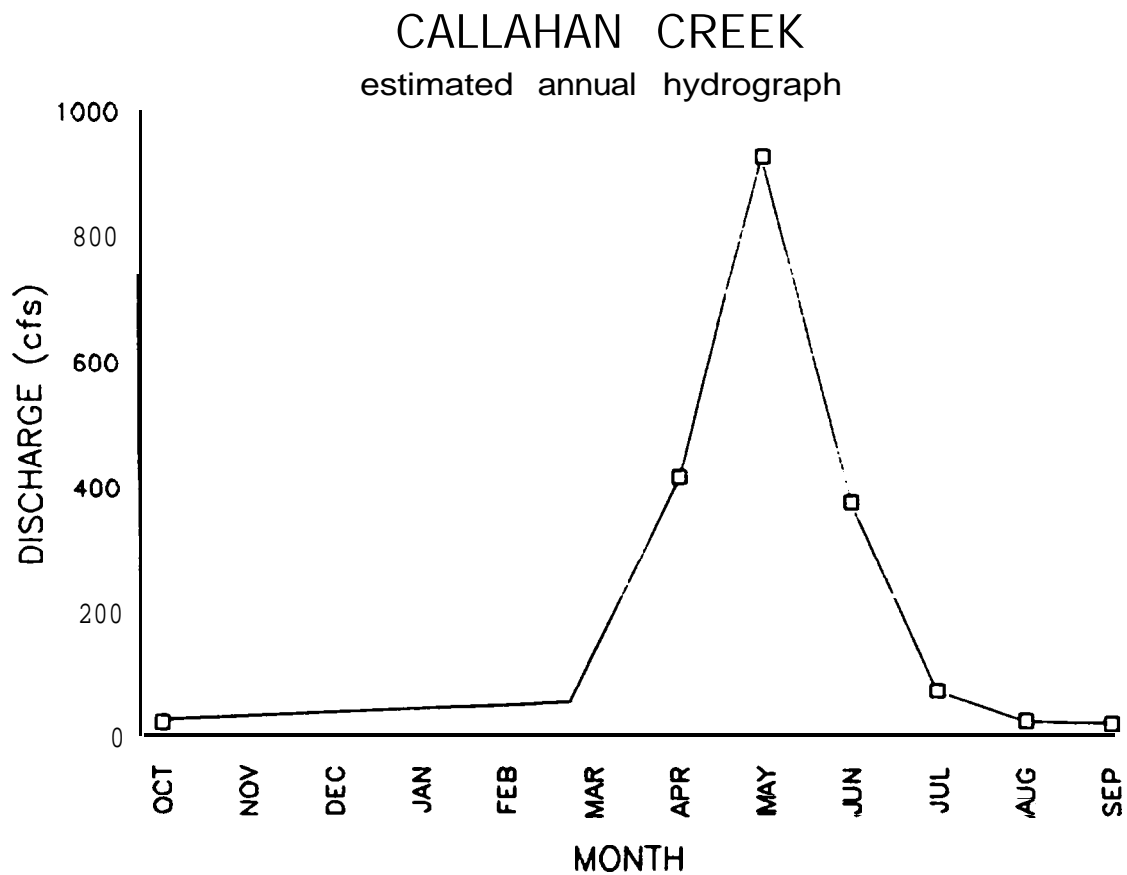
Figure 33.   An estimated annual hydrograph for Callahan Creek
based on USGS daily stage-discharge measurements
during the 1911 and 1012 water years, and miscel-
laneous measurements.

FISH POPULATIONS

Resident Fish

A mark-recapture population assessment was conducted in a representative 228.6-m section of stream chosen for its location between two channel constrictions. Game fish were predominantly pure-strain inland rainbow endemic to the Callahan drainage (Allendorf and Phelps 1980) and fewer numbers of bull trout (Table 19). Length-frequency histograms show modal lengths (Appendix A15). The native rainbow trout in upper Callahan Creek are genetically isolated from Kootenai River rainbow which have become hybridized with a coastal form. It is believed that the falls located between lower and upper Callahan Creek is a barrier to migrants from the river, creating aboundarybetweenthetwo dissimilar genetic strains.

Migrant Fish

A spring spawning run of riverine <u>Salmo</u> spp. was observed entering Callahan Creek. Access is apparently available for spawning migrants only in the lower 8.0 km of the tributary. High flows precluded migrant trapping, however, one large female rainbow trout (540 mm, 2,127.3 g) was successfully captured, tagged and released.

FLOW RECOMMENDATIONS

A total of 9 transects were established in riffle areas on Callahan Creek, four above (T31N, R34W, Sec. 20), and five below the probable fish barrier (T31N, R34W, Sec. 22). One transect in the lower section was washed out prior to completion of the study. Consequently calculations are based on four transects in each area. The wetted perimeter program was calibrated to stage and discharge measurements at flows of 31.3, 61.3, 180.1 below the barrier (lower) and 61.7, 175.3, and 407.5 above the barrier (upper). The two inflection points in a plot of the wetted perimeter-discharge relationship occur at 35 and 60 cfs (lower) and 28 and 50 cfs (upper) (Figures 34 and 35). A flow of 60 cfs is recommended for the lower reach and a flow of 50 cfs is recommended for the upper reach during the low flow period from July 1 through March 31.

An average depth of 0.5 ft is not reached in all transects until the flow equals or exceeds 75 cfs, (Table 20). consequently, a flow of 75 cfs is recommended for the period of April 1 through June 30.

Table 19. Results of a mark-recapture population estimate
conducted in Callahan Creek (T31N, R34W, Sec. 20)
during August 1986. No flow on record

	Total Number Captured	Estimated Numbr Fish $\geq$75 mm per km
Native rainbow trout	74	906 $\pm$551[a]
Bull trout	3	[b]

[a] **Low** conductance of water reduced catch efficiency.

[b] Insufficient captures.

75
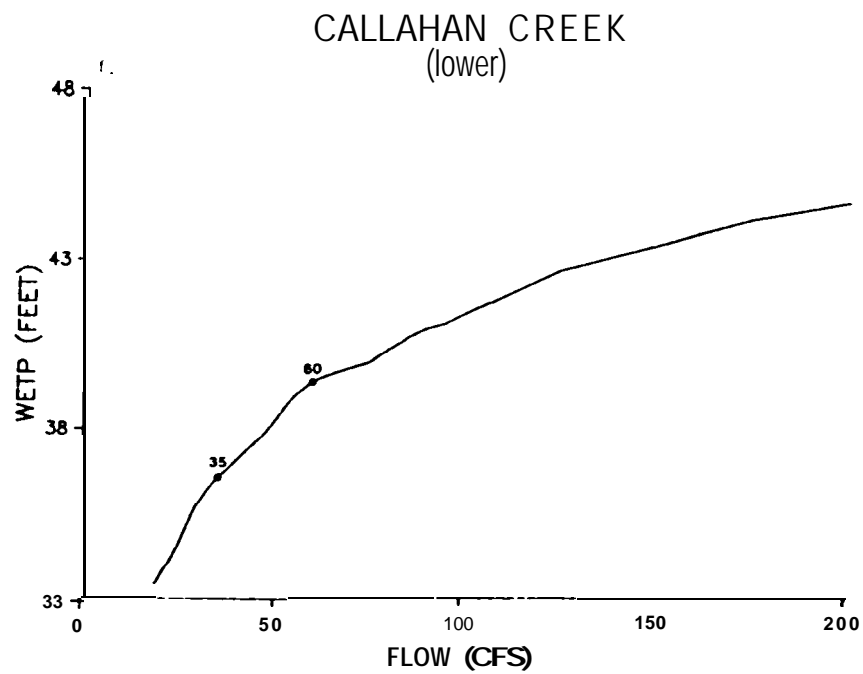
Figure 34.   The wetted perimeter-discharge relationship for
              four riffle transects on Callahan Creek below the
              falls, 1985-1986
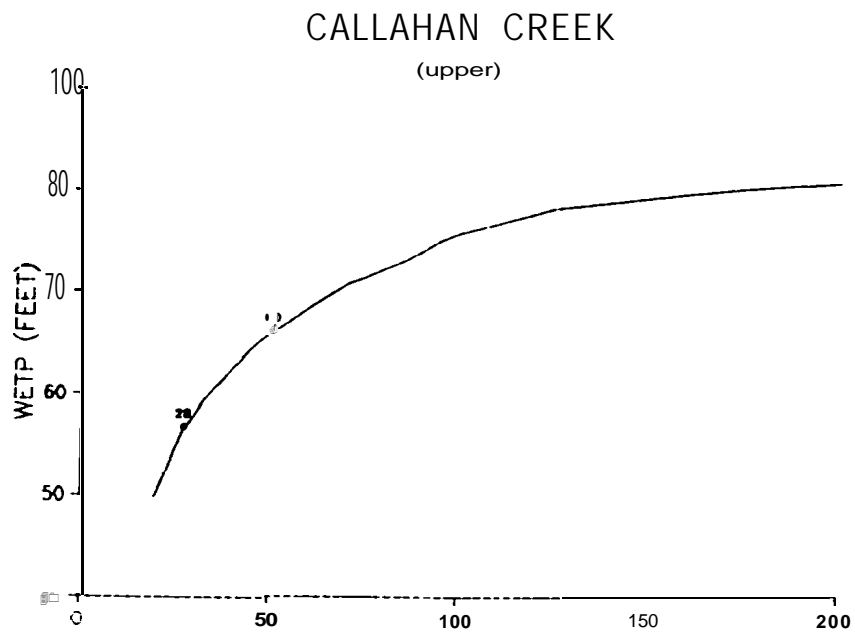
Figure 35.   The wetted perimeter-discharge relationship for
              four riffle transects on Callahan Creek above
              the falls, 1986.

Table 20. The average depth for nine riffle cross-sections on
          Callahan Creek at selected flows of interest.

Flow (cfs)	Average depth (ft)			
Lower	Cs2	Cs3	Cs4	cs5
35	.73	.78	.88	.70
60	.89	.94	1.01	.86
75	.97	1.01	1.12	.96
Upper	CS6	Cs7	CS8	cs9
28	.48	.41	.54	.34
50	.65	.56	.57	.41
75	.78	.66	.64	.50

Fisher River

Description

Stream reach: The Fisher River form its confluence with the Kootenai River (T27N, R29W, Sec. 17) upstream to Loon Lake (T27N, R28W, Sec. 27) (Figure 36).

Stream length: mouth to Wolf Creek, 18.0 km; Wolf Creek to Loon Lake, 51.8 km. Total length, mouth to Loon Lake, 69.8 km. Total drainage area: 2,170.4 km^2. Gradient: Wolf Creek to W. Fisher Creek, 3.9 m per km.

Source and Land Use

The Fisher River begins on the west slopes of the Salish Mountains and is the largest tributary to the Montana portion of the Kootenai River drainage. Approximately 80 percent of the Fisher watershed is privately owned, mainly by Burlington Northern and Champion International; the remainder is in the Kootenai National Forest. Nearly all of the river bottom is bordered by private land. The primary land uses in the drainage include timber production and cattle ranching.

Flows

A continuous stage recording station was maintained by the US. Geological Survey, Water Resources Division from 1967 through 1985 (T30N, R29W, Sec. 21). Monthly mean discharges based on 18 years of daily stage measurements and associated eightieth percentile exceedence flows are summarized in Figure 37. Mean annual discharge is 507.7 cfs.

Potential Environmental Problems

Timber production and cattle ranching have increased erosion in the watershed and destroyed much of the original riparian vegetation. Soils in the watershed are primarily unconsolidated glacio-lacustrine silts, easily eroded when the vegetation cover is depleted.

The lower reach of Fisher River from the mouth upstream to Wolf Creek was extensively channelized between 1965 and 1968 during relocation of the railroad. Construction activities denuded large areas of land and created steep slopes along the railroad grade and in channelized portions of the river. Increased sediment loading is most serious in Wolf Creek and the Fisher River downstream of the mouth of Wolf Creek.

KOOTENAI
RIVER

FISHER RIVER

12

—S—	SEDIMENT POINT SOURCE
—X—	LOG JAM
—8—	BEAVER ACTIVITY
++++	TRANSECT LOCATION
—X—	POTENTIAL FISH BARRIOR
—■—	FISH TRAP
—X—	FISH BARRIOR
—●—	ELECTROFISHING SECTION

TONY PEAK | FISHER MTN.
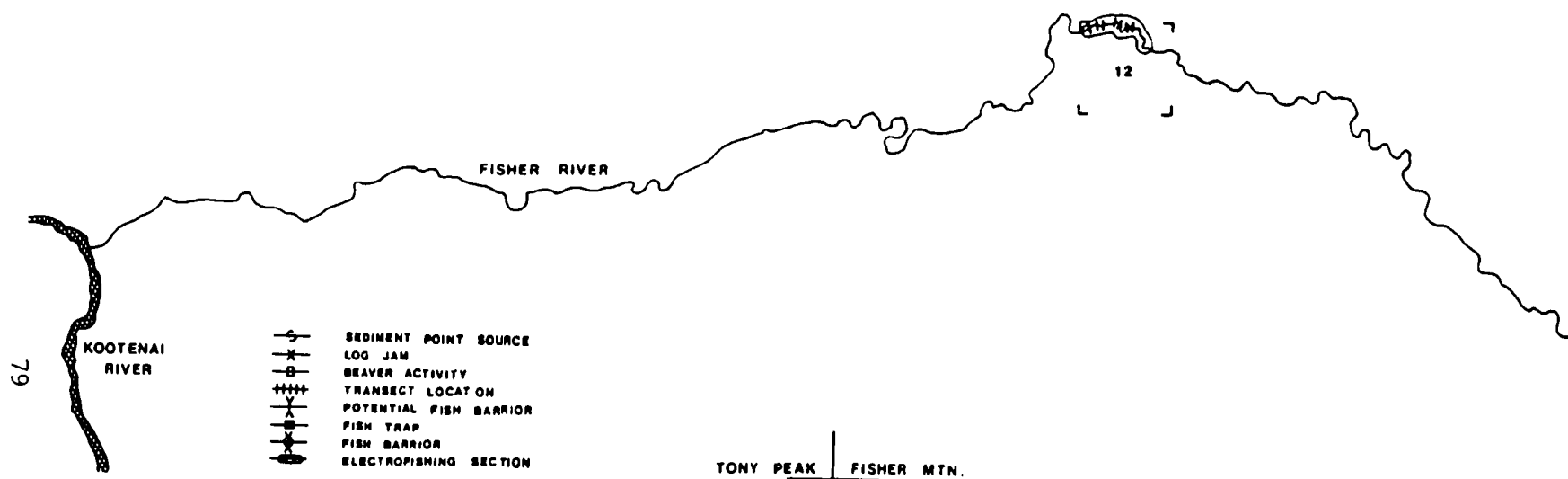
Figure 36.   A map of the Fisher River showing the location of transects and other points
of interest.

FISHER RIVER
discharge
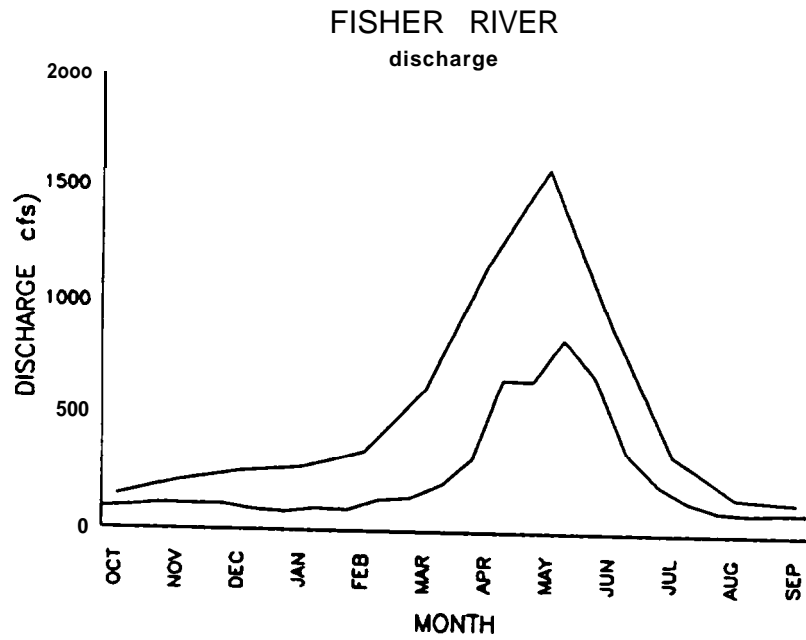
Figure 37.   Mean monthly flows (top line) and eightieth
              percentile exceedence flows (bottom line) based
              on 18 years of daily stage records for the
              Fisher River (USGS).
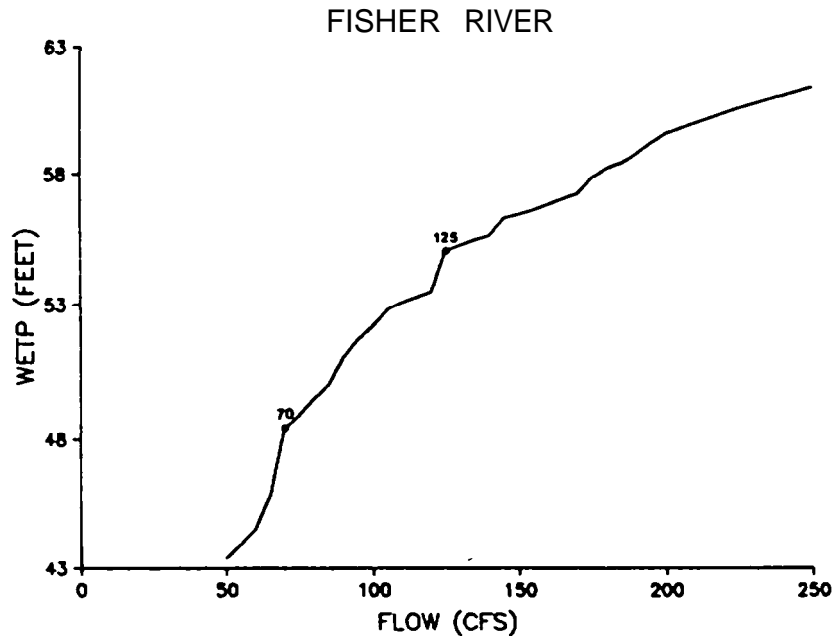
FISHER RIVER

Figure 38.   The wetted perimeter-discharge relationship for
              eight riffle transects on the Fisher River 1985-1986.

FISH POPULATIONS

Resident and Pre-emigrant Fish

A mark-recapture population estimate was conducted on a 4,828-m section of the Fisher River from Snell to Cow creeks, chosen for a comparison with a previous population assessment (May 1972). Mountain whitefish appeared to be the most abundant fish species in the sample areas based on snorkeling observations. A small recapture percentage reduced the reliability of an estimate and suggested that the population may have been migrating, violating the assumption of a closed population. A length-frequency histogram depicts modal lengths (Appendix A16). Rainbow trout were the most numerous fish captured, followed by eastern brook trout and burbot (3) (Table 21).

The length-frequency histogram (Appendix A17) and catch efficiency curves pertaining to rainbow trout (Appendix A18) indicate that the population is best described in three length groups: fish >55 mm through 90 mm; fish > 90 mm through 160 mm: and fish > 160 mm through 305 mm. It appears as though little change has occurred in the rainbow population since 1970.

Migrant Fish

Box trap sampling, conducted during the fall spawning run of 1969 and 1971 revealed that mountain whitefish run was the primary species taken, with fewer numbers of bull trout and eastern brook trout. The minimum estimate of the whitefish river was 1,131 in 1969 and 2,641 in 1970. These are the minimum number of whitefish that entered the Fisher River to spawn because trap operation was not 100 percent efficient (May 1982).

A kokanee salmon run in the Fisher River was subsampled by commercial whitefish fisherman (Gary Smith, Rear Creek Fisheries, Libby, MT, personal communications). Although catch information is incomplete due to inconsistent trapping effort, an estimated 4,000 to 5,000 kokanee were captured and released from the trap, suggesting that the Fisher River may contribute recruits to the Kootenai River and Kootenay Lake below Libby Dam.

FLOW RECOMMENDATIONS

Eight permanent transects were establishment on riffle areas in the Fisher River between the mouths of Snell and Cow Creeks (T28N, R29W, Sec. 12). The WETP program was calibrated to stage and discharge measurements at the following flows:

Table 21. The results of a mark-recapture population estimate
conducted on the Fisher River from Snell Creek to Cow
Creek (T28N, R29W, Sec. 12) during August 1986.
Discharge 73.4 cfs.

	Total Number Captured	Estimated Number Fish per km
Mountain Whitefish >85 - 440 mm	262	a/
Rainbow trout >55-90 mm >90-160 mm >160-305 mm	141 611 130	83 +34 219 +38 52 +20
Total		354 +92
Rainbw trout (May 1982) >75 mm (1970) >75 mm (1971)		246 +153 525 +310
Eastern brook trout >75-205	20	4 +1

a/ Insufficient recaptures for estimate.

82

Transect:	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8
Flows:	155.0	132.2	132.2	132.2	132.2	132.2	155.0	155.0
(cfs)	220.0	155.0	155.0	155.0	155.0	155.0	220.0	220.0
	446.4	220.0	220.0	220.0	220.0	391.2	446.0	446.0
		391.0	391.0	391.0	391.0	446.6		990.8
		446.0	446.4	446.0	446.0			
			1965.7					

The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occurred at 70 and 125 cfs, respectively (Figure 38). A flow of 125 cfs is recommended for the low flow period from July 1 through March 31. Since the flow characteristics change substantially in the portion of the Fisher River upstream of West Fisher Creek, further research is recommended to clarify discharge requirements in West Fisher Creek, Pleasant Valley Fisher River, Silver Butte and East Fisher River.

The flow required to ensure fish passage during the spring spawning run (0.5 ft average depth) is 100 cfs (Table 22). A flow of 100 cfs is recommend for fish passage during the period from April 1 through July 15. Since these flows are within the recommended minimum flow during the period from July 16 through March 31, fish passage should not be a problem if recommended minimum flows are maintained (Table 23). Recommended flows amount to 48.3 percent of mean annual discharge on record.

Libby Creek

Description

Stream reach: Libby Creek from the mouth on the Kootenai River (T30N, R31W, Sec. 2) to the headwaters (T27N, R31W, Sec. 21) (Figure 39).

Stream length: 42.2 km. Total drainage area: 597.7 km^2. Gradient: 14.8 m per km.

Source and Land Use

Libby Creek originates on the east slope of the Cabinet Mountains and flows north, northeast to the Kootenai River. Approximately 82 percent of the Libby Creek watershed is in the Kootenai National Forest, with the remainder in private and state ownership. Source headwaters drain portions of the Cabinet Mountain Wilderness. Timber production is the primary land use in the drainage. The lower section of creek bottom is subdivided into 1-10 acre plots. The area of Libby Creek from the mouth upstream for 1.6 km flows adjacent to a Champion International Lumber Mill.

Table 22. The average depth for eight riffle cross-sections in
           Fisher River at selected flows of interest.

Flow	Average depth (ft)							
(cfs)	csl	CS2	CS3	CS4	CS5	CS6	CS7	CS8
70	1.13	.95	1.50	1.11	1.45	.90	.98	.43
100	.78	1.09	1.61	1.26	1.46	1.05	1.10	.50
125	.80	1.20	1.70	1.36	1.60	.99	1.13	.59

Table 23. Recommended minimum flows for the Fisher River and
historical water availability records based on 18 years
of daily records (USGS).

Period of Water Year	Recommended Flows	80% Exceedence Flows	Mean Flows	Acre Feet
OCT 1 - OCT 15	125.0	89.4	141.2	4200.0
OCT 16 - OCT 31	125.0	96.0	141.2	4480.0
NOV 1 - NOV 15	125.0	106.4	201.7	5999.6
Nov 16 - NOV 30	125.0	105.0	201.7	5999.6
DEC 1 - DEC 15	125.0	105.1	244.3	7266.7
DEC 16 - DEC 31	125.0	84.7	244.3	7751.2
JAN 1 - JAN 15	125.0	78.9	264.9	7879.5
JAN 16 - JAN 31	125.0	92.4	264.9	8404.7
FEB 1 - FEB 15	125.0	87.3	336.3	10003.2
FEB 16 - FEB 28	125.0	129.5	336.3	8002.6
MAR 1 - MAR 15	138.0	137.8	619.8	18436.0
MAR 16 - MAR 31	195.0	195.3	619.8	19665.0
APR 1 - APR 15	312.0	312.3	1163.4	34605.3
APR 16 - APR 30	659.0	659.2	1163.4	34605.3
MAY 1 - MAY 15	**657.0**	657.0	1587.0	47205.3
MAY 16 - MAY 31	**842.0**[a]	841.9	1587.0	50352.3
JUN 1 - JUN 15	678.0	678.2	919.2	27341.6
JUN 16 - JUN 30	324.0	342.3	919.2	27341.6
JUL 1 - JUL 15	207.0	207.1	330.8	9839.6
JUL 16 - JUL 31	125.0	133.0	330.8	10495.6
AUG 1 - AUG 15	125.0	96.4	150.7	4482.6
AUG 16 - AUG 31	125.0	87.9	150.7	4781.4
SEP 1 - SEP 15	125.0	92.2	133.3	3965.0
SEP 16 - SEP 30	125.0	93.1	133.3	3965.0
				367574.0

[a] A dominant discharge flow (approximated bankful flow presently
undefined) should be maintained for 24 hours during this
period.

85

LIBBY

KOOTENAI
RIVER

LIBBY

LIBBY CREEK

16

HWY
2

FARM TO MARKET
ROAD

SWEDE MTN. HORSE MTN.
LITTLE HOODOO CABLE MTN.
MTN.

MAY 1982

CRAZYMAN CREEK

LITTLE CHERRY
CREEK

BEAR CREEK

SEDIMENT POINT SOURCE
LOG JAM
BEAVER ACTIVITY
TRANSECT LOCATION
FISH BARRIOR
FISH TRAP
FISH BARRIOR
ELECTROFISHING SECTION
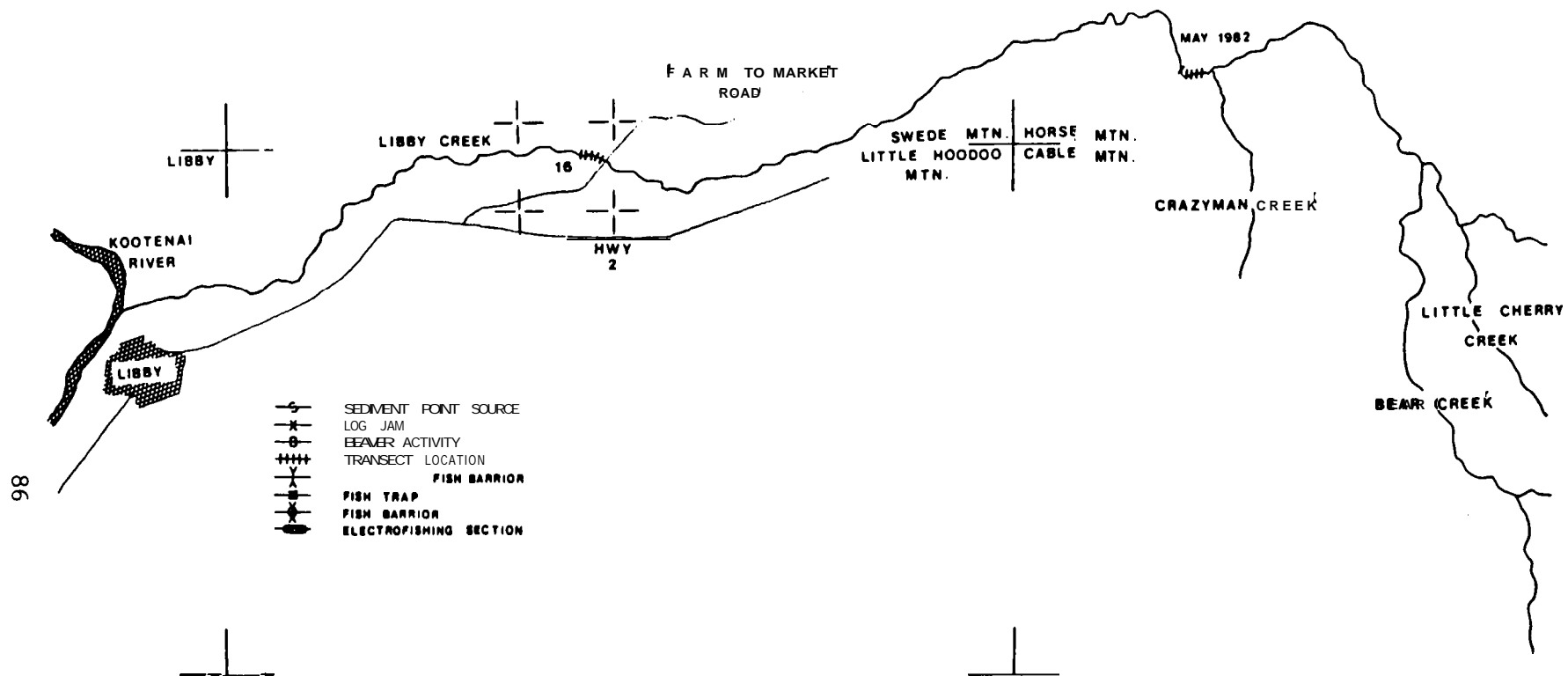
Fiqurc 39.   A map of Libby Creek showing the location of transects and other points of interest.

<u>Flows</u>

Little flow information exists for Libby Creek except for miscellaneous measurements taken by the U.S. Geological Survey and by personnel of the Kootenai National Forest. Estimated mean annual discharge is 157.2 cfs. A wetted perimeter analysis was performed by the Montana Department of Fish, Wildlife and Parks approximately 21 km upstream from its confluence with the Kootenai River (T28N, R30W, Sec. 5) (May 1982).

