FLATHEAD RIVER FISHERY STUDY
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EXECUTIVE SUMMARY

This fishery study is a baseline environmental assessment of the North and Middle Forks of the Flathead River drainage, which began in 1978 and will be completed in 1982. This report concerns the analysis of cutthroat and bull trout distribution and abundance, movement, age and growth, fish habitat, spawning, and food habits. The bull trout provide a trophy fishery (18-36 inches in length) in the lake and rivers. Westslope cutthroat trout provide a good fishery throughout the study area.

Fish distribution and abundance was studied in the North and Middle Fork drainages during 1979 and 1980 to determine the relative importance of the tributaries as rearing areas for juvenile trout, and for long-term monitoring of trout populations. Westslope cutthroat were found in 19 (50%) of the tributaries in the North Fork drainage, and 18 (75%) of the tributaries in the Middle Fork drainage. Fish population estimates were made by snorkeling in 142 tributary reaches. A total of 4,199 cutthroat, 413 juvenile bull trout, and 411 mountain whitefish were recorded by observers. The average density of cutthroat trout in the 112 reaches in which they were found was 7.2 fish per 100 m^2 surface area. Juvenile bull trout densities average 1.7 fish per 100 m^2 for 52 reaches in which they were observed. Critical rearing areas for cutthroat trout were identified, and included 17 reaches in the North Fork drainage and nine reaches in the Middle Fork drainage. Critical rearing areas for juvenile bull trout included seven North Fork reaches and nine Middle Fork reaches. Comparisons of cutthroat population estimates made by snorkeling and electrofishing in 12 North Fork tributary reaches indicated no significant difference ($p<.05$) between the two methods. Fish density estimates made in the North and Middle Forks of the Flathead River indicated Mountain whitefish densities were 10 times larger than total trout densities.

A total of 1,990 juvenile cutthroat, 167 juvenile bull trout, and 44 juvenile rainbow trout were tagged with dangler tags during 1980 to assess movement of juvenile trout in the Flathead drainage. Recovery of trout tagged by angling, trapping and electrofishing can provide information on the timing and distribution of spawning and smolt migrations. Fisherman tag return rates are an indication of the harvest of the fish population. The majority of the 3.5 percent of the tagged trout recovered had moved downstream. Maximum distance moved was 135 kilometers by a cutthroat tagged in the upper Middle Fork and recovered from the Flathead River near Columbia Falls. The return rates for the 177 adult cutthroat and 90 adult bull trout tagged were 12 and three percent, respectively. A total of 1,061 fish were trapped in the North Fork of the Flathead River and tributaries. The catch was dominated by westslope cutthroat and mountain whitefish. Adfluvial cutthroat were trapped in Langford, Cyclone, Trail, and Red Meadow creeks. Outmigrating juvenile bull trout were captured in Trail, Red Meadow, Moose, and Moran creeks.

Age and growth information is necessary to determine the relative capability of tributaries for trout production. Analysis of growth patterns on scales can provide information concerning the rearing patterns of fluvial

and adfluvial trout. Scales were collected from 1,267 cutthroat trout in 18 North and Middle Fork tributaries. Most of the fish (87%) were 0-3 years old. The majority (86%) of the 309 cutthroat collected from the North and Middle Forks of the Flathead River were 3-5 years old. Calculated lengths for annuli 1-5 were generally larger for river cutthroat than for tributary cutthroat. It was determined from growth patterns on the scales that 73 percent of the river cutthroat had reared two or three years in the tributaries, while most of the remainder had reared one year in the tributaries. Scale samples from 196 juvenile and 35 mature bull trout were collected. The juveniles were 0-3 years old and the adult spawners ranged from 5-8 years old.

A major objective of this study was to assess existing fish habitat of tributaries in the North and Middle Fork drainages and to identify important habitat components which affect fish densities. Fish habitat was evaluated for a total of 142 tributary reaches in the North and Middle Fork drainages comprising 675 stream kilometers. Of the 41 physical habitat variables tested for their relationships to total trout densities, trout cover, stream order, D-90, and percent run formed the best significant combination or model ($p<.001$). Fish densities predicted for 110 reaches based on the measurements of these four habitat components had a highly significant correlation ($r=.653$, $p<.001$) with measured trout densities. Model precision was limited by the low trout densities and multiple trout populations of tributaries in the North and Middle Fork drainages.

A survey of bull trout spawning sites (redds) was conducted to provide information on the importance of each tributary for spawning and long term trends in population abundance and stability. A total of 568 redds were located; 268 in the North Fork drainage (168 in the U.S. and 100 in Canada), and 300 in the Middle Fork drainage. This represents nearly a basin-wide survey with an estimated 80 percent of all redds in the North Fork (U.S. portion) and the Middle Fork drainages counted. An estimated 60 percent of all redds in the Canadian portion of the North Fork drainage were counted. The largest number of redds (89) were found in the Morrison Creek drainage of the Middle Fork. The Coal Creek drainage contained 60 redds, the highest number counted in the North Fork. An estimated 2,400 - 2,925 mature bull trout reached tributary or mainstem areas to spawn in the North and Middle Fork drainages.

Food habits of cutthroat and bull trout were studied to determine the relationship between trout diet and the available insect food supply. Analysis of the food habits of cutthroat and bull trout indicated these fish were opportunistic feeders in the North and Middle Fork drainages. Ephemeroptera and Diptera were the most abundant insect order in both the benthic community and in the diets of the trout. Cutthroat trout in the Middle Fork drainage consumed more winged insects taken from the water's surface than cutthroat in the North Fork drainage.

The cutthroat and bull trout populations in the Flathead Lake-River system represent a valuable resource for the Flathead Valley. Regulations have been established in the past, such as stream closing and size limits, in an effort to afford added protection for the adfluvial trout populations in the upper North and Middle Fork drainages. More restrictive regulations will be necessary to maintain a viable fishery due to accelerated development of resources in these drainages.

More restrictive regulations alone will not be enough to protect the fishery. A cumulative impact overview is presented for the North Fork the Flathead River using bull trout spawning as an example. At least 72 percent of the prime spawning and over 30 percent of the critical rearing areas in the North Fork could be directly affected by planned development in the U.S. and Canada. Oil and gas exploration is also being considered in wilderness areas in the Middle Fork drainage, which presently contributes half of the total bull trout spawning in the Flathead drainage. This study has made it possible for the first time to adequately present the threat on the bull trout fishery in a basin-wide perspective.

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INTRODUCTION

This study is part of a baseline environmental assessment funded by the EPA under the direction of the Flathead River Basin Steering Committee, a fifteen-member group representing land management agencies, political bodies, and private citizens or groups in the area.

This is the third Annual Progress Report, and presents a large amount of data collected during the preceeding year. Two separate reports were prepared this year. This report covers work in the North and Middle Forks of the Flathead River. In general, this report presents baseline data that will be useful to identify, quantify, and monitor the affects of perturbations in the upper watershed of the Flathead River Basin. The river-lake ecosystem is nationally recognized for its uniqueness including its Wild and Scenic Rivers, Flathead Lake, Glacier National Park, and the Bob Marshall Wilderness area, which comprise a valuable recreation resource and symbolize the quality of life in the Flathead River Basin.

It should be noted that data are reported in metric units except for stream flows. These are reported in English units because most stream discharge information collected by other agencies is reported in English units. Also, agencies responsible for adjudicating water rights do so in English units. A separate report is being prepared on instream flow requirements for maintenance of the native cold water fisheries in the Flathead River system. This will include the North Fork, Middle Fork, South Fork upstream from Hungry Horse Reservoir, and the main Flathead River downstream to Flathead Lake.

This report also contains a section concerning cumulative impact assessment which exemplifies how and why this baseline data collection is being and will continue to be used in basin-wide impact analysis.

STUDY OBJECTIVES

A. North Fork of the Flathead River Funded Projects

1. Assess relative importance of tributary streams for producing migratory and resident populations of westslope cutthroat and bull trout.

2. Develop a long-term monitoring index for juvenile trout in major tributaries and the main river for correlation with habitat inventories and to monitor changes in environmental quality.

3. Identify the timing and distribution of spawning, feeding, and "smolt" migrations for major fish species.

4. Assess existing aquatic habitat in major tributary streams and the main river. Habitat components will be assessed to determine their importance in maintaining the existing cutthroat trout, bull trout, and sculpin community. Stream reaches will be ranked in relation to relative importance for providing spawning and rearing areas.

5. Determine habitat requirements and species interaction for juvenile bull trout and westslope cutthroat trout.

6. Quantify instream flows for maintenance of native fish species in the North Fork of the Flathead River.

B. Middle Fork of the Flathead River Fisheries Study

1. Assess relative importance of tributary streams for producing migratory and resident populations of westslope cutthroat and bull trout. To compare the potential contribution of juvenile fish from the North and Middle Forks to Flathead Lake.

2. Develop a long-term monitoring index for juvenile trout in major tributaries and the main river for correlation of habitat inventories and to monitor changes in environmental quality in a natural system in the event development continues in the North Fork drainage.

3. Identify the timing and distribution of spawning, feeding, and "smolt" migrations for major fish species.

DESCRIPTION OF STUDY AREA

A more complete description of the upper Flathead River system was presented in Graham et. al. (1980b). Sections reported in that Description of Study Area, but not included or expanded on in this report, include Fish Species and Land Use Patterns.

NORTH FORK OF THE FLATHEAD RIVER

A comprehensive description of the North Fork drainage was written in the 1980 Annual Report (Graham et. al. 1980b). The following description will be limited to that portion of the North Fork studied in 1980.

Most tributaries along the west bank of the North Fork of the Flathead River were studied in 1979. The four drainages that remained to be inventoried in 1980 were Moose, Hay, Moran, and Canyon creeks (Figure 1). All four were small drainages compared to most other west side tributaries. Drainage areas ranged from 78.2 km^2 for Hay Creek to 23.6 km^2 for Moran Creek (Appendix A, Table 1). Hay Creek, the largest of the four, had a late summer flow of 21.3 cubic feet per second (cfs) which was comparable to Red Meadow Creek, the smallest drainage inventoried in 1979 (Appendix A, Table 1). Canyon Creek had a permanent barrier to adfluvial fish one kilometer from its mouth. McGuiness Creek, a tributary of Canyon which entered below the barrier, had a six meter waterfall two kilometers upstream. These were the only streams worked in 1980 with complete barriers to upstream fish movement although three other streams had partial barriers in the form of beaver dams. All four drainages have been heavily logged. Some areas were clear cut to the water's edge.

All or part of 12 east bank drainages which lie in Glacier National Park were worked in 1980. Sage, Spruce, Kishenehn, and Starvation creeks

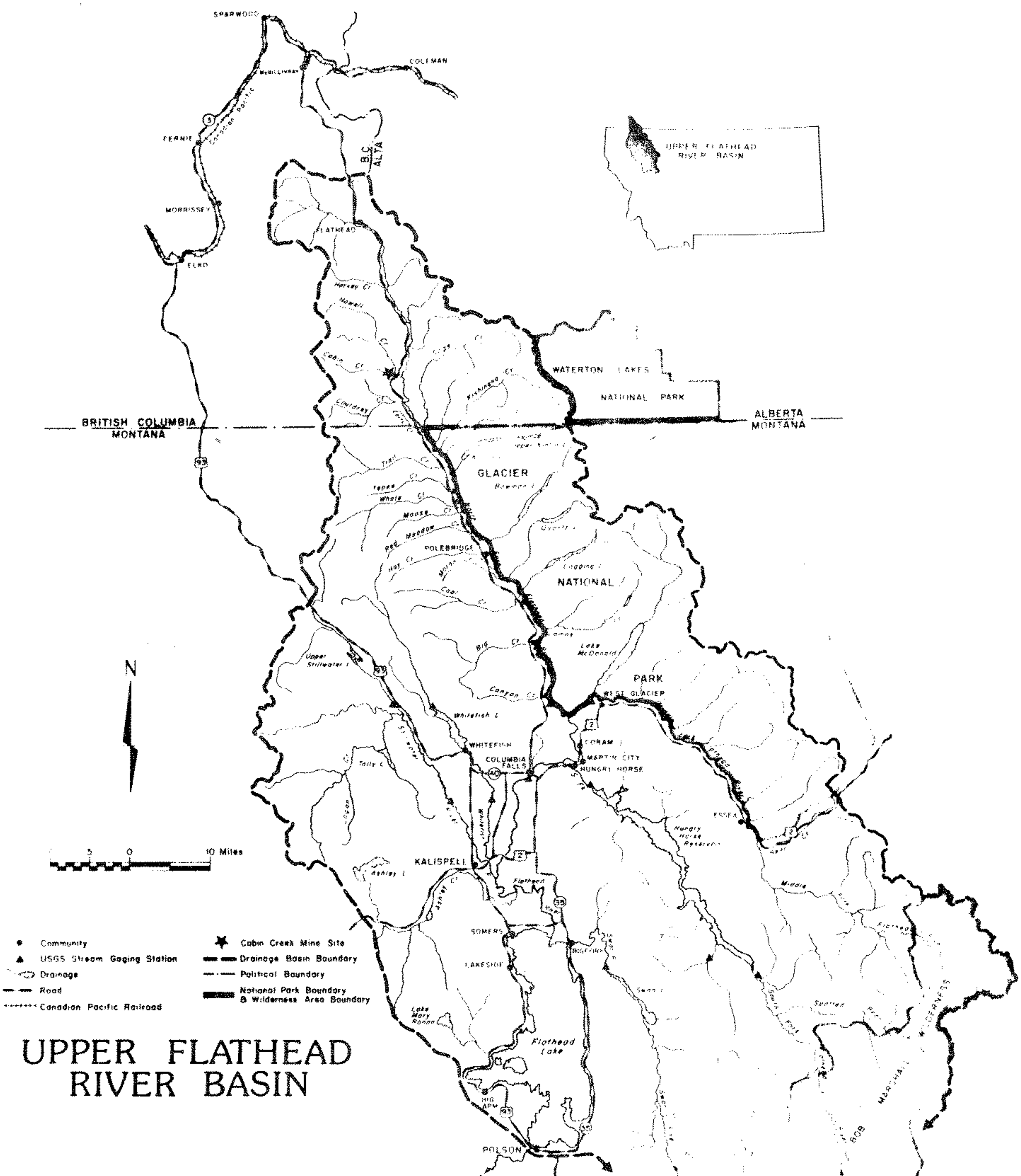


Figure 1 . Drainage map of the upper Flathead River Basin (adapted from Montana Department of Natural Resources and Conservation, 1977).

originate in British Columbia and most of the study on these drainages was limited to that part in Montana. Kintla, Bowman, Quartz, and Logging creeks all drain large deep lakes which noticeably affects their flow and thermal characteristics. Surveys on these creeks were restricted to the portion downstream from the lakes. Ford, Akokala, Anaconda, and Camas creeks are also located in Glacier National Park, but do not have large lakes in their drainages. Dutch Creek, a major tributary to Camas, was also surveyed and was morphologically similar to Anaconda Creek. Drainage areas ranged from 178 km^2 for Bowman Creek to 7.6 km^2 for Spruce Creek (Appendix A, Table 1). Late summer flows ranged from 125.5 cfs in Kintla Creek to 2.4 cfs in Spruce Creek.

A limited amount of time was spent on Howell, Cabin, Couldrey, Sage, and Kishenehn creeks in Canada. This activity was primarily directed toward collection of water samples for water quality analysis and counting bull trout redds. Howell and Cabin creeks may be directly affected by coal development while the others have been subjected to concentrated logging of beetle infested lodgepole pine.

Water quality information collected on North Fork tributaries in 1980 is presented in the Fish Habitat Evaluation section of this report.

Geology

In 1980, the U.S. Forest Service began a soils classification program in the North Fork that should be completed in 1981. The geology of the west and east side of the North Fork drainage differs considerably. The west side is a dip slope that is primarily of late Precambrian origin overlain by tertiary siltstone. The upper ends of west side tributaries meander through bedrock benches while the lower reaches flow through siltstone. The east side of the drainage is a scarp slope that has been uplifted resulting in a plateau that is early Precambrian in origin and contains soil similar to that in the south-eastern United States which has been subjected to less glaciation. The soils on the west side have a gravel content of 35-60 percent compared to approximately 15-20 percent for soils on the east side (Al Martinson, Flathead National Forest, Kalispell, personal communication 1981). This may be one reason why most of the better spawning streams are on the west side of the North Fork. The constant water flow provided by underground water sources during late summer in some larger west side tributaries is also beneficial for maintaining fish habitat.

Temperatures and Flows in North Fork Tributaries

Monthly summaries of temperature information collected in 1980 have been compiled from selected locations in five tributaries (Appendix A, Table 3). Data were obtained from either seven-day continuous recording thermographs or maximum-minimum thermometer readings.

All locations attained maximum temperatures during July. West side streams reached maximum temperatures of 11-13° C and mean monthly maximum temperatures exceeded 10° C only during July and August. The North Fork River at Polebridge reached a maximum of 18° C which was considerably warmer than any west side tributary. Logging Creek attained the highest mean maximum of 19° C in July. Higher water temperatures are generally characteristic of most streams draining Glacier Park (Graham et. al. 1980b).

Water levels of nine west side tributaries were again monitored by reading permanent gauges where the creeks cross the North Fork road. Results of these gauge readings are presented in the Appendix (Appendix A, Figure 1 through 5). Peak flows generally occurred during the end of May. Late summer flows for all creeks except Hay Creek were generally higher in 1980 than in 1979.

A high and low flow were measured in 1980 and calculated for most west side tributaries (Appendix A, Table 4). High flows were taken near the peak discharge but limitations of equipment made it difficult to obtain peak flows for some larger creeks.

Intermediate flows gathered in 1980 enabled the construction of gauge height-stream flow relations (Appendix A, Figures 6 through 13). Gauges were left in the streams for continued monitoring. Sufficient data on Coal Creek were not available to depict a similar relationship.

MIDDLE FORK OF THE FLATHEAD RIVER

The Middle Fork of the Flathead River is formed by the confluence of Strawberry and Bowl creeks in the Bob Marshall Wilderness Area below the western slopes of the Continental Divide (Figure 2). From its origin, the river flows northwest for approximately 144 kilometers to meet the North Fork of the Flathead River below West Glacier. The drainage area of the Middle Fork is 2922 km^2 (Pacific Northwest River Basins Commission, 1976) and the average annual discharge is 2,956 cfs (U.S.G.S. 1979).

The 74 kilometer portion of the Middle Fork above Bear Creek is within the Bob Marshall and Great Bear Wilderness Areas and was classified as a Wild River under the Wild and Scenic Rivers Act of 1976. This upper portion of the river flows from its headwaters through a timbered valley to Schafer Meadows, where the flood plain widens to approximately 2 kilometers. From 3 kilometers below Schafer Meadows to Bear Creek, the Middle Fork flows through a steep, rocky canyon. The Middle Fork drops an average of 6.1 meters per kilometer from its origin to where it meets U.S. Highway 2 at Bear Creek.

The river upstream from Bear Creek is bound by the Lewis and Clark Range of the Rocky Mountains to the east and the Flathead Range to the west. Major tributaries to the upper Middle Fork are Gateway, Trail, Strawberry, Bowl, and Clack creeks above Schafer Meadows and Schafer and Dolly Varden creeks in the Schafer Meadows area. From below Schafer Meadows to Bear Creek the major tributaries are Morrison, Lake, Granite, and Long creeks.

From Bear Creek to where it meets the North Fork, the river flows for 70 km, mainly through a steep canyon, except for the Nyack Flats area where the flood plain is up to 3 kilometers wide. This lower portion

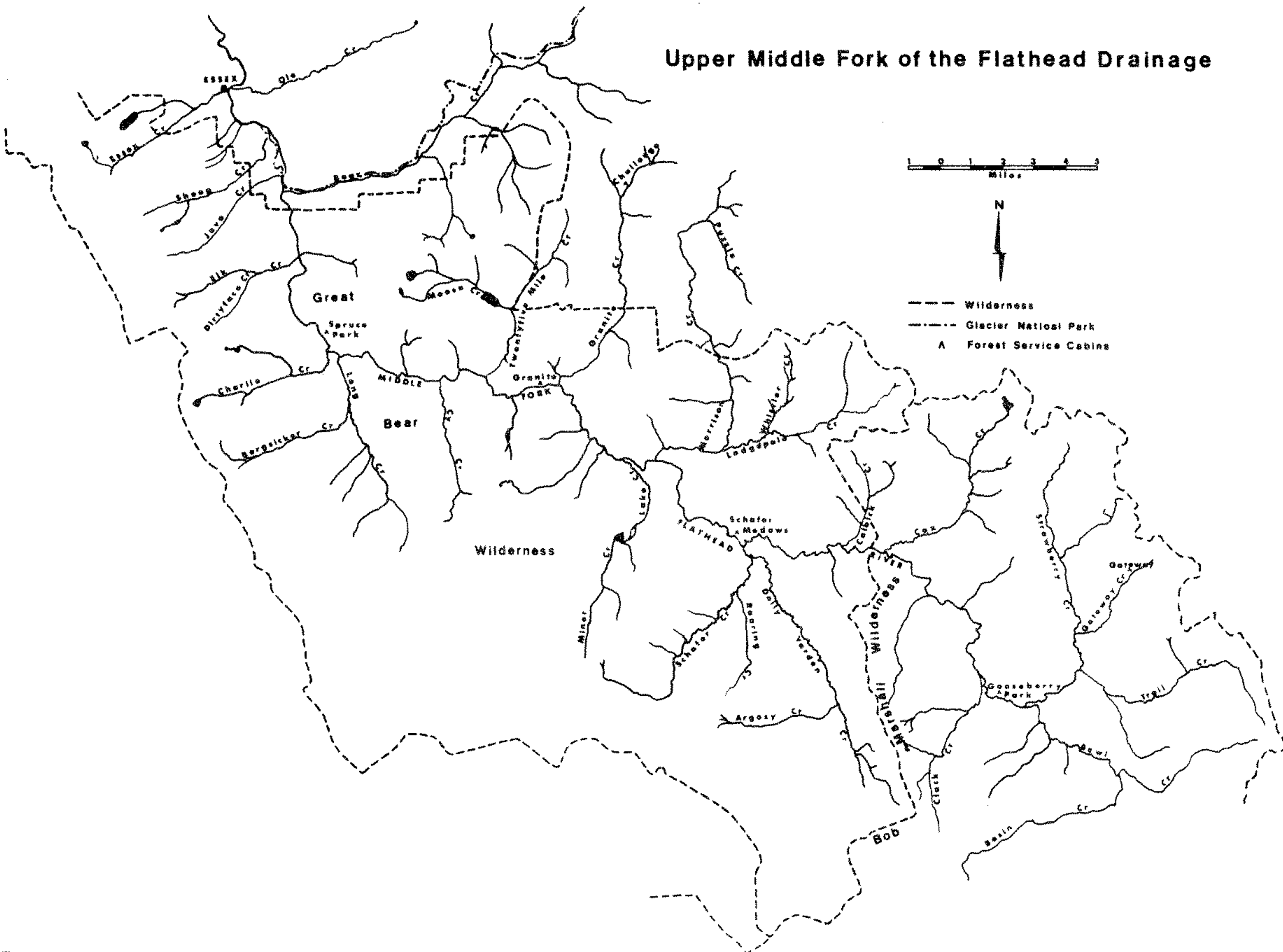


Figure 2 . Map of the upper Middle Fork of the Flathead drainage.

of the Middle Fork is classified as a recreational river. The Middle Fork drops an average of 3.1 meters per kilometer along this lower portion.

The lower Middle Fork is bound by the Flathead Range to the southwest and the Livingston Range to the northeast. The northeast bank of the Middle Fork forms a large portion of the southern boundary of Glacier National Park. Major tributaries to the river below Bear Creek entering from the Flathead Range are Java, Essex, Paola, Stanton, and Deerlick creeks. These creeks are small with relatively steep gradients. Major tributaries entering from the Livingston Range on the Glacier Park side are larger with flatter gradients and include Ole, Park, Muir, Coal, Nyack, Harrison, Lincoln, and McDonald creeks.

Research conducted by the Department of Fish, Wildlife and Parks in 1980 was concentrated on the river and all the major tributaries above Bear Creek.

Geology

The portion of the Middle Fork drainage downstream from Bear Creek is almost entirely underlain by Precambrian rock of the Helena, Snowslip, Sheppard, and Mt. Shields groups (Johns 1970, Mudge et. al. 1977). These formations contain about 25 percent Precambrian limestone which is relatively low in carbonate content (Al Martinson, U.S. Forest Service, personal communication).

The geology of the Middle Fork drainage above Bear Creek is more complex. A major fault called the Lewis Overthrust passed through the upper portion of the drainage and caused layers of old Precambrian rock to overlay more recent Paleozoic and Cretaceous limestones, dolomites, shales, and sandstones. About 60 percent of the Middle Fork drainage above Bear Creek is underlain by Precambrian rock. Cretaceous and Paleozoic rocks comprise 25 and 15 percent of the upper drainage, respectively (Phyllis Marsh and Al Martinson, U.S. Forest Service, personal communication). These Paleozoic and Cretaceous formations are relatively high in carbonate content.

Lake and Schafer creeks drain the Precambrian McNamara formation, which is very low in carbonate content. The Dolly Varden and Clack creek drainages are dominated by carbonate rich Paleozoic limestones. The headwaters area of the Middle Fork (Gateway, Strawberry, Trail, and Bowl creeks) is underlain by the Kootenai Formation of the Cretaceous Period, which is also relatively high in carbonate content. The water chemistry of the Middle Fork drainage is directly related to this varied geologic pattern.

Water Chemistry

Water chemistry information concerning the Middle Fork of the Flathead River below Bear Creek has been reported by Nunnalee (1976), the Flathead Drainage 208 Project (1976), and Stanford et. al. (1979 and 1980). The river above Bear Creek has been less studied. The Montana Department of Health sampled the river near Schafer Meadows in 1976. The Flathead

Research Group collected water samples from the river in the Schafer Meadows area in 1980. Alkalinity, conductivity and flows measured by Fish, Wildlife and Parks personnel during 1980 are presented in Table 1. The maximum water temperature of the Middle Fork at Schafer meadows during the summer of 1980 was 20°C.

Water chemistry data concerning Middle Fork tributaries has been limited. Stanford et. al. (1979) reported chemical parameters for McDonald Creek. The U.S. Forest Service measured water chemistry parameters in Challenge, Puzzle, Skyland, and Morrison creeks during 1980. Chemical parameters measured for water samples collected by Fish, Wildlife and Parks personnel during October, 1980 for ten tributaries of the Upper Middle Fork are presented in the Fish Habitat Evaluation section of this report. The highest ion concentrations were measured in the tributaries of the upper portion of the drainage.

METHODS

UNDERWATER CENSUS OF FISH POPULATIONS

North and Middle Fork Tributaries

Fish population estimates were made on a randomly chosen 100-150 m long section of each North and Middle Fork tributary reach. Observers wore a wet suit, diving mask and snorkel and estimated the number of fish in each age class for pools, runs, riffles, and pocket water habitat types as they pulled themselves upstream.

The numbers of fish in each age class were estimated by a predetermined length frequency for each species. Cutthroat trout of age classes 0, I, and II had maximum lengths of 40, 80 and 130 mm, respectively. Cutthroat longer than 130 mm were classed age III or older. The upper size limits for juvenile bull trout were 50, 90 and 140 mm for age classes 0, I, and II. Juvenile bull trout longer than 140 mm were age III or older. Each stream feature snorkeled was measured to determine fish density by surface area. Biomass estimates (g/100 m^2 surface area) were made by multiplying the measured density times the length-weight relationship determined for each species.

Snorkeling was preferrable to electrofishing because of the clarity, low conductivity, and inaccessibility of many waters in the Flathead drainage. In wilderness areas and Glacier National Park where regulations prohibit electrofishing equipment, snorkeling was an effective and practical method for obtaining fish population estimates. This method had been used with success in other drainages of high water clarity as reported in Graham et. al. (1980b).

Thirteen 100 meter sections of North Fork and Middle Fork tributaries were sampled to compare the effectiveness of the snorkeling and electrofishing methods of estimating fish populations. The sections were snorkeled and fish numbers in each age class were estimated. In North Fork sections, two passes were made (upstream and downstream) using a gasoline powered backpack shocker. A population estimate consisted of the total number of fish captured in both passes. The sections were blocked at the upper

Table 1. Alkalinity, conductivity, and flows measured at points on the Middle Fork of the Flathead River, 1980.

Site	Date	Alkalinity ($mg/l\ CaCO_3$)	Conductivity ($\mu mhos/cm$)	Flow(cfs)
Middle Fork at Gooseberry Park	10/7	150	220	44.1
Middle Fork at Schafer Meadows	10/10	152	220	56.0
Middle Fork at Granite Creek	10/16	117	185	---
Middle Fork[1] at Bear Creek	9/18	114	210	198

1: Alkalinity and conductivity are from measurements made by the Montana Bureau of Mines and Geology, September 13, 1980 (U.S. Forest Service, unpublished data) and lower ends using nets.

In Middle Fork sections, two passes were made with electrofishing gear to mark fish after the section was snorkeled. In two days, two passes were made to recapture fish and fish populations were estimated by the Peterson mark-recapture method reported in Vincent (1971). The section was blocked using nets to stop fish movement between the mark and recapture runs.

North and Middle Fork Rivers

Individual pool, run, riffle, and pocket water habitats were snorkeled on each reach of the North and Middle Fork Rivers during the summer of 1980. On the North Fork, two observers made underwater fish counts for each feature. Each observer worked up one side and then down the center of each feature snorkeled. Features snorkeled on the North Fork consisted almost entirely of runs and were selected at random for each of the two river reaches.

A more extensive fish population census was conducted on the Middle Fork, a small river where stream features are more easily defined. Pool and run habitat units were snorkeled on a 23 km section of river from the headwaters to Schafer Meadows, and a 48 km section from Schafer Meadows to Bear Creek, during mid-summer 1980. Fish counts were made in at least every third pool and fewer randomly selected runs in both river sections by a single observer. The observer snorkeled up each side and then down the center of each feature.

In late summer, fish density estimates were made on two 10 km sections of the Middle Fork. One section was located upstream from Schafer Meadows (headwaters to Cox Creek) and one was located downstream (3 km below Schafer Meadows to Granite Creek). In these two sections, observers made fish population estimates in every third pool, run, and pocket water feature and every fifth riffle feature. Surface areas for each feature snorkeled were calculated and average densities per $100/m^2$ surface areas by species for each age class were estimated. The total numbers of each feature or habitat unit in each 10 km section were counted and population estimates for each species by age class were made for the 10 km survey sections.

MARK AND RECAPTURE OF FISH

Tag return information from fish recaptured by anglers and department personnel during 1980 has been included in this report. Returns from previous years were assessed using the sorting program developed by Graham et. al. (1980a). Movements were analyzed with emphasis on juvenile westslope cutthroat. Only fish which moved at least two miles or were recaptured 30 days after initial tagging were included in the analysis. Data derived from the tagging program has helped to assess the importance of tributaries for production of cutthroat and bull trout as well as identifying the timing and distribution of spawning, feeding, and smolt migrations for major fish species.

Cold branding with liquid nitrogen was used prior to 1980 to mark juvenile fish for movement studies. While a large number of fish could be marked with this method, the brands were not easily identified by fishermen. The return rate for branded fish was less than one percent based on a sample size of over 5,000 bull trout and cutthroat trout. In an attempt to achieve a better return, we marked juveniles with individually numbered fingerling or "dangler" tags. Dangler tags have been successfully used in other areas (Lestelle 1978). The tag is oblong, 5 mm at the widest diameter, and attached with elastic thread. The thread is sewn underneath the skin between the first and second rays of the dorsal fin, tied off, and trimmed so there are no trailing ends. Tags were placed on fish from 75 to 250 mm in length. Floy tags were attached to fish over 250 mm in length.

An experiment was run on hatchery fish to assess tag loss and tag related mortality using dangler tags. One hundred age-one westslope cutthroat trout 95-110 mm in length were divided into two equal groups; only one group was tagged. Both were subjected to the same amount of handling and released into the same tank. After 45 days, five fish lost tags, no fish died, and the growth rate was the same for both groups.

The distribution of major fish species within the Flathead drainage has been determined using snorkeling, electrofishing, stream trapping, and hook and line sampling. Presence of adfluvial cutthroat trout in streams was assessed by trapping emigrating juveniles in early summer or marking them with individually numbered tags.

TRAPPING FISH

The primary objective of trapping fish in tributaries was to determine the presence and the relative importance of migratory trout populations in each stream. Trapping of fish also provided an opportunity to tag juvenile westslope cutthroat, whitefish, and bull trout to study fish movement. Streams were generally trapped in mid-summer after spring run-off had subsided. Traps were maintained for two weeks. Previous experience in trapping indicated that many fish had moved downstream during run-off and precluded a total count of out-migrants. Trap records also indicated that few fish migrated downstream from late July through September. Limitations in man-power necessitated maximizing fish catch and minimized length of the trapping period.

Two streams which had high densities of juvenile cutthroat trout were trapped during spring run-off. Upstream and downstream traps were placed in Langford and Cyclone creeks during May to monitor spawning migration of cutthroat trout and were operated until volcanic ash caused a shutdown May 18, 1980. During July, two-way traps were positioned in Trail and Logging creeks while downstream traps were placed in Moose, Red Meadow, Moran creeks and the North Fork near Polebridge (Figure 3). All traps remained in operation for 14 days, with the exception of the river trap which was operable for 38 days. Traps and leads were constructed of wire mesh (13 mm square) similar to that used in 1979. Traps were checked twice a day beginning at 11:00 p.m. and 7:00 a.m.. Bull trout, cutthroat

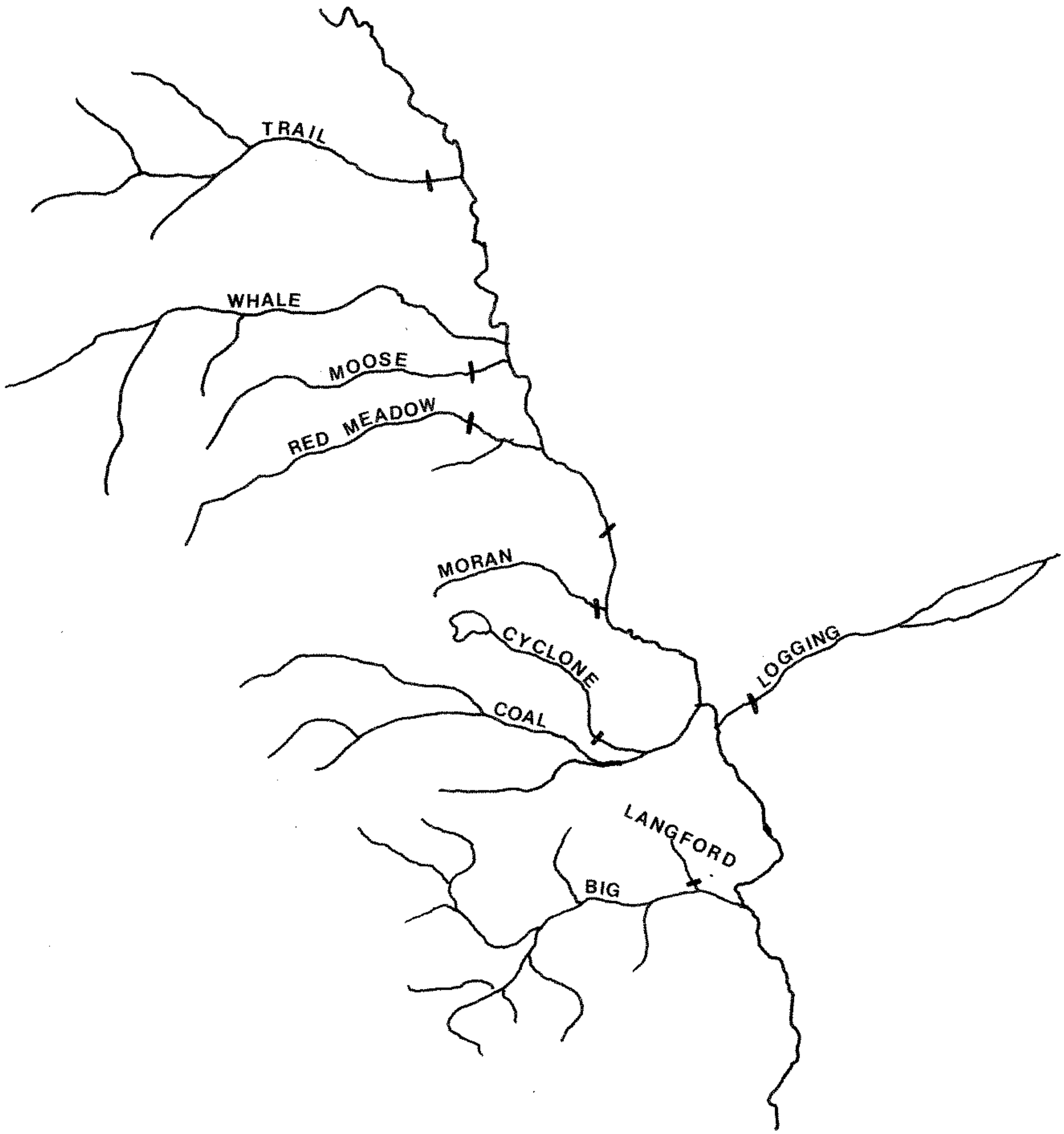


Figure 3 . North Fork trap sites for 1980.

trout, and whitefish were weighed, measured and tagged. Juvenile fish less than 250 mm were marked with dangler tags and adult fish were floy tagged.

AGE AND GROWTH

Westslope cutthroat and bull trout were captured by electrofishing equipment, traps and hook and line. Total length was recorded for each fish and weights were taken on most fish. Scales were taken between the dorsal fin and adipose fin above the lateral line. This area of the fish was chosen for scale collection because of the pattern of scale formation in juvenile trout. Some otoliths were taken for age confirmation following methods in Ricker (1971).

Cellulose acetate impressions of the scales were examined at 67X magnification and ages were assigned. Measurements (in mm) were made to each annulus and to the anterior edge from the center of the scale. An attempt was made to determine the number of years each fish collected in the North and Middle Fork rivers has reared in tributaries. This was accomplished by analyzing changes of growth increments on the scales.

The lengths, weights, ages, and scale measurements were entered in files on the Montana State University Sigma 7 computer in Bozeman. The FIRE I age and growth program (Hesse 1977) was used to calculate length-weight relationships, condition factors ($W \times 10^5 \div L^3$), length-frequencies, and lengths at previous annuli. The program calculates lengths at annulus formation using three linear methods and one logrithmic method of back-calculation described in Ricker (1971). The Monastyrsky logrithmic method calculated lengths at previous annuli based on a log-log plot of fish length and scale radius. This method expressed the relationship between fish length and scale radius as well or better than the linear methods as indicated by correlation coefficients of the regression equations. Also, backcalculated lengths from the Monastyrsky method agreed more closely than the other methods with lengths of fish in assigned age classes collected in late fall or early spring. All backcalculations presented in this report were generated using the Monastyrsky method.

Validity of the aging and backcalculation techniques was indicated by the following:

1. Ages assigned to scales agreed closely with ages assigned to otoliths of the same fish.

2. Mean lengths of fish in assigned age classes closely approximated age groups identified by length frequency.

3. There was a highly significant relationship between body length and scale radius.

4. Calculated lengths at each annulus were very similar to mean lengths of fish in assigned age classes collected in the spring.

It was found that 61 percent of the juvenile cutthroat in the North and Middle Fork drainages did not have an annulus at age I. The first annulus was absent because the scale had not formed after the first growing season or was too small to show the slow overwinter growth (Graham et. al. 1980b). Seven or more circuli before the first discernible annulus was indication of a missing first annulus. For these fish, location of the first annulus was estimated at the first complete circulus out from the scale focus. Backcalculations were made including and excluding fish with missing annuli and results were compared.