<u>Potential Environmental Problems</u>

Total water appropriations listed for Libby Creek amount to 124.3 cfs not including some allotments for livestock which are based on stock type and herd size. If all water users exercise their water rights to the fullest extent possible, the stream would be dewatered for mostofthe water year. It is not known, however, what percentage of existing claims are valid or presently in use.

Timber production, road building and the removal of vegetation from the floodplain for pasture and housing developments have increased peak flows resulting in severe channel instability and sediment loading to the drainage system.

Pollution from an abandoned mine and mill on Snowshoe Creek is limiting fish production on Snowshoe and Big Cherry Creeks, tributaries to Libby Creek (May 1982).

<u>FISH POPULATIONS</u>

<u>Resident and Pre-emigrant Fish</u>

A mark-recapture population survey was conducted on a 1,981.2-m section of Libby Creek from the Farm to Market Road bridge downstream to the Champion Hawl Road bridge. The location was selected for comparison with a similarly placed population assessment completed in 1977 (May 1982). Gamefish were composed primarily of rainbow trout and relatively fewer numbers of eastern brook trout and mountain whitefish (Table 24). Based on the length-frequency histogram (Appendix A19) and catch efficiency curves pertaining to rainbow trout in Libby Creek (Appendix A20), the population is best described in two groups:

Fish >75 mm through 155 mm TL
and Fish >155 mm through 345 mm TL.

Results indicate a substantial decline in rainbow trout since 1977. Length-frequency histograms describe modal lengths of eastern brook trout (Appendix A21).

Table 24.   Results of a mark-recapture population estimate conducted in Libby Creek (T30N, R31W, Sec. 36) during July
            1986. Discharge 27.7 cfs.

Length Category	Total Number Captured	Estimated Number Fish $\geq$75 mm per km
Rainbow trout (1986)		
>75-155 mm	251	236 $\pm$66
>155-345 mm	49	30 $\pm$13
Total		266 $\pm$79
Rainbow trout (1977)		850 $\pm$161[b]
Eastern brook trout		
>75-210 mm	38	25 $\pm$11
Mountain whitefish		
>70-360 mm	12	[a]

[a] Capture insufficient for estimate.

[b] Based on (P$\geq$0.80) (May 1982).

<u>Migrant Fish</u>

Based on sporadic fish trapping data during the spring spawning runs of 1976, 1977 and 1981, May (1982) stated that "Libby Creek probably supports a run of 400-1,000 rainbow trout andisthe most important spawning and nursery tributary down-stream from Libby Dam." Average length of males captured during thethreetrapping efforts were 408.9 mm, 411.5 mm and 368.3 mm, whereas females were larger averaging 472.4 mm, 485.1 mm, and 393.7 mm during 1976, 1977 and 1981 respectively.

A run of kokanee salmon was passed upstream through a trap structure near the mouth of Libby Creek by a commercial whitefish fisherman (Gary Smith, personal communications). Although catch information is incomplete due to inconsistent trapping effort, an estimated 100 kokanee entered Libby Creek to spawn, suggesting that Libby Creek and its tributaries may contribute recruits to the Kootenai River and Kootenay Lake below Libby Dam.

FLOW RECOMMENDATIONS

Five permanent transects were installed across riffle areas in Libby Creek (T30N, R31W, Sec. 36). The WETP program was calibrated to stage and discharge measurements at flows of 31.8, 82.2 and 209.6 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 9.0 and 22.5 cfs, respectively (Figure 40). Based on existing fish populations, the wetted perimeter analysis and estimated water availability, a flow of 22 cfs is recommended for the low flow period from July 16 through March 31.

An average depth of 0.5 ft, required for migrant fish passage, is not met until flows equal or exceed 37.5 cfs (Table 25). A flow of 38.0 cfs is recommended for the period from April 1 through July 15 in ensure a successful spawning run and to protect spawning redds from dewatering.

Based on a reanalysis of data compiled on Libby Creek by May (1982) at a station approximately 21 km upstream from its confluence with the Kootenai River, inflection points occurred at 12 and 45 cfs (Figure 41). A flow of 15 cfs is recommended for Libby Creek upstream of T28N, R30W, Sec. 5 to Bear Creek during the period from July 16 through March 31.

A depth of 0.5 ft is not reached at all transects until flows equal or exceed 35 cfs (Table 26). A fish passage flow of 35 cfs is recommended for the period from April 1 through July 15.
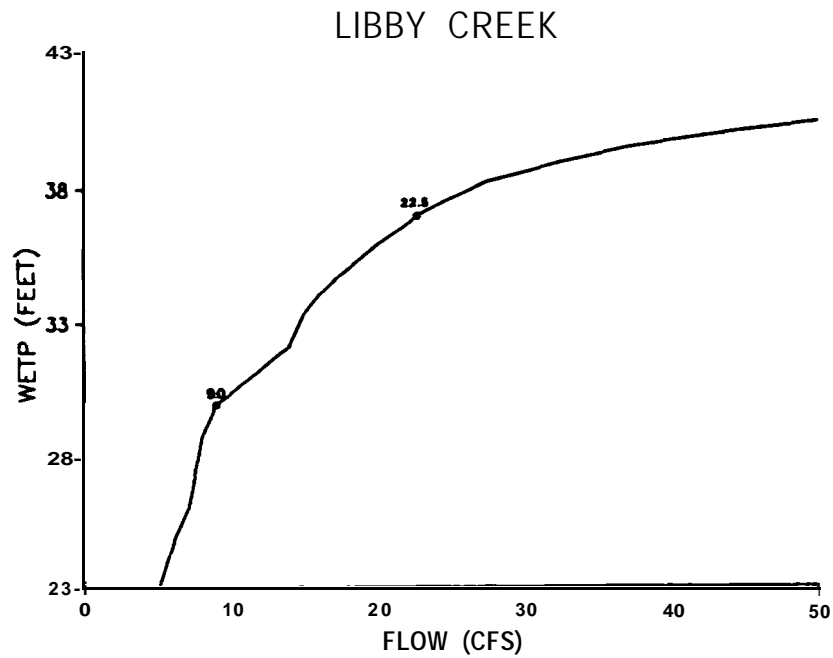
LIBBY CREEK

Figure 40. The wetted perimeter-discharge relationship for five riffle transects on Libby Creek 1985-1986.
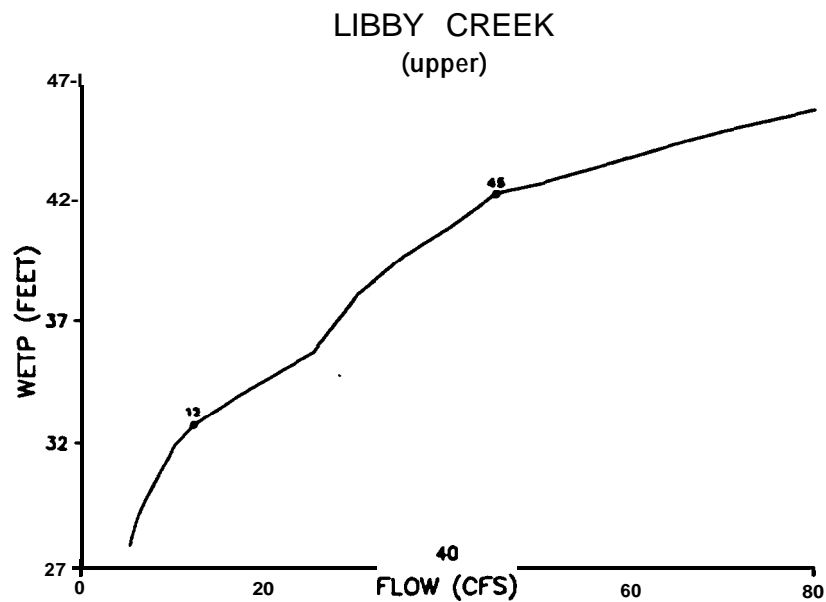
LIBBY CREEK
(upper)

Figure 41. The wetted perimeter-discharge relationship for five riffle transects on Libby Creek (May 1982).

Table 25. The average depth for five riffle cross-sections in
          Libby Creek at selected flows of interest.

Flow (cfs)	Average depth (ft)				
	CS1	Cs2	Cs3	Cs4	Cs5
9.0	**.36**	**.29**	**.31**	**.29**	.32
22.5	.57	.37	.53	.53	.51
37.5	.69	.50	.69	.70	.67

Table 26. The average depth for four riffle cross-sections in upper Libby Creek at selected flows of interest.

Flow (cfs)	Average depth (ft)			
	CS1	Cs2	Cs3	Cs4
12	.75	.37	.41	.42
35	1.16	.55	.50	.66
45	1.23	.61	.50	.76

Quartz creek

Description

Stream reach: Quartz Creek from the mouth on the Kootenai River (T31N, R32W, Sec. 24) upstream to Hennesy Creek (T32N, R32W, Sec. 11) (Figure 42).

Stream length: 14.7 km. Total drainage area: 93.1 km^2. Gradient: 30.8 m per km.

Source and Land Use

Quartz Creek originates in Ransom Creek on the southern slopes of the Purcell Mountains and flows south for 16.3 km to the Kootenai River. Approximately 3.3 percent of the drainage is privately owned, much of which belongs to Champion International and Burlington Northern. The remainder of the watershed is in the Kootenai National Forest. Timber production is the major land use in the basin.

Flows

Little flow information exists for Quartz Creek other than sporadic measurements from a stage-discharge station maintained by the US Geological Survey, Water Resources Division (T31N, R32W, Sec. 24), and miscellaneous data compiled by personnel of the Kootenai National Forest. An annual hydrograph was constructed based on best available information (Figure 43). Estimated mean annual discharge is 33.9 cfs.

Potential Environmental Problems

Timber harvest may increase sediment loading and alter peak flows resulting in channel stability problems and damage to fish habitat.

FISH POPULATIONS

Resident and Pre-emigrant Fish

A mark-recapture population estimate was conducted in a 152.4-m blocknetted section of stream proximately 1 km above the mouth on the Kootenai River. Game fish were primarily _Salmo_ spp, and relatively fewer numbers of bull trout (5) and mountain whitefish (1) (Table 27). Based on a length-frequency histogram

TURNER MTN.

SCENERY MTN.

13   24

QUARTZ CREEK

WEST FORK QUARTZ

KOOTENAI
RIVER

SEDIMENT POINT SOURCE
LOG JAM
BEAVER ACTIVITY
TRANSECT LOCATION
POTENTIAL FISH BARRIOR
FISH TRAP
FISH BARRIOR
ELECTROFISHING SECTION
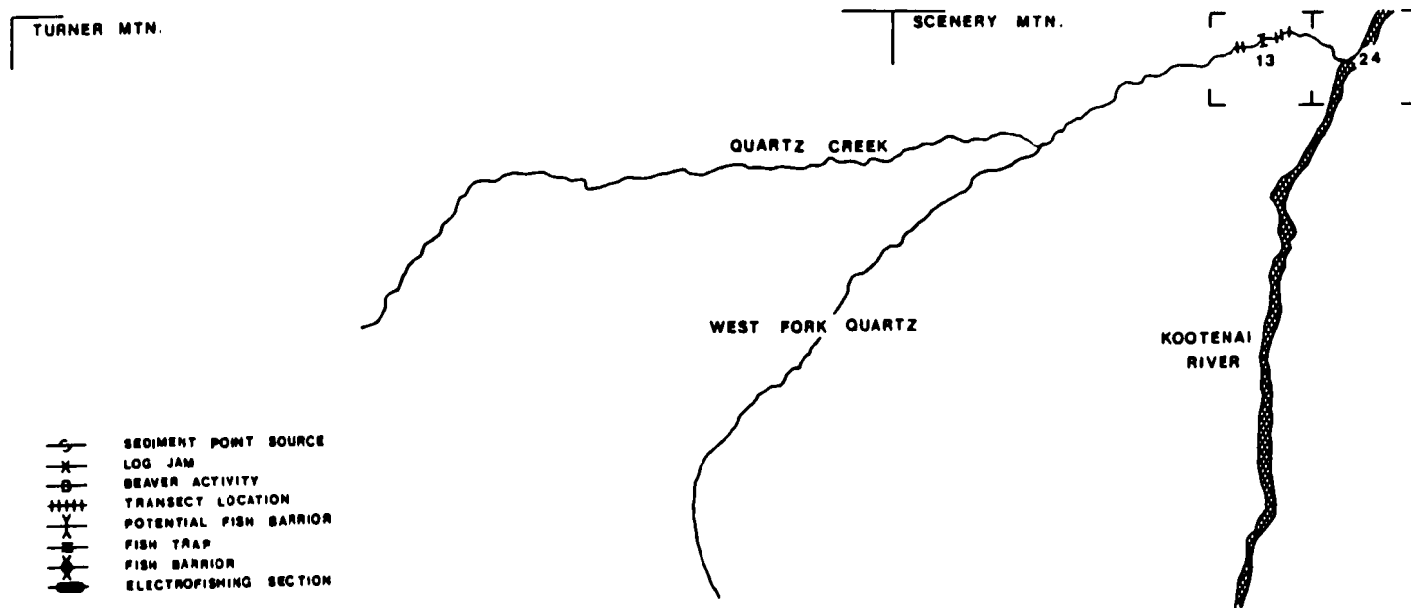
Figure 42. A map of Quartz Creek showing the location of transects and other points of
            interest.

QUARTZ CREEK
estimated annual hydrogroph
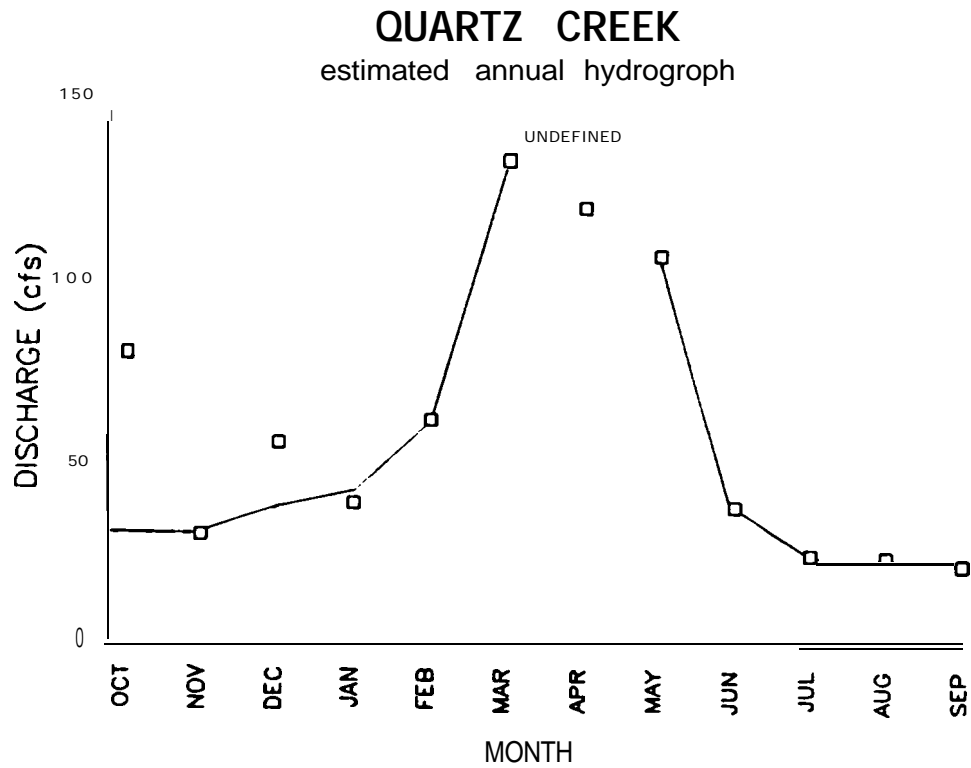
Figure 43. An estimated hydrograph for Quartz Creek based on a
comparison of seven concurrent flow measurements
made at the Fisher River USGS stage-discharge gauging
station and 117 miscellaneous measurements.

Table 27. Results of a mark-recapture population estimate
           conducted on lower Quartz Creek (T31N, R32W, Sec. 13)
           during September 1985. No flow on record

Length Category	Total Number Captured	Estimated Number Fish $\geq$75 mm per km
Salmo spp[a]		
>45-75 mm	67	1,772 $\pm$1371[b]
>75-135 mm	54	709 $\pm$400
>135-295 mm	33	144 $\pm$38
	TOTAL ($\geq$75 mm)	853 $\pm$438
Bull trout		
>165-220 mm	6	59 $\pm$18[c]

[a] Species composition: RB=94.9%, WCT=4.3%, HYB=0.8%

[b] Length category subject to high variance in estimate of this
    type.

[c] May be migrating recruits, estimate questionable.

(Appendix A27) and a catch efficiency **curve** (Appendix A23) the
Salmo spp. population is best described in three length groups:

             Fish >45 mm through 75 mm
             Fish >75 mm through 135 mm
       and Fish >135 mm through 295 mm TL

     A two-pass population estimate was conducted on a 182.8 meter
blocknetted section of Quartz Creek upstream of West Fork Quartz
Creek.   Came fish were primarily **Salmo** spp., and relatively fewer
numbers of bull trout and eastern brook trout (Table 28). A
length-frequency histogram presents modal lengths of Salmo spp
(Appendix A24).

Migrant Fish

     A bi-directional trap structure was installed approximately 1
km above the mouth in Quartz Creek (T31N, R32W, Sec. 13) to
capture migrants moving both upstream and downstream. The
upstream migrant trap was monitored singularly from April 7, 1986
through April 14, 1986 when the downstream migrant trap became
functional.   The traps continued to be monitored through
September, 1986.   The following discussion pertains to captures
prior to August 31, 1986.

     The first capture of upstream migrants occurred on April 8,
indicating that the spawning run had already begun.   The next
capture, however, took place on April 19 and catches were sparse
but consistent thereafter until mid May when captures became more
frequent.   The first fish sampled were males, 50 percent of which
were unripe, suggesting that the run was at its onset.   It is
therefore assumed that few fish migrated beyond the trap side
prior to installation of the trap

     A total of 96 Salmo spp. **$\geq$180** mm were captured migrating into
Quartz Creek, whereas only 32 fish returned to the trap site.

     The maximum likelihood estimate of the total migrant popula-
tion, estimated using Schnable's Multiple Census Formula (Ricker
1975), amounted to 280 fish, with a range of 177 to 444 **($p \geq 0.95$,**
Poisson). Species composition was RB=90.8%, WCT=1.5%, and
HYB=7.6%.

     Length-frequency histogram for upstream and downstream
migrants are similar in modal lengths indicating that the
assumption of a closed population was not violated by recruitment
of a different size category from within the creek (Figure 44).

Table 28. Results of a two-pass population estimate conducted on upper Quartz Creek (T32N, R32W, Sec. 35) during July, 1986. Discharge 8.2 cfs.

Length Category	Total Number Captured	Estimated Number Fish >75 mm per km
salmo spp. [a]	39	224 ±22
Bull trout	23	142 ±27
Eastern brook trout	14	[b]

[a] Species composition RB=10.3%, WCT=84.6%, HYB=5.1%.

[b] $\hat{p}$=undefined, insufficient for estimate.

QUARTZ CREEK
Salmo spp. (in migrants)

Salmo spp. (out migrants)
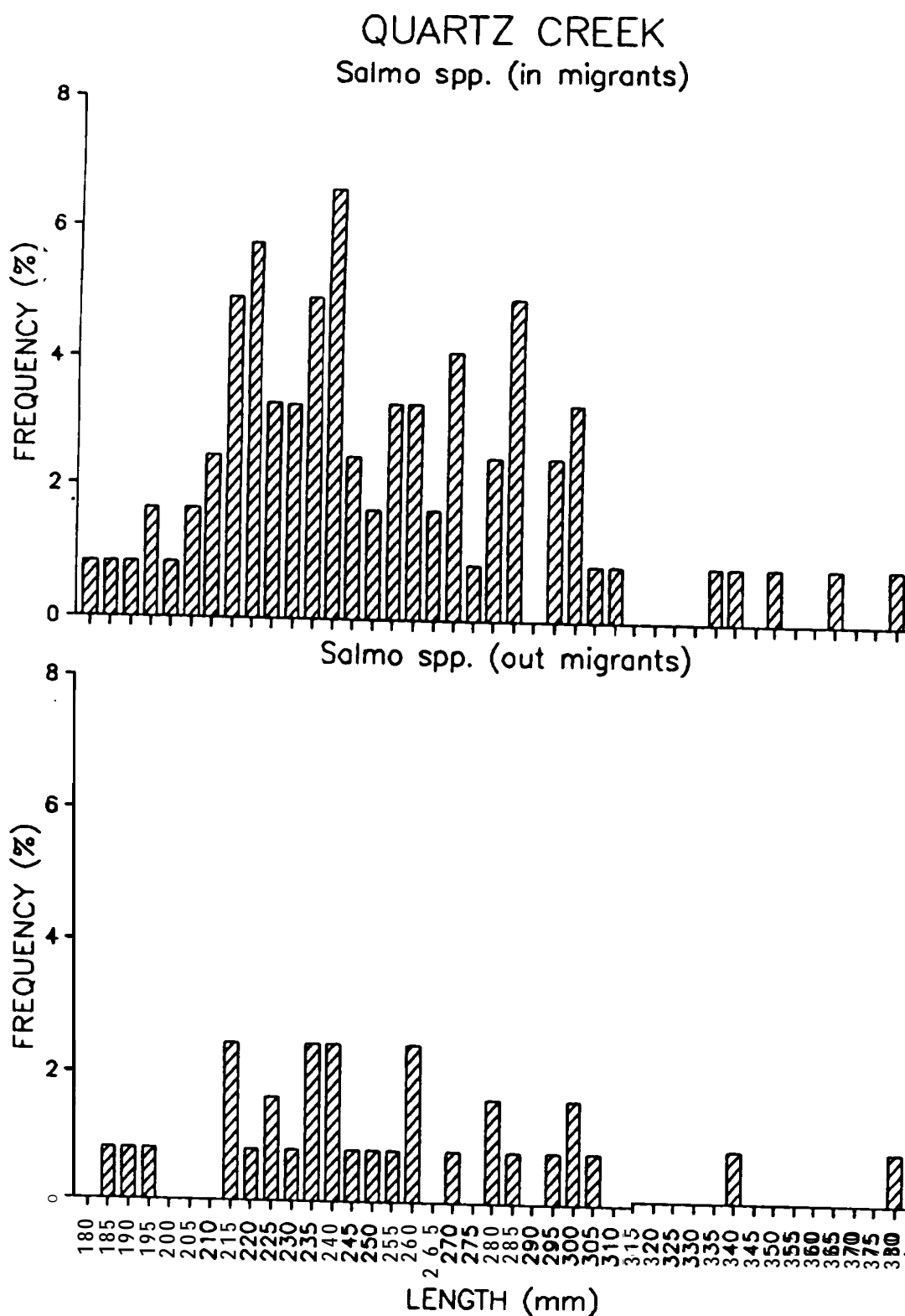
LENGTH (mm)

Figure 44   Length-frequency histograms of Salmo spp. captured while migrating into (top) and out of Quartz Creek (bottom) during the spring spawning run, 1986.

Both trap leads were breached simultaneously on the following dates:

Date	Estimated Time	Maximum Possible Time
April 10	24 hours	36 hours
April 23	30 hours	36 hours
May 20	8 hours	18 hours
May 27	8 hours	12 hours
May 28	8 hours	12 hours

Bias due to fish passing undetectedthroughthetrap system was considered negligible since unmarked and marked fish ≥ 180 mm were assumed to have had random chances of escapement.

The timing of the spawning run was protracted extending from approximately April 8 through June 26 (Figure 45). Tagged migrants remainedinthe creek for an average of 19 days with a range of 7 to 33 days at large. Catches were standardized as ln(catch per day + l), assuming catch rate was constant. Water temperature range and discharge (cfs) are overlaid on the plot.

Redd Survey

Redds (_Salmo_ spp.) observed by field personnel were placed in the following categories:

	Definite	Probable
Trap site to 1.6 km above Hennesy Creek	96	82
Total west fork	12	6

A comparison of estimated spawners (utilizing that portion of Quartz Creek above the trap site) to the number of redds classified as definite and probable, produced an estimate of approximately 1.4 fish per redd with a range of 0.9 to 2.3. The low estimate of fish per redd probably reflects the large population of resident _Salmo_ spp which create redds indistinguishable from those made by some migrant trout. The sex ratio of individual fish captured in the trap was 1.6:l males to females.

Fry Emergencee

Fry emergence traps described by Fraley et al. (1986) were placed on five randomly-selected, positively-identified _Salmo_ redds and monitored during the period from June 12 through September 2, 1986. Fry were enumerated and released from the holding bottle (Table 29).
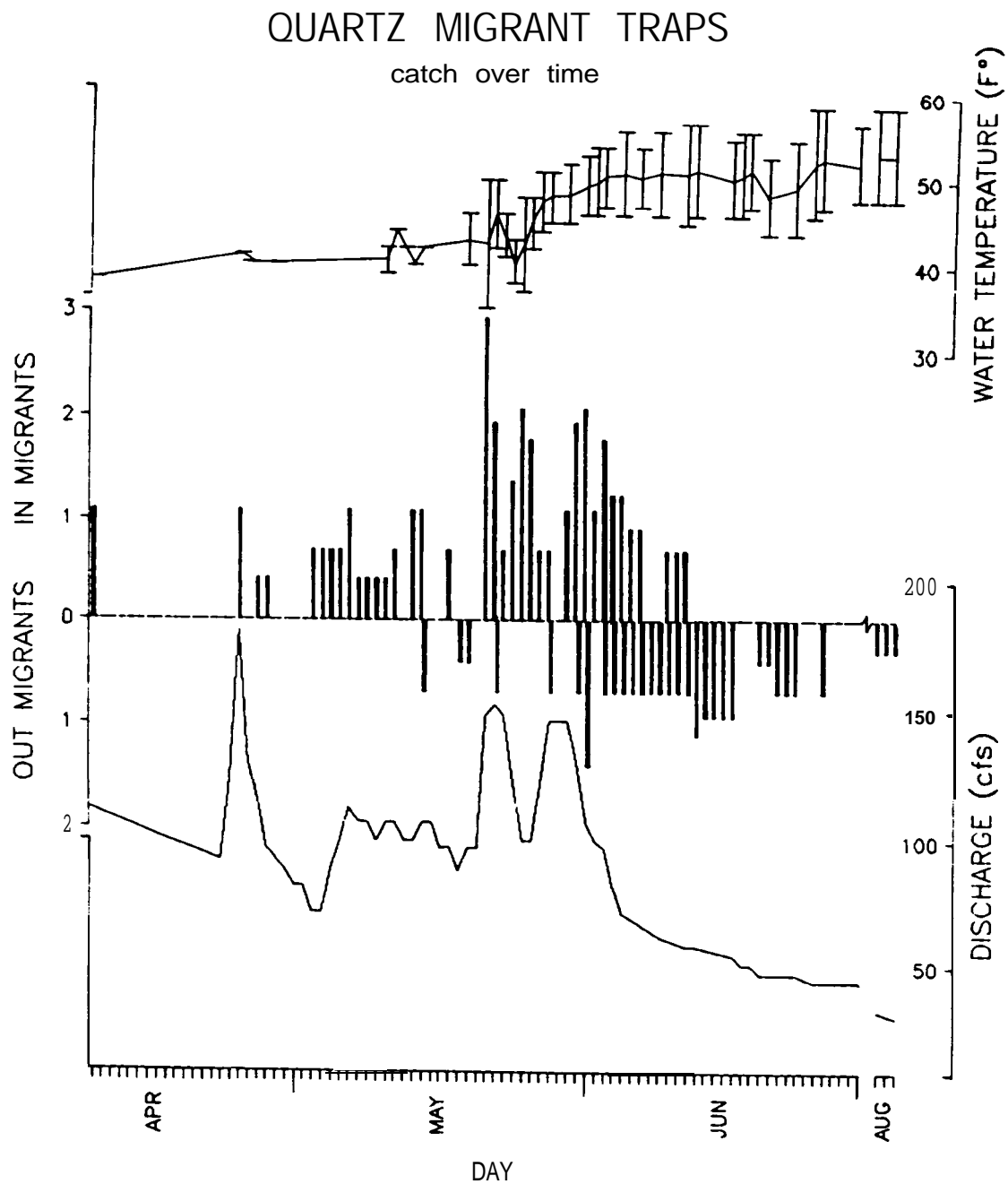
Figure 45. Catch direction and distribution over time of migrating
           Salmo spp. captured during spring 1986, and associated
           water temperatures and stream discharge.
           (Note: logarithmic scale)

Table 29. Captures of <u>Salmo</u> fry in emergence traps set in Quartz
          Creek (T32N, R32W, Sec. 35) from June 12 through
          September 2, 1986.

Date of Sample	Number Captured				
	Redd 1	Redd 2	Redd 3	Redd 4	Redd 5
July 28	1	1	3	5	0
August 2	0	12	2	7	0
August 4	3	2	1	37	0
August 6	2	4	0	5	0
August 11	9	2	0	0	0
August 14	0	0	0	0	0
TOTAL FOR REDD	15	21	6	54	0

Fry emergence averaged 19.2 fry per redd in 5 randomly selected spawning sites. Based on the total number of positive and probable redds (196), fry recruited to Quartz creek were estimated at 3,763 young.

Bull TroutMigrants

A total of 24 adults were captured entering Quartz Creek to spawn. The first two adults were caught on May 31, 1986; the remainder were sampled between July 9 and September 25. These migrants apparently escaped recapture on their downstream migration. Leaves and ice clogged the trap leads causing decreased trapping efficiency, precluding the possibility of a statistical population estimate. Captures ranged in length from 316 to 765 mm (TL) (Appendix **A25).**

A downstream migration of bull trout recruits began on April 21 and ended on September 19 as indicated by trap captures. Peak catches occurred during June. Eighteen individuals **>180** mm were captured, other recruits captured were not representative of the total run because smaller individuals could pass through the mesh of the trap leads.

Smaller meshed leads will be used for future sampling during the time of bull trout emigration from the stream.

Results indicated that Quartz Creek is a major bull trout production tributary for the Kootenai River above Kootenai Falls.

FLOW RECOMMENDATIONS

Five transects were permanently established across riffle areas in Quartz Creek approximately l km above the mouth (T31N, R32W, Sec. 13). the WETP program was calibrated to stage and discharge measurements at flows of 16.3, 51.3, 103.6, and 132.0. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occurred at 7.0 and 17.5 cfs, respectively (Figure 46). Based on the existing fish population, the wetted perimeter analysis and estimated water availability, a minimum discharge of 17.5 cfs is recommended for the low flow period from August 1 through April 15

An average depth of 0.5 ft, required for successful passage of migrant spawners, is not met in all riffle transects until discharge equals or exceeds 25 cfs (Table 30). A fish passage flow of 25 cfs is therefore recommended for the period of April 16 through July 31 to assume a successful spawning migration and to protect spawning redds from dewatering.
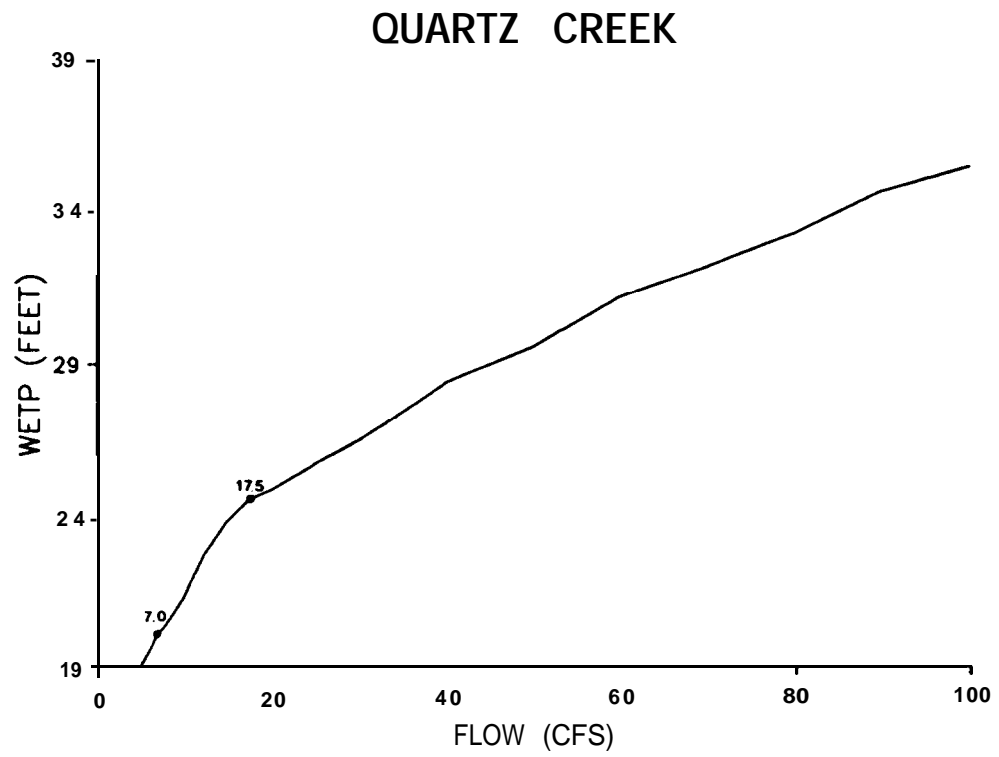
Figure 46. The wetted perimeter-discharge relationship for five
            riffle transects on Quartz Creek, 1985-1986.

Table 30. The average depth for five riffle transects in Quartz
          Creek at selected flows of interest.

Flow (cfs)	CS1	CS2	CS3	CS4	CS5
7.0	.40	.36	.45	.31	.70
17.5	.56	.55	.6 5	.44	.66
25.0	.66	.65	.76	.50	.72

Wolf Creek

Description

Stream reach: Wolf Creek from its confluence with the Fisher River (T29N, R29W, Sec. 34) to the headwaters (T32N, R26W, Sec. 31) (Figure 47).

Stream length: mouth to Little Wolf Creek, 25.3 km; Little Wolf Creek to headwaters, 33.8 km. Total drainage area: 547 km^2. Gradient: mouth to Little Wolf Creek, 8.7 m per km; Little Wolf Creek to headwaters, 8.8 m per km.

Source and Land use

Wolf Creek originates on the west slopes of the Salish Mountains and flows south then southwest for 59.1 km to its confluence with the Fisher River. Approximately 65 percent of the Wolf Creek drainage listed under private and state ownership. Champion International and Burlington Northern are the major private land owners. The remainder of the watershed is in the Kootenai National Forest. Timber production is extensive in the basin as well as smaller parcels used for cattle ranching.

Flows

A continuous stage-discharge recorder was maintained by the U.S. Geological Survey, Water Resources Division, from 1967 through 1977 (T29N, R29W, Sec. 35). Mean monthly discharge and eightieth percentile exceedence flows are presented in Figure 48. Mean annual discharge is 70.2 cfs.

Potential Environmental Problems

Wolf Creek was extensively channelized during the railroad relocation 1965-1968. Construction activities denuded large expanses of land and created steep slopes along the railroad grade and in channelized portions of the creek. Increased sediment loading was severe.

Heavy timber harvesting and cattle ranching activities have increased erosion and destroyed much of the original riparian vegetation in the basin. Soils in the vicinity are predominantly unconsolidated glacio-lacustrine silts, easily eroded when vegetation cover is depleted, resulting in increased sediment pollution and damage to the fishery habitat (May 1972).

FISHER MTN.
RICHARDS MTN.
CALX MTN.

20

SEDIMENT POINT SOURCE
LOG JAM
BEAVER ACTIVITY
TRANSECT LOCATION
POTENTIAL FISH BARRIOR
FISH TRAP
FISH BARRIOR
ELECTROFISHING SECTION

WOLF CREEK

LITTLE WOLF

WOLF PRAIRIE
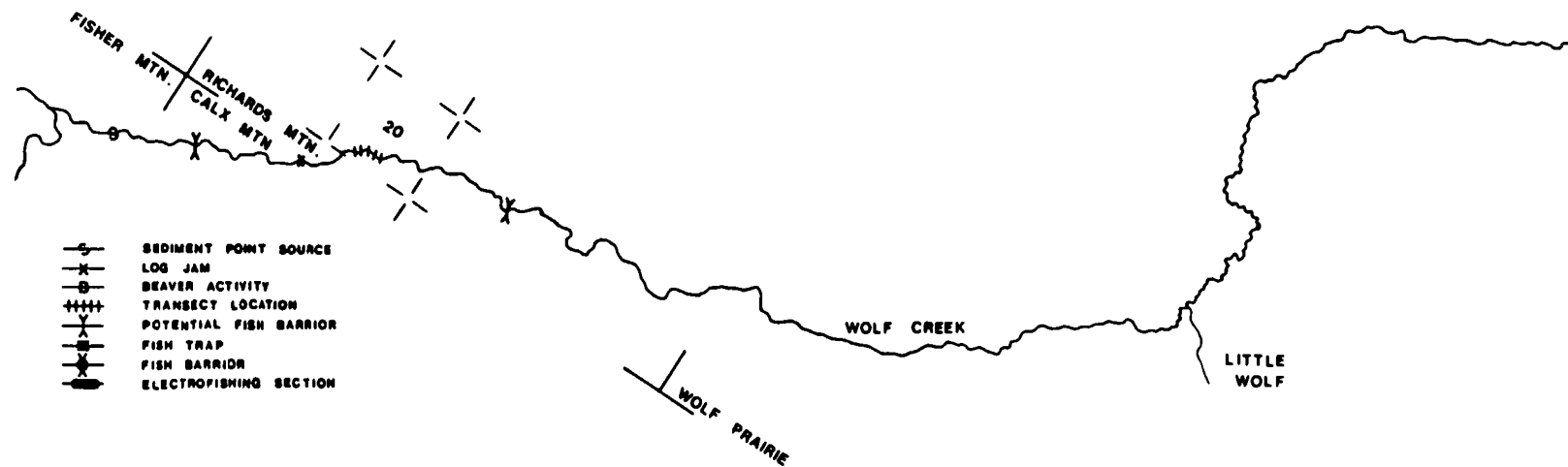
Figure 47. A map of Wolf Creek showing the location of transects and other points of interest. A total fish barrier at T31N, R26W, SE-1/4, Sec.33 is not on this map.

WOLF CREEK
discharge
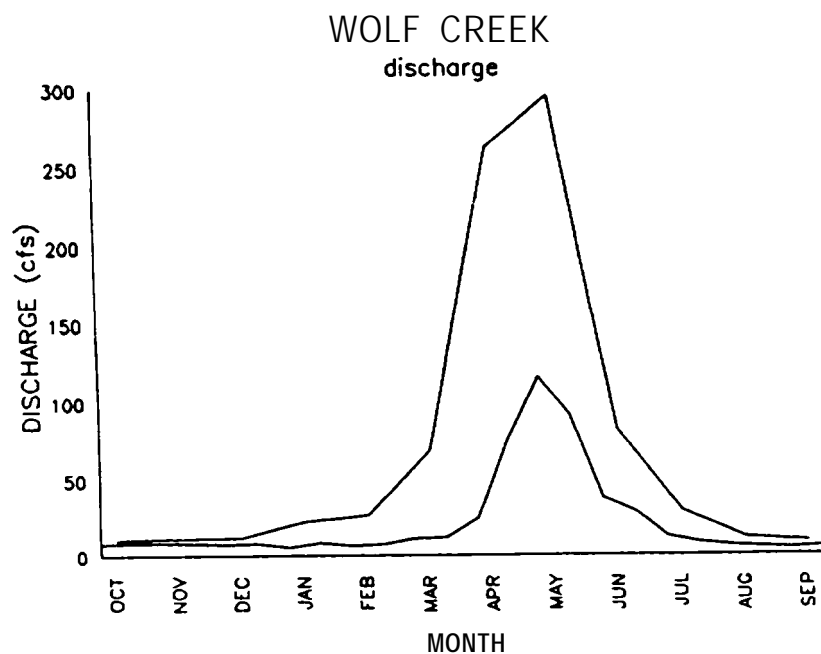
Figure 48. Mean monthly flows (top line) and eightieth percentile
exceedence flows (bottom line) based on ten years of
daily stage records for Wolf Creek (USGS.
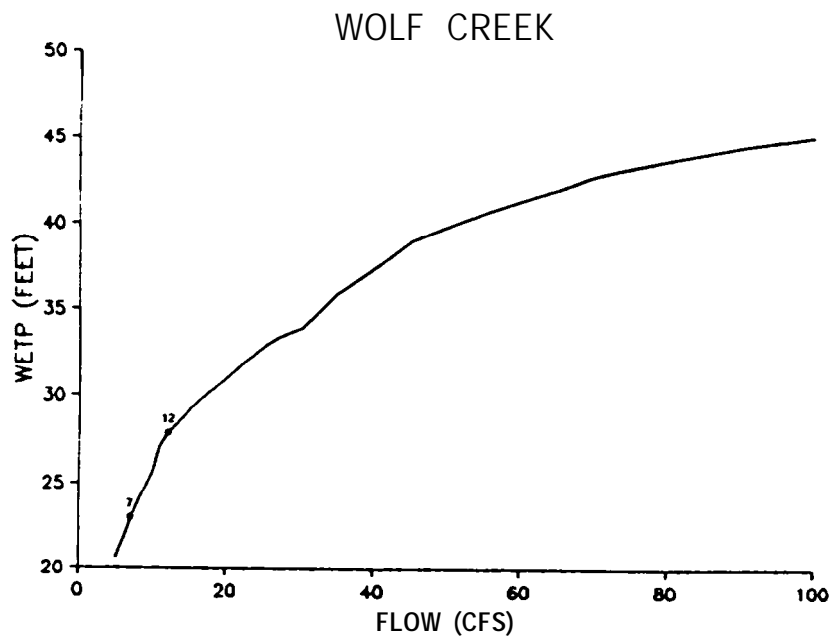
WOLF CREEK

Figure 49. The wetted perimeter-discharge relationship for five
riffle transects on Wolf Creek 1985-1986.

FISH POPULATIONS

Resident and Pre-emigrant Fish

A mark-recapture population assessment was conducted during August, 1986, on a 243.8-m section representative of Wolf Creek chosen for its location between two natural channel features presenting impedance to fish movement (T29N, R28W, Sec. 29). Came fish were primarily rainbow trout (80) resulting in an estimate of 455 **+l48** rainbow trout (> 75 mm) per km, and fewer numbers of mountain whitefish (1). A length-frequency histogram presents rainbow trout modal lengths (Appendix A26).

FLOW RECOMMENDATIONS

Five transects were permanently installed across riffle areas in Wolf Creek (T29N, R28W, Sec. 29). The WETP program was calibrated to stage and discharge measurements at flows of ll.0, 37.5, and 275.8 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 7.0 and 12.0 cfs, respectively (Figure 49). Based on existing fish populations, the wetted perimeter analysis and water availa-bility, a flow of 12.0 cfs is recommended for the low flow period from July 1 through March 31. Discharge declines to below the recommended minimum flow during a portion of this period during 8 of 10 water years indicating that fish habitat is sometimes suboptimal during portions of some water years (Table 31). Recommended flows amount to 34.5 percent of the mean annual discharge on record.

A minimum average depth of 0.5 ft is not reached until flows equal or exceed15 cfs (Table 32). Consequently, a passage flow of 15 cfs is recommended for the period from April 1 through June 30 to assure successful passage of spawning migrants

Table 31. Recommended minimum flows for Wolf Creek and historical water availability records based on ten years of daily records (USGS).

Period of Water Year	Recommended Flows	80% Exceedence Flows	Mean Flows	Acre Feet
OCT 1 - OCT 15	12.0	8.2	10.5	312.3
OCT 16 - OCT 31	12.0	8.6	10.5	333.1
NOV 1- NOV 15	12.0	8.6	11.4	339.1
NOV 16- NOV 30	12.0	8.1	11.4	339.1
DEC 1- DEC 15	12.0	7.8	12.0	356.9
DEC 16 - DEC 31	12.0	8.3	12.0	380.7
JAN 1 - JAN 15	12.0	5.8	22.2	660.3
JAN 16 -JAW 31	12.0	8.6	22.2	704.4
FEB 1- FEB15	12.0	6.8	26.6	791.2
FEB 16 - FEB 28	12.0	7.8	26.6	633.0
MAR 1-MAR 15	12.0	11.2	68.8	2046.5
MAR 16 - MAR 31	12.0	11.9	68.8	2182.9
APR 1 - APR 15	24.0	24.3	263.1	7825.9
APR 16 - APR 30	77.0	76.7	263.1	7825.9
MAY 1 - MAY 15	116.0[a]	116.3	295.7	8795.6
MAY 16 - MXi 31	91.0	91.3	295.7	9382.0
JUN 1-JUN 15	38.0	37.9	82.3	2448.0
JUN 16 - JUN 30	29.0	29.1	82.3	2448.0
JUL 1 - JUL 15	13.0	12.8	29.6	880.5
JUL 16 - JUL 31	12.0	8.7	29.6	939.1
AUG 1 - AUG 15	12.0	6.4	11.5	342.1
AUG 16 - AUG 31	12.0	5.2	11.5	364.9
SEP 1- SEP 15	12.0	4.7	9.2	273.7
SEP 16 - SEE' 30	12.0	5.8	9.2	273.7
				50849.4

[a] A dominant discharge flow (approximated bankful discharge presently undefined) should be maintained for 24 hours during this period.

Table 32. The average depths for five riffle transects in Wolf
           Creek at selected flows of interest.

Flow (cfs)	Average depth (ft)				
	CSl	cs2	cs3	cs4	CS5
7	.35	.40	.44	.48	.47
12	.44	.47	.47	.66	.54
15	.50	.52	.53	.72	.58

REANALYSIS OF STREAMS INVESTIGATED BY MAY (1982)

The following is a summary of several tributaries researched by May (1982), reanalyzed with the updated wetted perimeter analysis. The new program equates the lowest elevation in each riffle cross section to water stage at zero flow. This provides a known intercept in the log-linear relationship between stage and discharge, increasing accuracy in the calculation of predicted water stage at selected low discharges. The result is increased sensitivity in the estimation of wetted perimeter at flows of interest.

Bobtail Creek

Bobtail Creek from its confluence with the Kootenai River (T31N, R3lW, Sec. 30) to the junction of Bull Creek (T31N, `
sec. 5).

Inflection points occur at 5 and 10 cfs (Figure 50).

A minimum flow of 5 cfs is recommended for the low flow period from July 1 through March 31.

The fish passage requirement is met when flows equal or exceed 18 cfs (Table 33). A passage flow of at least 18 cfs should be maintained from April 1 through June 30.

East Fork of the Bull River

East fork of the Bull River from its confluence with the Bull River (T27N, R33W, Sec. 12) upstream to the junction of the East and North forks (T27N, R32W, Sec. 14).

Inflection points occur at 20 and 50 cfs (Figure 51).

As the recommended migrant passage depth is met when flows equal or exceed 10 cfs (Table 34), a flow of 35 cfs is recommended year-round to maintain fishery habitat and to assure successful migrant passage. The recommended flow is set at 35 cfs rather than the optimum flow of 50 cfs because available flows in the East Fork generally fall below 50 cfs, and 35 cfs is appropriate for maintaining adequate bank cover and wetted riffle areas.

Fortine Creek

Fortine Creek from its confluence with Grave Creek (T35N, R26W, Sec. 15), upstream to the junction of Edna Creek (T33N, R26W, sec. 2).

Inflection points occur at 35 and 55 cfs (Figure 52).
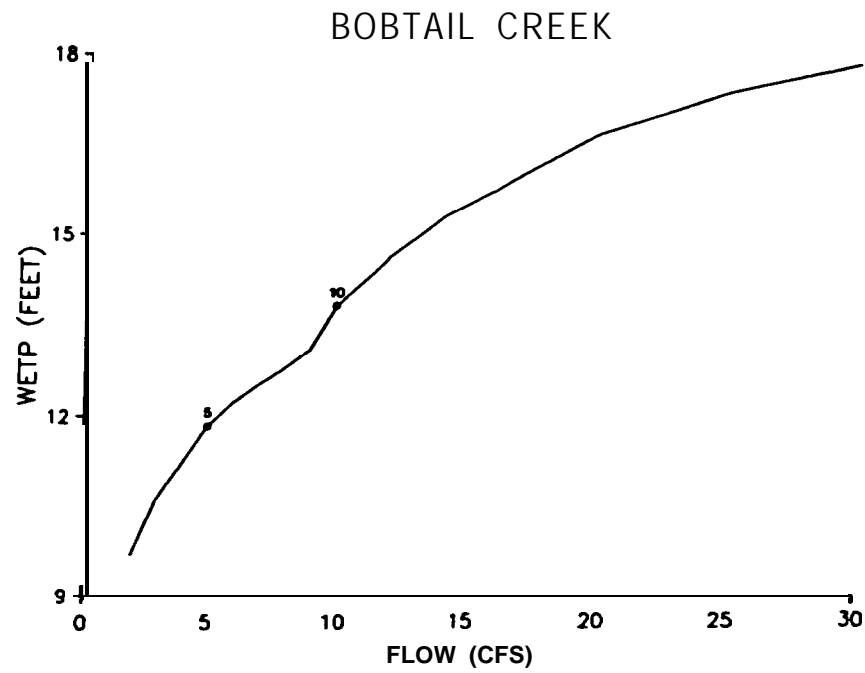
BOBTAIL CREEK

Figure 50.   The wetted perimeter-discharge relationship for five
             riffle transects on Bobtail Creek (May 1982).

EAST FORK OF THE BULL RIVER
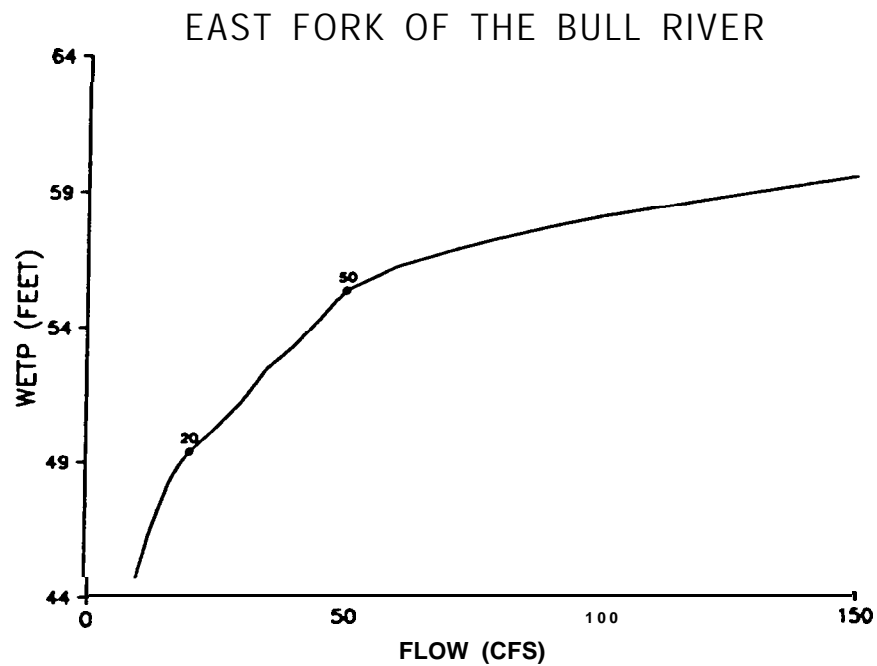
Figure 51.   The wetted perimeter-discharge relationship for five
             riffle transects on the East Fork of the Bull River
             (May 1982).

Table 33. Average depths for five riffle transects on Bobtail
Creek at selected flows of interest.

Flow (cfs)	Average Depth (ft)				
	CS1	CS2	Cs3	**CS4**	CS5
5	.42	.67	.39	.53	.42
10	.51	.79	.43	.63	.56
18	.60	.86	.52	.73	.70

Table 34. Average depths for five riffle transects on the East
           Fork of the Bull River at selected flows of interest.

Flow (cfs)	Average Depth (ft)				
	CS1	CS2	cs3	CS4	CS5
10	4.22	.51	.51	.75	.58
20	3.33	.63	.63	.92	.74
50	2.98	.88	.83	1.11	.94
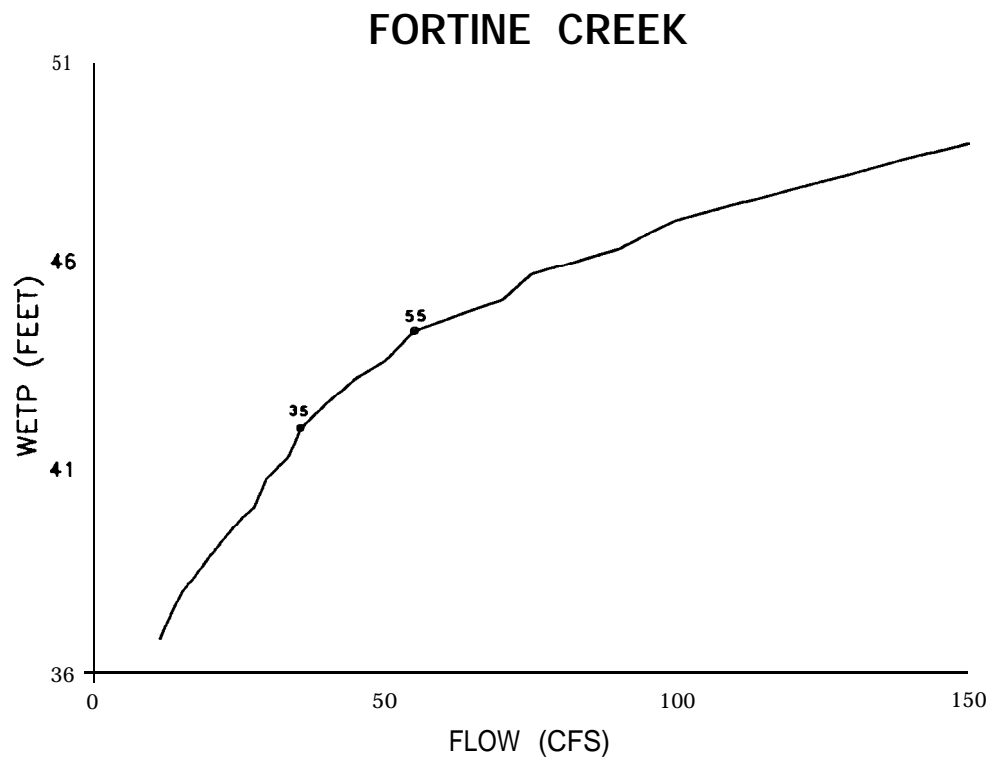
FORTINE CREEK

Figure 52.   The wetted perimeter discharge relationship for five
             riffle transects on Fortine Creek (May 1982).

The recommended fish passage depth is met when flows equal or exceed 28 cfs (Table 35). Consequently, a flow of 40 cfs is recommended year-round to maintain fishery habitat and to assure successfulmigrantpassage.

O'Brien Creek

O'Brien Creek from its confluence with the Kootenai River (T31N, R33W, Sec. 18), upstreamtothe junction of the North Fork (T32N, R33W, Sec. 7).

Inflection points occur at 16 and 27.5 cfs (Figure 53).

A minimum flow of 27.5 cfs is recommended for the low flow period from July 1 through March 31, Discharge has been observed to fall below the recommended flow during portions of some water years.

The fish passage requirement is met when flows equal or exceed 30 cfs (Table 36). A passage flow of at least 30 cfs should be maintained from April 1 through June 30.

Pinkham Creek

Pinkham Creek from its confluence with Libby Reservoir [T35N, R28W, Sec. 5), upstream to the junction of the East and West forks of Pinkham Creek (T34N, R27W, Sec. 32).

Inflection points occur at 5 and 35 cfs (Figure 54).

A flow of 5 cfs is recommended forthelow flow period from July 1 through March 31.

The dominant discharge/channel morphology concept was used to determine the flows during the high flow period from April 1 through June 30, rather than the fish passage criteria. The high flows that are needed to maintain existing stream morphology and provide a flushing action are higher than the flow required for fish passage.

Monthly flow recommendations for the low and high flow periods are compared in Table 37 to the median monthly flows of record, as derived from USGS flow records for the gauge near the mouth of PinkhamCreek. The flow recommendations would require that all the water during a normal water year be maintained instream from approximately August through March.

Table 35.   Average depths for five riffle transects on Fortine
Creek at selected flows of interest.

Flow (cfs)	Average Depth (ft)				
	CSl	CS2	Cs3	Cs4	CS5
28	**.57**	**.50**	**.73**	**.55**	**.75**
35	.63	.55	.70	**.60**	.82
55	**.77**	**.64**	**.81**	**.671**	**.96**

O'BRIEN

Figure 53.   The wetted perimeter-discharge relationship for five
             riffle transects on O'Brien Creek (May 1982).

PINKHAM CREEK

Figure 54.   The wetted perimeter-discharge relationship for five
             riffle transects on Pinkham Creek (May 1982).

119

Table 36. Average depths for five riffle transects on O'Brien
Creek at selected flows of interest.

Flow (cfs)	Average Depth (ft)				
	CS1	CS2	Cs3	cs4	CS5
16	.63	.54	.41	.71	.54
27.5	.69	.63	.49	.77	.66
30	.71	.64	.51	.77	.68

Table 37. Comparison of the instream flow recommendations for
Pinkham Creek to the approximated median flows of
record (May 1982).

	Instream Flow Recommendations [a]	Approximate Median Flows of Record [b]	
	CFS	CFS	AF
January	**5.0**	**1.72**	**108**
February	**5.0**	**1.24**	69
March	**5.0**	**4.93**	**303**
April 1-15	**5.3**	**20.6**	**613**
April 16-30	**36.3**	**76.3**	**2,270**
May 1-15	**73.5**[c]	**128.3**	**3,816**
May 16–31	**50.2**	**116.9**	**3,709**
June 1-15	**31.0**	**54.4**	1,618
June 16-30	11.0	**31.3**	931
July	**5.0**	**9.97**	613
August	**5.0**	1.38	**85**
September	**5.0**	0.79	**47**
October	**5.0**	**0.66**	**41**
November	**5.0**	**3.01**	179
December	**5.0**	**2.32**	**143**
			14,545[d]

[a] Derived using the wetted perimeter/inflection point method and
the dominant discharge/channel morphology concept.

[b] Derived from flow records for a 9-year period of record
(between 1973 and 1981 water years) for the USGS gauge on
Pinkahm Creek, 1.5 km upstream from Lake Koocanusa.

[c] The bankful discharge, which is presently undefined, should be
maintained for 24 hours during this period.

[d] Appoximate volume of water normally available on an annual
basis.

Pipe Creek

Pipe Creek from its confluence with the Kootenai River (T3lN, R3lW, Sec. 30), upstreamtothe junction of the East Fork (T33N, R31W, Sec. 16).

Inflection points occur at 16.0 and 27.5 cfs (Figure 55).

A minimum flow of 16 cfs is recommended for the low flow period from July 1 through March 31. Water availability does not normally suport the optimum flow of 27.5 cfs.

The fish passage requirement is met when flows equal or exceed 25 cfs (Table 38).   flow of at least 25 cfs should be maintained from April 1 through June 30.