Missing annuli were also reported in westlsope cutthroat populations in the Kootenai drainage, Montana (Bruce May, personal communication, Montana Fish, Wildlife & Parks, Libby, 1980), and in the Clearwater and St. Joe drainages in Idaho (Johnson and Bjornn 1978). Carlander (1969) reported missing annuli in stream populations of cutthroat from Utah and Colorado.

Juvenile bull trout scales from North and Middle Fork tributaries generally had an annulus at age I. In the upper reaches of two Middle Fork tributaries, 10 percent of the juvenile bull trout appeared to lack a first annulus on their scales. This could be due to late emergence or slow growth.

HABITAT EVALUATION

Habitat Characteristics of North and Middle Fork Tributaries

Stream habitat was evaluated using a modification of the system developed by the Resource Analysis Branch of the British Columbia Ministry of the Environment (Graham et. al. 1980b).

Each tributary to be surveyed was flown by helicopter and divided into one or more reaches. Reaches were identified as portions of the stream having distinct associations of physical habitat characteristics. Changes in stream gradient resulted in differences in bed material, stream pattern, and channel morphology, and was the major factor considered in reach delineation. Major stream features such as log jams, barriers, and mass wasted banks were also recorded during helicopter surveys.

Measurements of 30 individual physical habitat parameters were made by ground survey crews for each tributary reach. Major categories of habitat parameters measured were stream hydraulics, channel morphology, bed material, bank material, stream pattern, stream cover, pool, pool class, riffle, run, and pocket water ratios. Log jams, fish barriers, bank and bed stability, and debris were also measured and recorded.

These physical habitat parameters were measured on a 0.8 to 2.5 km (0.5 - 1.5 mi.) portion of each reach, depending on reach length. A total of 25 randomly selected points per kilometer were chosen in each subreach where measurements were made of selected habitat parameters. On a typical 1.6 km (1 mi) habitat survey section, 15 measurements were made of bed material compaction and inbededness, D-90, canopy, overhang, debris, channel width and average cross-sectional depth. The type of feature (pool, riffle, run, or pocket water) was recorded at 40 points and the wetted width was measured at 20 points. Bank material, bed material, and other parameters were assessed at least three times and the U.S. Forest Service stream stability form was completed for the section.

Chemical parameters and flows were measured once during late summer on the lowermost reach of major tributaries. Alkalinity, conductivity, and flow were measured in the field. Water samples were collected and returned to the University of Montana Biological Station for analysis of nitrate (NO_3-), total phosphorus (TP), total organic carbon (TOC), calcium (CA^{++}), magnesium (Mg^{++}), potassium (K^+), and sodium (Na^+).

All physical-chemical habitat parameters measured for each tributary reach were entered on standard Montana Interagency Stream Fishery Data forms (Fish, Wildlife & Parks, Helena 1980). A new portion of the form was developed to include additional physical-chemical habitat data and fish population data from North and Middle Fork tributaries. The data from the completed forms were keypunched and entered in the statewide data base administered through the Department of Fish, Wildlife and Parks in Helena. The instructions for entering physical-chemical habitat parameters and fish population data, including definitions for each parameter for cards 1-22 of the Standard form, appear in Appendix B. Instructions and definitions concerning the additional cards added to the forms (cards 30-38) and an example of the form for these cards is also presented in Appendix B.

A "dictionary" defining locations of each habitat and fish population variable in the data base was constructed on the Montana State University CP-6 Interactive Data Base Processing System. The dictionary enabled the user to request reports of any physical, chemical, or biological parameter available for each stream reach.

A regression analysis of physical-chemical habitat parameters and fish densities was conducted. A total of 40 physical and chemical habitat parameters were tested for their relationships to fish densities through the use of simple linear correlation. The step-up and step-down methods of multiple regression (Snedecor and Cochran 1969) were then utilized to identify the most significant combination of habitat variables which interacted to affect fish population densities. All correlation and regression calculations were made using the "Mregress", "Sumstat", and "Biplot" computer programs of the Montana State University Statistical Library.

INVENTORY OF BULL TROUT SPAWNING SITES

Eleven major North Fork tributary drainages and 14 Middle Fork drainages were surveyed for bull trout redds (spawning sites) during September and October, 1980. The North Fork survey in Montana was conducted from October 6 through 10. In the Middle Fork, the survey began on October 3, and continued to October 31. Canadian consultants (B.C. Research, Vancouver, B.C.) contracted by Sage Creek Coal Limited, surveyed five of the North

Fork drainages above the border and parts of the Flathead River above Howell Creek on September 29 and October 27, 1980. Their survey was a combination of low level helicopter flights and selected ground verifications. Parts of Howell, Kishenehn, and Sage creeks in British Columbia were also walked by fisheries personnel from Montana Department of Fish, Wildlife, and Parks late in October. Ground surveys in Montana conducted by Department personnel covered those sections of stream known to be used for spawning from previous redd surveys and included the entire length of stream below the uppermost barrier to spawning bull trout in streams not previously surveyed.

Timing of these surveys was critical. Observations made during the spawning season may result in lower counts, and delaying observations until long after spawning results in siltation of redds, making them difficult to find. During the spawning season, trips to known spawning areas were made periodically and surveys were begun when redds were completed and all fish were off the redds. Other studies indicate spawning activity continues for four to six weeks (McPhail and Murray 1979) but the peak of redd construction occurs in less than two weeks in the Flathead drainage.

To be classified as a redd the site must be excavated (pit) with a mound of gravel (tailspill) piled to the rear (Reiser and Bjornn 1979). The tailspill is made up of loosely compacted gravel which is easily moved by digging with fingers. The location of the redd was carefully checked so the depression did not result from a flow deflector such as a rock or a log. In areas of concentrated spawning multiple redds may occur. The female may begin excavating a redd then move slightly and complete the redd. As a complicating factor, a pair of bulls may finish spawning and move out while a different pair moves in and excavates a redd which overlaps part of the first. These are counted as separate redds only where there are well defined pits and tailspills for each redd. Some bulls move around extensively while spawning and create redds that are extremely long (over 4 m) and/or wide (over 3 m). Most redds were easily recognized by the clean appearance of the disturbed area. However, some redds had already become dark with silt or algae by the time surveys were commenced.

The parameters measured for each redd were length, width, depth, distance to nearest cover, and location in the stream. Eight gravel samples were collected from bull trout redds in four North Fork streams. These were oven dried and shaken through a series of graduated sieves. The sieve sizes we used constitute the Wentworth scale. Velocities were recorded at the head of each redd at a height of 0.4 of the distance from the stream bottom using a Marsh McBirney current meter. Areas of numerous redd sites were indexed on topographic maps and compared with previous year's locations.

A stepwise method of multiple regression was used to identify relationships between redd numbers and various habitat parameters. Parameters analyzed included stream order, percent riffle, percent run, stream stability score, D-90, elevation, gradient, percent fines, percent gravel, overhang and wetted width.

A complete survey of cutthroat trout spawning sites is impossible in most streams because of the high water conditions during the spawning season. Identification of general spawning areas can be made through observation of young-of-the-year fish, but this is also difficult to do on a basin-wide scale. Spawning sites were observed in Langford and Yakinikak creeks May 5, and June 18, 1980, respectively. Six gravel samples were collected in the two North Fork tributaries and analyzed as described for bull trout.

FOOD HABITS OF CUTTHROAT AND BULL TROUT

Major Fish Food Organisms

In order to effectively analyze trout food habits information, the composition of the available benthic insect food supply must be determined. Studies of the benthic insect communities in the North Fork drainage were made during 1975 and 1976 by personnel of the Flathead 208 project. Further studies have been conducted by the Flathead Research Group (Stanford et. al. 1979 and 1980), particularly concerning Trichoptera and Plecoptera. Peterson et. al. (1977) reported benthic insect community compositions in some North Fork tributaries.

Little information has been published concerning the benthic community of the Middle Fork drainage. The Flathead 208 personnel sampled the lower Middle Fork in 1975-1976. Stanford et. al. (1979 and 1980) have studied the insect communities, particularly Plecoptera and Trichoptera, in the lower and middle portions of the drainage.

Benthic insect samples were collected from the Middle Fork of the Flathead River near Bear Creek and the headwaters area of the Middle Fork (Strawberry Creek) to determine the nature of the benthic community in the upper drainage. These samples were collected from a 0.33 m^2 portion of the stream bottom with a modified kick net and processed following methods in Graham et. al. (1980c).

Adult aquatic insects were also collected by field crews throughout the drainage. These insects were preserved in 75 percent ethanol at time of collection. Identifications to species were provided by Dr. George Roemhild, Montana State University (Plecoptera, Ephemeroptera) and Dr. D.G. Denning (Trichoptera).

Analysis of Cutthroat and Bull Trout Stomach Contents

Stomachs were collected from fish taken incidental to other operations in the North and Middle Fork drainages in 1980. Trapping of tributaries and fishing during the summer accounted for nearly all samples in the North Fork drainage. Most samples in the Middle Fork were taken by hook and line sampling or electrofishing with a backpack shocker. Stomachs were sectioned from the base of the esophagus to the pylorus and placed directly into labeled vials of 10 percent formalin.

During the winter, the preserved stomachs were emptied and analyzed in the lab. The contents were identified, counted, and volumes were measured. Most aquatic insects were identified to family and most terrestrial insects were keyed to order. Since many insects were dismembered, head capsules were counted to determine numbers. A 10 milliliter graduated centrifuge tube was used to determine volumes by displacement. Any volume less than 0.05 ml was assigned a value of 0.01 ml.

Stomach contents were expressed in percent number, percent volume, or frequency of occurrence (Graham et. al. 1980b). The Index of Relative Importance (IRI) combines these three values into an arithmetic mean. No caloric analysis of stomach contents was undertaken this year since no acceptable caloric values for the various families identified were available.

MIDDLE FORK CREEL CARD SURVEY

Voluntary creel cards described in Graham et. al. (1980b) were distributed in the summer of 1980 on the Middle Fork above Bear Creek. Card distribution boxes were located at Bear Creek, Twenty-Five Mile Creek and Granite Creek trailheads, Schafer Meadows airstrip, and Gooseberry and Gateway U.S. Forest Service cabins. The cards were also distributed to fishermen by Fish, Wildlife and Parks field crews and U.S. Forest Service personnel. The creel cards were addressed and stamped and could either be mailed or placed in any of the card distribution boxes by the fishermen. Data from returned cards were used to calculate percent composition and catch per hour of each species.

Incidental hook and line sampling by department personnel was conducted in the Middle Fork drainage above Bear Creek and in the North Fork drainage during the summer of 1980 for the purpose of scale collection, fish tagging and indication of species composition. Fly fishing was the major method used in sampling cutthroat and mountain whitefish. Spin fishing with bait or lure and fly fishing with large streamers were the methods used to sample mature bull trout. The calculated percent composition and catch rate for each species were calculated and compared to results from previous years.

RESULTS AND DISCUSSION

FISH DISTRIBUTION AND ABUNDANCE

North and Middle Fork Tributaries

Fish Distribution and Density Estimates

Fish population estimates were made on 59 North Fork and 48 Middle Fork tributary reaches during the summer of 1980. These estimates were made to obtain baseline information on the fishery resource and to identify and quantify critical rearing areas for westslope cutthroat and bull trout. Fish density estimates in snorkel sections were considered representative of the reach because the randomly picked snorkel sections were very similar in stream feature ratio to the entire reach.

By analyzing these fish density estimates and related habitat measurements, important components of the habitat which influence fish populations can be identified. The potential rearing capacity of each tributary and its importance to the Flathead system can then be assessed.

Westslope cutthroat trout have been found in all 62 tributaries of the Middle Fork and the U.S. portion of the North Fork. Presence of adfluvial cutthroat in many tributaries to the Middle Fork remains unknown due to the relatively small amount of trapping and tag return information available. Bull trout have been observed in 19 (50%) of the major North Fork tributaries below the Canadian border and 18 (75%) of the tributaries of the Middle Fork surveyed to date (Tables 2 - 4).

The contribution by large lakes in Glacier Park to fish populations downstream from the lakes in both the lower North Fork and Middle Fork is unknown. All the lakes contain established populations of westslope cutthroat and bull trout (Peterson et. al. 1977).

Estimates have been made for a total of 142 tributary reaches during the summers of 1979 and 1980. In the 117 reaches surveyed which contained fish, observers recorded a total of 4,109 cutthroat, 413 juvenile bull trout, and 411 mountain whitefish. Cutthroat were present in 112 of the reaches while bull trout were observed in 52 reaches. Mountain whitefish were observed in 31 tributary reaches.

Cutthroat were the only trout species observed in 67 of the tributary reaches while only five reaches contained bull trout exclusively. A total of 45 reaches contained both cutthroat and bull trout.

Of the 14 major tributary drainages surveyed in the Middle Fork, 13 contained juvenile bull trout. However, they were found in fewer reaches of those major tributary drainages than were cutthroat trout. Juvenile bull trout were found in 13 of the 20 major North Fork tributary drainages. In the major North Fork tributary drainages in which they were found, they were present in fewer reaches than were cutthroat trout. Juvenile bull trout were present in a total of 33 Middle Fork tributary reaches and 19 North Fork tributary reaches.

This restricted distribution may be due to the selectivity of adfluvial bull trout spawners for certain types of reaches. However, juvenile bull trout were observed in some reaches where adults probably would not spawn due to the large size of bed material. Juvenile bull trout were also difficult to observe and may have been overlooked in some reaches.

Cutthroat and bull trout densities have been calculated by age class for 117 North and Middle Fork tributary reaches to date (Tables 5 and 6). Total density for each species refers to age I and older trout. Estimates of age 0 trout were not considered as accurate as other age classes due to difficulty in observation.

Densities of age I and older cutthroat in the 112 reaches in which they were present ranged from 0.1 to 74.2 fish per 100 m^2 surface area.

Table 2. Current information on fish distribution in west bank North Fork creeks: + = species present, - = species absent, ? = unknown, needs further study.

Creek	Cutthroat Adfluvial	Cutthroat Resident	Bull trout
Canyon	-	+	+ 2/
McGinnis	+	+	+ 2/
Big	+	+	+
Langford	+	+	+
Lookout	-	+	-
Elelehum	-	+	-
Hallawat	+	+	+
Skookoleel	?	+	+
Nicola	-	+	+
Kletomus	+	+	+
Werner	+	+	+
Coal	+	+	+
Cyclone	+	+	-
Deadhorse	?	+	-
South Fork Coal	+	+	+
Mathias	+	+	+
Moran	+	+	+ 1/
Hay	?	+	+ 1/
Red Meadow	+	+	+
Moose	+	+	+
Whale	+	+	+
Shorty	+	+	+
Ninko	-	+	-
Teepee	-	+	-
Trail	+	+	+
Ketchikan	+	+	-
Yakinikak	+	+	+
Antley	-	+	-
Nokio	-	+	-
Tuchuck	+	+	-
Colts	-	+	-

1/ = Possible resident population
2/ = Bulls present below falls 1/4 mile from mouth

Table 3. Current information on fish distribution in Glacier Park and Canadian creeks: + = species present, - = species absent, ? = unknown, needs further study.

Creek	Cutthroat Adfluvial	Cutthroat Resident	Bull trout
Glacier Park			
Camas	+	+	-
Anaconda	+	+	-
Dutch	+	+	-
Logging	?	+	+
Quartz	?	+	+
Bowman	?	+	-
Akokala	+	+	-
Ford	?	+	-
Kintla	?	+	-
Spruce	+	+	-
Starvation	+	+	+
Kishenehn	+	+	+
Sage	+	+	+
British Columbia			
Howell	+	+	+
Cabin	+	+	+
Couldrey	+	+	+

Table 4. Current information on fish distribution in Middle Fork creeks: + = species present, - = species absent, ? = unknown, needs further study.

Creek	Cutthroat Adfluvial	Cutthroat Resident	Bull trout	Sculpin
Argosy	?	+	+	?
Bowl	?	+	+	+
Basin	?	+	+	+
Calbic	?	+	+	?
Clack	?	+	+	?
Cox	?	+	-	+
Dolly Varden	?	+	+	?
Gateway	?	+	+	?
Granite	?	+	+	?
Lake	?	+	+	?
Long	?	+	+	?
Lodgepole	?	+	+	+
Miner	-	+	-	?
Morrison	?	+	+	?
Schafer	?	+	+	+
W. Fork Schafer	?	+	?	?
Strawberry	?	+	+	+
E. Fork Strawberry	?	+	+	?
Trail	?	+	+	?
S. Fork Trail	?	+	-	?
Whistler	?	+	+	?
Charlie	?	+	+	?
Bergsicker	?	+	+	?
Twenty-five Mile	?	+	-	?
Challenge	?	+	+	?

Table 5. Mean densities (No./100 m²) of cutthroat and juvenile bull trout by age class in North Fork tributaries surveyed during the summers of 1979 and 1980. Total for each species refers to age classes I, II, and III+ combined.

		Fish per 100 m² surface area									
		Cutthroat trout					Bull trout				
Stream	Reach No.	Age 0	Age I	Age II	Age III+	Total	Age 0	Age I	Age II	Age III+	Total
Canyon Cr.	001	---	---	0.2	0.8	1.0	---	---	---	---	---
McGinnis Cr.	001[1]	---	---	0.7	2.3	3.0	---	---	---	1.5	1.5
Kimmerly Cr.	001[1]	---	---	1.9	5.3	7.2	---	---	---	---	---
Big Cr.	001	---	---	---	0.1	0.1	---	---	---	---	---
	002	---	---	---	---	---	0.7	0.1	0.1	0.1	0.3
Langford Cr.	001[1]	2.7	1.8	---	38.6	40.4	---	---	---	---	---
	002[1]	5.0	---	13.5	60.9	74.4	---	---	---	---	---
Hallowatt Cr.	001	---	---	0.2	---	0.2	0.6	---	---	0.8	0.8
	002	---	---	---	---	---	---	---	0.4	---	0.4
Werner Cr.	001[1]	---	---	0.5	1.7	2.2	---	---	---	---	---
Kletomus Cr.	001[1]	---	---	---	0.3	0.3	---	---	---	---	---
Camas Cr.	002	---	---	0.2	0.7	0.9	---	---	---	---	---
Dutch Cr.	001	2.1	1.5	2.3	5.2	9.0	---	---	---	---	---
	002	10.6	5.7	3.8	2.7	12.2	---	---	---	---	---
	003	0.7	---	1.3	1.6	2.9	---	---	---	---	---
Anaconda Cr.	001	3.2	3.6	3.8	3.1	10.5	---	---	---	---	---
	002	---	---	0.5	2.6	3.1	---	---	---	---	---
Coal Cr.	001	---	---	0.9	---	0.9	---	---	---	---	---
	003	0.7	1.2	2.4	3.4	7.0	---	1.2	0.4	---	1.6
	004	0.2	---	1.0	1.2	2.2	---	1.4	---	---	1.4

Table 5. (Continued)

Stream	Reach No.	Cutthroat trout Age 0	Cutthroat trout Age I	Cutthroat trout Age II	Cutthroat trout Age III+	Cutthroat trout Total	Bull trout Age 0	Bull trout Age I	Bull trout Age II	Bull trout Age III+	Bull trout Total
Cyclone Cr.	001	34.9	2.9	5.1	4.9	12.9	---	---	---	---	---
Dead Horse Cr.	001[1]	1.7	---	0.6	0.3	0.9	---	---	---	---	---
	002[1]	---	0.6	---	1.2	1.8	---	---	---	---	---
S.F. Coal Cr.	001[1]	---	---	0.2	0.2	0.4	0.2	0.2	0.3	0.2	0.7
Mathias Cr.	001	---	---	1.5	---	1.5	---	---	0.5	0.2	0.7
Logging Cr.	001	3.2	0.9	1.0	0.7	2.6	---	---	---	---	---
Quartz Cr.	001	---	1.9	1.1	1.5	4.5	---	---	---	---	---
Cummings Cr.	001	0.5	0.7	1.5	3.7	5.9	---	---	---	---	---
Moran Cr.	001	0.6	4.2	9.8	6.9	20.9	0.2	---	0.2	0.6	0.8
	002	---	---	0.5	3.6	4.1	---	---	---	---	---
	003	---	---	0.2	0.2	0.4	---	---	---	---	---
Hay Cr.	001	1.2	---	0.5	2.9	3.4	---	---	---	---	---
	002	0.7	0.2	0.4	7.0	7.6	---	---	---	0.1	0.1
	003	0.1	0.2	0.6	3.5	4.3	---	---	---	0.3	0.3
	004	1.7	0.6	1.1	2.3	4.0	---	---	---	---	---
Bowman Cr.	001	---	0.1	0.1	11.0	11.2	---	---	---	---	---
Akokala Cr.	001	0.6	0.4	0.1	1.3	1.8	---	---	---	---	---
	002	---	0.7	1.3	4.8	6.8	---	---	---	---	---
Parke Cr.	001[1]	---	1.9	2.2	3.2	7.3	---	---	---	---	---
	002[1]	2.1	1.2	2.1	1.7	5.0	---	---	---	---	---
Long Bow Cr.	001[1]	---	0.3	2.6	3.8	6.7	---	---	---	---	---