Rock Creek

Rock Creek from its mouth on the Clark Fork near Noxon, Montana (T26N, R32W, Sec. 32), upstream to Rock Creek Meadows (T26N, R31W, Sec. 6).

Inflection points occur at 9.0 and 16.0 cfs (Figure 56).

The recommended fish passage depth is met at all transects when flows equal or exceed 10 cfs (Table 39). Consequently, a flow of 16 cfs is recommended for the entire year to maintain fishery habitat and to ensure successful migrant passage.

Ross Creek

Ross Creek from its confluence with Bull Lake (T28N, R33W, Sec. **4),** upstreamtothe junction of the South Fork of Ross Creek (T28N, R34W, Sec. 15).

Inflection points occur at 20 and 70 cfs (Figure 57).

A minimum flow of 20 cfs is recommended for the low flow period from July 1 through March 31.

The fish passage requirement is met when flows equal or exceed 30 cfs. A flow of at least 30 cfs should be maintained from April 1 through March 31 (Table 40).

Yaak River

Yaak River from its mouth on the Kootenai River (T32N, R34W, Sec. **5),** upstream to the Yaak Falls (T33N, R33W, Sec. 4). **Yaak** Falls upstream to its confluence with Spread Creek (T35N, R33W, sec. 10).
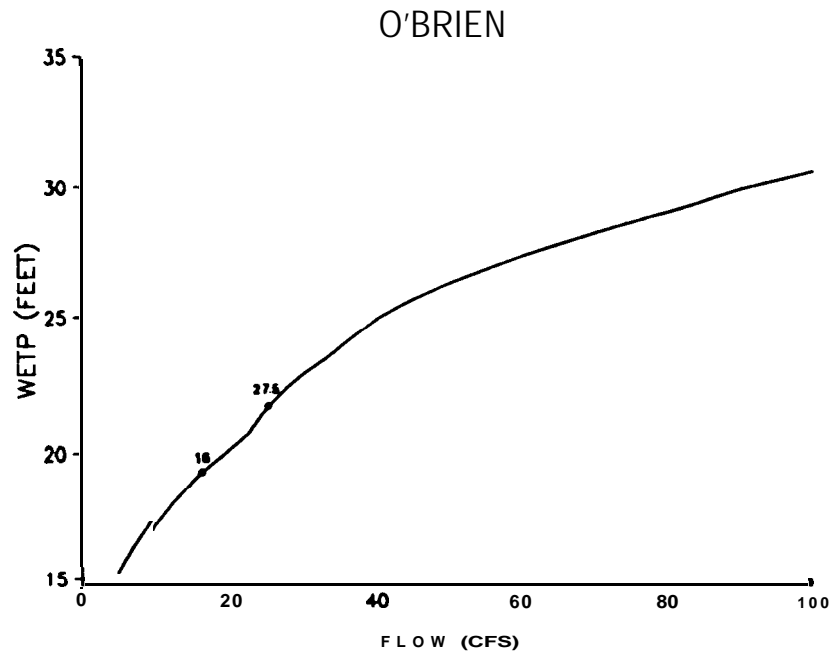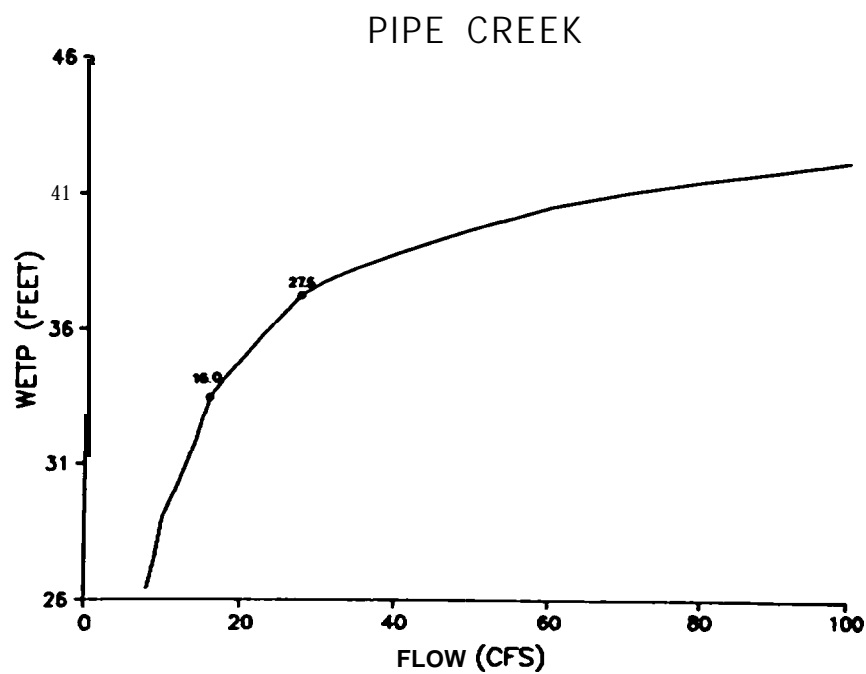
PIPE CREEK

Figure 55.   The wetted perimeter-discharged relationship for five
riffle transects on Pipe Creek (May 1982).
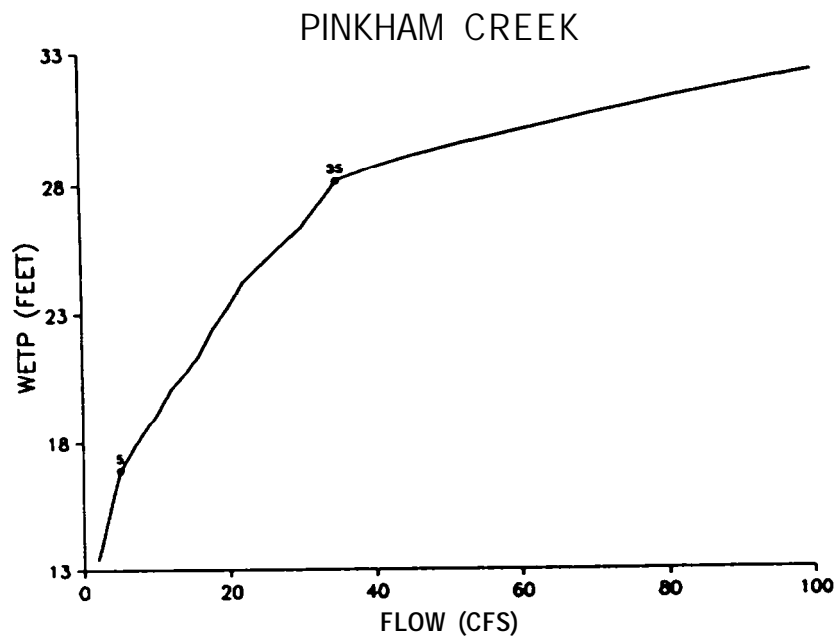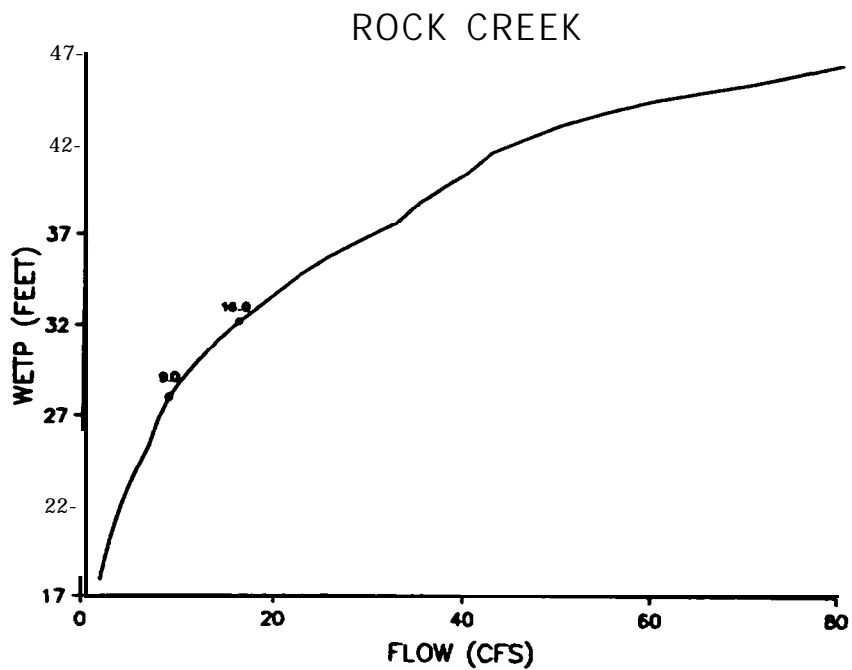

ROCK CREEK

Figure 56.   The wetted perimeter-discharge relatlonshlp for five
riffle transects on Rock Creek (May 1982).

123

Table 38. Average depths for five riffle transects on Pipe Creek at selected flows of interest.

Flow (cfs)	Average Depth (ft)				
	CS1	Cs2	Cs3	CS4	CS5
16	.67	.40	.47	.64	.41
25	.65	.52	.55	.76	.52
27.5	.65	.55	.56	.78	.54

Table 39. Average depths for five riffle transects on Rock Creek at selected flows of interest.

Flow (cfs)	Average Depth (ft)				
	CSl	Cs2	Cs3	CS4	CS5
9	.52	.60	.49	.57	.73
10	.53	.62	.52	.59	.76
16	.58	.69	.60	.71	.91

Figure 57. The wetted perimeter-discharge relationship for five riffle transects on Ross Creek (May 1982).

126

Table 40.   Average depths for five riffle transects of Ross Creek
at selected flows of interest.

Flow (cfs)	Average Depth (ft)				
	CSl	cs2	Cs3	cs4	CS5
20	1.10	.42	.51	.73	.74
30	1.23	.52	.62	.80	.86
70	1.56	.78	.89	.78	1.14

Yaak River mean monthly discharge and eightieth percentile exceedence flows are provided in the annual hydrograph (Figure 58).

Inflection points occurred at 110 and 170 cfs in the Lower Yaak River and 97.5 and 145 in the upstream reach (Figures 59 and 60). Due to the high fishery value of the Yaak River and similarities in the hydrology within the two reaches, an overall flow recommendation is set for the entire designated length of river (Table 41). A minimum passage flow of 77.5 cfs will be satisfied if instream flow recommendations are implemented as stated. Recommended flows in the lower section amount to 45.6 percent of the mean annual flow on record.

Young Creek

Young Creek from its confluence with Libby Reservoir (T37N, R28W, Sec. 24) upstream to the confluence of the South Fork (T37N, R29w, sec. 14).

Inflection points occur at 3.0 and 8.0 cfs (Figure 61).

Based on a reanalysis of data compiled by May (1982) an optimal minimum flow was identified as 8 cfs; however a flow of 5 cfs was previously applied to Young Creek for the low flow period from July 1 through April 30. To be consistent with previous recommendations, the minimum flow recommendation will be maintained as stated.

The fish passage requirement is met when flows equal or exceed 30 cfs (Table 42). A passage flow of at least 30 cfs is needed to ensure successful migrant passage; however, a passage flow of 25 cfs was previously applied to the period from May 1 through June 30, therefore the recommended flow will be maintained at 25 cfs. This should be adequate to maintain passage.

YAAK RIVER
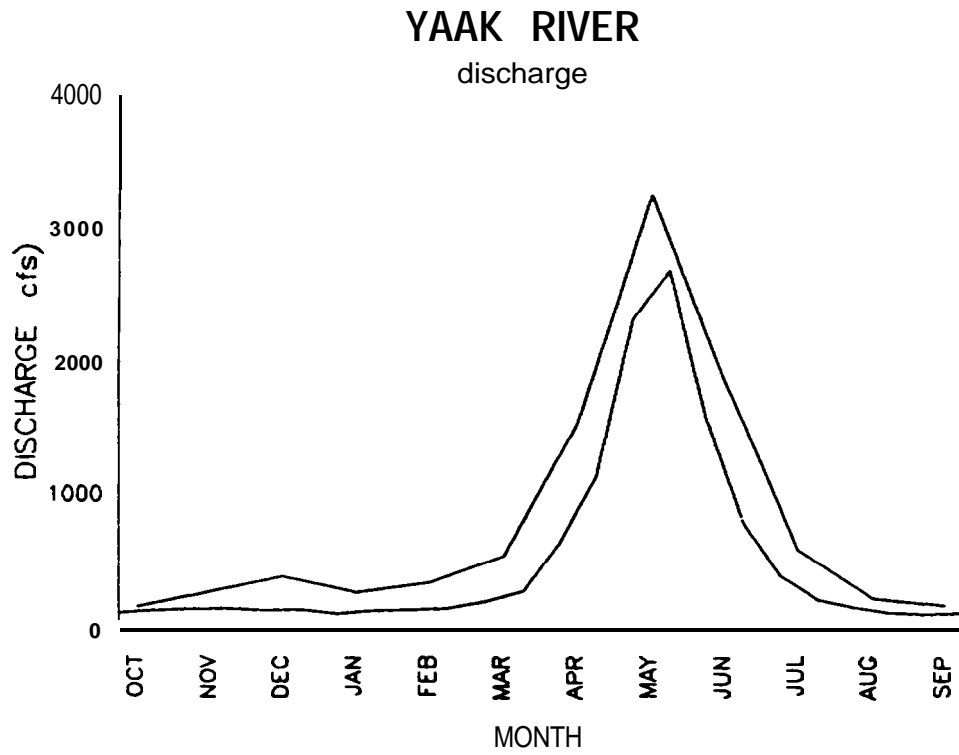
discharge

Figure 58. Mean monthly flows (top line) and eightieth percentile exceedence flows (bottom line) based on ten years of daily stage records for the Yaak River (USGS).
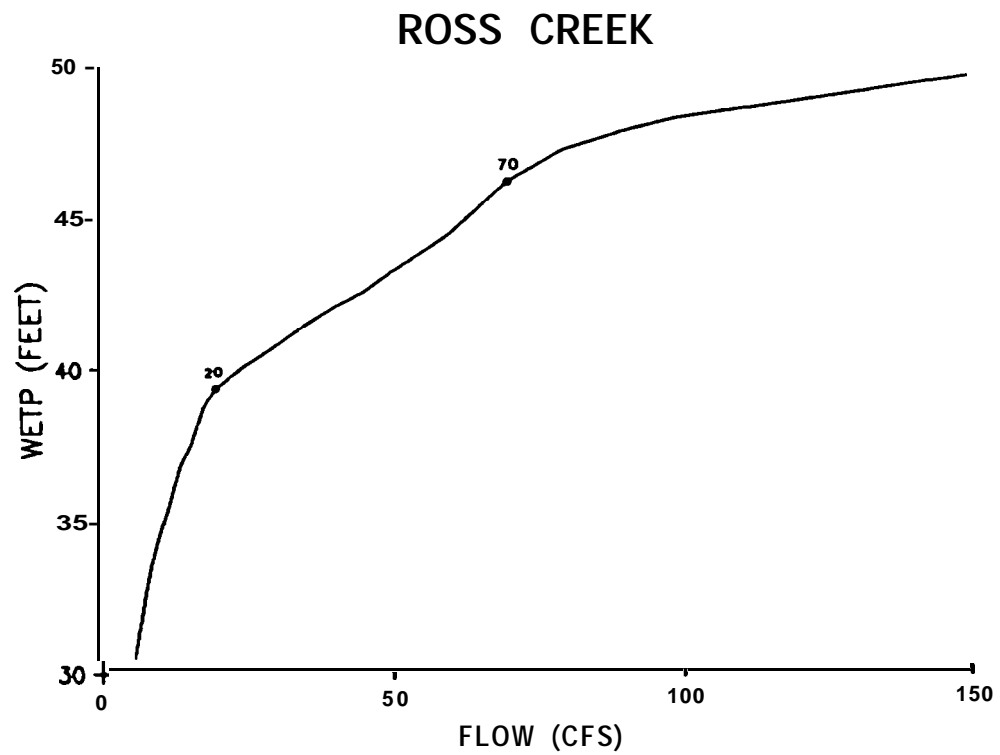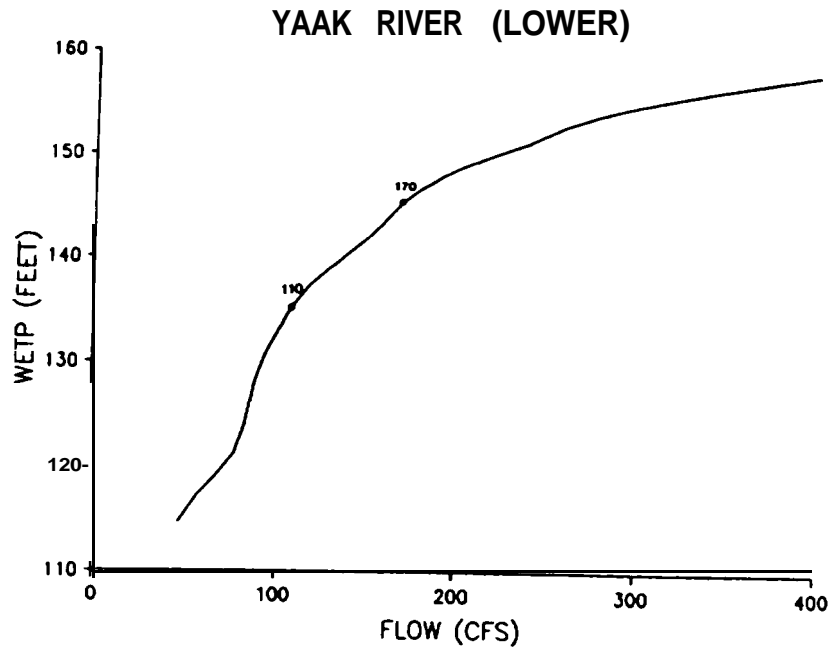
YAAK RIVER (LOWER)

Figure 59. The wetted perimeter-discharge relationship for five riffle transects on the lower Yaak River (May 1982).
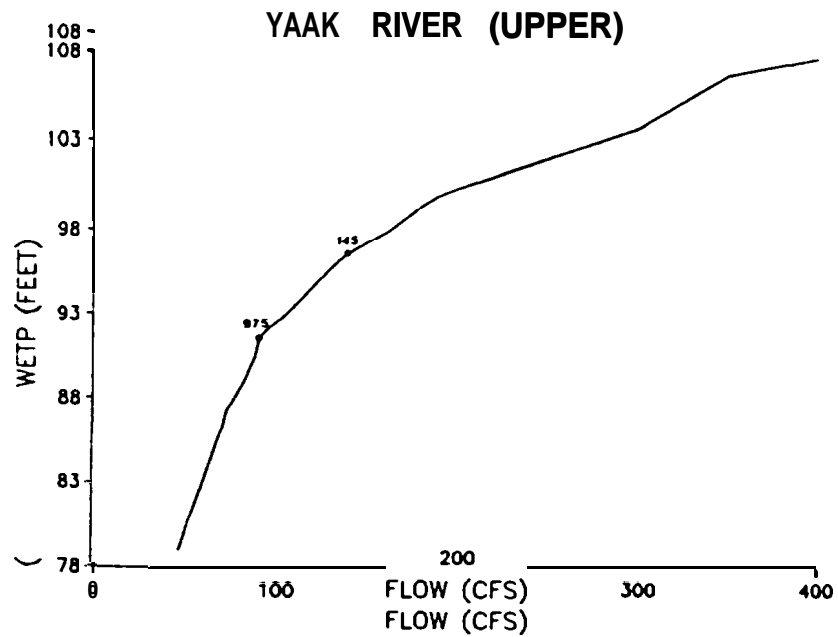
YAAK RIVER (UPPER)

Figure 60. The wetted perimeter-discharge relationship for five riffle transects on the upper Yaak River (May 1982).

Table 41. Recommended minimum flows for the Yaak River and
           historical water availability records based on ten
           years of daily records (USGS).

Period of Water Year	Recommended Flows[a]		80% Exceedence Flows	Mean Flows	Acre Feet	Median Flows[b]
	(lower)	(upper)				
OCT 1 - OCT 15	170.0	145.0	128.8	168.5	5012.0	183
OCT 16 - OCT 31	170.0	145.0	144.0	168.5	5346.2	183
Nov 1 - NOV 15	170.0	145.0	154.1	273.5	8135.3	231
NOV 16 - NOV 30	170.0	145.0	155.9	273.5	8135.3	231
DEC 1 - DEC 15	170.0	145.0	144.7	384.8	11445.9	219
DEC 16 - DEC 31	170.0	145.0	146.9	384.8	12208.9	219
JAN 1 - JAN15	170.0	145.0	119.0	269.0	8001.4	233
JAN 16 - JAN 31	170.0	145.0	141.3	269.0	8534.8	233
FEE3 1 - FEB 15	170.0	145.0	146.7	339.4	10095.4	319
FED 16 - FEB 28	170.0	145.0	156.8	339.4	8076.4	319
MAR1 - MAR 15	170.0	145.0	205.3	530.7	15785.7	404
MAR 16 - MAR 31	170.0	145.0	270.6	530.7	16838.1	404
APR 1 - APR 15	300.0	300.0	624.8	1,524.3	45340.3	1,006
APR 16 - APR 30	300.0	600.0	1,129.1	1,524.3	45340.3	1,375
MAY 1 - MAY 15[c]	1200.0	1200.0	2,326.0	3,246.3	96561.2	3,372
MAY 16 - MAY 31	1800:0	1800.0	2,681.8	3,246.3	10299.8	4,302
JUN 1 - JUN 15	1200.0	1200.0	1,556.0	1,844.5	54864.7	2,914
JUN 16 - JUN 30	600.0	600.0	776.5	1,844.S	54864.7	1,410
JUL 1 - JUL 15	300.0	300.0	392.7	578.8	17216.4	707
JUL 16 - JUL 31	170.0	145.0	220.8	578.8	18364.1	343
AUG 1 - AUG 15	170.0	145.0	166.9	225.5	6707.5	196
AUG 16 - AUG 31	170.0	145.0	125.8	225.5	7154.7	196
SEP 1 - SEP 15	170.0	145.0	116.0	175.0	5205.4	164
SEP 16 - SEP 30	170.0	145.0	122.8	175.0	5205.4	164
					576803.6	

[a] Derived from the dominant discharge/channel morphology
     concept, the wetted perimeter/inflection point method and the
     trout passage requirement.

[b] Derived from a nine-year period of record (1965-1973) for the
     USGS gauge located .32 km upstream from the mouth of the Yaak
     River.

[c] A flow of 6,400 cfs (the approximate bankful discharge) should
     'be maintained for 24 hours during this period (May 1982).
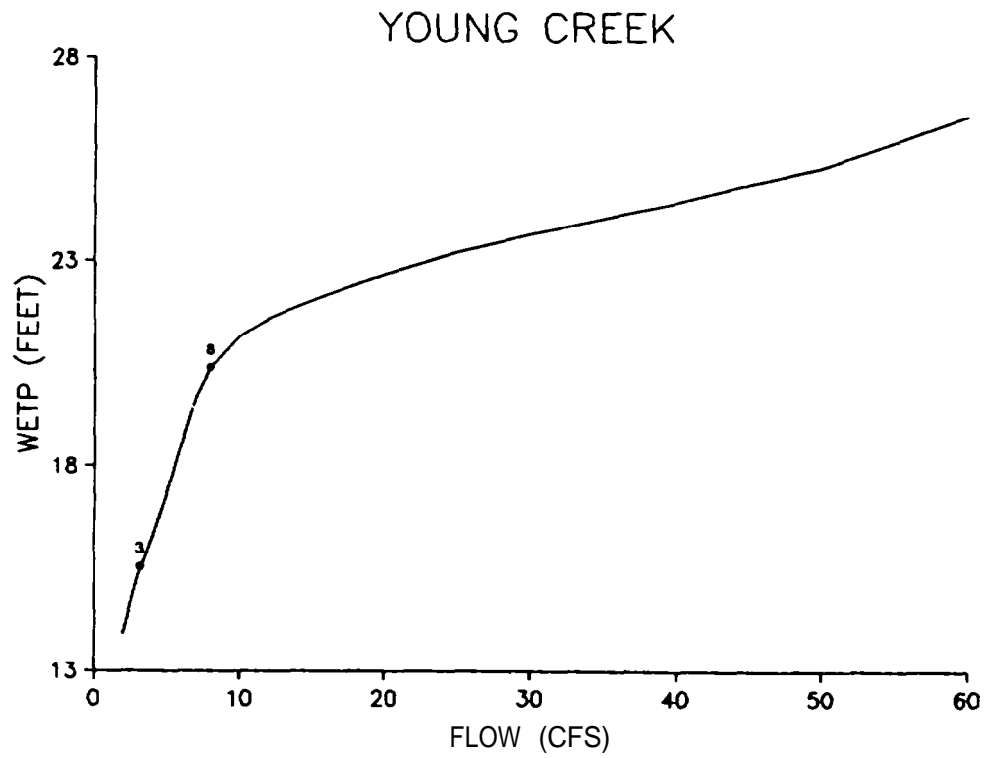
Figure 61. The wetted perimeter-discharge relationship for five riffle transects on Young Creek (May 1982).

Table 42. Average depths for five riffle transects on Young Creek at selected flows of interest.

Flow (cfs)	Average Depth (ft)				
	CS1	Cs2	Cs3	Cs4	CS5
3	.37	.19	.31	.38	.17
8	.55	.26	.48	.43	.27
25	.78	.52	.74	.88	.47
30	.83	.57	.79	.96	.51

RECOMMENDATIONS

Instream Flow

To maintain the spawning potential of the stream, it is important that instream flow recommendations resulting from investigations in the Kootenai watershed be protected by application to the DNRC. A basin-wide approach should be implemented with flow recommendations filed in groups based on the degree of conflict, stream location and fishery information, to facilitate consideration This should be accomplished with minimum delay to secure a timely priority date and to balance fishery requirements with future water use.   Major forks of the tributaries in this report, and upper stream reaches exhibiting dissimilar hydrologic characteristics, should be researched to clarify instream flow needs.

Fish Populations

Fish population estimates were performed during late summer and fall to avoid the capture of <u>Salmo</u> spp. during their spawning run and to target resident and pre-emigrant fish. Electrofishing results do not identify the stream's importance to spawning adults but instead indicate the streams ability to support a resident population and recruits. In this study, the location of the sampled reach corresponded to a representative stretch of stream near the established riffle transects. Transects were, in most cases, installed near tributary mouths where the hydrologic conditions were often erratic and fishery habitat was less optimal, and thus less capable of supporting the quantity of fish than portions further upstream. For this reason, population surveys may underestimate the tributary's importance as a rearing stream The entire identified stream reach should be considered for placement of the sampling section.

Kokanee Spawning

Migrant kokanee salmon entered the Fisher and Tobacco rivers, and Libby Creek during fall. High autumn flows dislodged fry traps and scoured marked redds or buried them beneath thick deposits of sediment and debris, consequently, efforts to estimate fry survival in the Tobacco River failed. Further research is needed to determine the importance of Montana's Kootenai River tributaries to kokanee spawning success. It is apparent that Canadian tributaries support the majority of kokanee reproduction (Huston et al. 1984). They should be protected from degradation if kokanee are to be maintained as the most important sportfish in Libby Reservoir.

Native Raibow Trout

Callahan Creek is one of two Kootenai River tributaries in Montana known to contain a genetically isolated population of native rainbow trout. Genetic contamination and habitat degradation should be avoided to preserve this remaining population.

Fish Barrier Removal

A rock barrier located at the mouth of Barron Creek should be modified into a step-like cascade to allow for migrant passage during spring. The drainage is similar to Bristow Creek which developed a substantial run of westslope cutthroat, rainbow and hybrid trout. Debris and log jams deemed to be barriers should be removed from Barron, Bobtail, Bristow, Deep, Fivemile, Pinkham, Pipe and Quartz creeks to ensure access to spawning areas. Barriers may form in other tributaries as well. However, debris removal should be conservative because partial blockage of the channel is desirable for cover, pool production and gravel deposition.

Migrant passage during fall low flows is especially important in creeks supporting bull trout spawning (e.g. Grave, Libby, Pipe and Quartz creeks, and the Fisher River). Rock and log jams illegally erected to create recreational "swimming holes" should be breached prior to the low flow period when water flows through rather than over the structures, presenting barriers to migrants.

Tributary Habitat

Protection of the aquatic habitat in Kootenai River tributaries is of paramount importance to the maintenance of the resident fishery resource. This report summarizes research to support efforts to maintain existing stream flow conditions favorable for fish production. Sediment pollution and channel instability caused by man's activities in the Kootenai Drainage, however, are additional threats to juvenile recruitment and food production. If present trends continue, it is likely that the cumulative effects will result in damage to this valuable inland fishery. A comprehensive approach by cooperating land management agencies is needed to assess the extent of present environmental problems and to determine methods for eliminating harmful contributing factors.

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APPENDIX A

BARRON CREEK
eastern brook trout
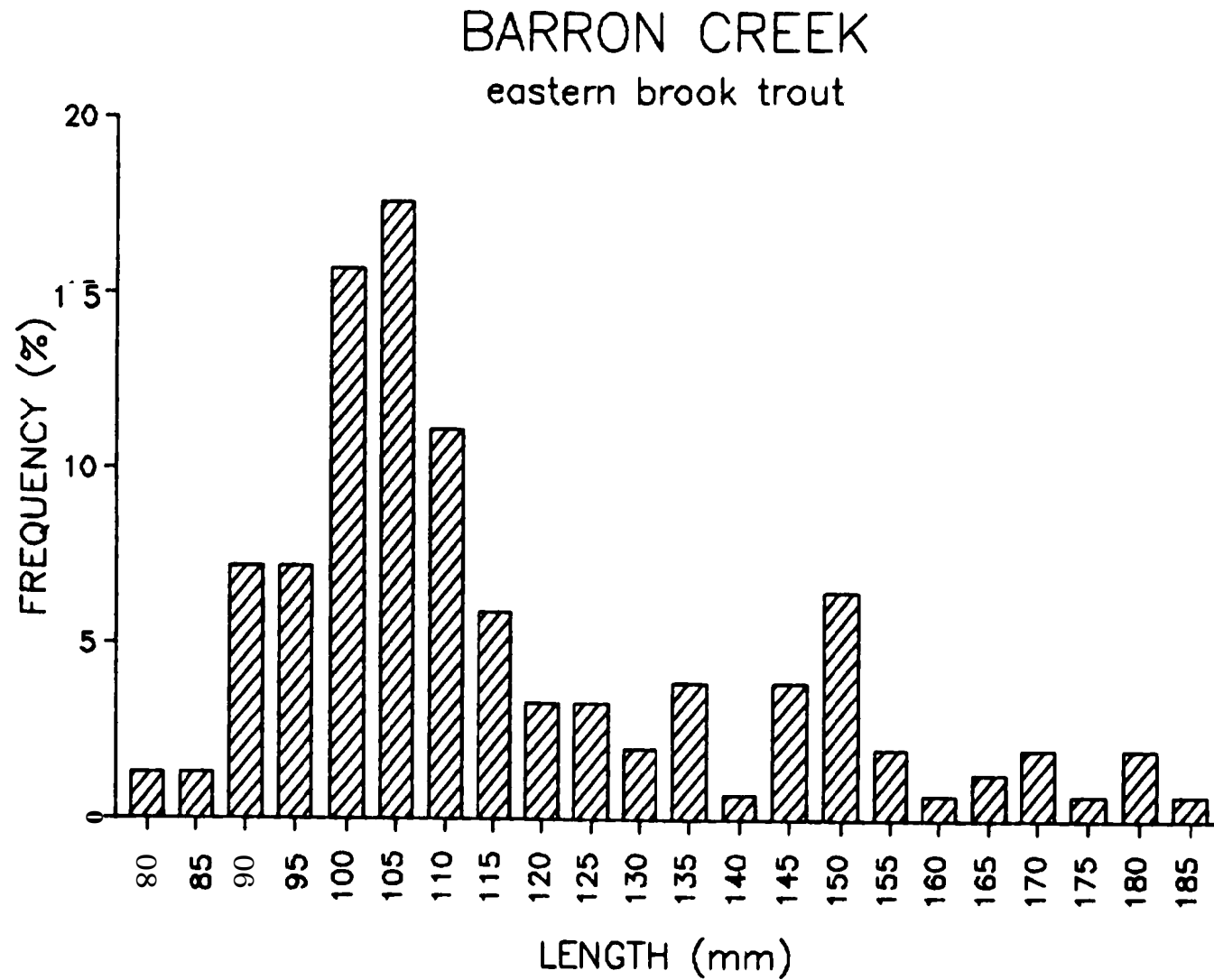
Appendix A1. Length frequency histogram of eastern brook trout captured in Barron Creek electrofishing survey.
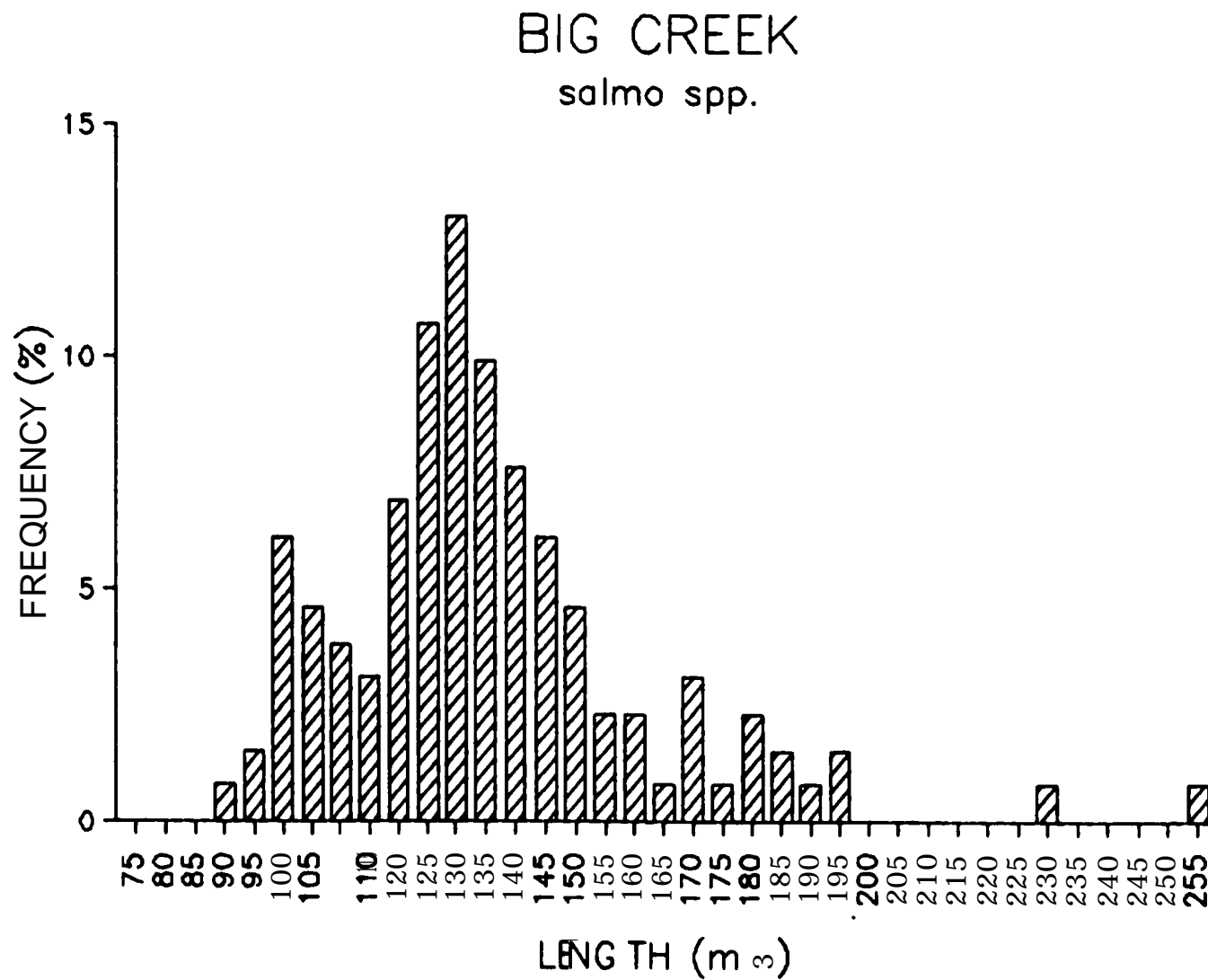
BIG CREEK
salmo spp.

Appendix A2. Length freencyhistog rarof Salmo spp .ca ptre i Bi gCreek ele ctro-
fishing suey.

BIG CREEK
catch efficiency curves
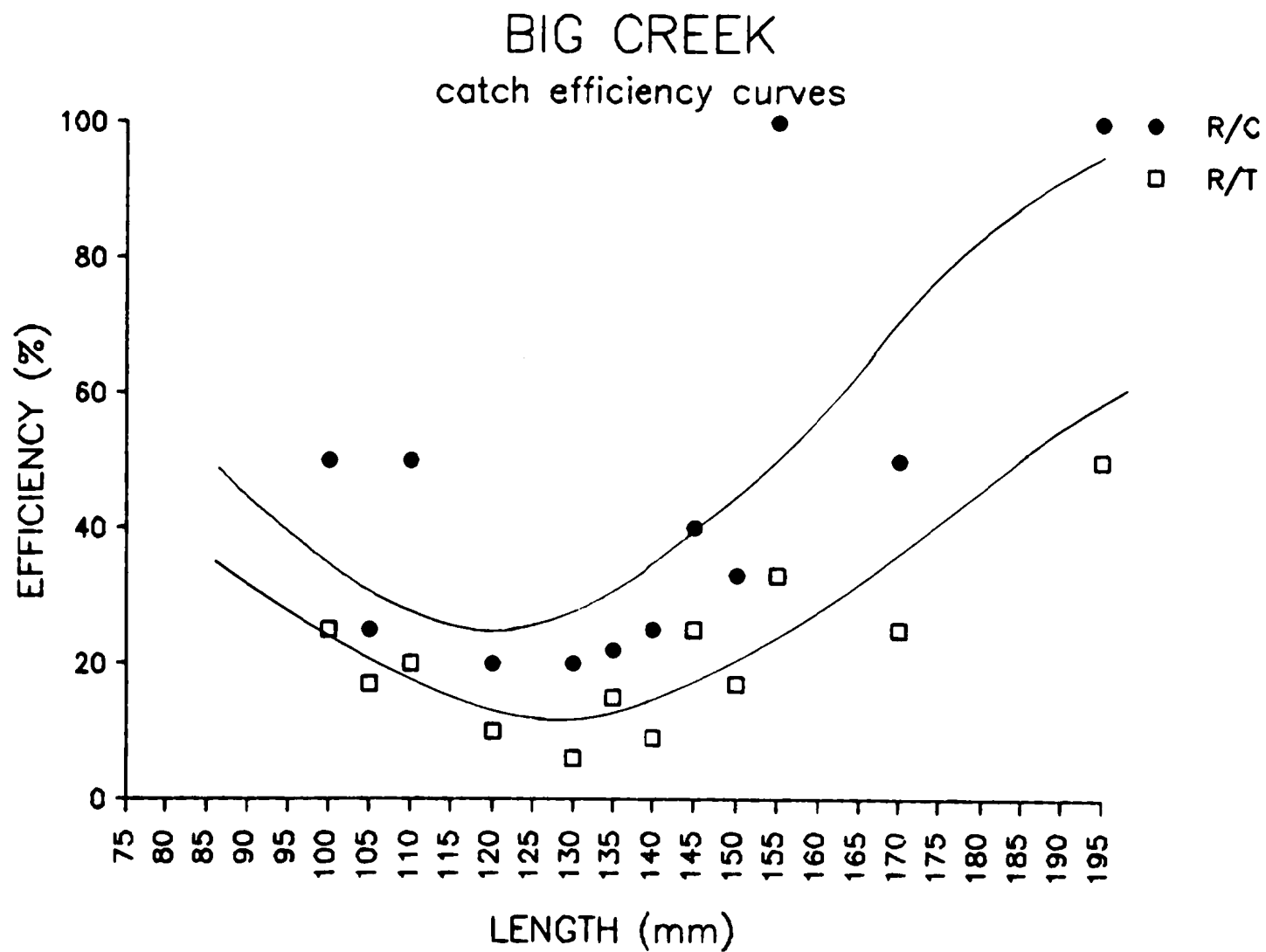
Appendix A3. Catch efficiency of Salmo spp. based on recaptures in each length
category of total catch (R/T) and recapture pass (R/C) in Big Creek.

BRISTOW CREEK
salmo spp.
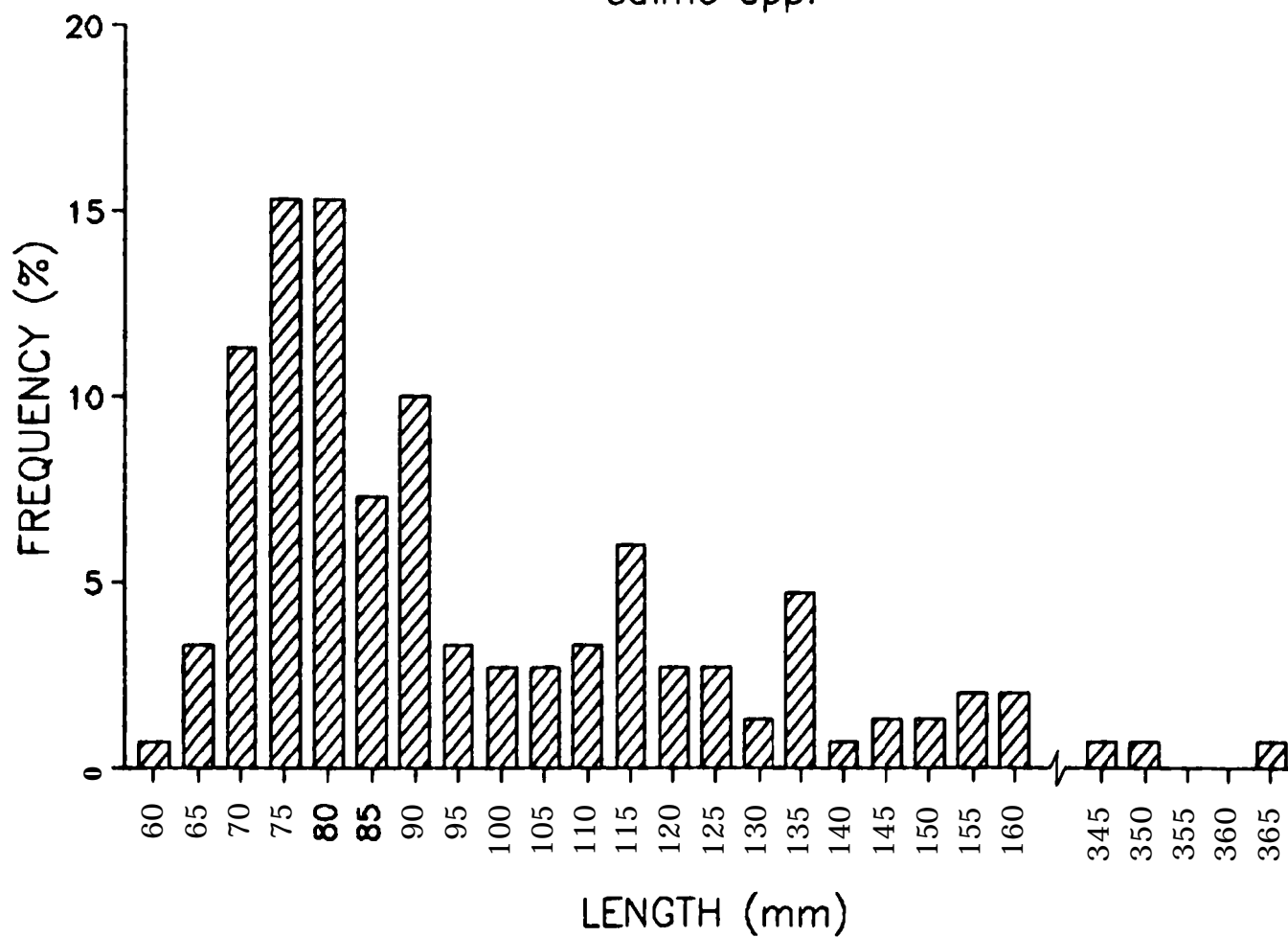
Appendix A4. Length frequency histogram of <u>Salmo</u> spp. captured in Bristow Creek electro-
fishing survey.

DEEP CREEK
salmo spp.
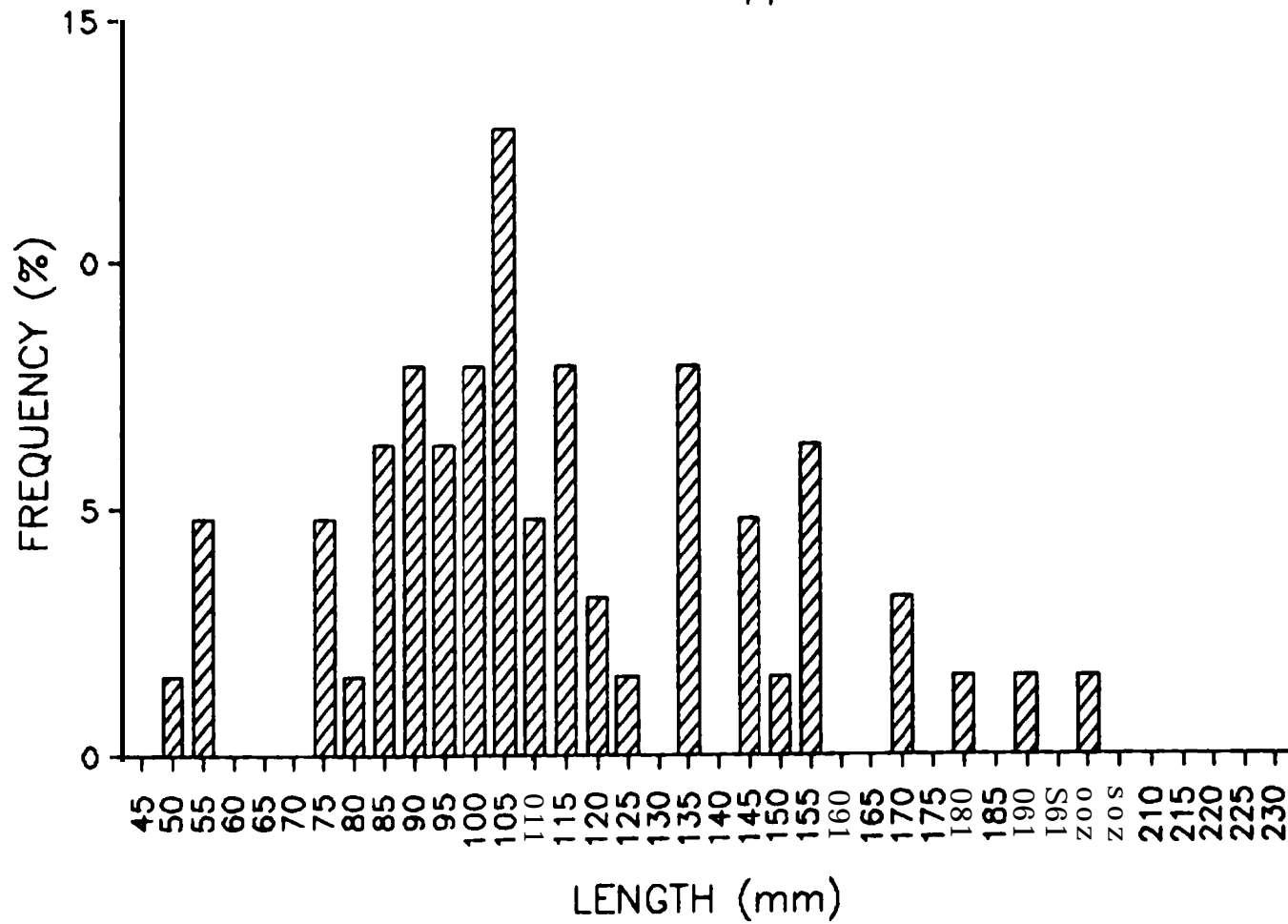
Appendix A5.   Length frequency histogram of <u>Salmo</u> spp. captured in Deep   electro-
             fishing survey.

DEEP CREEK
eastern brook trout
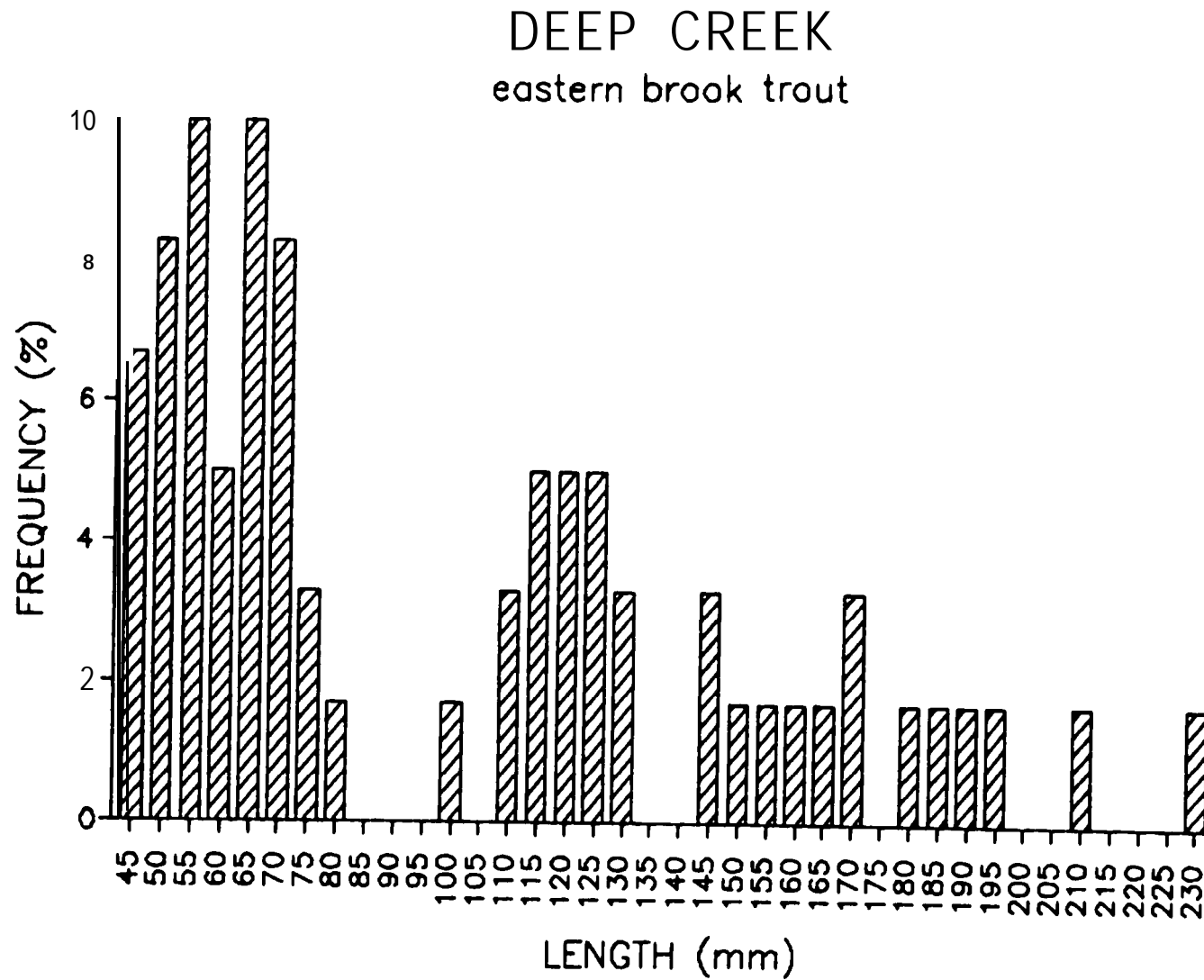
Appendix A6. Length frequency histogram of eastern brook trout captured in Deep Creek electrofishing survey.

FIVEMILE CREEK
salmo spp.
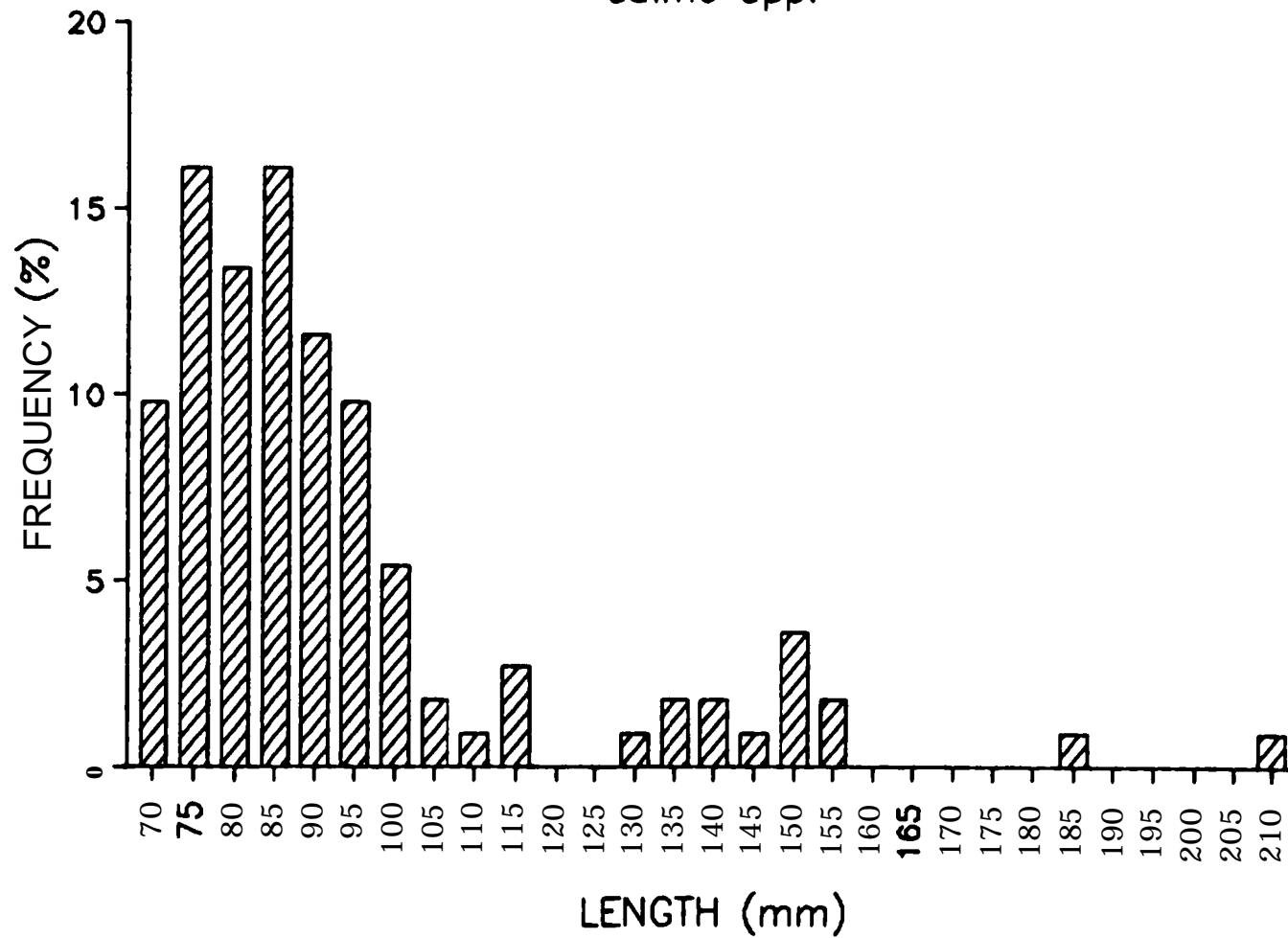
Appendix A7. Length frequency histogram of <u>Salmo</u> spp. captured in Fivemile Creek electrofishing survey.

FIVEMILE CREEK
eastern brook trout
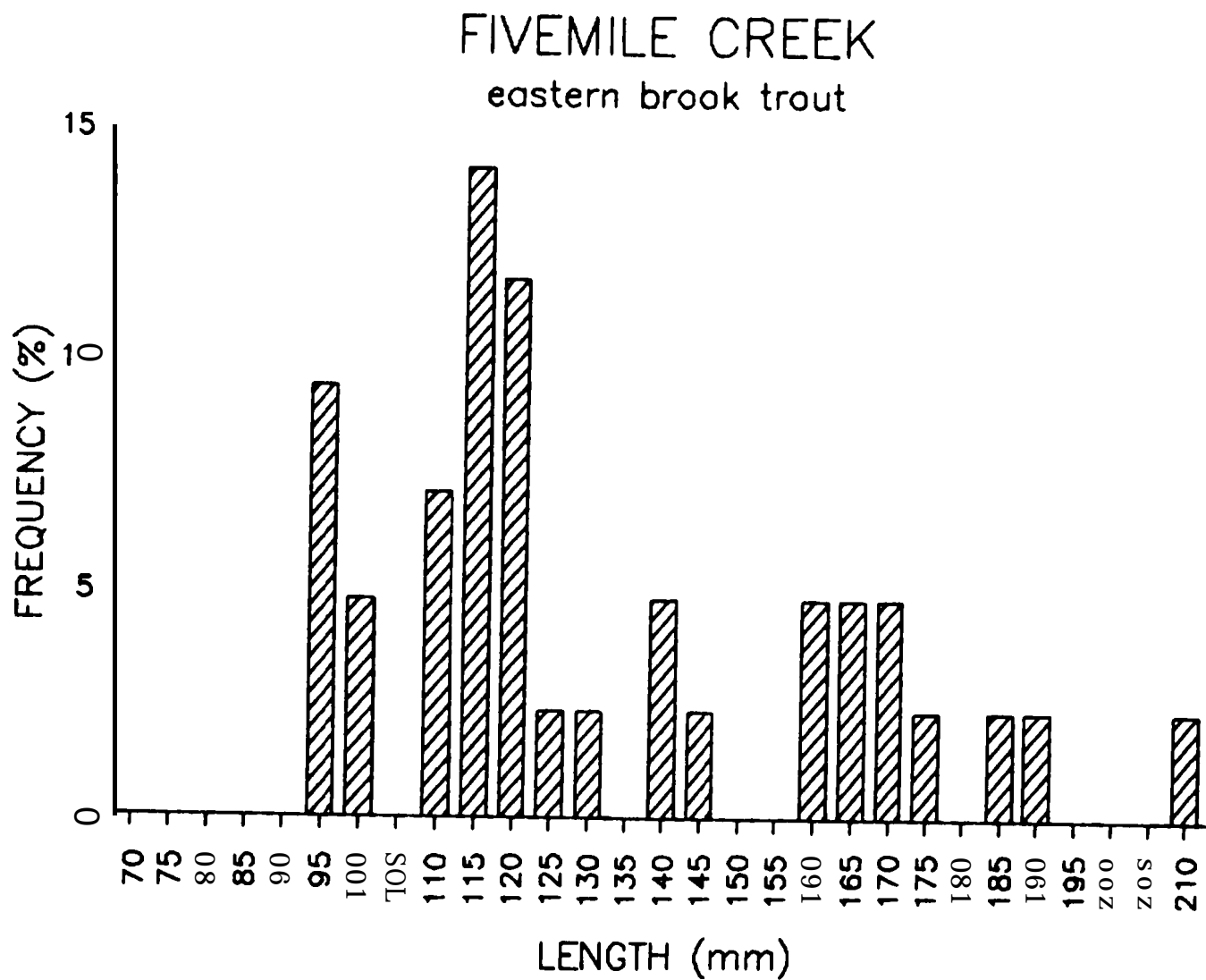
Appendix A8. Length frequency histogram of eastern brook trout captured in Fivemile Creek electrofishing survey.