Fish per 100 m^2 surface area

Table 5. (Continued)

Stream	Reach No.	Fish per 100 m² surface area: Cutthroat trout Age 0	Age I	Age II	Age III+	Total	Bull trout Age 0	Age I	Age II	Age III+	Total
Red Meadow Cr.	001	4.5	7.9	2.8	0.5	11.2	---	---	0.4	---	0.4
	002	---	1.1	3.8	9.7	14.6	---	1.1	4.4	1.6	7.1
	003	---	---	1.2	3.4	4.6	---	---	3.4	0.8	4.2
Moose Cr.	001	3.4	2.4	5.3	3.1	10.8	---	---	---	---	---
	002	0.4	9.4	12.4	5.6	27.4	---	---	---	---	---
	003	---	5.9	10.1	46.0	62.0	---	---	---	---	---
Whale Cr.	001	---	---	---	---	---	0.3	---	0.1	0.3	0.4
	002	---	---	---	0.6	0.6	0.1	0.2	0.1	1.3	1.6
Shorty Cr.	001	---	0.3	-.4	0.4	1.1	0.7	0.4	0.7	0.5	1.6
Ford Cr.	001[1]	5.0	3.9	5.0	0.9	9.8	---	---	---	---	---
	002[1]	---	---	---	4.7	4.7	---	---	---	---	---
	003	---	0.3	0.7	2.7	3.7	---	---	---	---	---
Kintla Cr.	001	0.1	0.2	1.0	0.7	1.9	---	---	---	---	---
Trail Cr.	001	---	---	---	0.6	0.6	1.6	0.1	0.9	0.7	1.7
Ketchikan Cr.	001[1]	29.8	4.8	11.5	17.3	33.6	---	---	---	---	---
	002[1]	1.7	3.8	4.7	8.6	17.1	---	---	---	---	---
	003	8.1	4.1	4.1	8.9	17.1	---	---	---	---	---
Yakinikak Cr.	004	---	---	0.4	5.7	6.1	---	---	---	---	---
	005	---	---	0.1	0.7	0.8	---	---	---	---	---
Tuchuck Cr.	001	2.3	2.8	6.9	9.3	19.0	---	---	---	---	---
Starvation Cr.	001	3.2	---	0.9	1.1	2.0	---	---	0.7	0.6	1.3
	002	---	0.3	0.3	0.4	1.0	1.6	1.5	1.0	1.0	3.5

Table 5. (Continued)

Stream	Reach No.	Fish per 100 m^2 surface area									
		Cutthroat trout					Bull trout				
		Age 0	Age I	Age II	Age III+	Total	Age 0	Age I	Age II	Age III+	Total
Spruce Cr.	001	---	---	1.0	2.6	3.6	---	---	---	---	---
	002	---	2.2	5.8	1.8	9.8	---	---	---	---	---
Sage Cr.	001	0.4	0.1	---	11.0	11.1	---	---	---	---	---

1: Based on 75 m snorkel section

Table 6. Mean densities (No./100 m²) of cutthroat and juvenile bull trout in Middle Fork tributaries surveyed during the summer of 1979 and 1980. Total for each species refers to age classes I, II, and III+ combined.

		Fish per 100 m² surface area									
		Cutthroat trout					Bull trout				
Stream	Reach No.	Age 0	Age I	Age II	Age III+	Total	Age 0	Age I	Age II	Age III+	Total
Charlie Cr.	001	0.5	1.0	2.0	1.0	4.0	1.5	5.6	0.7	---	6.3
	002	---	---	---	0.3	0.3	---	4.5	4.2	---	8.7
Long Cr.	001	---	---	---	---	---	---	---	0.2	---	0.2
	002	0.2	---	0.2	0.5	0.7	---	0.2	0.7	0.3	1.2
	003	---	0.2	0.5	0.1	0.8	---	0.6	0.4	0.9	1.9
Bergsicker	001	---	---	---	0.6	0.6	---	---	0.4	---	0.4
Twenty-Five Mile Cr.	003	---	5.7	5.0	3.0	13.7	---	---	---	---	---
Granite Cr.	001	---	---	---	0.5	0.5	---	---	0.7	1.4	2.1
	002	---	0.2	---	1.3	1.5	0.1	----	0.2	---	0.2
Challenge	001	1.3	3.8	6.6	3.5	13.9	---	---	---	0.25	0.25
Lake Cr.	001	---	---	0.3	2.1	2.4	---	---	---	---	---
	002	---	---	---	0.5	0.5	---	---	---	---	---
Miner Cr.	001	---	---	---	1.3	1.3	---	---	---	---	---
	002	---	---	---	2.8	2.8	---	---	---	---	---
Morrison Cr.	001	---	---	---	0.2	0.2	---	0.2	0.3	0.3	0.8
	002	---	---	---	0.7	0.7	---	0.5	1.1	2.4	4.0
	003	---	---	0.6	3.0	3.6	---	---	2.7	5.1	7.8
	004	---	---	---	---	---	0.4	0.5	0.5	0.3	1.3

Table 6. (Continued)

		Fish per 100 m² surface area									
		Cutthroat trout					Bull trout				
Stream	Reach No.	Age 0	Age I	Age II	Age III+	Total	Age 0	Age I	Age II	Age III+	Total
Lodgepole Cr.	001	---	---	0.1	0.4	0.5	---	0.3	---	---	0.4
	002	0.2	0.8	2.3	1.2	4.3	---	0.2	---	0.2	0.4
Whistler Cr.	001	---	---	0.2	1.2	1.4	---	0.5	5.5	1.2	7.2
Schafer Cr.	001	---	0.1	---	---	0.1	0.1	---	---	---	0.1
	002	---	0.1	0.5	1.1	1.7	---	---	---	---	---
	003	---	---	0.8	3.1	3.9	---	---	---	---	---
	004	---	1.3	1.7	0.9	3.9	---	---	---	---	---
W.F. Schafer Cr.	001	---	0.7	2.2	2.6	5.5	---	---	---	---	---
Dolly Varden Cr.	001	---	---	0.1	0.1	0.2	0.1	---	---	---	0.1
Argosy Cr.	001	---	---	0.2	1.0	1.2	---	---	---	0.4	0.4
	002	---	2.2	7.9	1.3	11.4	---	0.9	0.2	---	1.1
Calbic Cr.	001	---	2.4	4.1	0.6	7.1	---	0.6	---	---	0.6
Cox Cr.	001	---	---	0.1	0.3	0.4	---	---	---	---	---
	002	1.1	1.1	2.7	6.5	10.3	---	---	---	---	---
Clack Cr.	003	---	---	---	0.6	0.6	---	---	---	---	---
Bowl Cr.	001	---	---	0.2	---	0.2	---	---	---	---	---
	002	---	---	---	0.3	0.3	---	---	---	---	---
	003	0.1	1.0	1.2	2.4	4.6	---	0.2	0.4	0.2	0.8
	004	---	0.3	---	0.6	0.9	---	---	0.1	0.3	0.4
	005	---	---	0.2	---	0.2	---	---	---	0.2	0.2

Table 6. (Continued)

Stream	Reach No.	Fish per 100 m² surface area: Cutthroat trout Age 0	Cutthroat trout Age I	Cutthroat trout Age II	Cutthroat trout Age III+	Cutthroat trout Total	Bull trout Age 0	Bull trout Age I	Bull trout Age II	Bull trout Age III+	Bull trout Total
Basin Cr.	001	0.4	3.0	4.2	4.5	11.7	---	0.1	---	---	0.1
	002	1.2	1.3	3.4	2.0	6.7	---	---	0.5	0.1	0.6
	003	---	0.2	1.4	11.9	13.5	---	---	---	0.7	0.7
Strawberry Cr.	001	---	---	---	0.1	0.1	---	---	---	0.1	0.1
	002	---	0.7	2.6	2.0	5.3	---	0.2	0.2	0.3	0.7
	003	---	---	---	0.1	0.1	---	---	0.2	---	0.2
	004	---	0.2	0.4	---	0.6	---	0.2	3.1	---	3.3
E.F.Strawberry	001	---	---	2.1	9.6	11.7	---	---	0.6	0.8	1.4
Trail Cr.	001	---	---	---	0.3	0.3	0.7	0.4	0.7	0.5	1.6
	002	---	0.3	---	0.8	1.1	---	---	---	0.3	0.3
Gateway Cr.	001	---	---	0.5	0.3	0.8	---	0.4	0.5	0.2	1.1
	002	---	---	0.4	1.3	1.7	---	---	---	---	---
	003	0.6	3.3	4.0	3.2	10.5	---	---	---	---	---
	004	2.0	1.8	18.7	6.7	27.2	---	---	---	---	---

Mean age I and older cutthroat density was 7.2 fish per 100 m^2. This is equivalent to approximately 44 fish per 100 linear meters of stream. Horner (1978) reported densities of 5.5 age I and older cutthroat and rainbow trout per 100 m^2 surface area in Big Spring Creek, Idaho during 1976. Densities of juvenile bull trout were much small than cutthroat densities. In the 50 reaches where bull trout were observed, the densities of age I and older fish ranged from 0.1 to 8.7 and averaged 1.7 juvenile bull trout per 100 m^2 surface area. This is equivalent to approximately 10 bull trout per 100 linear meters of stream. Adult adfluvial bull trout were observed in some tributary reaches but were not included in density estimates. Densities of trout and char in small northern Idaho streams draining the Gospel Hump Wilderness Area were similar to those found in the Flathead tributaries (Idaho Coop. Fish, Res. Unit, Moscow unpub. data).

Total cutthroat densities average 10.1 fish per 100 m^2 in North Fork tributaries and 4.2 per 100 m^2 in Middle Fork tributaries. Mean total bull trout densities were 1.5 fish per 100 m^2 in North Fork tributaries and 1.7 fish per 100 m^2 in Middle Fork tributaries.

Relatively large densities of cutthroat or juvenile bull trout in a reach indicate the high value of that reach as a rearing area for that species. These rearing areas and the stream corridors leading to them are critically important for maintaining populations of cutthroat and bull trout in the Flathead River-Lake system. Critical rearing areas for cutthroat identified in the North Fork drainage include 17 reaches in Langford, Moose, Ketchikan, Moran, Cyclone, Tuchuck, Bowman, Red Meadow, Sage, Dutch, and the South Fork of Coal creeks. Critical cutthroat rearing areas in the Middle Fork drainage identified to date include nine reaches in Gateway, Basin, Challenge, Twenty-five Mile, Argosy, Cox, and the East Fork of Strawberry creeks. This is not a complete list because one-third of the Middle Fork drainage has not been surveyed.

Critical rearing areas identified in the North and Middle Fork drainages all supported densities of age I and older cutthroat larger than 10 fish/100 m^2. Many other reaches supporting somewhat smaller densities are also important as rearing areas for cutthroat.

Critical areas for bull trout rearing as indicated by total densities larger than 1.5 fish per 100 m^2 were 7 reaches in Red Meadow, Starvation, Trail, Coal, Whale, Shorty, and McGinnis creeks in the North Fork drainage. A total of nine reaches in Whistler, Morrison, Charlie, Strawberry, Granite, Long, and Trail creeks were identified as critical rearing areas for bull trout in the portion of the Middle Fork drainage surveyed to date.

At least two, and possibly three species of sculpins have been identified during a taxonomic study in two North Fork drainages (Fish, Wildlife and Parks unpub. data 1980). Fresh sculpins were keyed out on the basis of ten morphological characteristics and then subjected to electrophoretic analysis. Presence or absence of palatine teeth appeared to be the most reliable meristic characteristic. The slimy sculpins C. *cognatus* and shorthead sculpin C. *confusus* were most abundant. Only shorthead sculpins were found in Trail Creek. Thirteen of twenty sculpins from the Coal Creek drainage were identified as slimy sculpins, five were shorthead sculpins, and two had characteristics of both. A few preserved specimens were identified as mottled sculpins, C *bairdi*, but further electrophoretic verification is needed. The distribution of sculpins in the North Fork with species identification for certain streams is presented in Tables 7 and 8. Information about sculpins throughout the Flathead drainage is limited and further study on the life history, distribution, and importance in the food chain would be beneficial.

Densities of Cutthroat and Bull Trout by Stream Feature

A total of 333 pools, 425 runs, 441 riffles, and 108 pocket water areas were snorkeled in 1979 and 1980. Mean fish densities by age class for each species is presented in Table 9. Densities of age II and III+ cutthroat were largest in pools, followed by runs, pocket water areas, and riffles in order of decreasing abundance. Age 0 cutthroat densities were largest in runs, while age I densities were about equal in runs and pools.

Bull trout densities varied little between features, except for age II fish which had substantially larger densities in pools than in other features (Table 9).

Biomass Estimates

Biomass estimates for cutthroat, bull trout, and mountain whitefish were made for the purpose of estimating fishery productivity of North and Middle Fork tributaries. Mean biomass estimates for cutthroat and bull trout in 117 reaches in which trout were found are given in Table 10. Mean total biomass of age I and older cutthroat was 224.9 g per 100 m^2 surface area or 1.4 kg per 100 linear meters of stream. The mean biomass of bull trout in the 52 reaches in which they were present was 104.3 g per 100 m^2 surface area or 0.65 kg per 100 linear meters of stream.

Mean biomass of mountain whitefish in the 31 reaches in which they were present was 80.1 g per 100 m^2 surface are or .5 kg per 100 linear meters of stream.

Snorkeling - Electrofishing Comparisons

Population estimates for cutthroat by age class were made by snorkeling and electrofishing in 12 North Fork tributary reaches (Tables 11 - 15). Numbers of age 0 fish estimated by snorkeling were generally higher than numbers estimated by electrofishing. Numbers of age 0 fish are difficult to estimate by any method which makes these results questionable. Graham (1977) reported difficulties in observing age 0 fish because of their size and habitat associations. Snorkeling estimates for age I cutthroat were larger than electrofishing estimates, while estimates of mean numbers of age II and III+ fish were similar between methods. Total estimates of age I and older cutthroat made by snorkeling averaged 25 percent higher than electrofishing estimates for the 12 sections. The differences between

Table 7. Current information on sculpin distribution in west bank North Fork creeks: by method of species identification used: + = species present, - = species absent, ? = unknown.

Creek	Sculpin present	*C. confusus* Morph	*C. confusus* Electro	*C. cognatus* Morph	*C. cognatus* Electro	*C. bairdi* Morph only
Canyon	?					
McGinnis	?					
Big	+					
Langford	+					
Lookout	-					
Elelehum	-					
Hallawat	+					
Skookoleel	-					
Nicola	-					
Kletomus	-					
Werner	-					
Coal	+	+	+	+		
Cyclone	+	+	-			
Deadhorse	-					
South Fork Coal	-					
Mathias	-					
Moran	+					
Hay	+				+	
Red Meadow	+					
Moose	+					
Whale	+		+	+		
Shorty	-					
Ninko	?					
Teepee	?					
Trail	+	+	+	-	-	
Ketchikan	-					
Yakinikak	-					
Antley	-					
Nokio	-					
Tuchuck	-					
Colts	?					

Table 8. Current information on sculpin distribution on east bank North Fork creeks by method of species identification used: + = species present, - = species absent, ? = species unknown.

Creek	Sculpin present	*C. confusus* Morph	*C. confusus* Electro	*C. cognatus* Morph	*C. cognatus* Electro	*C. bairdi* Morph only
Glacier Park						
Camas	+	+				
Anaconda	+					
Dutch	+					
Logging	+	+				
Quartz	+					
Bowman	+					
Akokala	+	+				
Ford	+	+	+			
Spruce	+					
Starvation	+	+				
Kishenehn	+	+				+ ?
Sage	+					
British Columbia						
Howell	+					
Cabin	+					
Cauldrey	+					

Table 9. Mean densities (No. fish/100 m²) by age class of westslope cutthroat and bull trout in run, riffle, pool & pocket water habitat units (features) snorkeled in 1979 and 1980. Number of features snorkeled is in parentheses.

	Feature or habitat use			
Species	Pool (333)	Run (425)	Riffle (441)	Pocket water (108)
Cutthroat trout				
Age 0	.8	1.7	.7	.6
Age I	1.6	1.9	.4	.9
Age II	4.8	2.9	.5	2.9
Age III+	12.3	4.8	1.5	3.1
Ages I and older	18.7	9.7	2.1	6.9
Bull trout				
Age 0	.2	.5	.1	.1
Age I	.6	.7	.6	.1
Age II	1.7	.5	.4	.3
Age III+	.1	.2	.1	.3
Ages I and older	2.3	1.6	1.2	.7
Total trout	22.0	13.5	4.1	8.3

Table 10. Mean biomass estimates (g/100 m²) for cutthroat and bull trout of each age class in North and Middle Fork tributary reaches. Total refers to ages I, II and III+ combined.

		Age class				
Species	Number of reaches	0	I	II	III+	Total
Cutthroat trout	112	2.1	10.5	44.7	169.7	224.9
Bull trout	52	.3	3.7	17.9	82.6	104.2

Table 11. Comparison between snorkel and electrofishing counts of age 0 cutthroat in 12 North Fork tributary reaches.

Stream	Reach	Date	Electrofishing count	Snorkel count	Difference (Percent)
Red Meadow	1	8/79	3	35	-32(91)
Red Meadow	2	8/79	4	6	-2(33)
Red Meadow	2a	8/79	1	0	-
Red Meadow	3	8/79	0	0	-
Yakinikak	1	8/79	0	0	-
Yakinikak	2	8/79	0	0	-
Tuchuck	1	8/79	0	10	-
Coal	1	9/79	2	5	-3(60)
Moose	2[1/]	7/80	6	1	+5(500)
Moose	3[1/]	8/80	0	0	-
Kimmerly	1[1/]	9/80	2	0	-
Hay	3[1/]	8/80	0	0	-
	Mean[2/]		1.5	4.75	-3.25(68)

1: 75 m section

2: Paired T test indicates no significant difference between means at the 95% level (P=.272 T=1.16).

Table 12. Comparison between snorkeling and electrofishing counts of age I cutthroat in 12 North Fork tributary reaches.

Stream	Reach	Date	Electrofishing count	Snorkel count	Difference (Percent)
Red Meadow	1	8/79	10	69	-59(86)
Red Meadow	2	8/79	1	3	-2(67)
Red Meadow	2a	8/79	2	11	-9(82)
Red Meadow	3	8/79	0	0	-
Yakinikak	1	8/79	8	0	-
Yakinikak	2	8/79	0	0	-
Tuchuck	1	8/79	7	13	-6(46)
Coal	1	9/79	17	11	+6(55)
Moose	2[1/]	7/80	12	32	-20(63)
Moose	3[1/]	8/80	12	15	-3(20)
Kimmerly	1[1/]	9/80	6	0	-
Hay	3[1/]	8/80	7	0	-
	Mean[2/]		6.8	12.83	-6.03(47)

1: 75 m section

2: Paired T test indicates no significant difference between mean at the 95% level (P=.285 T=1.28).

Table 13. Comparison between snorkel and electrofishing counts of age II cutthroat in 12 North Fork tributary reaches.

Stream	Reach	Date	Electrofishing count	Snorkel count	Difference (Percent)
Red Meadow	1	8/79	18	25	-7(28)
Red Meadow	2	8/79	11	2	+9(450)
Red Meadow	2a	8/79	8	17	-9(53)
Red Meadow	3	8/79	3	5	-2(40)
Yakinikak	1	8/79	2	2	-
Yakinikak	2	8/79	2	1	+1(0)
Tuchuck	1	8/79	20	29	-9(31)
Coal	1	9/79	15	18	-3(17)
Moose	2[1/]	7/80	15	21	-6(29)
Moose	3[1/]	8/80	20	29	-9(31)
Kimmerly	1[1/]	9/80	18	6	+12(200)
Hay	3[1/]	8/80	11	4	+7(175)
	Mean[2/]		11.9	13.25	-1.35(10)

1: 75 m section

2: Paired T test indicates no significant difference between means at the 95% level (P=.543 T=.628).

Table 14. Comparison between snorkel and electrofishing counts of age III+ cutthroat in 12 North Fork tributary reaches.

Stream	Reach	Date	Electrofishing count	Snorkel count	Difference (Percent)
Red Meadow	1	8/79	10	11	-1(9)
Red Meadow	2	8/79	5	9	-4(44)
Red Meadow	2a	8/79	7	25	-17(68)
Red Meadow	3	8/79	7	17	-10(59)
Yakinikak	1	8/79	11	30	-19(63)
Yakinikak	2	8/79	4	5	-1(20)
Tuchuck	1	8/79	22	39	-17(44)
Coal	1	9/79	33	17	+16(94)
Moose	2[1/]	7/80	8	19	-11(58)
Moose	3[1/]	8/80	10	23	-13(57)
Kimmerly	1[1/]	9/80	31	16	+15(94)
Hay	3[1/]	8/80	23	8	+15(188)
	Mean[2/]		14.25	18.25	-4(22)

1: 75 m section

2: Paired T test indicates no significant difference between means at the 95% level (P=.314 T=1.06).

Table 15. Comparison between snorkel and electrofishing counts of age I and older cutthroat in 12 North Fork tributary reaches.

Stream	Reach	Date	Electrofishing count	Snorkel count	Difference (Percent)
Red Meadow	1	8/79	38	104	+66(63)
Red Meadow	2	8/79	17	14	+3(21)
Red Meadow	2a	8/79	17	53	-36(68)
Red Meadow	3	8/79	10	22	-12(55)
Yakinikak	1	8/79	21	32	-11(34)
Yakinikak	2	8/79	6	6	0( )
Tuchuck	1	8/79	49	81	-32(40)
Coal	1	9/79	65	46	+19(41)
Moose	2[1]	7/80	35	72	-37(51)
Moose	3[1]	8/80	42	67	-25(37)
Kimmerly	1[1]	9/80	57	22	+35(159)
Hay	3[1]	8/80	41	12	+29(242)
	Mean[2]		33.2	44.3	-11.1(25)

1: 75 m section

2: Paired T test indicates no significant difference between means at the 95% level (P=.227 T=1.28) the mean estimates by each method were tested (paired t test) for each age class and for age I and older cutthroat combined. There was no significant difference in the estimates made by the two methods at the 95 percent level.

Electrofishing and snorkeling estimates were made for cutthroat on one Middle Fork tributary. The electrofishing estimate was made by the mark and recapture method and was 20 percent higher than the snorkeling estimate for age I and older cutthroat. Comparison of the two methods indicates that snorkeling and electrofishing estimates of cutthroat trout numbers in North and Middle Fork tributaries are reasonably comparable, although snorkeling provided a better estimate of the number of age I and older cutthroat trout then the two pass method of electrofishing.

Estimates of cutthroat by the two methods varied between streams, probably due to differences in physical habitat characteristics of the sections. It appears that snorkeling is more effective than electrofishing for estimating cutthroat numbers in streams where levels of debris and turbulence are not great. However, in sections which have large amounts of debris or water turbulence, electrofishing is probably a more effective method than snorkeling.

Graham and Sekulich (in preparation) reported snorkeling estimates of cutthroat numbers were comparable to estimates made by various methods of removal. Northcote and Wilkie (1963) found snorkeling to be an effective method of estimating numbers for several species of fish.

Estimates of bull trout numbers for each age class made by snorkeling and electrofishing in four 100 m sections of North Fork tributary reaches are given in Tables 16 - 18. Electrofishing estimates for age 0 and age I bull trout were considerably higher than snorkeling estimates while estimates of age II and age III+ bull trout by both methods were similar. Electrofishing estimates of age I, II, and III+ bull trout combined was 27 percent larger than snorkeling estimates for the five sections. Paired t tests indicated no significant difference between the means of the estimates for each age class made by snorkeling and electrofishing, but the sample size was small. We believe the habits of juvenile bull trout make them more difficult to observe while snorkeling than cutthroat trout. A better evaluation of snorkeling as a method to estimate juvenile bull trout numbers will be made in 1981 when more sections have been sampled.

North and Middle Fork Rivers

Middle Fork

Fish populations in the Middle Fork above Bear Creek were censused to obtain baseline information on fish densities in a natural river system. This information will form the basis of a long-term monitoring system as development continues in the Middle Fork and North Fork drainages.

Underwater fish counts were made in 120 pool, 41 run, 22 riffle, and 10 pocket water habitat units in the wilderness portion of the

Table 16. Comparison between snorkel and electrofishing counts of age 0 and age I bull trout in five North Fork tributary reaches.

Stream	Reach	Date	Electrofishing count	Snorkel count	Difference (Percent)
Age 0					
Red Meadow	1	8/79	0	0	-
Red Meadow	2	8/79	1	4	-3(75)
Red Meadow	3	8/79	1	0	-
Coal	1	9/79	11	0	-
Hay	3[1]	8/80	0	0	-
		Mean[2]	2.6	.80	-1.8(225)
Age I					
Red Meadow	1	8/79	0	0	-
Red Meadow	2	8/79	6	0	-
Red Meadow	3	8/79	8	0	-
Coal	1	9/79	18	13	+5(39)
Hay	3[1]	8/80	0	0	-
		Mean[3]	6.4	2.6	+3.8(146)

1: 75 m section

2: Paired T test indicates no significant difference between means at the 95% level (P=.494 T=-.751)

3: Paired T test indicate no significant differences between means (P=.080 T=-2.34)

Table 17. Comparison between snorkel and electrofishing counts of age II and III+ bull trout in five North Fork tributary reaches.

Stream	Reach	Date	Electrofishing count	Snorkel count	Difference (Percent)
Age II					
Red Meadow	1	8/79	1	3	-2(67)
Red Meadow	2	8/79	3	4	-1(25)
Red Meadow	3	8/79	12	17	-5(29)
Coal	1	9/79	4	3	+1(33)
Hay	3[1]	8/80	0	0	--
	Mean[2]		4.0	5.40	-1.4
Age III+					
Red Meadow	1	8/79	5	2	+3(150)
Red Meadow	2	8/79	0	1	--
Red Meadow	3	8/79	5	2	+3(150)
Coal	1	9/79	0	0	--
Hay	3[1]	8/80	1	2	-1(50)
	Mean[3]		2.2	1.40	+8.57

1: 75 m section

2: Paired T test indicates no significant difference between means at the 95% level (P=.246 T=1.36)

3: Paired T test indicates no significant difference between means at the 95% level (P=.4320 T=-.873)

Table 18. Comparison between snorkel and electrofishing counts of age I and older bull trout in five North Fork tributary reaches.

Stream	Reach	Date	Electrofishing count	Snorkel count	Difference (Percent)
Age I and older					
Red Meadow	1	8/79	6	5	+1(20)
Red Meadow	2	8/79	9	4	+5(125)
Red Meadow	3	8/79	25	19	+6(32)
Coal	1	9/79	22	16	+6(38)
Hay	3[1]	8/80	1	2	-1(50)
	Mean[2]		12.6	9.2	3.4(37)

1: 75 m section

2: Paired T test indicates no significant difference between means at the 95% level (P=.077 T=2.369)

Middle Fork above Bear Creek during the summer of 1980. A total of 993 westslope cutthroat, 18 juvenile bull trout, 132 mature bull trout, and 5,762 mountain whitefish were counted by observers during fish density estimates.

Density estimates were made in mid-summer for pool and run habitat units in a 23 km section of the Middle Fork above Schafer Meadows and a 48 km section below Schafer Meadows (Table 19). Total densities of cutthroat were 1.55 fish per 100 m² in pools and runs in the river upstream from Schafer Meadows and 0.97 fish per 100 m² downstream. Only two juvenile bull trout were seen during these mid-summer estimates. River densities of mature bull trout on their spawning migration from Flathead Lake were 0.06 fish per 100 m² in the upper section and 0.12 fish per 100 m² in the lower section. Mountain whitefish densities were relatively high, averaging 2.84 fish per 100 m² surface area in the upper section and 7.76 fish per 100 m² in the lower section.

Density estimates by species were made in late summer in the same two areas of the Middle Fork. These estimates were made to determine seasonal differences in fish populations of the river and to determine densities of fish by stream feature. These estimates were concentrated on 10 km of the river above Schafer Meadows (Gooseberry Park downstream to Cox Creek) and a 10 km section downstream from Schafer Meadows (from three km below Schafer Meadows downstream to Granite Creek). Fish densities were estimated in every third pool, run, and pocket water habitat unit, and every fourth riffle habitat unit. The density estimates by species for each feature are presented in Table 20.

Late summer density of cutthroat in pool and run habitats was less than half of that found in mid-summer estimates. Smaller densities in late summer may be due to oversummer mortality, movement of trout into tributary streams or out-migration to the lower Flathead River or Flathead Lake.

More juvenile bull trout were observed in late summer than in early summer. Densities of mature bull trout spawners was twice as large in the upper section and similar in the lower section in the mid-summer and late summer estimates.

Densities of cutthroat and juvenile bull trout in pocket water habitat units in both sections was similar to that found in run habitats and slightly lower than pool densities. No cutthroat trout and very few juvenile bull trout were seen in riffle habitats. Riffles were dominated by mountain whitefish in both river sections averaging just over one fish per 100 m² surface area. The average density of mountain whitefish in all features combined was more than 10 times larger than the average total trout density.

An estimate of total surface area of each feature was calculated. The estimate was based on the total number of each habitat unit in two 10 km sections and average feature size measured on randomly selected features in each reach. A population estimate for each species in the

Table 19. Fish densities (No./100 m^2) by age class in pool and run habitat units of the Middle Fork of the Flathead River during mid-summer, 1980. Numbers of each feature snorkeled and numbers of fish observed are in parentheses.

Feature	Cutthroat trout			Bull trout				Mountain whitefish	
	Age I	Age II	Age III+	Age I	Age II	Age III+	Mature	<152mm	>152mm
Middle Fork above Schafer Meadows (7/24 - 7/29)									
Pool (42)	.04 (13)	1.19 (342)	.41 (119)	---	---	.007 (2)	.06 (18)	.33 (96)	2.53 (727)
Run (7)	.09 (4)	.51 (22)	.33 (14)	---	---	---	.02 (1)	.49 (21)	2.21 (95)
Combined (49)	.05 (17)	1.10 (365)	.40 (133)	---	---	.006 (2)	.06 (19)	.35 (117)	2.49 (822)
Middle Fork below Schafer Meadows (8/5 - 8/12)									
Pool (56)	---	.01 (3)	.98 (330)	---	---	--	.11 (37)	.26 (86)	7.32 (2475)
Run (3)	---	---	.59 (10)	---	---	---	.29 (5)	---	11.46 (195)
Combined (59)	---	.01 (3)	.96 (340)	---	---	---	.12 (42)	.24 (86)	7.52 (2670)

Table 20 . Fish densities by age class for pool, riffle, run, and pocket water habitats in 10km sections of the Middle Fork of the Flathead River above and below Schafer Meadows during late summer, 1980. Number of features snorkeled and numbers of fish observed in each age class are in parentheses.

	Fish per 100 m² surface area								
	Cutthroat trout			Bull trout				Mountain whitefish	
Feature	Age I	Age II	Age III+	Age I	Age II	Age III+	Mature	<152mm	>152mm
Middle Fork above Schafer Meadows (8/23 - 8/27)									
Pool (12)	.01 (1)	---	.38 (44)	---	---	.02 (2)	.19 (22)	.43 (50)	2.30 (269)
Run (15)	---	.03 (2)	.26 (19)	.01 (1)	.04 (3)	.03 (2)	.15 (11)	.15 (11)	2.50 (185)
Riffle (11)	---	---	---	.03 (1)	---	.06 (2)	---	.15 (5)	.98 (33)
Pocket water (6)	---	.07 (2)	.22 (6)	.13 (3)	---	.04 (1)	---	.13 (3)	2.43 (66)
Combined (44)	.004 (1)	.016 (4)	.27 (69)	.02 (5)	.012 (3)	.027 (7)	.12 (33)	.27 (69)	2.17 (553)
Middle Fork below Schafer Meadows (9/5 - 9/8)									
Pool (10)	.01 (1)	---	.40 (30)	---	---	---	.24 (18)	.01 (1)	10.91 (820)
Run (16)	.01 (2)	---	.09 (24)	---	---	.004 (1)	.07 (20)	.04 (11)	2.1 (583)
Riffle (11)	---	---	---	---	---	---	---	.20 (14)	.86 (59)
Pocket water (4)	.07 (1)	---	.34 (5)	---	---	---	---	.27 (4)	3.78 (56)
Combined (41)	.01 (4)	---	.13 (59)	---	---	.002 (1)	.10 (38)	.07 (30)	3.48 (1518)

10 km sections was based on the average density of species in a randomly selected sample of each feature or habitat unit (Table 21). The number of mature adfluvial bull trout was estimated by actual counts of all likely looking habitat in each 10 km section.

Mountain whitefish dominated the river fish population, outnumbering trout by more than ten to one. Cutthroat trout in the two sections averaged 575 fish per 10 km. This estimate represents late summer numbers of the resident fluvial population of cutthroat after summer mortality or migration had occurred. Mid-summer population numbers of cutthroat were probably much larger. Accurate estimates of juvenile bull trout numbers, especially age I, were difficult to make in the river due to their secretiveness and association with the rocky substrate. They were common under rocks along the river margin, but very few were seen in snorkeling estimates.

Mature bull trout were generally easy to observe because of low flows and good water clarity. They were observed mainly in pools and runs. Numbers were generally largest in areas just below the mouths of major bull trout spawning tributaries. Areas in the river with relatively large concentrations of adfluvial bull trout were Dryad Creek to Morrison Creek in the lower river section, and Clack Creek to Bowl Creek in the upper section. Late summer estimates could be an effective long-term monitoring procedure to assess fluctuations of fluvial cutthroat populations and adfluvial bull trout numbers in this system.

North Fork

Limited fish density estimates were made for two sections of the North Fork River. The lower section was located between Big Creek and Red Meadow Creek, and the upper section was located between Red Meadow Creek and the Canadian Border. Observers counted a total of 262 cutthroat, 4 bull trout, and 664 mountain whitefish in 11 run habitat units considered representative of the two sections. Calculated cutthroat densities (Table 22) were larger in the river upstream from Red Meadow Creek than below, and averaged 0.59 fish per 100 m^2 in the two sections. Mountain whitefish densities averaged 1.74 fish per 100 m^2 surface area in the two sections.

A comparison of fish densities in North Fork run and Middle Fork run-pool habitats is presented in Table 23. Mean densities of cutthroat were considerably larger in Middle Fork run-pool habitats than in North Fork runs. The density of mature bull trout was much larger in the Middle Fork River. They may be due to the small sample size of features snorkeled and greater difficulty in observation in the North Fork. Mountain whitefish densities averaged three times larger in runs and pools in the Middle Fork than in runs in the North Fork.

Fish Movement

Tag Returns

Data on the temporal and spatial distribution of migrating fish in the Flathead River system is necessary to identify factors which may affect

Table 21 . Estimates of number of cutthroat trout, bull trout, and mountain whitefish in 10 km sections of the Middle Fork of the Flathead River above and below Schafer Meadows. Estimates are based on snorkel runs made in late summer.

	Number of fish per 10 km								
	Cutthroat trout			Bull trout				Mountain whitefish	
Area	Age I	Age II	Age III+	Age I	Age II	Age III+	Mature[1]	<150mm	>150mm
Above Schafer Meadows	10	41	670	61	29	6	42	720	5,850
Below Schafer Meadows	28	1	401	<1	55	<1	58	220	10,620

1: Estimated numbers per km is based on actual counts.

Table 22 . Estimated densities (No./100 m^2) of fish by age class in run habitats of two sections of the North Fork River during the summer of 1980. Numbers of fish of each age class observed and numbers of features snorkeled are in parentheses.

	Fish per 100 m^2 surface area						
	Cutthroat trout			Bull trout		Mountain whitefish	
Feature	Age I	Age II	Age III+	Age III+	Mature	150mm	150mm
North Fork above Red Meadow Creek (7/23 - 7/25)							
Runs (5)	.01 (3)	.50 (115)	.50 (113)	.01 (3)	.004 (1)	.50 (114)	1.09 (248)
North Fork below Red Meadow Creek (8/12 - 8/13)							
Runs (6)	---	.02 (2)	.26 (29)	---	---	.95 (106)	1.76 (196)

Table 23. Comparisons of mean densities of fish per 100 m^2 in North Fork River run habitats and Middle Fork River Run-Pool habitats. Number of features snorkeled and number of fish observed are in parentheses.

	Fish per 100 m^2 surface area						
	Cutthroat trout			Bull trout		Mountain whitefish	
Feature	Age I	Age II	Age III+	Age III+	Mature	150mm	150mm
North Fork average							
Run (11)	.01 (3)	.31 (117)	.37 (113)	.01 (3)	<.01 (1)	.59 (220)	1.18 (444)
Middle Fork average							
Run-Pool (161)	.02 (21)	.41 (369)	.66 (590)	.01 (7)	.14 (122)	.31 (276)	5.95 (5349)

their survival. Although general patterns of movement by juvenile and adult cutthroat and bull trout has been documented (Graham et. al. 1980b), the length of time juvenile cutthroat and bull trout spend in the river before entering Flathead Lake remains unclear.

Juvenile Tag Returns

During the field season, a total of 1,986 juvenile westslope cutthroat, 167 bull trout, 44 rainbow trout, and 4 Yellowstone cutthroat trout were marked with dangler tags. The overall return for juveniles was 3.5 percent (Table 24). The higher rate of return for juvenile cutthroat tagged in the North Fork drainage was possibly due to a more intense recovery program in the North Fork by department personnel using traps, electrofishing, and hook and line sampling. Of 16 juvenile cutthroat that displayed movement, three moved upstream and 13 migrated downstream (Table 25). Maximum distance moved was 135 Km by a 220 mm cutthroat tagged in the upper Middle Fork near Schafer Meadows and recovered at Columbia Falls. There was a net downstream movement of cutthroat trout tagged in the North Fork drainage (Figure 4). It appears the movement of juvenile cutthroat trout downstream toward Flathead Lake occurs over a period of several months.

Only two juvenile bull trout have been recovered to date. A lower percent return for these fish may be due to reduced susceptibility to angling, the relatively small number of tagged fish, and the 18 inch minimum size restrictions. Efforts to mark and recover tags will be continued to determine the period of time these juveniles remain in the larger rivers.

Adult Tag Returns

During 1980, 90 mature bull trout were tagged in the Flathead drainage. Forty of these were tagged in the upper Middle and North Forks and 52 were tagged in the main stem above Flathead Lake. A total of 102 westslope cutthroat over 25 centimeters were tagged in the upper forks and 75 in the lower Flathead River. The percent recapture for bull trout tagged and returned in 1980 was three percent, compared with six percent in 1979 (Table 26). The combined return for tagged adult cutthroat trout was 12 percent compared with 14 percent in 1979 and 11.4 percent from 1953-1965 (Hanzel, 1966). The rate of return for cutthroat tagged in the North Fork remained high at 21 percent, as compared to 29 percent in 1979. Movements of adult bull trout and cutthroat trout were similar to those described previously (Graham et. al. 1980b).

A total of 491 mountain whitefish was tagged in the Flathead drainage in 1980. Most of these were tagged in the main stem of the Flathead River. Twelve whitefish were recaptured, a two percent return. Ten of the 12 were recaptured near the point of tagging and two moved a short distance downstream. Two whitefish were recovered in Red Meadow Creek, a tributary to the North Fork, in July. Both were tagged emigrating from Red Meadow Creek in July 1979.