GRAVE CREEK
salmo spp.
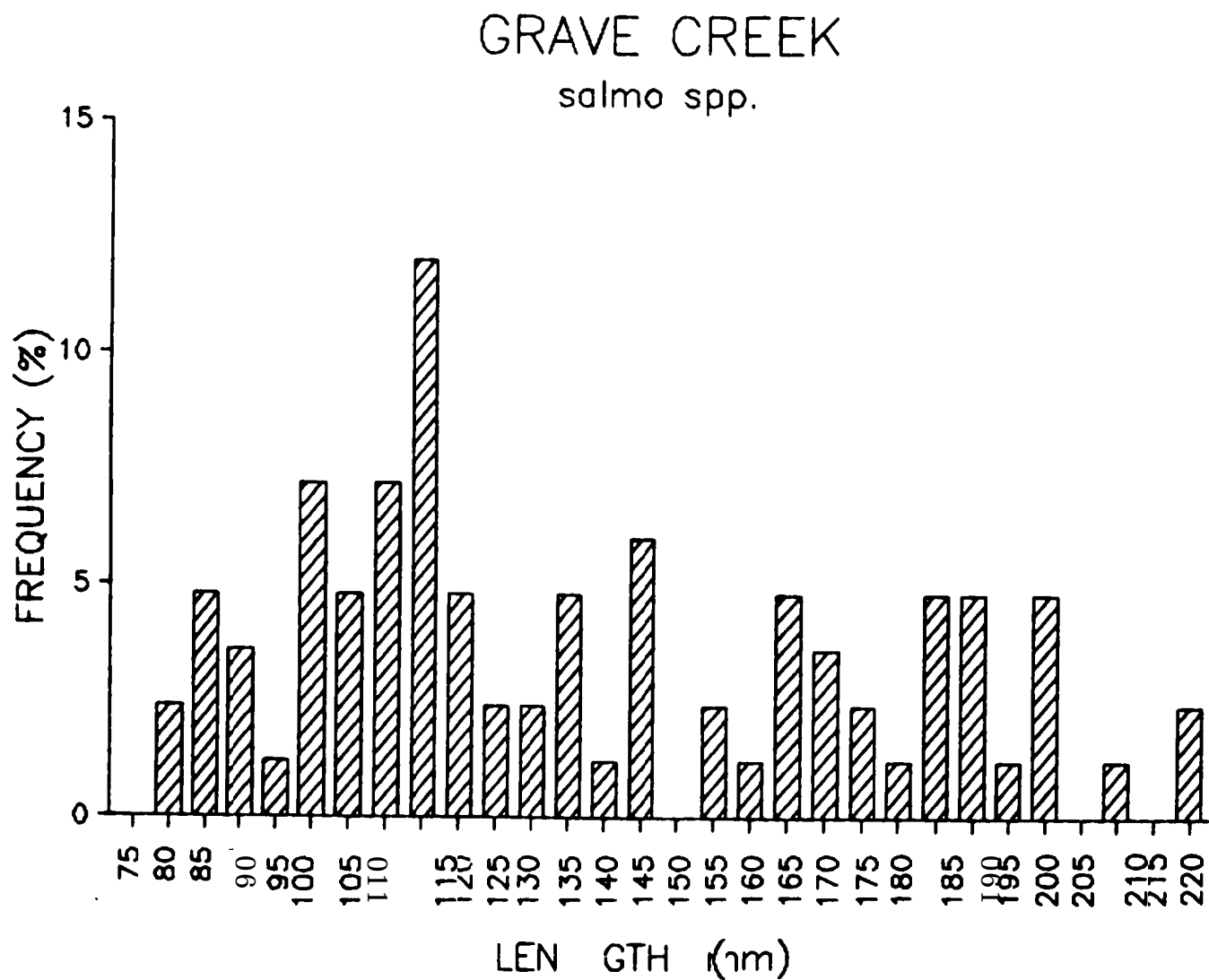
Appendix A9. Length frequency histogram of <u>Salmo</u> spp captured in Grave Creek electro—
fishing survey.

GRAVE CREEK
eastern brook trout

FREQUENCY (%)

LENGTH (mm)

AppendixA 10. Le ng frequ ency hisogram of easte rbook   tou tcaptre isGrave   Creek
el ecofi s ing su rve,

GRAVE CREEK
catch efficiency curves
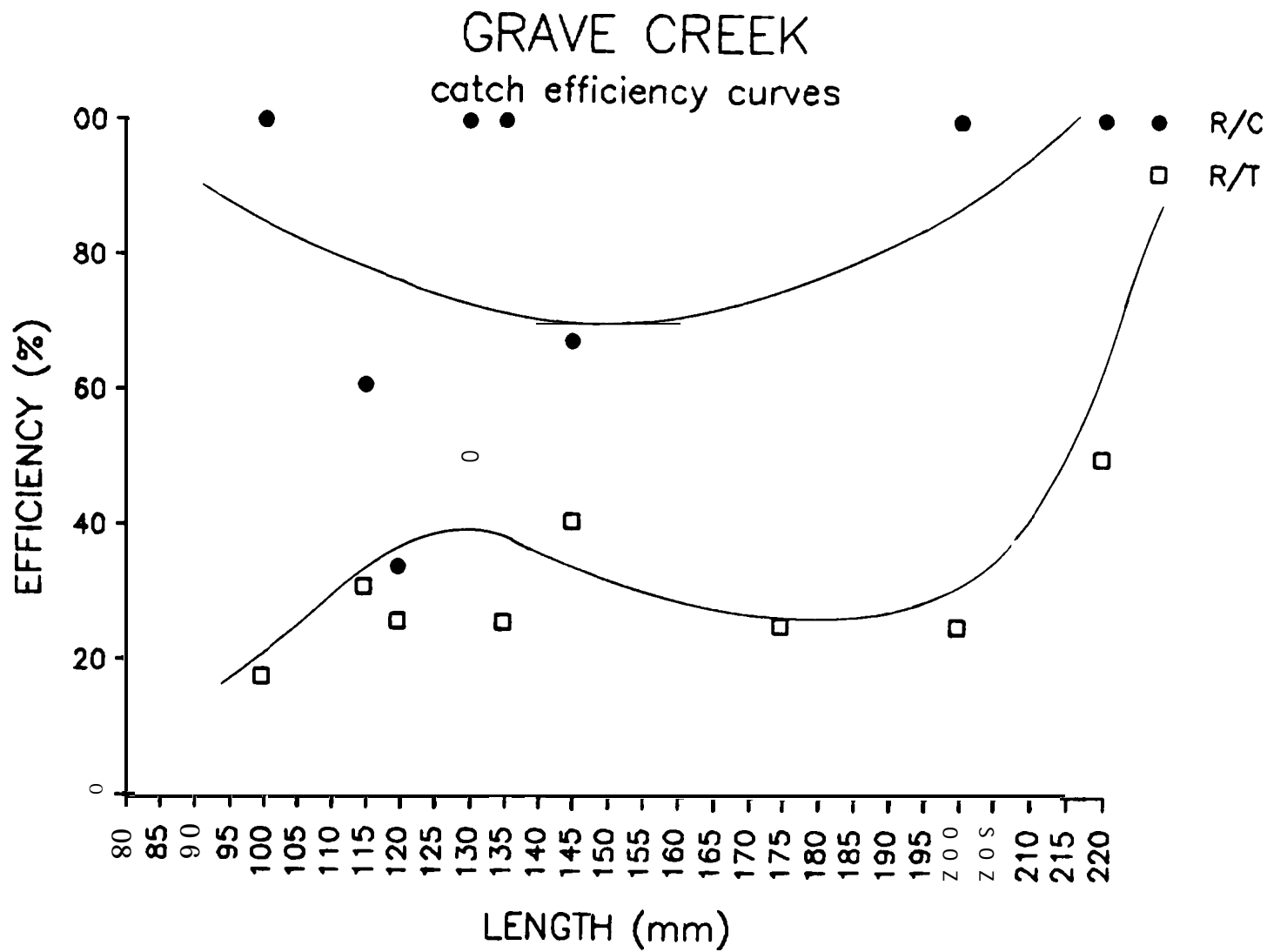
Appendix A11 Catch efficiency of _Salmo_ spp. based on recaptures in each length
category of total catch (R/T) and recapture pass (ᵖ/C) in Grave Creek.

ToBACCO RIVER
salmo spp.
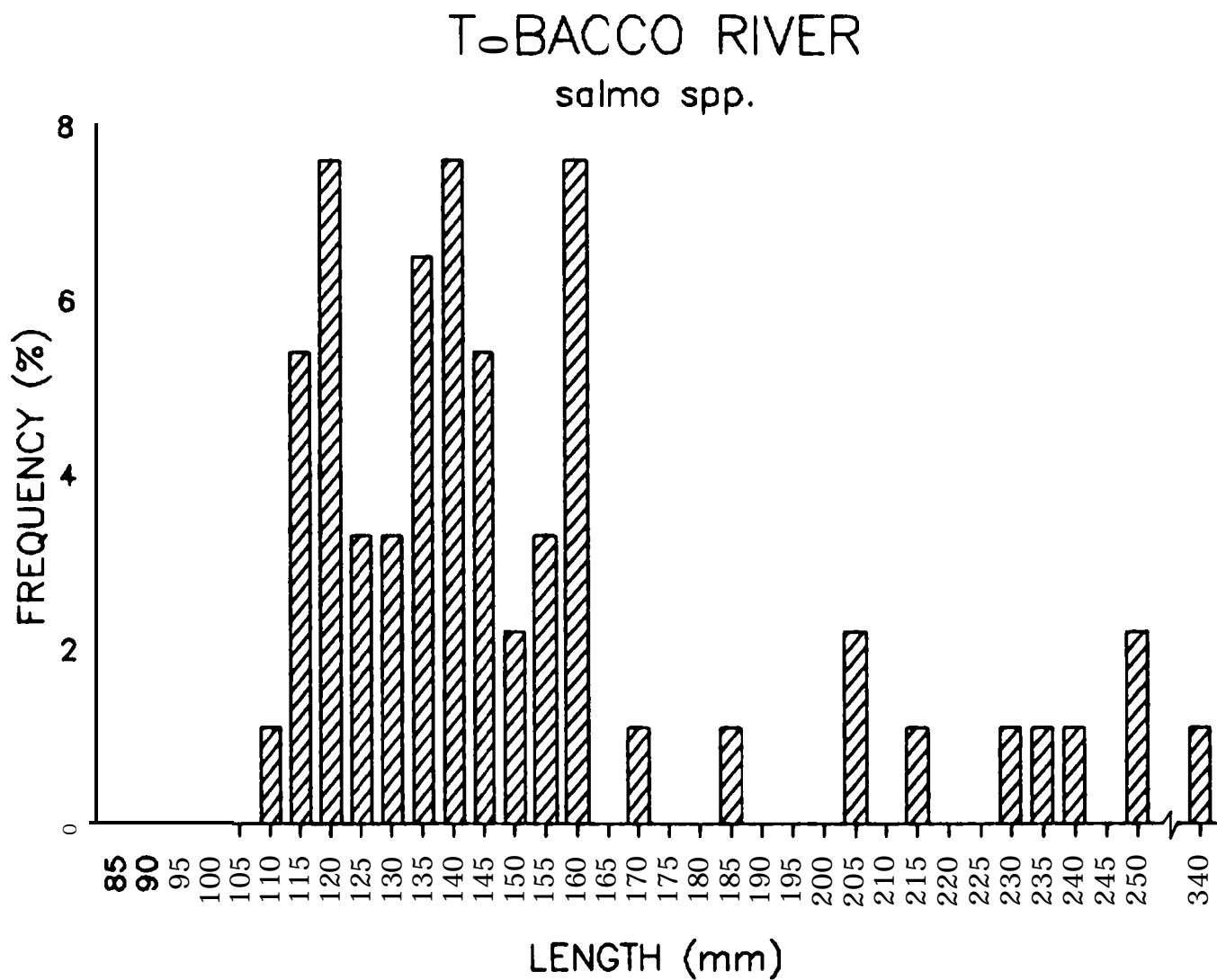
Appendix A12. Length frequency histogram of <u>Salmo</u> spp. ture in the Tobac River electrofishing survey .

TOBACCO RIVER
catch efficiency curves

Appendix A13. Catch efficiency of <u>Salmo</u> spp. based on recaptures in each length category of total catch (R/T) and recapture pass (R/C) in the Tobacco River.

BIG CHERRY CREEK
rainbow trout

Appe   ndix A14. Lenqto frequency histogram of rainbow trou t catu raữ in BigCher ry Creek
electroофishing survey.

CALLAHAN CREEK
rainbow trout

Appe ndix A 15.   Lengthfequ ery hi st ogram of rnbow   trou tca ţu re ซ์n Cal   ahan Cr ek
electrfshi nงurv ey .

FISHER RIVER
mountain whitefish

Appendix A16. Length frequency histogram of mountain whitefish captures in the Fisher River electrofishing survey.

FISHER RIVER
rainbow trout

Appendix A17   Length frequency histogram of rainbow trout captured in the Fisher River electrofishing survey.

FISHER RIVER
catch efficiency curves
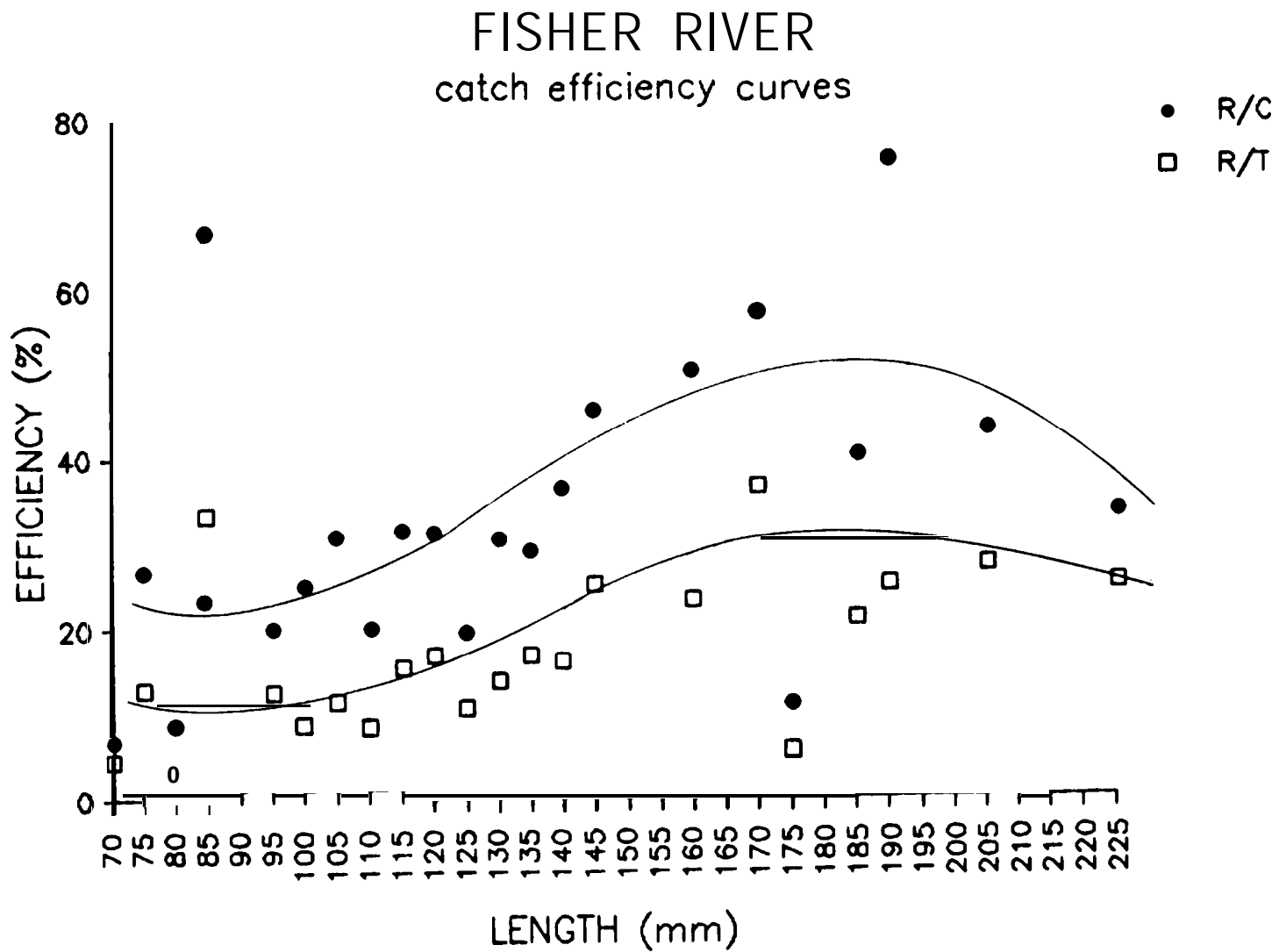
Appendix A18. Catch efficiency of rainbow trout based on recaptures in each length
category of total catch (R/T) and recapture pass (R/C) in the Fisher River.

LIBBY CREEK
rainbow trout
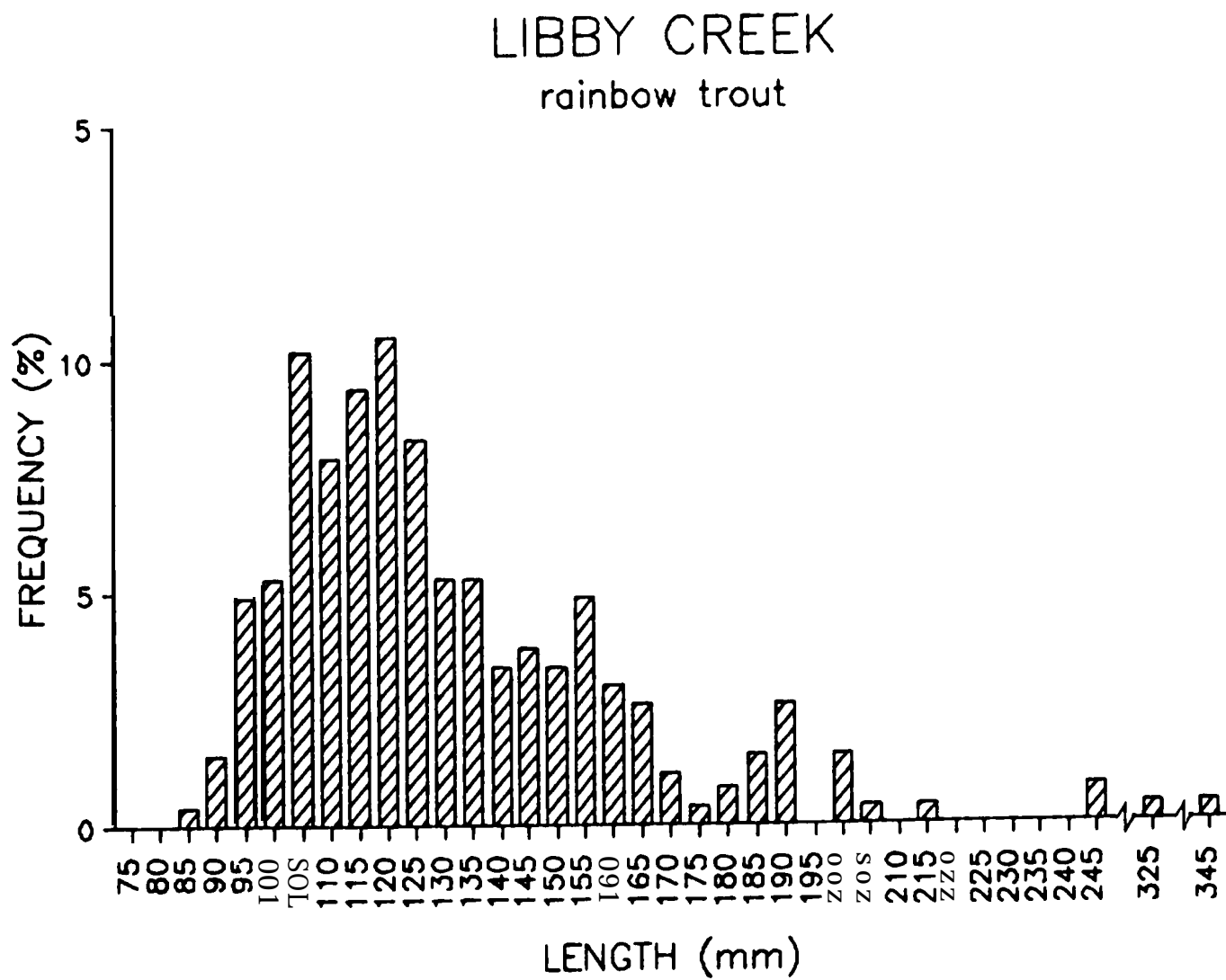
Appendix A19. Length frequency histogram of rainbow trout captured in Libby Creek electrofishing survey

LIBBY CREEK
catch efficiency curves
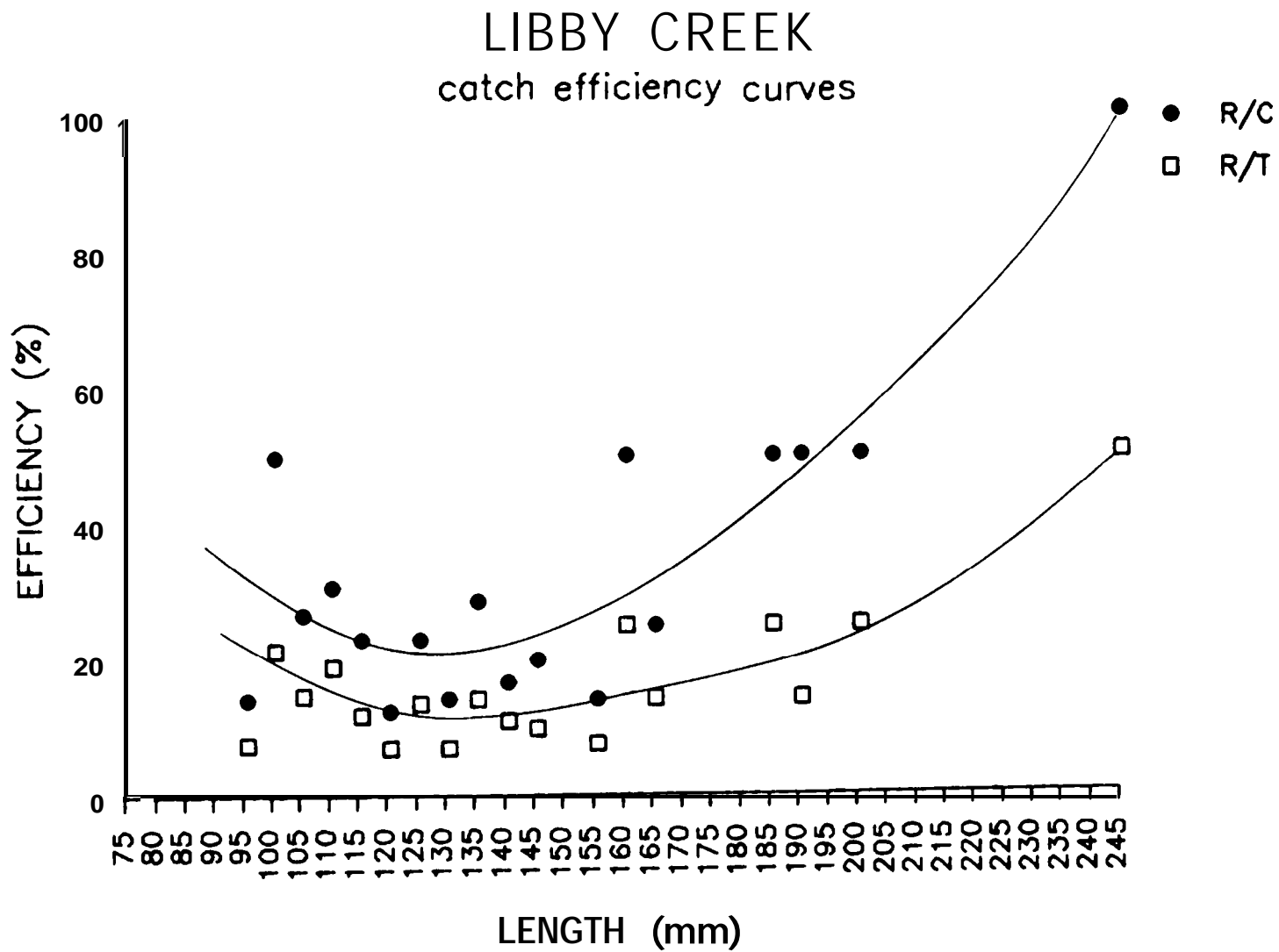
Appendix A20. Catch efficiency of rainbow trout based on recaptures in each length category of total catch (R/T) and recapture pass (R/C) in Libby Creek.

LIBBY CREEK
eastern brook trout
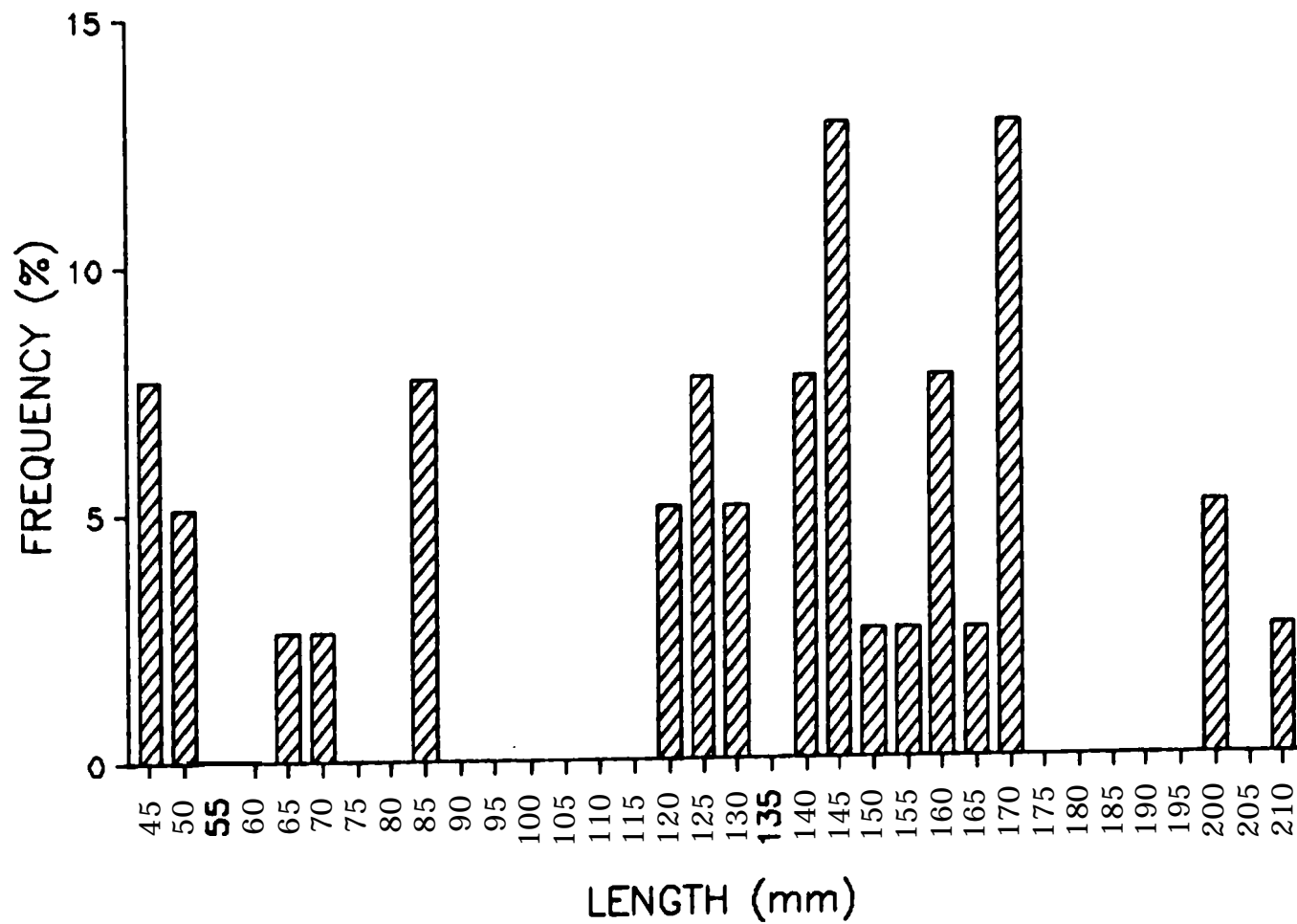
Appen A21. Length frequency histogram of eastern brook trout captured in Libby Creek electrofishing survey.

QUARTZ CREEK
salmo spp.