Table 24. Percent return of juvenile westslope cutthroat and bull trout in 1980.

Drainage	Westslope cutthroat Number tagged	Number returned	Percent return	Bull trout Number tagged	Number returned	Percent return
North Fork	1570	61	4	117	1	1
Middle Fork	315	3	1	31	0	0
Main Flathead	101	5	7	19	1	5
Combined totals	1986	69	3.5	167	2	1

Table 25. Summary of juvenile westslope cutthroat trout movement from designated tagging locations.

Tagging location	Number recovered	Percent Up-stream	Down-stream	No movement	Average (km) Up-stream	Down-stream	Range (Km)
Upper North Fork	61	3	30	67	2	26	0-101
Upper Middle Fork	3	33	33	33	14	135	0-135

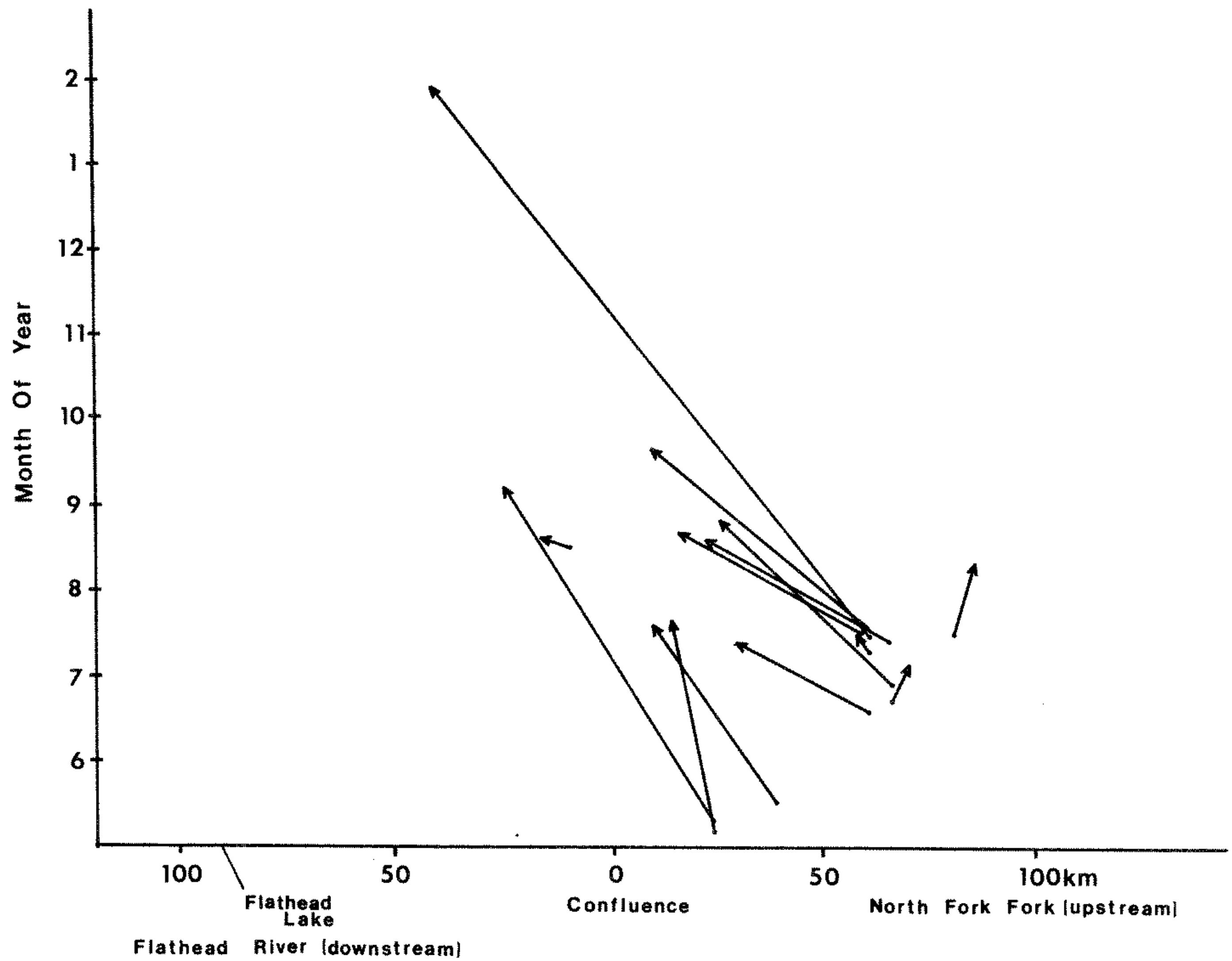


Figure 4. Date and location of juvenile westslope cutthroat tagged (·) in the North Fork of the Flathead River and recaptured (→) at various points in the drainage. All movements are for fish tagged and recaptured within a six month period.

Table 26. Percent return of adult westslope cutthroat and bull trout in 1980.

Drainage	Westslope cutthroat Number tagged	Westslope cutthroat Number returned	Westslope cutthroat Percent return	Bull trout Number tagged	Bull trout Number returned	Bull trout Percent return
North Fork	14	3	21	2	0	0
Middle Fork	88	9	10	36	1	3
Main Flathead	75	10	12	52	2	4
Combined totals	177	22	12	90	3	3

Stream Trapping

A combined total of 1061 westslope and Yellowstone cutthroat, bull trout, Arctic grayling, mountain whitefish, and a variety of non-game species were trapped in the North Fork drainage during 1980. A break-down of the total catch by creek is shown in Appendix C, Figures 1 through 10.

Langford Creek

Langford and Cyclone creeks were both trapped in May to monitor upstream movements of spawning westslope cutthroat and downstream movement of juveniles. (the Langford trap was installed on April 29). Langford is a small tributary to Big Creek and contained mainly cutthroat (Appendix C , Figure 1). Part of the catch of cutthroat in the downstream trap probably consisted of resident fish, but a number of tagged fish were subsequently recovered in the North Fork River. The reach of this creek downstream from Mud Lake has excellent spawning and rearing habitat for resident and migratory cutthroat.

Cyclone Creek

Cyclone is the first tributary to Coal Creek upstream from the mouth. The reach downstream from Cyclone Lake is used for spawning and rearing by cutthroat trout. Large densities of age 0 and age I cutthroat were found in both 1979 and 1980. During late summer, the mouth of Cyclone Creek goes dry which prevents movement of spawning bull trout into the creek. This may serve as a type of refuge to the large numbers of young cutthroat in the stream. Although the trapping period was cut short (7 days) due to the hazard of volcanic ash to field personnel, six mature adfluvial cutthroat were caught in the upstream trap (Appendix C , Figure 2).

Moran Creek

A downstream trap was operated in Moran Creek from 7 July to 24 July. Moran Creek had been trapped in 1976 and no fish were caught. The larger catch in 1980 was probably the result of the smaller mesh size of the leads. The most abundant emigrants were cutthroat trout, all less than 200 mm (Appendix C, Figure 3). There were also a number of longnose suckers less than 150 mm. The presence of six juvenile bulls indicates bull trout may use Moran Creek for spawning .

Moose Creek

A downstream trap was operated in Moose Creek from 7 July to 24 July. The majoritiy of fish caught in Moose Creek were westslope cutthroat (Appendix C , Figure 4). A series of beaver dams at the mouth normally prevents the movement of spawning bulls upstream which may account for the small number of juvenile bulls. However, it is quite probable that adfluvial cutthroat can move into Moose Creek during spring run-off when water flows over the dams. There is a moderate amount of suitable spawning gravel in reaches 1 and 2 of Moose Creek which may be used by resident and migrant westslope cutthroat. Although no mature adfluvial cutthroat were trapped, several emigrating juveniles have been recovered in the North Fork River.

Logging Creek

Logging Creek was the only stream in Glacier National Park trapped in 1980. Downstream and upstream traps were operated from 11 July to 24 July. The water temperature averaged nearly 7° C higher than west side tributaries, and Logging Creek also had the larges number of non-game fish in the catch (81 percent) (Appendix C , Figure 5). Most of these were longnose suckers but coarse scale suckers, redside shiners, and northern squawfish were also collected. The most abundant game fish in the catch was westslope cutthroat (Appendix C , Figure 6). One mature bull (75.4 cm) was caught in the downstream trap. Whether this fish was from Flathead Lake or Logging Lake could not be determined. The movements of cutthroat and bull trout into and out of Logging, Quartz, Kintla, and Bowman lakes is poorly understood. As a case in point, two mature cutthroat tagged in tributaries to the North Fork of the Flathead River upstream from Kintla Lake were later recovered in Kintla Lake (Graham et. al. 1980b).

Red Meadow Creek

A downstream trap was operated in Red Meadow Creek from 7 July through 24 July. Red Meadow Creek had the largest variety of game fish species with westslope cutthroat being most abundant (Appendix C , Figure 7). Arctic grayling and Yellowstone cutthroat in the catch resulted from downstream movement out of Red Meadow Lake where these species had historically been stocked. In addition to resident cutthroat, there are also established populations of adfluvial cutthroat and bull trout in Red Meadow (Graham et. al. 1980b). Cutthroat trout comprised a slightly larger percentage of the combined catch of bull and cutthroat trout in 1980 (86%) than in 1979 (73%).

Trail Creek

Downstream and upstream traps were operated in Trail Creek from 10 July to 24 July. Bull trout, cutthroat trout, and mountain whitefish were the primary species caught in Trail Creek. The majority of bulls and cutthroat were moving downstream; however, the net movement of whitefish was upstream (Appendix C, Figures 8 and 9). The Trail Creek drainage is used extensively by adfluvial cutthroat and bull trout as well as mountain whitefish. Westslope cutthroat trout constituted 58 percent of the total trout catch in 1979 and 1980.

North Fork Flathead

The downstream trap near Polebridge was placed in the main river on 21 July as the tributary traps were taken down, and was operated through 24 August. The catch consisted mostly of cutthroat trout (Appendix C , Figure 10). In addition to cutthroat and bull trout, eight suckers, four mountain whitefish, four sculpins, and one Arctic grayling were present in the catch.

Smolt Migration

Length frequencies of cutthroat emigrating from Trail and Red Meadow creeks in 1980 were similar to those in 1979 with fish in the 126-151 mm and 152-176 mm size classes comprising most of the catch (Appendix C, Figure 11). Length frequency of cutthroat caught in Moose, and Moran creeks and the North Fork River trap are also presented. Cutthroat trout 152-176 mm in length predominated the catch in the river trap.

Length frequencies of emigrating bull trout revealed much the same pattern for Trail and Red Meadow creeks as occurred in 1979. Bulls 101-125 mm in length made up the largest percentage in Trail Creek and bulls 152-176 mm in length made up the largest percentage in Red Meadow Creek (Appendix C, Figure 12). The catch of bull trout in the river trap was comprised mainly of fish 152-176 mm in length.

AGE AND GROWTH

Age and growth characteristics are important descriptors of the health and structure of trout populations. These data are necessary to assess the potential capacity of the individual tributaries and the rivers of the North and Middle Fork drainages for trout growth and production. Age and growth information is helpful in studying the dynamics of trout rearing and outmigration of the tributaries and river of the two drainages.

Cutthroat trout

Scales collected from 1267 cutthroat trout in 18 North and Middle Fork tributaries and 309 cutthroat from the North and Middle Fork rivers were used for age and growth determinations. Scales were collected from May to October, 1980, and May to September, 1979. Annulus formation occurred in May and June, except that 61 percent of the age I fish failed to form a first annulus.

Eighty-seven percent of the cutthroat trout caught in tributary streams were 0-3 years old at time of aging, while 86 percent of the fish caught in the river were 3-5 years old. It was determined that 73 percent of the fish collected in the North and Middle Fork rivers had reared two or three years in the tributaries before entering the river (Table 27). About 22 percent had reared one year in tributaries. The pattern of tributary rearing and outmigration to the river for age classes I-IV was very similar in the two drainages.

The age structure of outmigrating juvenile cutthroat from traps placed in North Fork tributaries in 1979 was also dominated by age II and III fish (Graham et. al. 1980b). There were very few age I and younger fish captured, possibly because they could escape through the trap mesh. Also, it is probable that fewer trout leave the tributaries at age I or younger.

Table 27. Number of cutthroat trout of each age class rearing 1, 2, 3 and 4 years in the tributaries before entering the North and Middle Forks of the Flathead River.

Years in tributary	Age class II	III	IV	V	Total	(%)
North Fork of the Flathead River						
1	13	11	2		27	(21)
2	14	26	2		44	(33)
3		40	9	1	50	(39)
4			7	1	8	(6)
Middle Fork of the Flathead River						
1	2	22	14	5	41	(22)
2	14	20	18	3	58	(33)
3		40	32	7	78	(42)
4			5	1	6	(3)
5				1	1	(<1)

Analysis of scales of cutthroat from Flathead Lake indicates few juvenile cutthroat trout reach the lake at age I (Montana Dept. of Fish, Wildlife & Parks, unpublished data, 1981). May and Huston (1975) found that 82 percent of the outmigrating cutthroat from Youngs Creek in the Kootenai drainage from 1972 to 1974 were two and three years old. About 18 percent of the outmigrants were one year old. Huston (1972) reported a similar age structure of outmigrants from Hungry Horse Creek in the South Fork of the Flathead drainage.

The relationships between fish length and scale radius for North and Middle Fork cutthroat are presented in Figure 5. A somewhat different relationship, as indicated by the regression lines, appeared to be present in the two drainages. Slopes for individual tributaries and the river varied from 0.604 to 0.754 in the North Fork drainage, and 0.747 to 0.897 in the Middle Fork drainage. The Y intercepts ranged from 11.63 to 19.01 in the North Fork drainage and from 7.79 to 10.75 in the Middle Fork drainage. A relationship calculated for 1724 cutthroat collected from the North and Middle Fork drainages, the mainstem Flathead River, and Flathead Lake was similar to the relationship found for the combined North and Middle Fork drainages (Figure 5).

Backcalculated lengths at annulus formation for all cutthroat collected were made with fish missing a first annulus, fish having a first annulus, and the combined sample (Table 28). The slope and Y intercept of the body length-scale radius regressions for the three groups differed by less than three percent. Calculated lengths of fish missing a first annulus were smaller at each age class, indicating these fish had slower growth rates than fish that had formed a first annulus. It appeared that backcalculations from the combined sample gave the best indication of the average growth rates of the population.

Calculated lengths and increments of growth for cutthroat collected in the river are presented in Table 29. Calculated lengths of cutthroat at ages 3-5 were larger in the Middle Fork than in the North Fork. In the Middle Fork, the length increments increased after age II reflecting the increased growth rates of fish as they entered the river from the tributaries. The increase was not as apparent in the North Fork fish, suggesting cutthroat growth did not increase as much when the fish entered the North Fork River from tributaries as in the Middle Fork drainage.

Backcalculated lengths and increments of length for cutthroat from North and Middle Fork tributaries are given in Table 30. Calculated lengths for ages 1-3 were similar in North and Middle Fork tributaries. Increments of growth of cutthroat decreased from age 1-5 in the North Fork tributaries. Increments of growth of cutthroat increased for ages 3-5 in Middle Fork tributaries, indicating that many of these fish were probably fluvial cutthroat that had entered the lower portions of the tributaries during late summer for feeding or some other purpose.

Grand mean calculated lengths of cutthroat in age classes 1-3 for individual North and Middle Fork tributaries are presented in Table 31. Calculated lengths at annuli 4 and 5 are excluded so only growth in

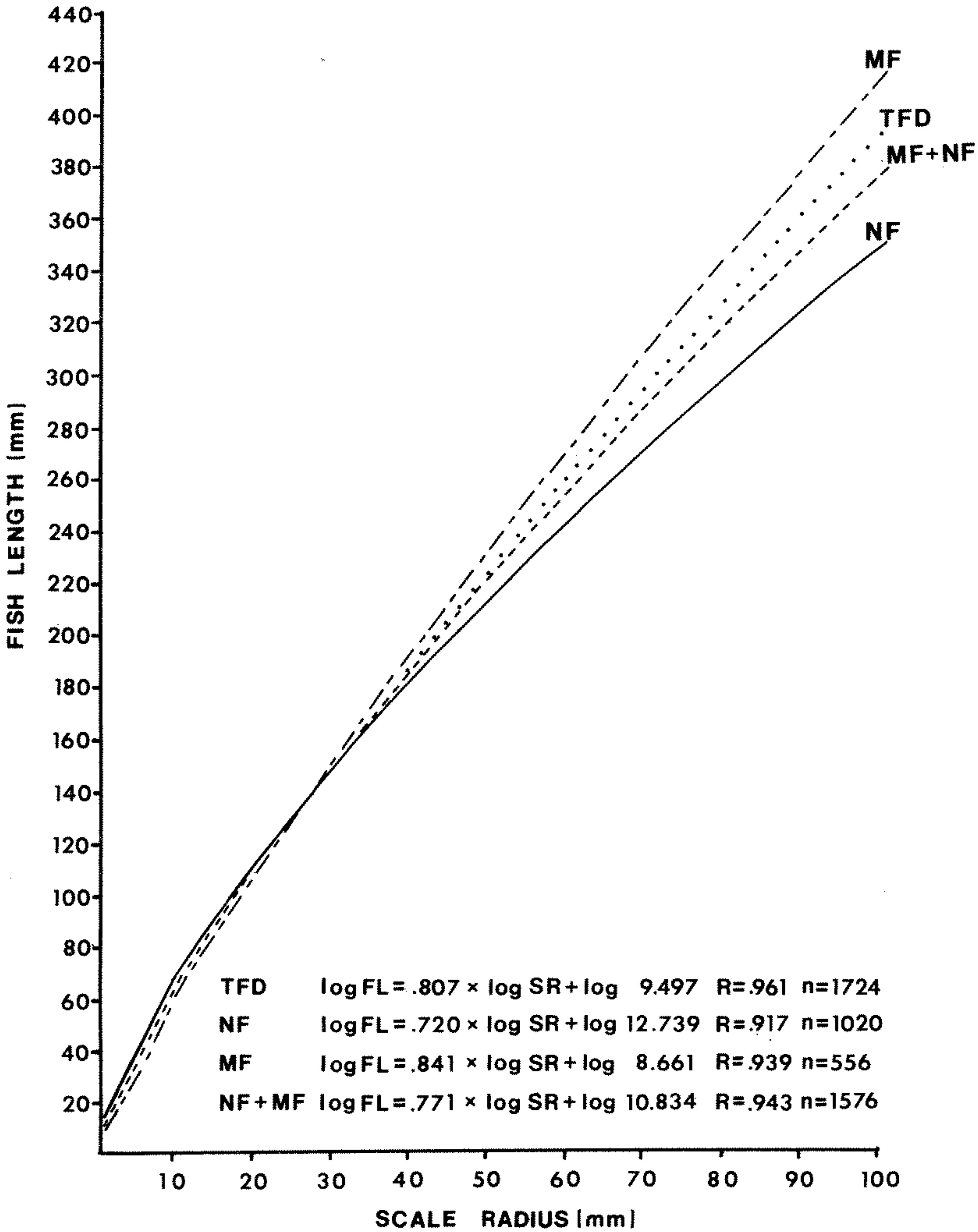


Figure 5 . Body length-scale radius regressions for total North Fork drainage cutthroat (NF), total Middle Fork drainage cutthroat (MF), North and Middle Forks combined (NF-MF) and total Flathead drainage cutthroat (TFD).

Table 28. Average backcalculated lengths of cutthroat trout having the first annulus, missing the first annulus, and combined from the North and Middle Fork drainages.

	Age at annulus				
	1	2	3	4	5
With annulus 1	56	105	148	203	261
Number of fish	(554)	(491)	(297)	(53)	(11)
Missing annulus 1	49	91	136	188	257
Number of fish	(858)	(828)	(527)	(158)	(15)
Combined sample	53	97	141	192	258
Number of fish	(1412)	(1319)	(824)	(211)	(26)

Table 29. Calculated lengths and increments of length for cutthroat trout collected in the North and Middle Forks of the Flathead River in 1980.

Age	Number of fish	Length at annulus 1	2	3	4	5
North Fork River						
1	0	--				
2	28	63	116			
3	78	64	107	154		
4	19	64	96	136	179	
5	2	66	100	127	183	213
Grand mean calculated length		64	108	150	180	213
Number of fish		(127)	(127)	(99)	(21)	(2)
Length increment		64	44	44	44	30

Age	Number of fish	Length at annulus 1	2	3	4	5
Middle Fork River						
1	0	--				
2	16	51	95			
3	82	49	99	154		
4	69	50	97	156	217	
5	17	51	107	161	217	269
Grand mean calculated length		50	99	156	217	269
Number of fish		(184)	(184)	(168)	(86)	(17)
Length increment		50	49	57	6	52

Table 30. Calculated lengths and increments of length for cutthroat from nine North Fork and eight Middle Fork tributaries.

Age	Number of fish	Length at annulus 1	2	3	4	5
North Fork tributaries						
1	48	53				
2	323	52	95			
3	296	55	97	132		
4	60	57	96	135	164	
5	3	64	106	159	188	202
Grand mean calculated length		54	96	135	166	202
Number of fish		(730)	(682)	(359)	(63)	(2)
Length increment		54	42	36	29	14

Age	Number of fish	Length at annulus 1	2	3	4	5
Middle Fork tributaries						
1	45	49				
2	135	51	95			
3	164	51	95	138		
4	24	48	90	141	191	
5	4	59	101	139	204	251
Grand mean calculated length		51	95	139	193	251
Number of fish		(377)	(327)	(191)	(28)	(4)
Length increment		51	44	44	52	47

Table 31. Grand mean calculated lengths of cutthroat from individual North and Middle Fork tributaries with adequate sample sizes (number of fish are in parentheses).

Stream	Length at annulus 1	2	3
North Fork drainage			
Red Meadow Creek	56 (127)	104 (113)	142 (76)
Langford Creek	65 (126)	108 (126)	144 (63)
Hay Creek	50 (116)	93 (110)	135 (83)
Moose Creek	55 (114)	89 (107)	119 (65)
Trail Creek	53 (78)	96 (78)	131 (19)
Moran Creek	58 (70)	92 (70)	117 (30)
Middle Fork drainage			
Challenge Creek	49 (161)	94 (127)	136 (65)
Basin Creek	57 (77)	94 (67)	129 (34)

tributary streams is reflected. Cutthroat in Moose and Moran creeks had the slowest growth rates, while cutthroat from Red Meadow and Langford creeks had the fastest growth rates. The average growth rate of cutthroat in nine North Fork tributaries was similar to the average for the eight Middle Fork tributaries through age class 3 (Table 30). These growth rates are at the lower end of the range reported by Carlander (1969) for cutthroat from various Western streams.

A total of 108 otoliths of cutthroat from North and Middle Fork tributaries were aged. Agreement between ages assigned otoliths and scales from the same fish was 72 percent.

Length frequencies of cutthroat collected from the North and Middle Fork rivers are presented in Figure 6. Average lengths of cutthroat were 186 mm in the North Fork River, and 247 mm in the Middle Fork River. Cutthroat trout collected in tributaries averaged 130 mm in the North Fork drainage and 142 mm in the Middle Fork drainage (Figure 7). Average size of age groups identified by length frequency corresponded closely to the average length of fish in assigned age classes.

The length-weight relationships for cutthroat from the two drainages are presented in Figure 8. The relationships for the North and Middle Fork rivers are similar except that the Middle Fork River line extends past 280 mm to include the larger fish that were collected there. The relationship for the tributary cutthroat was similar to the rivers for fish up to about 140 mm in length. At lengths greater than 140 mm, the Middle Fork tributary cutthroat weighed more at a given length and the North Fork tributary cutthroat weighed less. These tributary relationships may be affected by movements of river fish into the tributaries.

Condition factors for cutthroat averaged .95, 1.02, 1.09, and 1.09 in the North Fork River, North Fork tributaries, Middle Fork River, and Middle Fork tributaries, respectively. Mean condition factors by month for cutthroat collected in the North and Middle Fork Rivers are presented in Table 32.

Bull trout

Scale samples for age and growth determinations were collected from 196 juvenile bull trout from Trail and Red Meadow creeks in the North Fork drainage, and Morrison, Puzzle, Granite and Strawberry creeks in the Middle Fork drainage. Scales were collected from 35 adult spawners taken in the Middle Fork River and tributaries to determine the age structure of the spawning population. All scales were collected from June to September, 1980. Juvenile bull trout were 0-3 years old at time of collections, while adults ranged from 5-8 years old.

The relationships between fish length and scale radius for North and Middle Fork juvenile bull trout was similar (Figure 9). The relationship for combined juvenile and adult fish was similar up to about 150 mm fish length, where the relationships diverged. The relationship for Middle Fork juveniles and adults combined was very similar to a relationship generated for a combined sample of 840 juvenile and adults from the Middle

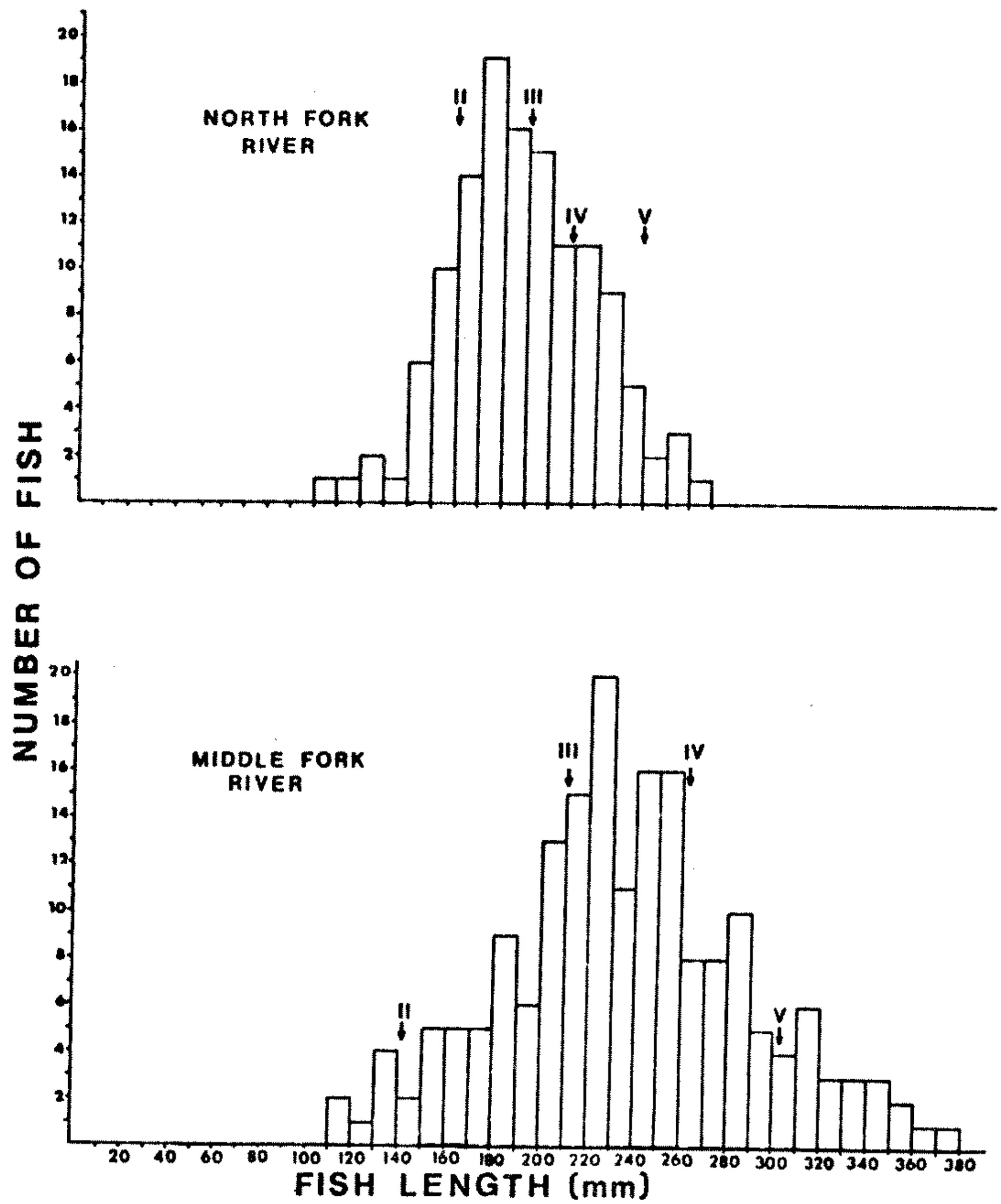


Figure 6. Length frequency for North and Middle Fork River cutthroat. Mean length of fish in each age class assigned by scale reading is indicated by an arrow.

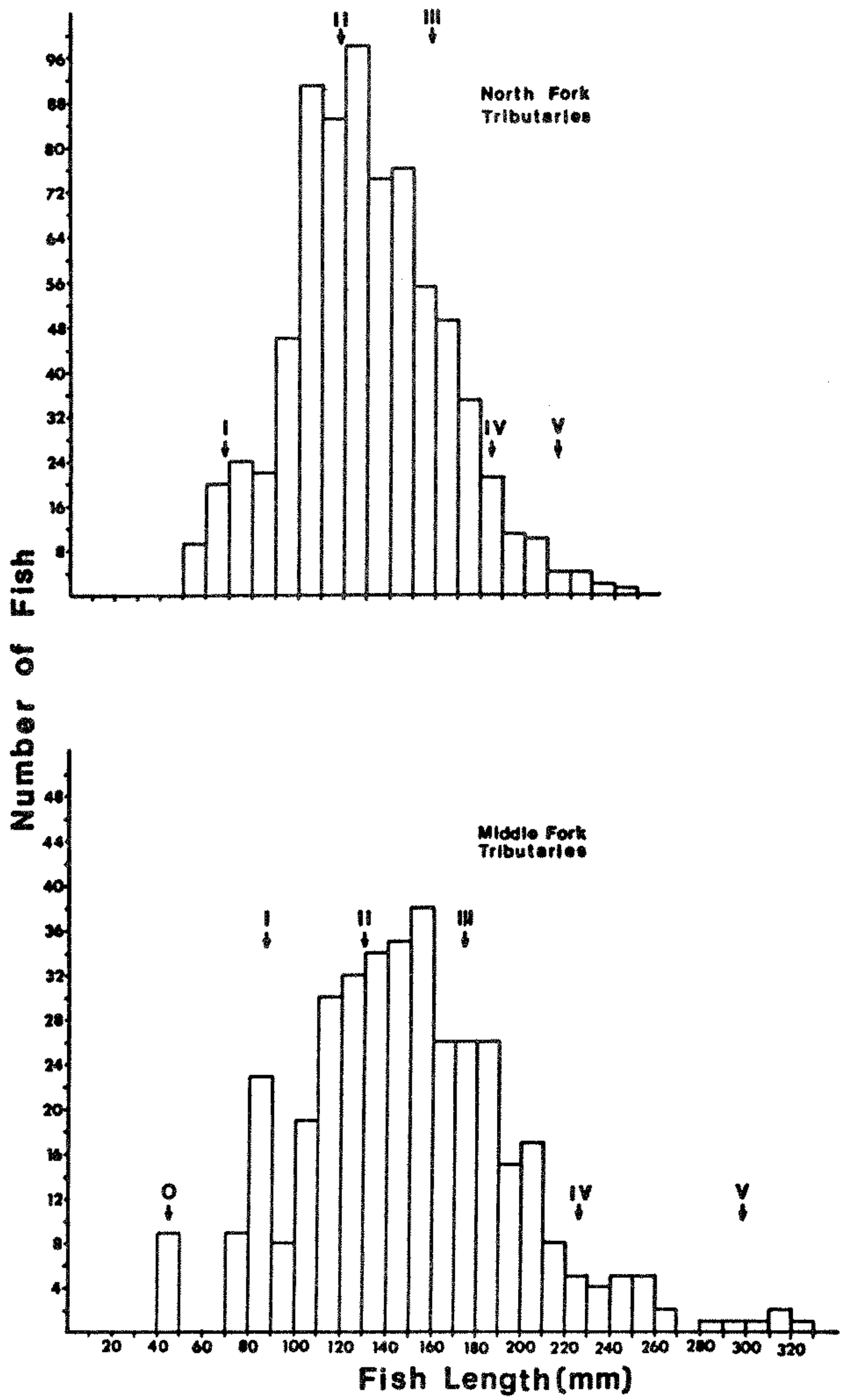


Figure 7. Length frequencies for North and Middle Fork tributary cutthroat. The mean length of fish in each age class assigned by scale reading is indicated by an arrow.

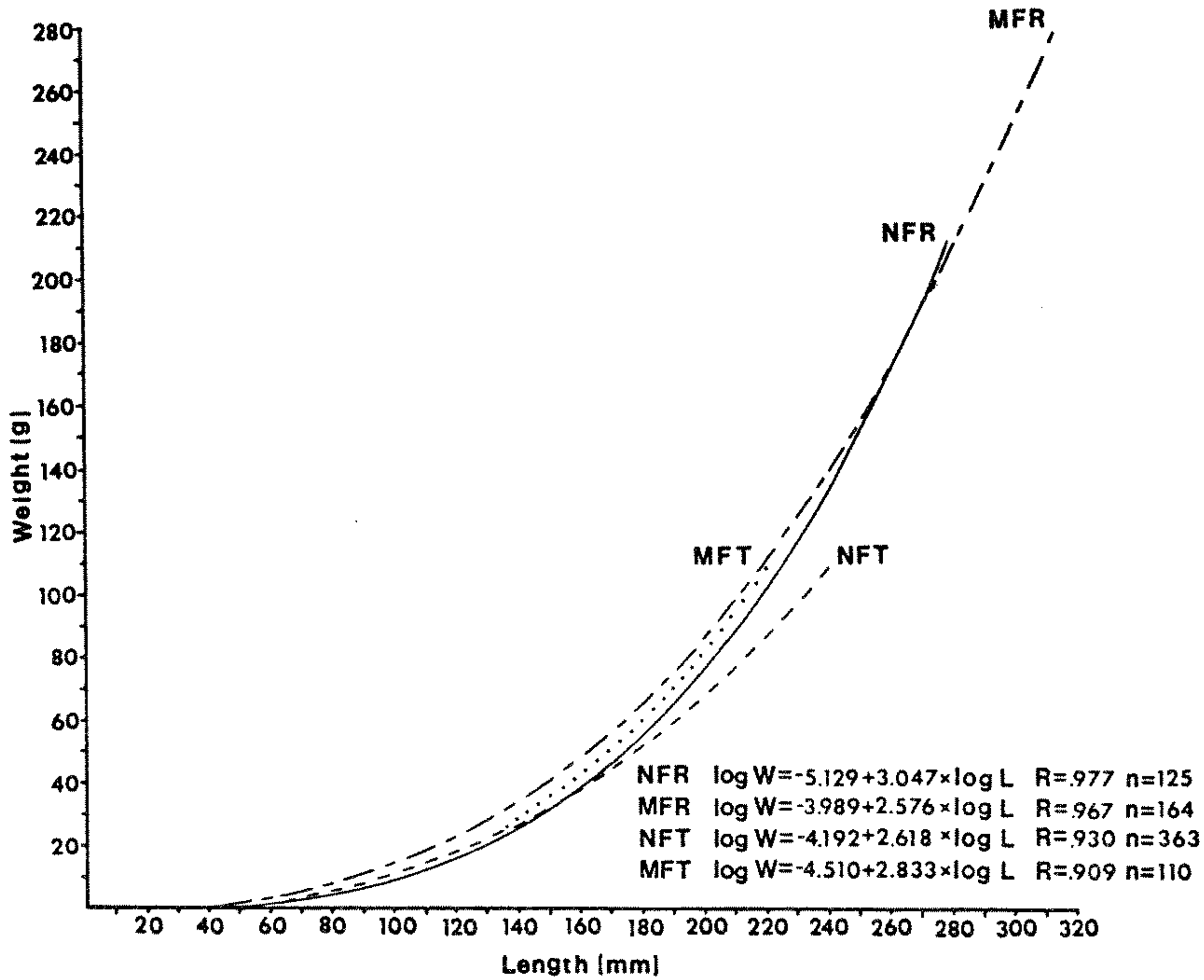


Figure 8. Length-weight regressions for cutthroat from the North Fork River (NFR), Middle Fork River (MFR), North Fork tributaries (NFT), and Middle Fork tributaries (MFT).

Table 32. Mean condition factors by month for North and Middle Fork River cutthroat trout (standard deviations in parentheses).

	Month			
	June	July	August	September
North Fork River				
Mean condition factor	.94(.11)	.95(.11)	.96(.10)	---
Number of fish	8	100	19	
Middle Fork River				
Mean condition factor	---	.97(.15)	1.09(.21)	1.01(.12)
Number of fish		64	93	20

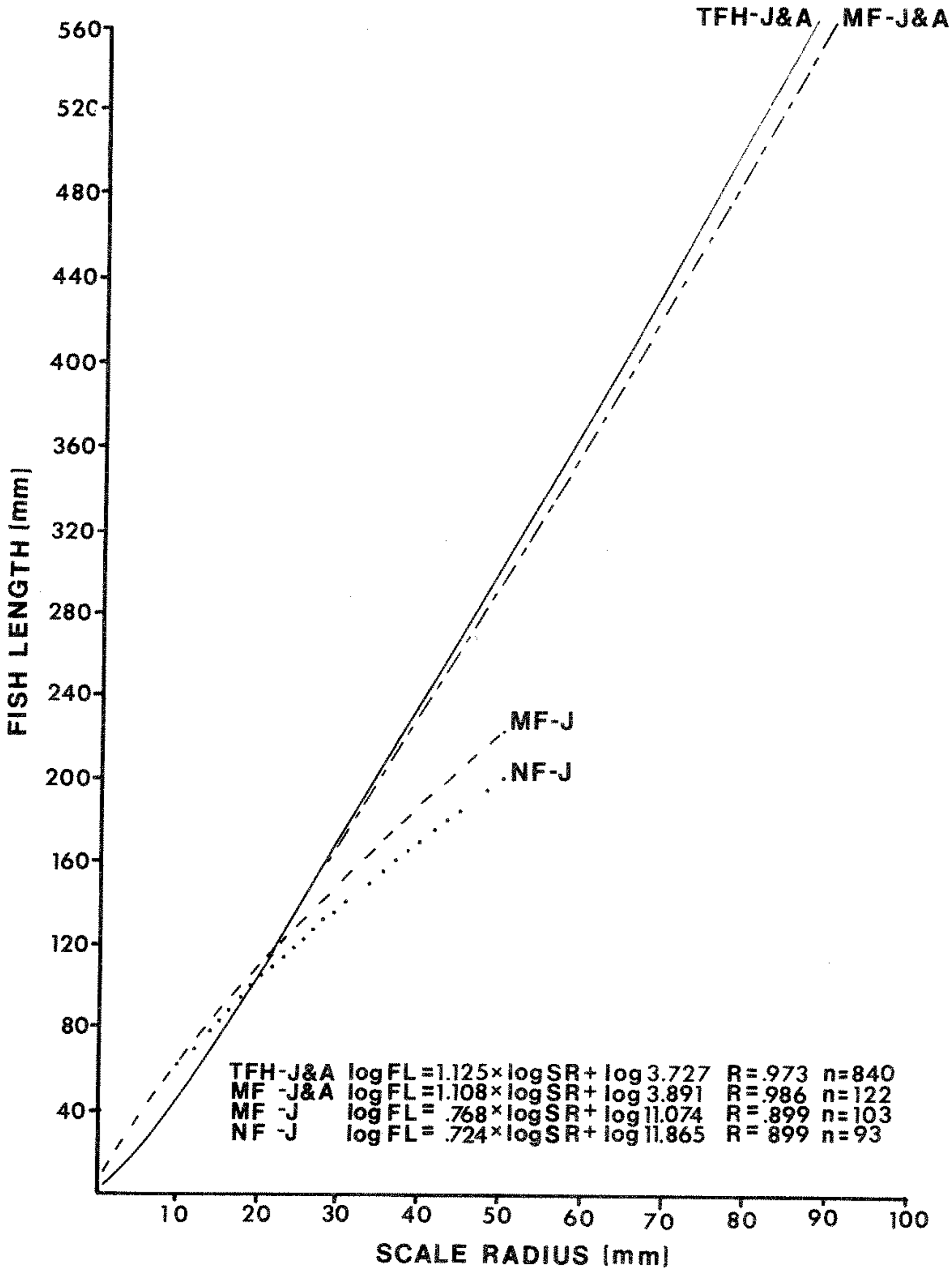


Figure 9. Body length-scale radius regressions for North Fork juvenile bull trout (NF-J), Middle Fork juveniles (MF-J), Middle Fork juveniles and adults (MF-J+A) and total Flathead drainage juveniles and adults (TFD-J+A).