FREQUENCY (%)
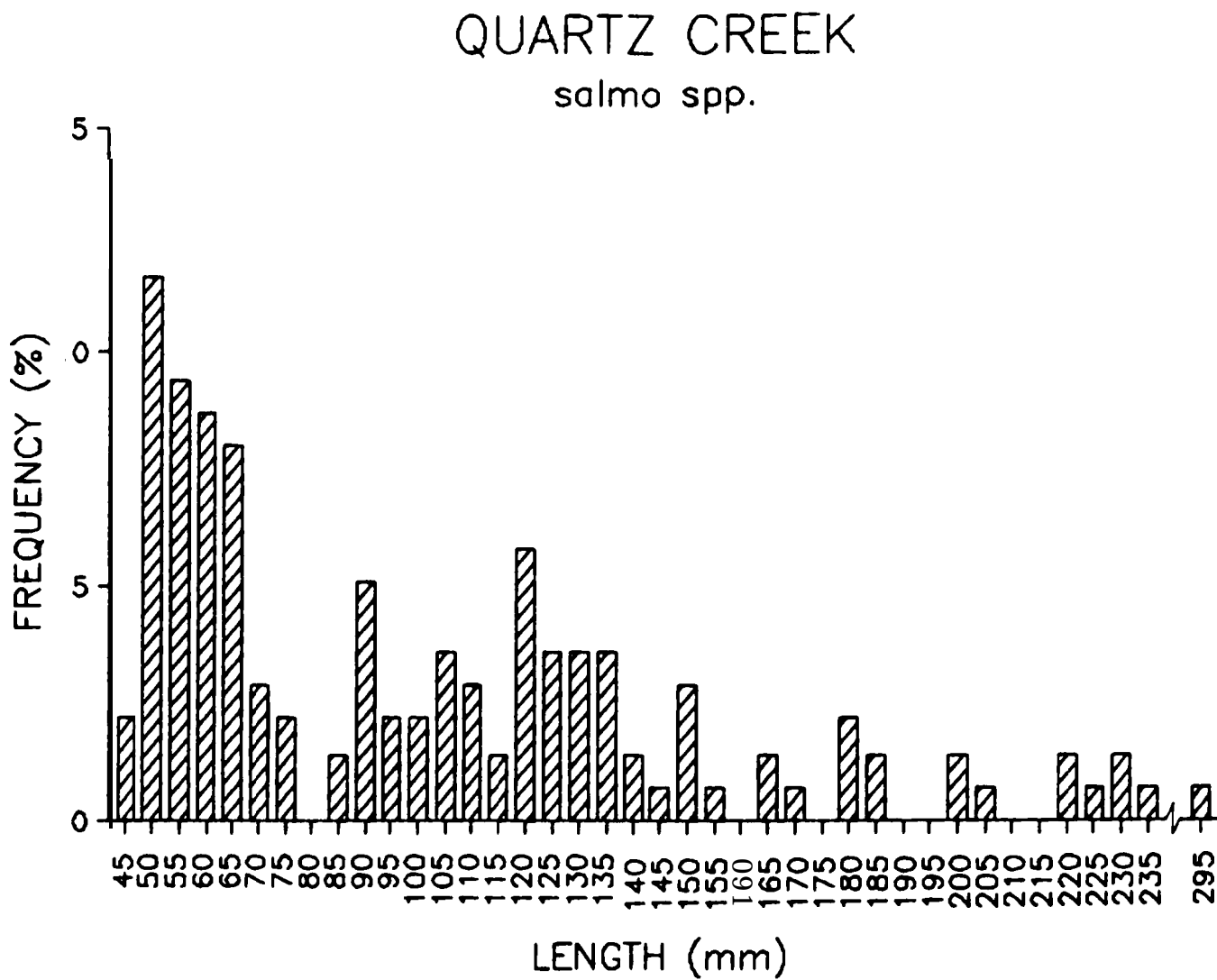
LENGTH (mm)

Appendix A22. Length frequency histogram of <u>Salmo</u> spp. captured in lower Quartz Creek electrofishing survey.

QUARTZ CREEK
catch efficiency curves

EFFICIENCY (%)
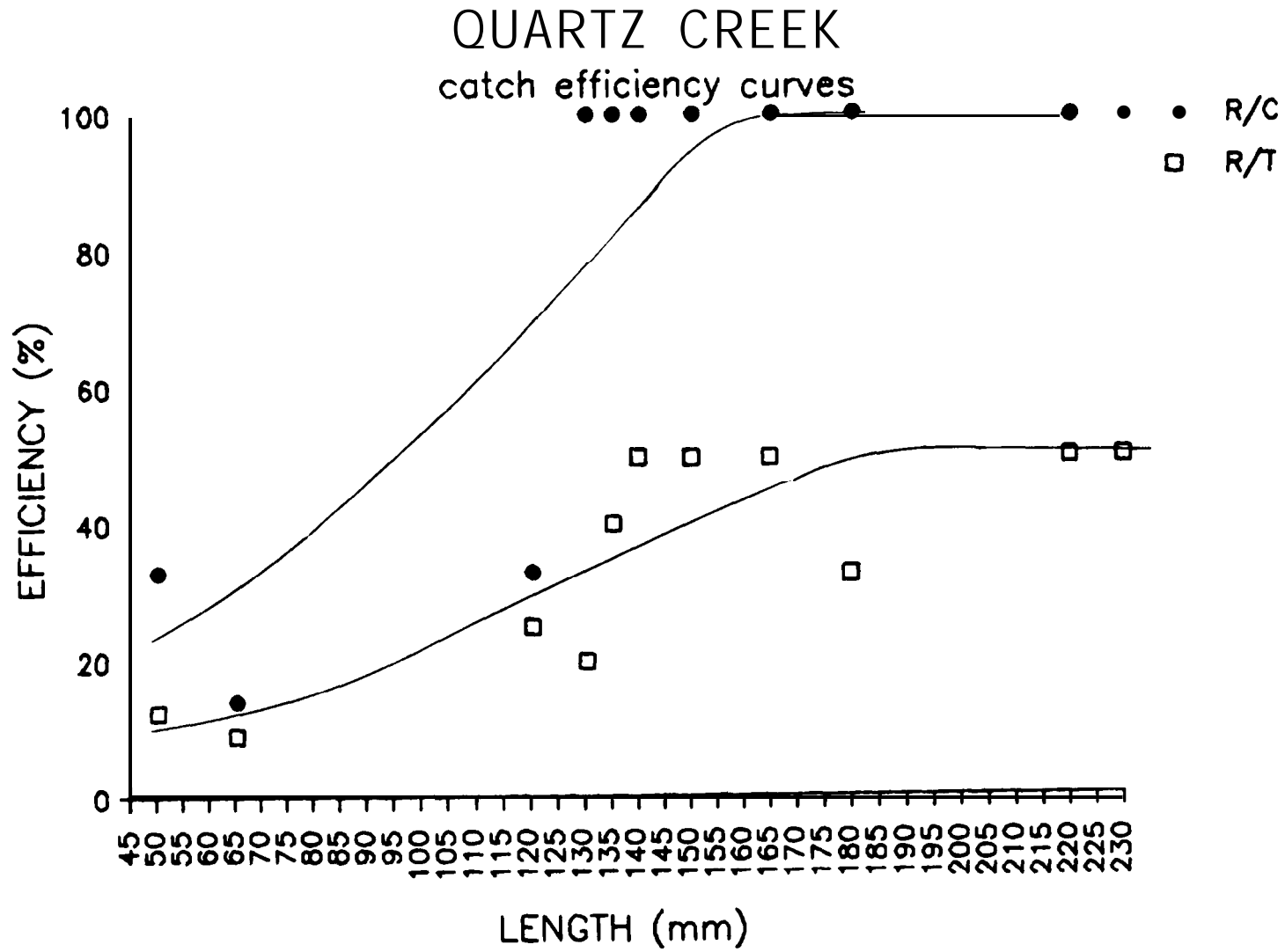
LENGTH (mm)

Appendix A23.   Catch efficiency of Salom spp. based on recaptures in each length category of total catch (R/T) and recapture pass (R/C) in lower Quartz Creek.

QUARTZ CREEK (UPPER)
salmo spp.
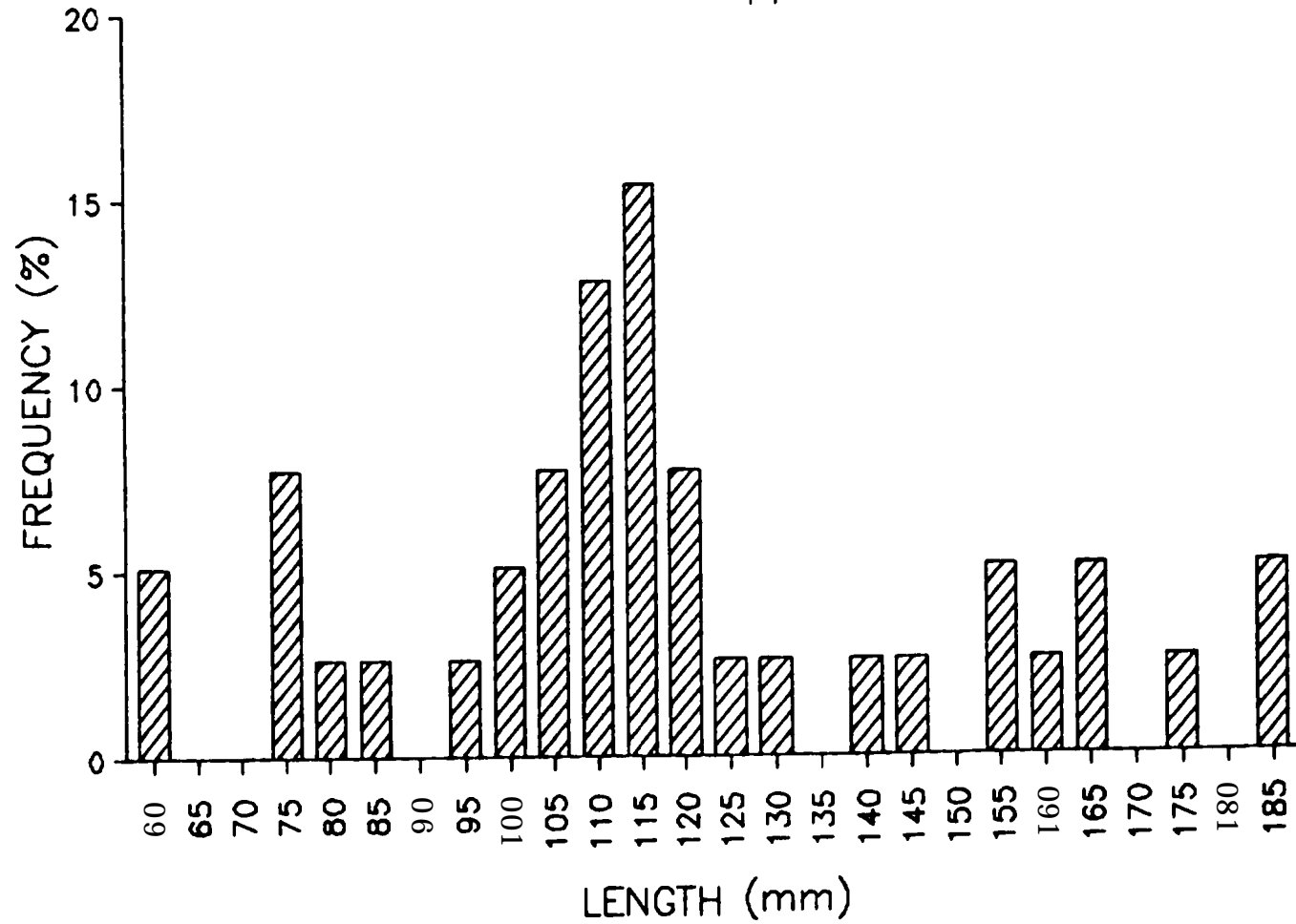
Appendix A24   Length frequency histogram of <u>Salmo</u> spp. captured in upper Quartz Creek electrofishing survey.

QUARTZ (MIGRANT TRAPS)
bull trout
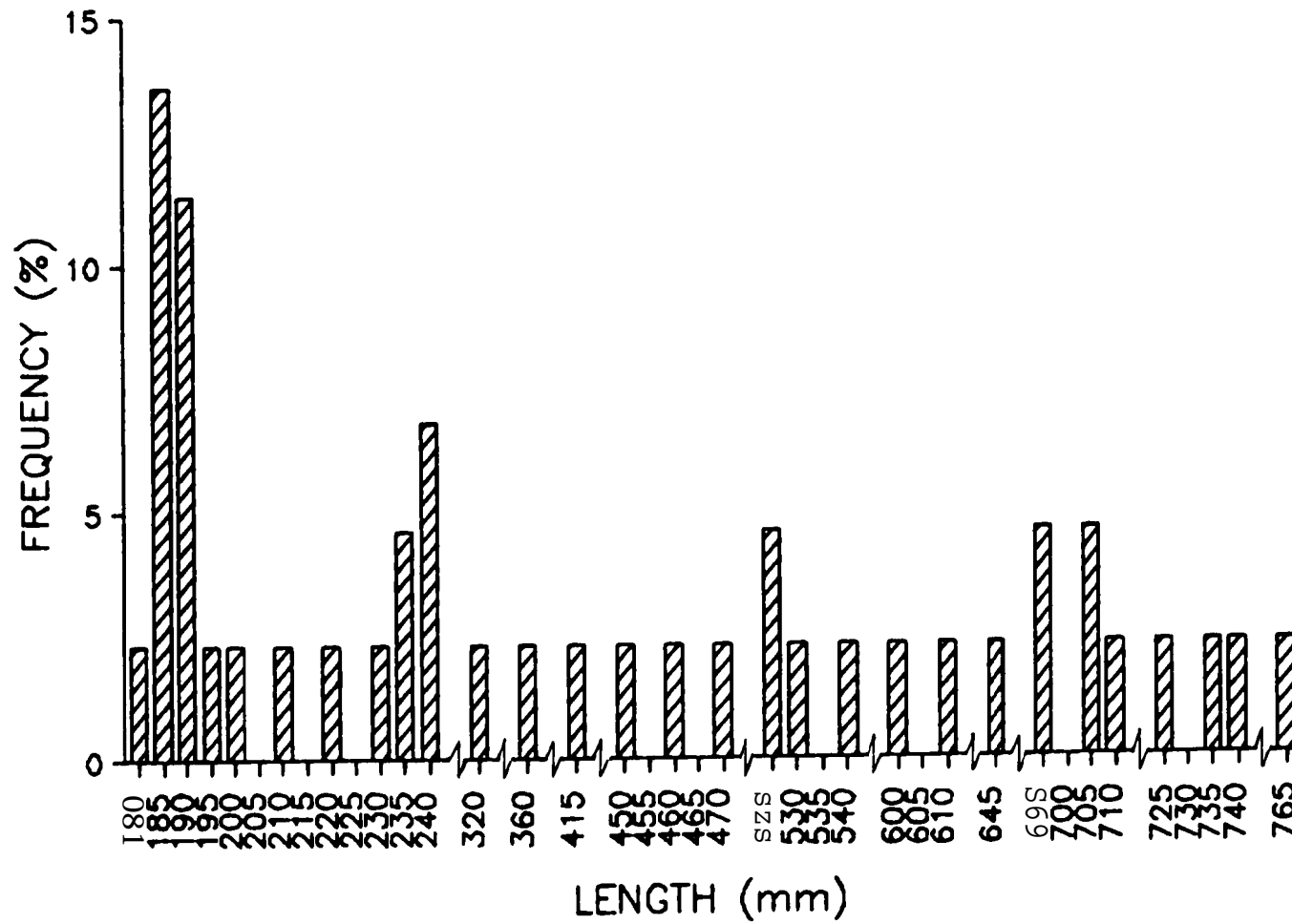
Appendix A25. Length frequency histogram of bull trout migrants captured in Quartz
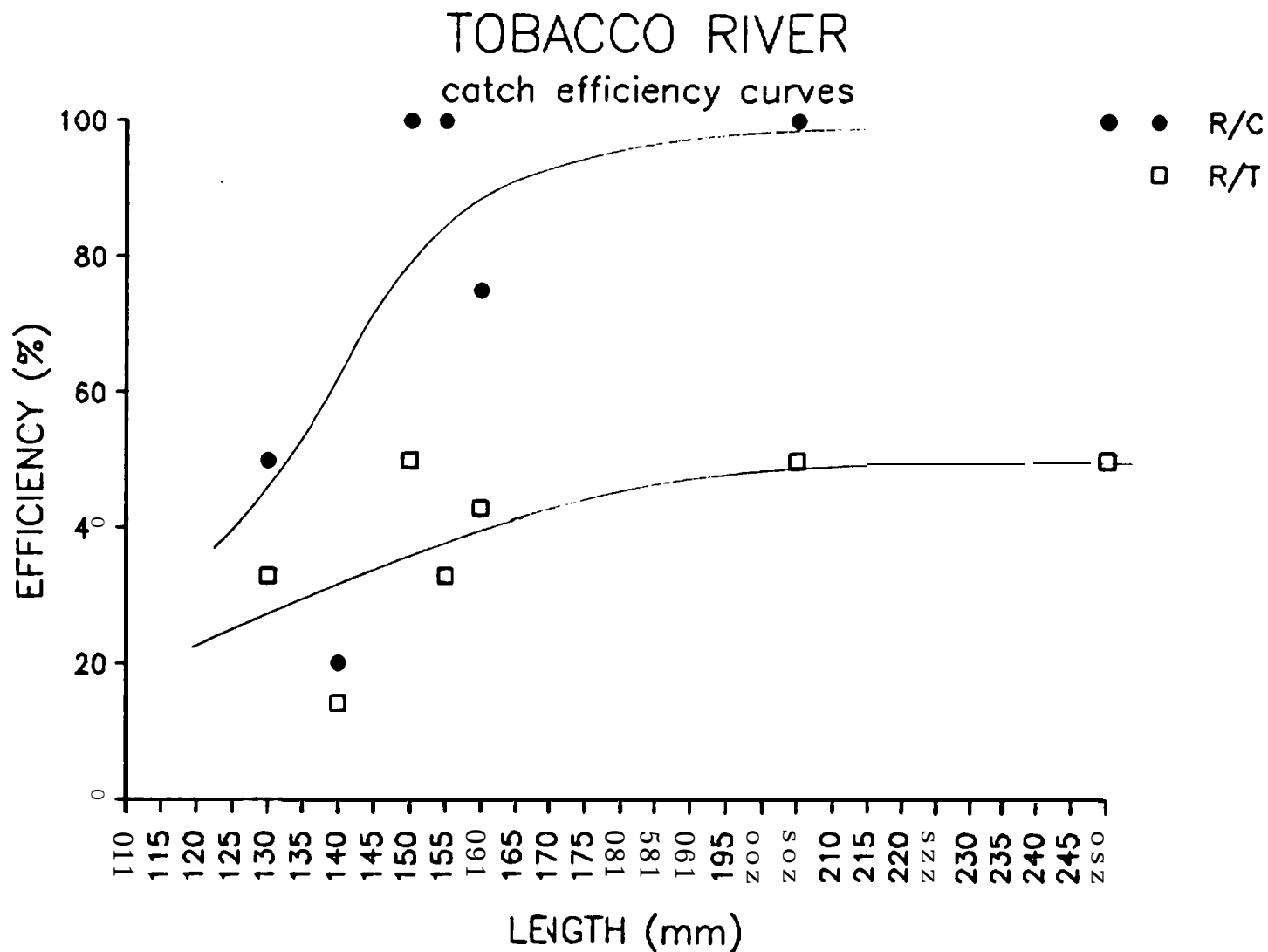Creek trap.

WOLF CREEK
rainbow trout
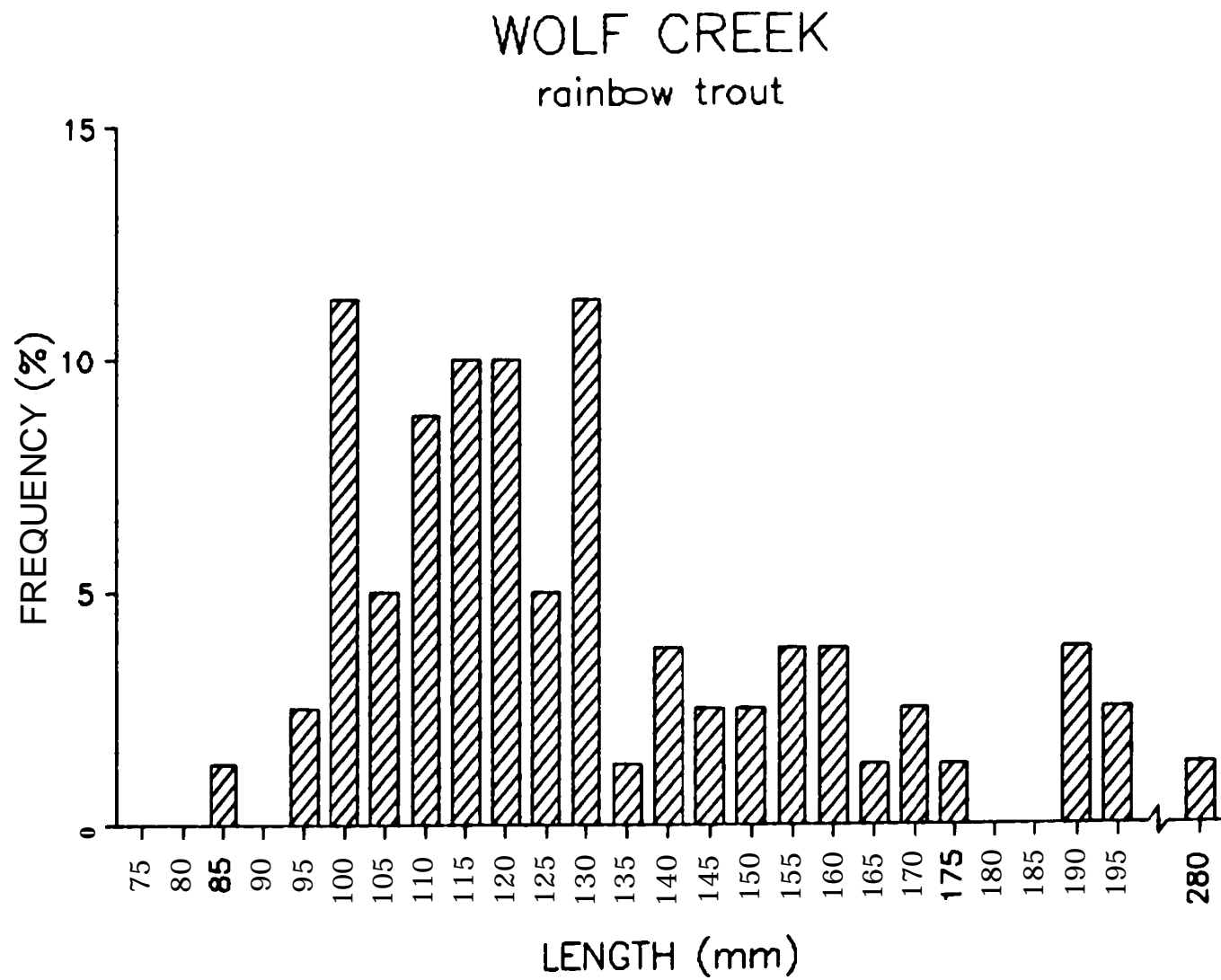
Appendix A26. Length frequency histogram of rainbow trout captured in Wolf Creek
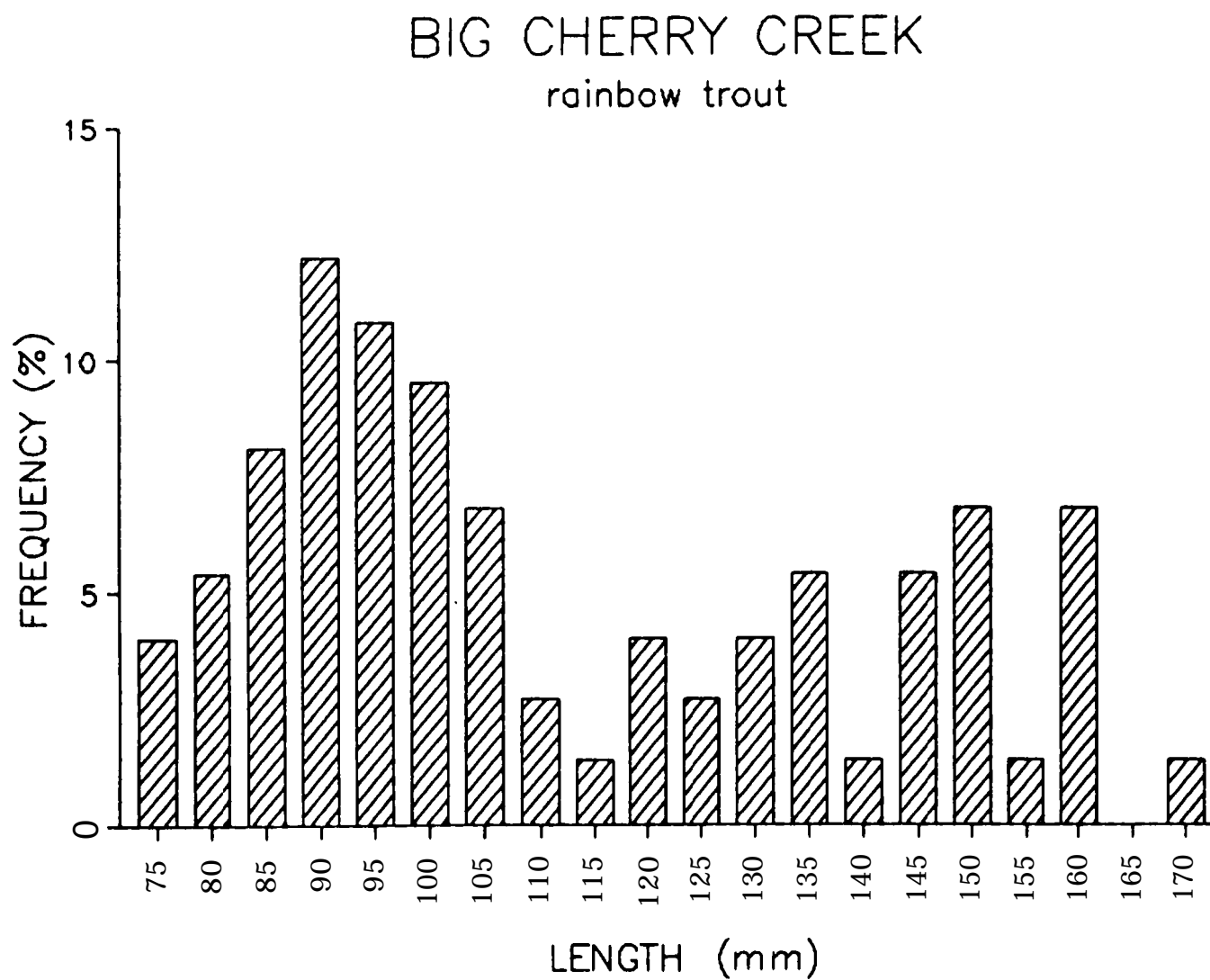electrofishing survey.
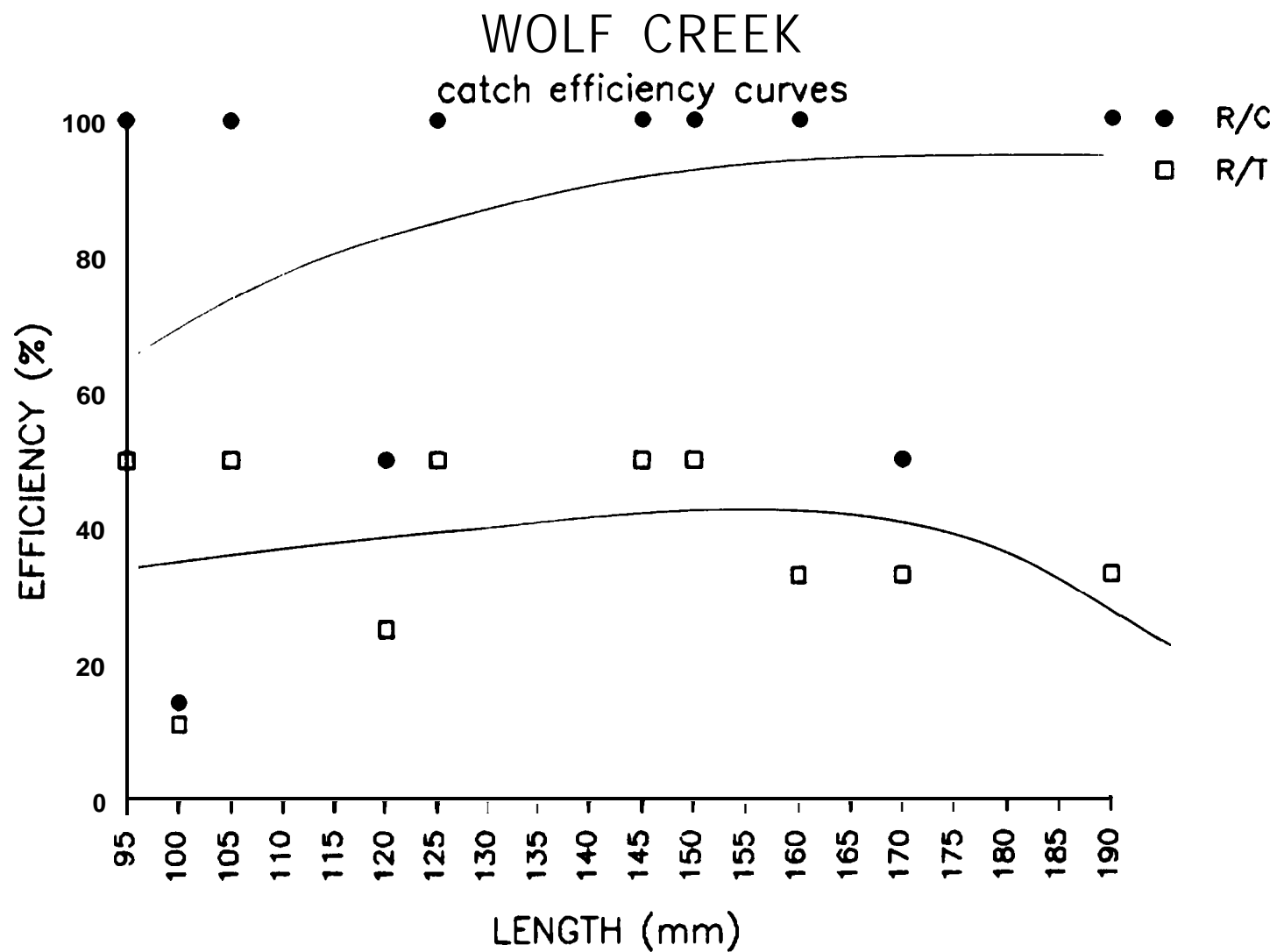
Appendix A27. Catch efficiency of rainbow trout based on recaptures in each length category of total catch (R/T) and recapture pass (R/C) in Wolf Creek.
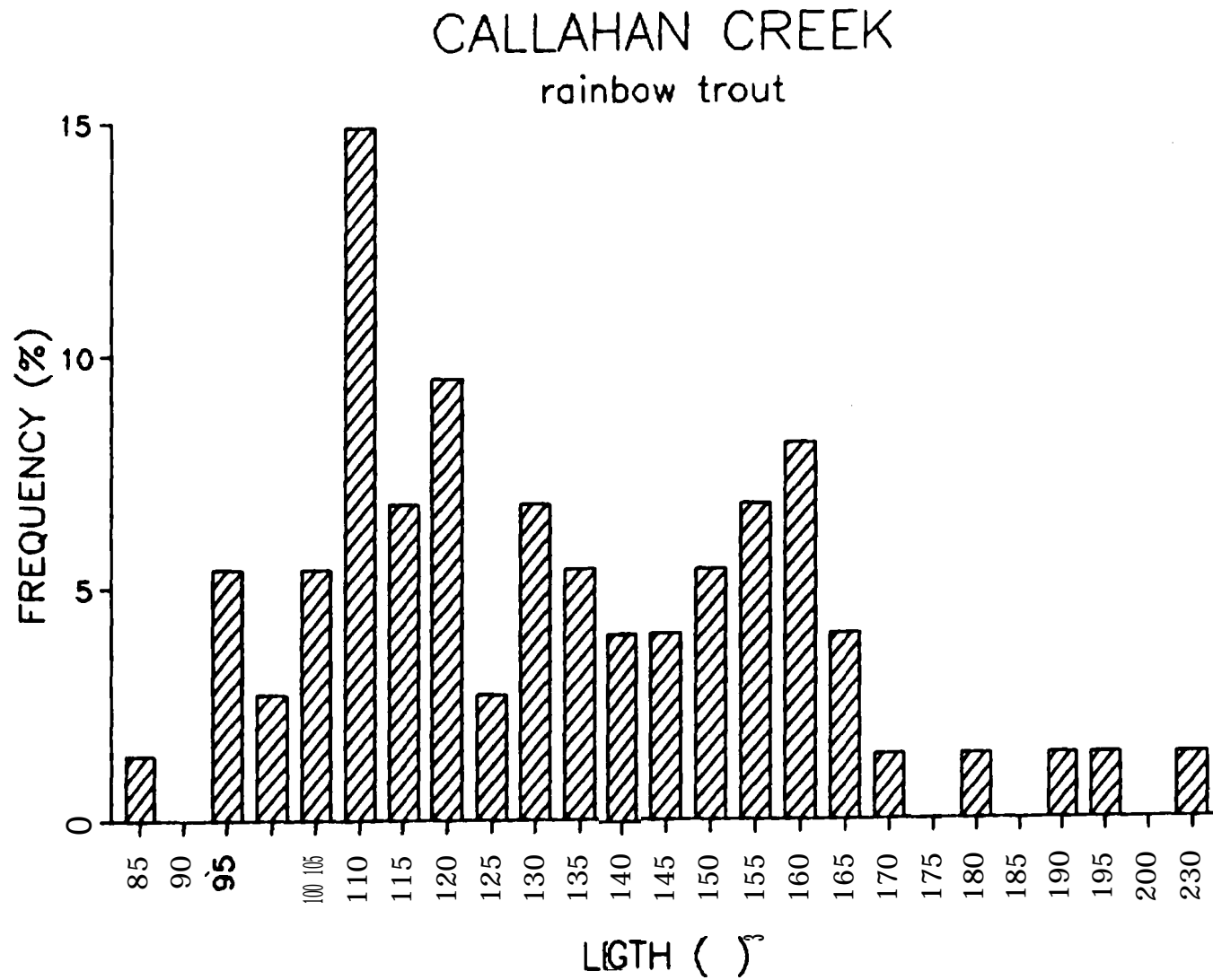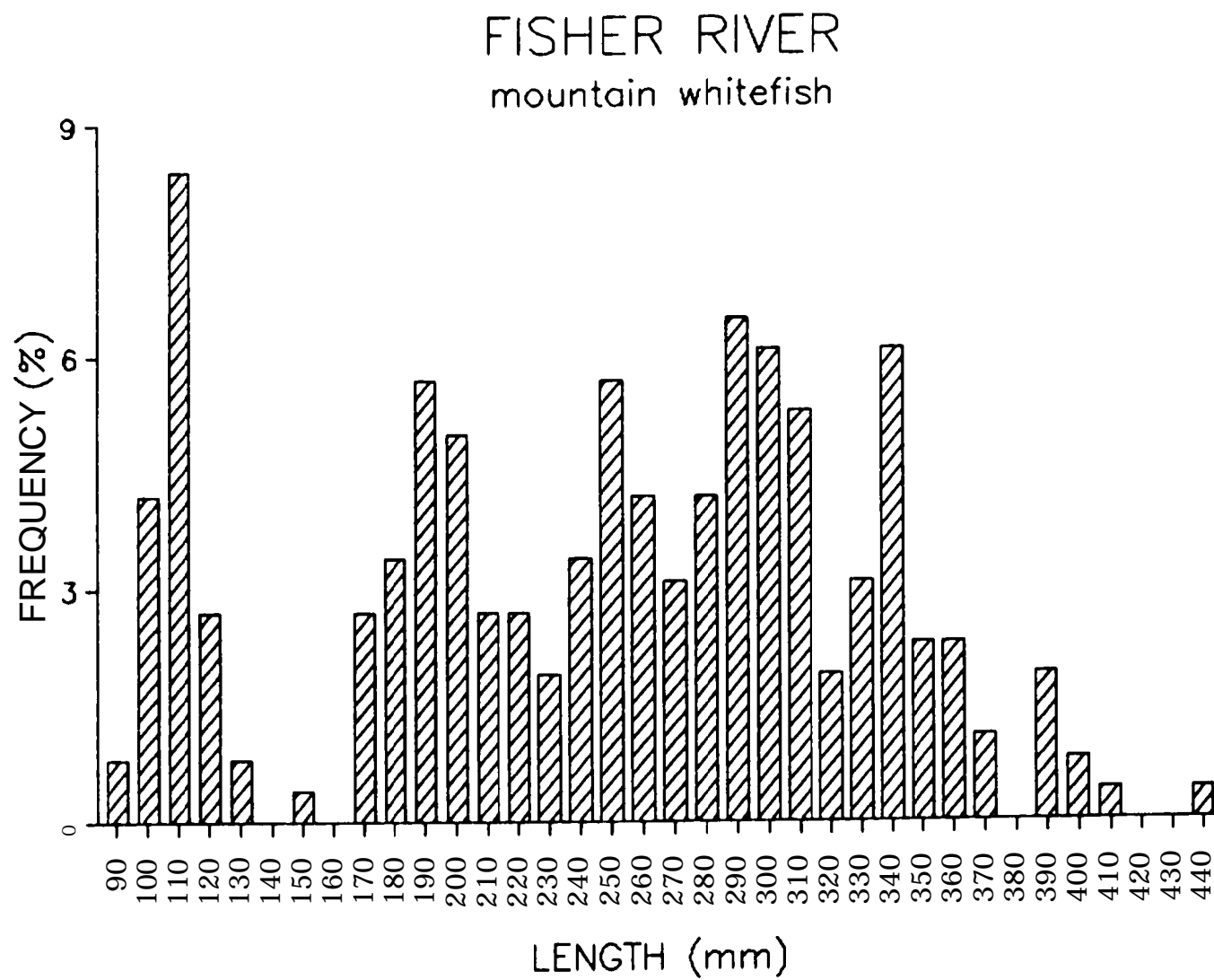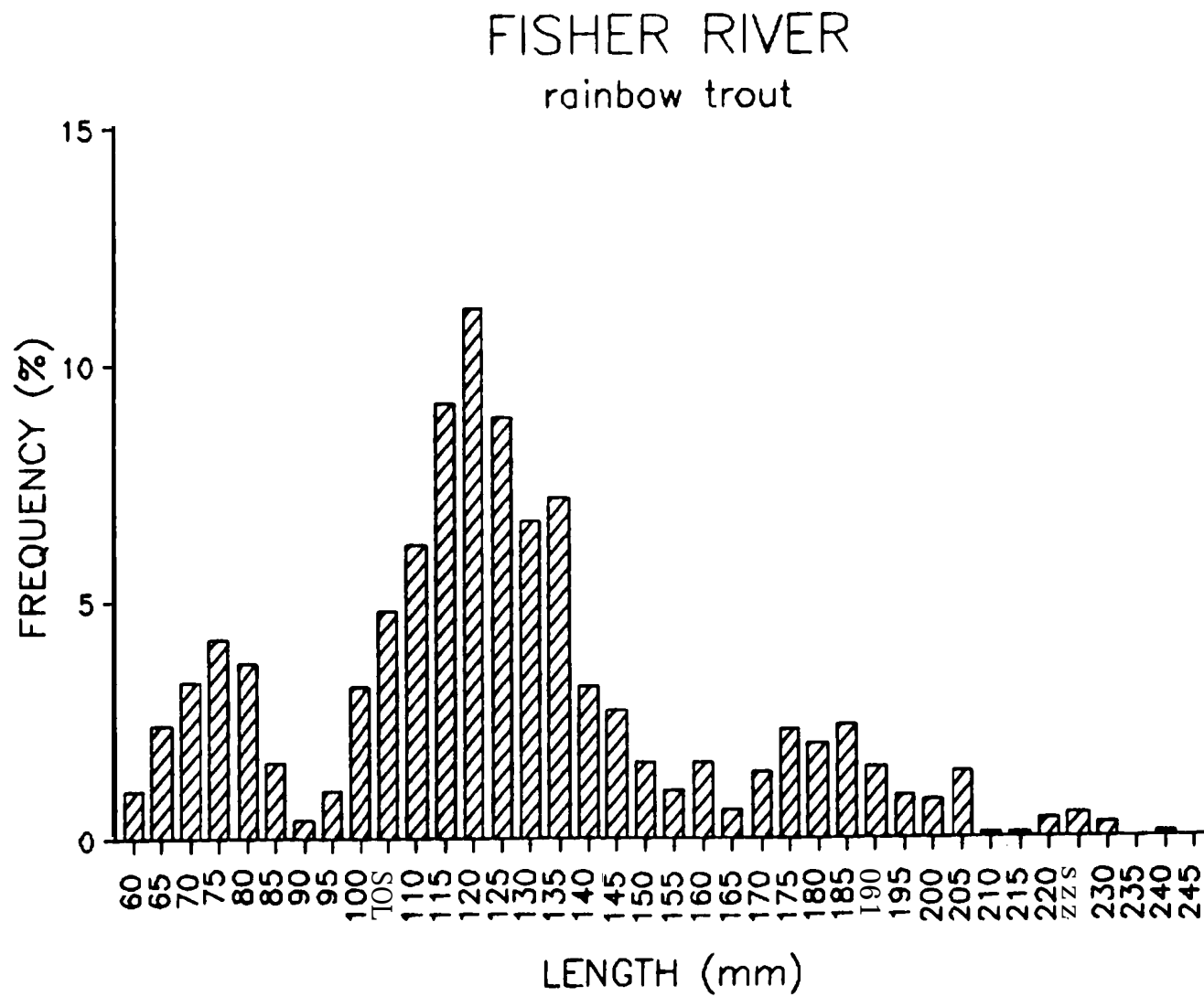
APPENDIX B

Flow recommendations for tributaries to the
Kootenai drainage and Clark Fork drainager required for
successful migration, spawning and rearing of game fish

Appendix B. Flow recommendations for tributaries to the Kootenai drainage and Clark Fork drainage required for successful migration, spawning and rearing of game fish.

| STREAM NAME	Reach Boundaries Lower	Upper	Trib. to	Low flow (cfs)	Dates	Passage flow (cfs)	Dates
Barron Creek	32N,29W,S27	32N,30W,S22	LK	2.0	JUL 1 – MAR 31	12.5	APR 1 – JUNE 30
Big Creek	35N,29W,S3	35N,30W,S28	LK	19.0	OCT 1 – OCT 31		
				19.0	NOV 1 – NOV 30		
				19.0	DEC 1 – DEC 31		
				19.0	JAN 1 – JAN 31		
				19.0	FEB 1 – FEB 28		
				19.0	MAR 1 – MAR 31		
				37.5	APR 1 – APR 16	37.5	APR 1 – JUL 15
				110.0	APR 16– APR 30	37.5	
				324.0	MAY 1 – MAY 16	37.5	
				269.0	MAY 16– MAY 31	37.5	
				151.0	JUN 1 – JUN 15	37.5	
				60.0	JUN 16– JUN 30	37.5	
				37.5	JUL 1 – JUL 15	37.5	
				19.0	JUL 16– JUL 31		
				19.0	AUG 1 – AUG 31		
				19.0	SEP 1 – SEP 15		
Big Cherry Creek	30N,31W,S14	29N,31W,S2	LC	20.0	JUL 1 – MAR 31	50.0	APR 1 – JUN 30
Bobtail Creek	31N,31W,S30	31N,31W,S5	KR	5.0	JUL 1 – MAR 31	18.0	APR 1 – JUN 30
Bristow Creek	32N,29W,S15	32N,30W,S2	LK	12.0	JUL 16– MAR 31	13.0	APR 1 – JUL 15
U. Callahan Cr.	31N,34W,S21	60N,2E,S34	KR	50.0	JUL 1 – MAR 31	75.0	APR 1 – JUN 30
L. Callahan Cr.	31N,34W,S13	31N,34W,S21	KR	60.0	JUL 1 – MAR 31	75.0	APR 1 – JUN 30
U. Deep Creek	35N,25W,S29	35N,24W,S17	FC	4.0	JUL 1 – MAR 31	30.0	APR 1 – JUN 30
L. Deep Creek	35N,26W,S25	35N,25W,S29	FC	8.0	JUL 1 – MAR 31	30.0	APR 1 – JUN 30
E. Fk. Bull River	27N,33W,S12	27N,32W,S14	CF	35.0	ENTIRE YEAR	35.0	

Appendix B, page 2

STREAM NAME	Reach Boundaries Lower	Upper	Trib. to	Low flow (cfs)	Dates	Passage flow (cfs)	Dates
Fisher River	30N,29W,S17	27N,28W,S27	KR	125.0	OCTOBER		
				125.0	NOVEMBER		
				125.0	DECEMBER		
				125.0	JANUARY		
				125.0	FEB 1 – FEB 15		
				125.0	FEB 16– FEB 28		
				138.0	MAR 11– MAR 15		
				195.0	MAR 16– MAR 31		
				312.0	APR 1 – APR 16	100	APR 1 – JUL 15
				659.0	APR 16– APR 30	100	
				657.0	MAY 1 – MAY 16	100	
				842.0	MAY 16– MAY 31	100	
				678.0	JUN 1 – JUN 15	100	
				324.0	JUN 16– JUN 30	100	
				207.0	JUL 1 – JUL 15	100	
				125.0	JUL 16– JUL 31		
				125.0	AUGUST		
				125.0	SEPTEMBER		
Fivemile Creek	32N,28W,S18	32N,27W,S19	LK	4.0	JUL 16– MAR 31	20.0	APR 1 – JUL 15
Fortine Creek	35N,26W,S15	33N,26W,S2	KR	35.0	ENTIRE YEAR	35.0	
Grave Creek	35N,26W,S15	37N,24W,S29	KR	70.0	ENTIRE YEAR	70.0	
Libby Creek	30N,31W,S2	27N,31W,S21	KR	22.0	JUL 16– MAR 31	38.0	APR 1 – JUL 15
O'Brien Creek	31N,33W,S18	32N,33W,S7	KR	27.5	JUL 1 – MAR 31	30.0	APR 1 – JUN 30
Pinkham Creek	35N,28W,S5	34N,27W,S32	LK				
				5.0	OCTOBER		
				5.0	NOVEMBER		
				5.0	DECEMBER		
				5.0	JANUARY		
				5.0	FEBRUARY		
				5.0	MARCH		
				5.3	APR 1 – APR 15		

| STREAM NAME | Reach Boundaries | | Trib. | Low flow | | Passage | |
	Lower	Upper	to	(cfs)	Dates	flow (cfs)	Dates
Pinkham Creek, continued				36.3	APR 16- APR 31		
				73.5	MAY 1 - MAY 15		
				50.2	MAY 16- MAY 31		
				31.0	JUN 1 - JUN 15		
				11.0	JUN 16- JUN 30		
				5.0	JULY		
				5.0	AUGUST		
				5.0	SEPTEMBER		
Pipe Creek	31N,31W,S30	33N,31W,S16	KR	16.0	JUL 1 - MAR 31	25.0	APR 1 - JUN 30
Quartz Creek	31N,32W,S24	32N,32W,S11	KR	17.5	AUG 1 - APR 15	25.0	APR 16- JUL 31
Rock Creek	26N,32W,S32	26N,31W,S6	CF	16.0	ENTIRE YEAR	16.0	
Ross Creek	28N,33W,S4	28N,34W,S15	BL	20.0	JUL 1 - MAR 31	30.0	APR 1 - MAR 31
Tobacco River			LK	(Lower)			
	36N,27W,S8	35N,26W,S15		95.0	OCTOBER		
				95.0	NOVEMBER		
				95.0	DECEMBER		
				95.0	JANUARY		
				95.0	FEBRUARY		
				95.0	MARCH		
				110.0	APR 1 - APR 15	110.0	APR 1 - JUL 15
				110.0	APR 16- APR 30	110.0	
				200.0	MAY 1 - MAY 15	110.0	
				400.0	MAY 16- MAY 31	110.0	
				400.0	JUN 1 - JUN 15	110.0	
				200.0	JUN 16- JUN 30	110.0	
				110.0	JUL 1 - JUL 15	110.0	
				95.0	JUL 16- JUL 31		
				95.0	AUGUST		
				95.0	SEPTEMBER		

Appendix B, page 4

STREAM NAME	Reach Boundaries		Trib. to	Low flow (cfs)	Dates	Passage flow (cfs)	Dates
	Lower	Upper					
Wolf Creek	29N,29W,S34	32N,26W,S31	FR	12.0	OCTOBER		
				12.0	NOVEMBER		
				12.0	DECEMBER		
				12.0	JANUARY		
				12.0	FEBRUARY		
				12.0	MARCH		
				24.0	APR 1 – APR 15	15	APR 1 – JUN 30
				77.0	APR 15 – APR 30	15	
				116.0	MAY 1 – MAY 15	15	
				91.0	MAY 16 – MAY 31	15	
				38.0	JUN 1 – JUN 15	15	
				29.0	JUN 16 – JUN 30	15	
				13.0	JUL 1 – JUL 15		
				12.0	JUL 16 – JUL 31		
				12.0	AUGUST		
				12.0	SEPTEMBER		
Yaak River				(Lower)			
	32N,34W,S5	33N,33W,S4	KR	170.0	OCTOBER		
				170.0	NOVEMBER		
				170.0	DECEMBER		
				170.0	JANUARY		
				170.0	FEBRUARY		
				170.0	MARCH		
				300.0	APR 1 – APR 15		
				600.0	APR 16– APR 30		
				1200.0	MAY 1 – MAY 15		
				1800.0	MAY 16– MAY 31		
				1200.0	JUN 1 – JUN 15		
				600.0	JUN 16– JUN 30		
				300.0	JUL 1 – JUL 15		
				170.0	JUL 16– JUL 31		
				170.0	AUGUST		
				170.0	SEPTEMBER		

B-5

Appendix B, page 5

STREAM NAME	Reach Boundaries		Trib. to	Low flow (cfs)	Dates	Passage flow (cfs)	Dates
	Lower	Upper					
Yaak River, continued	33N,33W,S4	35N,33W,S10		(Upper)			
				145.0	OCTOBER		
				145.0	NOVEMBER		
				145.0	DECEMBER		
				145.0	JANUARY		
				145.0	FEBRUARY		
				145.0	MARCH		
				300.0	APR 1 - APR 15		
				600.0	APR 16- APR 30		
				1200.0	MAY 1 - MAY 15		
				1800.0	MAY 16- MAY 31		
				1200.0	JUN 1 - JUN 15		
				600.0	JUN 16- JUN 30		
				300.0	JUL 1 - JUL 15		
				145.0	JUL 16- JUL 31		
				145.0	AUGUST		
				145.0	SEPTEMBER		
Young Creek	37N,28W,S24	37N,29W,S14	LK	5.0	OCTOBER		
				5.0	NOVEMBER		
				5.0	DECEMBER		
				5.0	JANUARY		
				5.0	FEBRUARY		
				5.0	MARCH		
				5.0	APRIL		
				25.0	MAY	25.0	MAY 1 - MAY 31
				25.0	JUNE	25.0	JUN 1 - JUN 30
				5.0	JULY		
				5.0	AUGUST		
				5.0	SEPTEMBER		

APPENDIX C

Fishery information, compiled by
Montana Fish, Wildlife and Parks
pertaining to streams under investigation

Appendix C. Fishery information, compiled by Montana Fish, Wildlife and Parks, pertaining to streams under investigation.

Stream Name	Fisheries information	Coordinates of study site	Species	Estimate	Date	Associated discharge (cfs)
Barron Creek	2-pass estimate	32N,29W,S21	EBT Salmo spp. RB=0.0% WCT=67.0% HYB=33.0%	1,537 $\pm$139/km 83 $\pm$55/km	Jul 1985 Jul 1985	1.9 1.9
Big Creek	Mark-recapture estimate	35N,29W,S32	Salmo spp. RB=63.4% WCT=16.8% HYB=19.8%	819 $\pm$388/km	Aug 1986	37.5
Big Cherry Creek	Mark-recapture estimate	30N,31W,S35	RB	873 $\pm$604/km	Aug 1986	24.3
Bobtail Creek	Migrant Trap Minimum estimate	31N,31W,S30	RB immigrants RB immigrants RB immigrants RB recruits	305 minimum 378 minimum 155 minimum 5,000-7,000/yr	Spring 1980 Spring 1980 Spring 1978 1978-1979	
Bristow Creek	2-Pass estimate	32N,29W,S10	Salmo spp. RB=4.0% WCT=50.0% HYB=46.0%	1,179 $\pm$143/km	Jul 1985	6.6
	Migrant Trap Schnabel estimate	32N,29W,S10	Salmo spp. RB=9.5% WCT=66.9% HYB=23.6%	285 (224-336) 1:2 male to female	May 12-Jun 29 1986	

Stream Name	Fisheries information	Coordinates of study site	Species	Estimate	Date	Associated discharge (cfs)
Bristow (continued)	Redd survey	Trap to source	Salmo spp.	44 definite, 39 probable ~3 fish/redd	Spring 1986	
Bull River East Fork (May 1982)	U/W fish census	3 Class-1 pools	WCT EBT DV MWF	7.3/92.9m^2 surface area 8.6/92.9m^2 surface area 1.3/93.9m^2 surface area 3.3/92.9m^2 surface area	Aug 1981	
Callahan Creek	Mark-recapture estimate	31N,34W,S20	RB	906 $\pm$551/km	Aug 1986	
Deep Creek	2-pass estimate	32N,28W,S24	Salmo spp. RB=83.0% WCT=10.7% HYB=6.3% EBT	465 $\pm$128/km 243 $\pm$160/km	Jul 1985	
Fisher River	Mark-recapture estimate Migrant trap	28N,29W,S12	RB EBT RB RB MWF MWF MWF	354 $\pm$92/km 4 $\pm$1/km 246 $\pm$153/km 525 $\pm$310/km 2,015 minimum 2,641 minimum 1,131 minimum	Aug 1986 Aug 1986 Oct 1970 Aug 1971 Fall 1971 Fall 1970 Fall 1969	73.4 73.4
Fivemile Creek	2-pass estimate	32N,28W,S24	Salmo spp. RB=83.0% WCT=10.7% HYB=6.3% EBT	465 $\pm$128/km 243 $\pm$160/km	Jul 1985	

Stream Name	Fisheries information	Coordinates of study site	Species	Estimate	Date	Associated discharge (cfs)
Fortine Creek (May 1982)	Sparse migrant trap information					
	Mark-recapture estimate	Sec.1	WCT	331 ±122/km	Jul 1971	
			WCT	397 ±79/km	Aug 1970	
			EBT	735 ±206/km	Jul 1971	
			EBT	1450 ±363/km	Aug 1970	
		Sec. 6	RB	312 ±97/km	Jul 1971	
			RB	335 ±114/km	Aug 1970	
			WCT	121 ±59/km	Jul 1971	
			WCT	184 ±63/km	Aug 1970	
			EBT	531 ±133/km	Jul 1971	
			EBT	797 ±215/km	Aug 1970	
Grave Creek	Mark-recapture	32N,26W,S14	Salmo spp. RB=73.5% WCT=7.2% HYB=19.3%	428 ±151/km	Sep 1986	42.8
			EBT	142 ±105/km		
Libby Creek	Mark-recapture	30N,31W,S36	RB	266 ±79/km	Jul 1986	27.7
			EBT	25 ±11/km	Jul 1986	27.7
(May 1982)	Mark-recapture	30N,31W,S36	RB	850 ±161/km[a]	1977	
	Sparse migrant trap information (May 1982)			[a]		
O'Brien Creek	Mark-recapture	32N,33W,S32	WCT	10.8 ±2.6/92.9m^2 surface area	Aug 1979	
(May 1982)	U/W fish census	32N,3W,S32	WCT	22.7/92.9m^2 surface area		
Pinkham Creek	U/W fish census	35N,27W,S31	RB	59.1/92.9m^2 surface area	Aug 1981	
	Redd survey	Total Creek	WCT	135 redds	1978	
			WCT	231 redds	1977	
	Population est. Based of redd count		WCT	400-600 redds	1977-1978	

a/ Based on 80% confidence limit

Stream Name	Fisheries information	Coordinates of study site	Species	Estimate	Date	Associated discharge (cfs)
Pipe Creek	Migrant trap minimum estimate	31N,31W,S30	RB	85 minimum	Mar 17–Apr 20, 1981	
			RB	78 minimum	Mar 3 – May 20 1977	
			RB	54 minimum	Mar 18–Apr 5, 1976	
	U/W fish census	31N,31W,S20	RB	32.6/92.9m^2 surface area	August 1981	
Quartz Creek	Mark-recapture	31N,32W,S13	Salmo spp RB=94.9% WCT=4.3% HYB=0.8% DV[b/]	853 ±438/km 59 ±18	Sep 1985	
	2-pass estimate WCT=84.6%	32N,32W,S35	Salmo spp RB=10.3% HYB=5.1% DV[b/]	224 ±22 142 ±27	Jul 1986	8.2
	Migrant trap Schnabel estimate	31N,32W,S13	Salmo spp. RB WCT HYB DV immigrants DV recruits		Apr 8 – Sep 9, 1986	
	Redd survey	Trap to sources	Salmo spp.	108 definite, 88 probable,	1976	
	Fry emergence	Total Quartz Cr.	Salmo spp.		Jun 12–Sep 2, 1986	
Ross Creek (May 1982)	U/W fish census	28N,34W,S7	WCT	9.9/92.9m^2 surface area	Aug 1981	

b/ May be migrating population

Stream Name	Fisheries information	Coordinates of study site	Species	Estimate	Date	Associated discharge (cfs)
Tobacco River	Mark-recapture	36N,27W,S8	Salmo spp. RB=96.6% WCT=1.7% HYB=1.7%	156 ±62/km	Aug 1986	89.4
	Aerial spawning Migrant estimate	Tobacco River	KOK	3,000-5,000 migrants	Oct 1985	
(May & Huston, 1980)	Migrant capture	Tobacco River	Salmo spp. RB=92.0% WCT=8.0%	5,937 ±2,375 migrants 516 ±181 migrants	Apr-Jul 1979 Apr-Jul 1979	
Wolf Creek	Mark-recapture estimate	29N,28W,S29	RB	455 ±148/km	Aug 1986	
(May 1972)	Mark-recapture estimate	Sec. 6 Sec. 1 Chan. Ch. 10 Chan. Ch. 10	RB RB RB RB	154 ±112/km 314 ±88/km 69 ±26/km 331 ±53/km	Oct 1971 Aug 1970 Oct 1971 Aug 1970	
Yaak River	Migrant Trap Minimum estimate		MWF KOK	53 minimum 11 minimum	Sep 29-Nov 4, 1971	
(May 1982)	U/W fish census	33N,33W,S30	RB	$2.0/92.9m^2$ surface area	Aug 1981	
(May 1982)	U/W fish census	33N,33W,S30	MWF	$0.5/92.9m^2$ surface area	Aug 1981	
Young Creek (Huston et al. 1984)	Migrant Trap	37N,28W,S24	WCT migrants	21 54 86 115 305 390 750 750 345 380 260 354 71	1970 1971 1972 1973 1974 1975 1976 1977 1979 1980 1983 1984 1985	