Fork drainage, North Fork drainage, main Flathead River and Flathead Lake collected in 1980, 1968 and 1963 (Figure 9). Measurements for fish collected in the lower Flathead River and Flathead Lake are from unpublished data, Montana Fish, Wildlife and Parks, Kalispell.

Backcalculated lengths of juvenile bull trout are presented in Table 33. Lengths of North Fork juveniles at annuli 1, 2, and 3 were 20 percent, 10 percent, and three percent larger than Middle Fork juveniles, respectively. This is probably due to the fact that juvenile bull trout for age and growth analysis collected in the Middle Fork drainage were taken from the upper reaches of the tributaries where growth rates are slower. Growth of juvenile bull trout in tributary streams of Priest Lake, Idaho, as reported by Bjornn (1961) was very similar to growth in Middle Fork tributaries.

Backcalculated lengths of bull trout based on juveniles and adult spawners collected in the Middle Fork drainage are presented in Table 34. Lengths at annuli 1, 2, and 3 differed substantially from lengths calculated from juveniles only. It appears that backcalculations for annuli 1, 2, and 3 are not accurate when adult spawners are included in the calculations. Backcalculated lengths for annuli 3 through 8 are larger than those reported by Bjorn (1961) for Upper Priest Lake, but smaller than lengths reported for Lower Priest Lake, Idaho.

Length frequencies for juvenile bull trout from the North Fork drainage, and juvenile and adult bull trout from the Middle Fork drainage, are presented in Figure 10. Age classes identified by peaks in the length frequencies agreed closely with average lengths of the fish in assigned age classes. The length frequency for a large sample of juvenile bull trout collected from Trail Creek in 1979 and 1980 is presented in Figure 11.

A total of 40 otoliths from juvenile bull trout were read. Ages assigned otoliths and scales from the same fish were in nearly 100 percent agreement.

Average length of adult spawners collected by hook and line in the Middle Fork drainage was similar to average lengths recorded for adult bull trout in some previous studies in the Flathead River system (Table 35).

Length-weight relationships for North and Middle Fork juvenile bull trout were similar (Figure 12). Slopes of the regression lines were nearly identical and close to 3.0. Ricker (1971) reported that many salmonid populations have a weight-length regression slope near 3.0, indicating symmetrical growth.

Mean condition factors of juvenile bull trout were .93 (sd=.17) in the Middle Fork drainage and .91 (sd=.37) in the North Fork drainage.

Table 33. Backcalculated lengths of juvenile bull trout collected in North and Middle Fork tributaries.

Age	Number of fish	Length at annulus 1	2	3
North Fork tributaries				
1	60	79		
2	28	82	117	
3	5	82	112	143
Grand mean calculated length		80	116	143
Number of fish		(93)	(33)	(5)
Length increment		80	34	31

Age	Number of Fish	Length at annulus 1	2	3
Middle Fork tributaries				
1	39	62		
2	53	66	104	
3	11	63	104	138
Grand mean calculated length		64	104	138
Number of fish		(103)	(64)	(11)
Length increment		64	39	34

Table 34. Backcalculated lengths at annulus formation for juvenile and adult bull trout collected in the Middle Fork drainage in 1980.

Age	Number of fish	Length at annulus 1	2	3	4	5	6	7	8
1	39	51							
2	42	44	87						
3	10	40	82	122					
4	0								
5	2	55	132	228	337	464			
6	15	52	111	183	280	384	486		
7	11	50	122	201	292	392	488	581	
8	3	43	100	169	254	358	462	555	636
Grand mean calculated length		48	97	174	286	389	484	575	636
Number of fish		(122)	(83)	(41)	(31)	(31)	(29)	(14)	(3)
Length increment		48	51	77	112	104	99	93	81

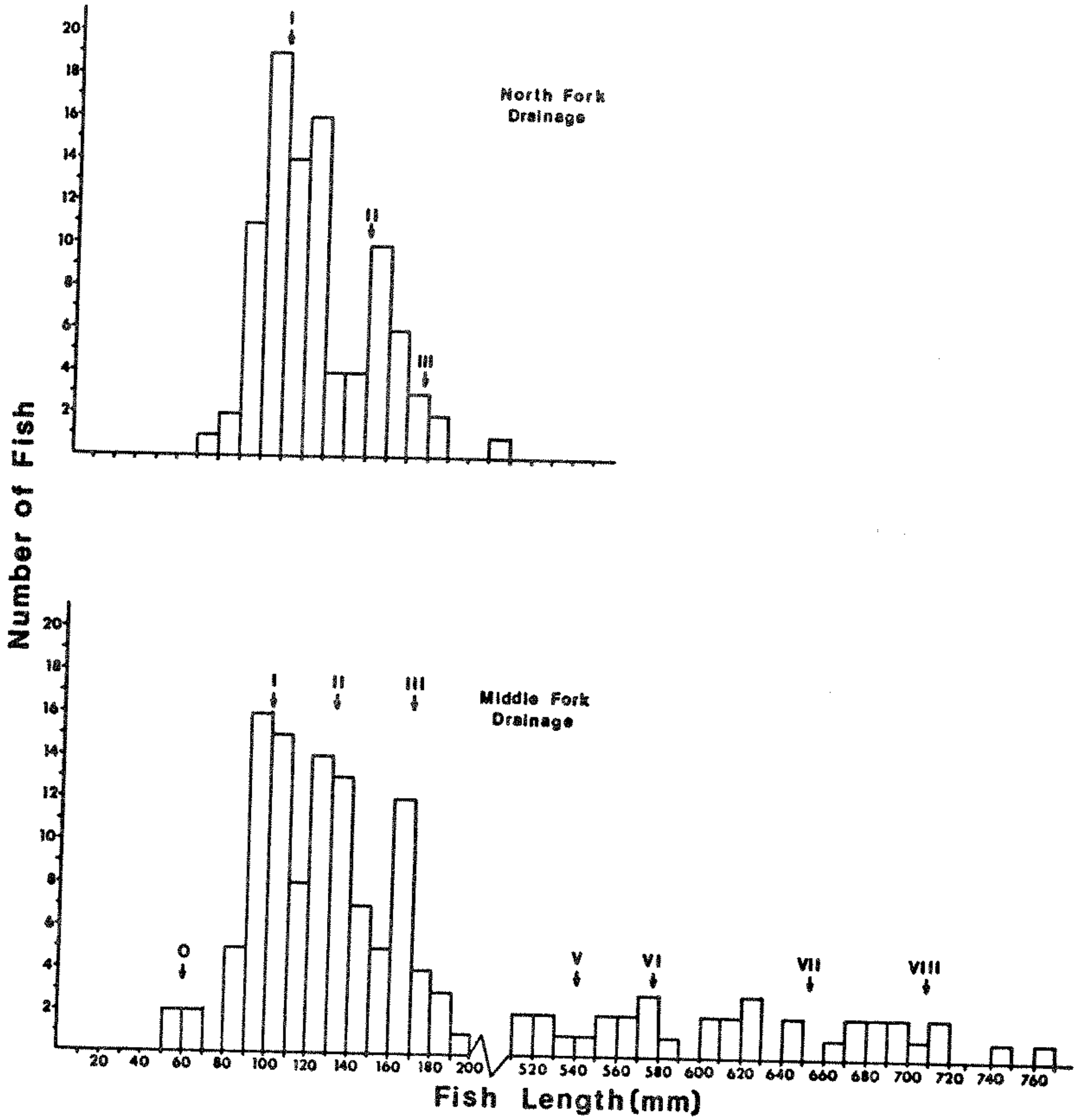


Figure 10. Length frequency of 93 juvenile bull trout collected from North Fork tributaries and 103 juveniles and 35 adult bull trout collected from the Middle Fork of the Flathead River and tributaries in 1980. Mean lengths of fish in each age class assigned by scale reading are indicated by an arrow.

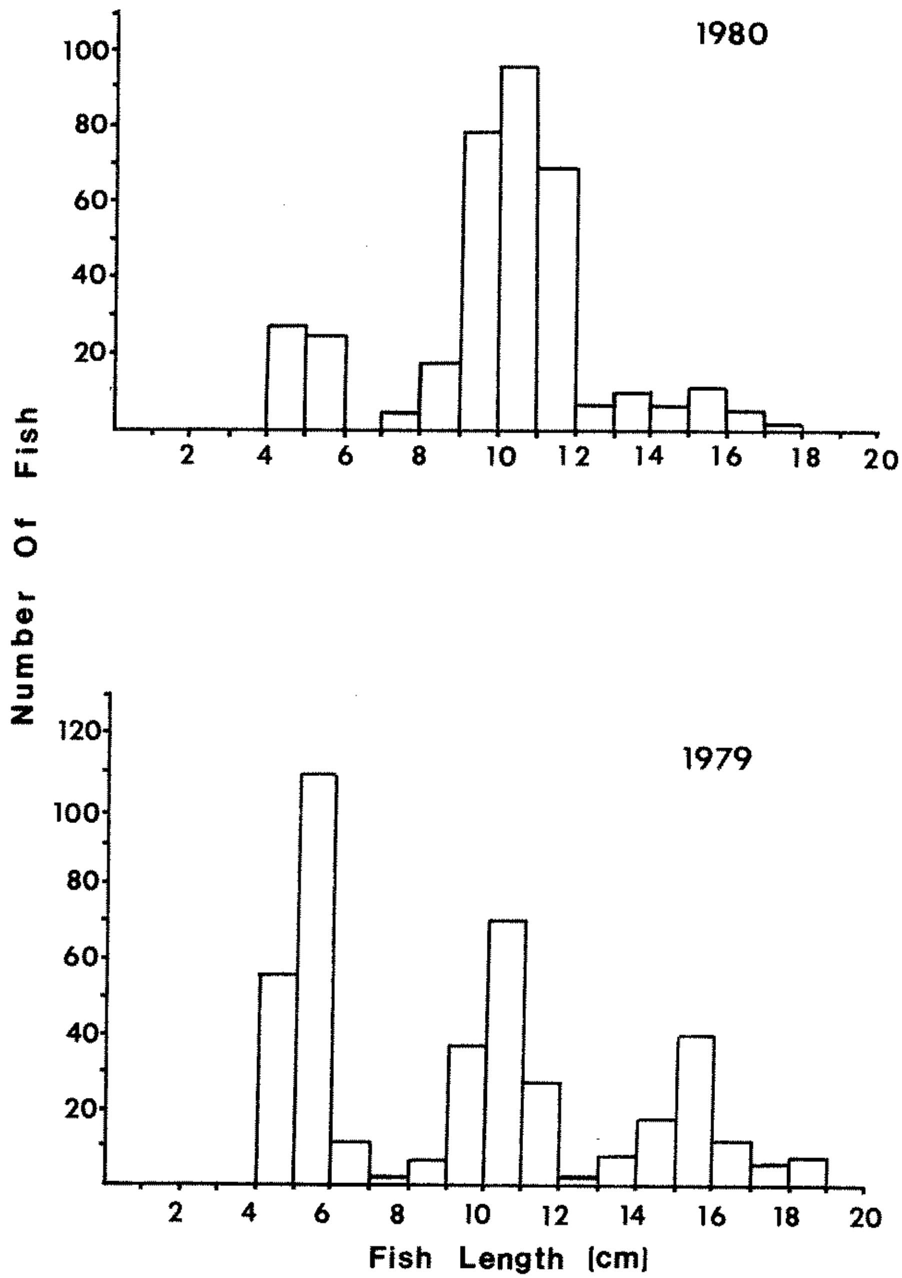


Figure 11. Length frequency of juvenile bull trout collected from Trail Creek in 1979 and 1980.

Table 35. Comparison of lengths of adult bull trout collected in the Middle Fork drainage with previous studies in the Flathead River system.

Study	Average length (mm)	Number of fish
Middle Fork, 1980	618	35
North Fork creel census, 1979 (Graham, unpub. data)	638	36
Flathead River, all forks, creel census, 1975 (Hanzel 1975)	628	46
Middle Fork River trap at Bear Creek, 1957 (Stefanich 1958)	622	87

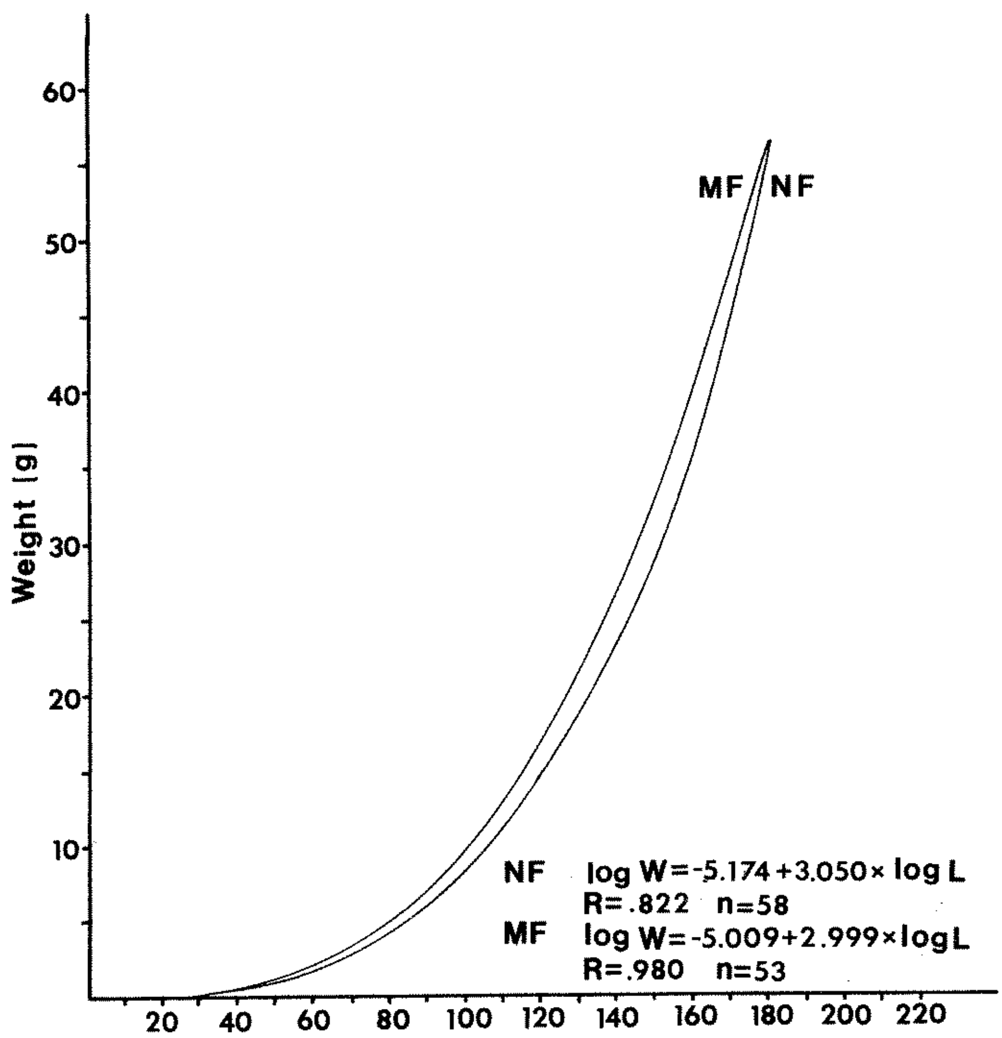


Figure 12. Length-weight regressions for North Fork juvenile bull trout (NF) and Middle Fork juvenile bull trout (MF) collected in 1980.

FISH HABITAT EVALUATION

Fish Habitat Characteristics of North and Middle Fork Tributary Reaches

Habitat surveys were conducted on 245 kilometers of 22 tributaries in the North Fork of the Flathead River drainage during the summer of 1980. The 22 tributaries were divided into 44 reaches. Habitat was evaluated on 210 kilometers of 21 tributaries of the Middle Fork during the summer of 1980. The 21 Middle Fork tributaries were divided into 53 reaches.

The drainage areas, reach lengths, late summer flows and gradients of the 97 North and Middle Fork tributary reaches surveyed in 1980 are presented in Appendix A, Tables 1 and 2. Drainage areas of the tributaries ranged from 7.6 to 177.9 km^2 in the North Fork drainage and from 15.4 to 133.1 km^2 in the Middle Fork drainage. Late summer flows ranged from 3.2 to 67.4 cubic feet per second in North Fork tributaries, and from 2.5 to 28.5 cfs in Middle Fork tributaries. The mean maximum summer water temperature in North and Middle Fork tributaries was 16.1° C.

Chemical parameters measured in the lower reaches of major North and Middle Fork tributaries are presented in Table 36. Total organic carbon, total phosphorus, nitrate, potassium, and sodium were similar among the tributaries. Magnesium, calcium, total alkalinity and conductivity were generally higher in Middle Fork tributaries than in North Fork tributaries.

All physical-chemical habitat data and fish population information collected for each stream reach surveyed in 1979 and 1980 will be presented in a separate report. This report will include a map describing physical habitat characteristics and a map containing fish population information for each reach. An example of the format of this report concerning reach I of Trail Creek is presented in Appendix D.

Relationships Between Habitat Variables and Fish Densities

Habitat and fish populations have now been evaluated on a total of 142 North and Middle Fork tributary reaches comprising 675 stream kilometers. This total includes all major tributaries south of the Canadian border in the North Fork drainage and approximately two-thirds of the tributaries in the Middle Fork drainage. This basin-wide approach in assessing habitat components and fish densities in North and Middle Fork tributaries has been conducted to accomplish the following objectives:

1. Assessment of the relative importance of tributary streams for producing migratory and resident populations of westslope cutthroat and bull trout.

2. Development of long term monitoring index for juvenile trout in major tributaries for correlation with habitat inventories and monitor changes in environmental quality.

Table 36 . Chemical parameters of the lower reaches of major tributaries of the North and Middle Forks of the Flathead River in October, 1980. Total alkalinity and conductivity were measured in the field. BDL indicates the value for the parameter is below the detection limit.

Creeks	TP	TOC	SO_4^--N	NO_3^--N	Mg^{++}	Ca^{++}	K^+	Na^+	Total alkalinity	Conductivity
North Fork drainage										
Camas	.011	1.36	.67	BDL	2.7	10.0	.24	.73	35	40
Anaconda	.007	1.20	.87	BDL	1.7	5.8	.29	1.8	19	33
Logging	.008	1.04	.63	BDL	1.7	6.4	.17	1.0	23	25
Bowman	.004	.89	.83	.023	5.7	21.0	.23	.85	68	122
Akokala	.010	1.02	.67	BDL	3.7	13.8	.30	1.2	47	65
Ford	.014	1.67	.43	BDL	5.5	24.7	.56	2.0	85	105
Starvation	.003	.54	1.3	0.56	6.5	24.9	.26	1.3	83	100
Kishenehn	.005	.46	5.1	<.01	7.3	24.9	.39	1.6	70	112
Sage	.006	.71	3.4	<.01	7.8	29.4	.50	1.8	92	115
Coal	.007	.65	1.1	.018	6.8	20.5	.26	1.2	73	82
Hay	.004	.70	1.0	BDL	9.5	26.6	.32	1.1	100	148
Red Meadow	.005	.98	.87	<.01	6.1	23.5	.21	.87	79	132
Moose	.004	1.02	1.0	BDL	8.4	20.6	.32	1.0	78	90
Couldrey	.005	.63	.93	BDL	6.8	27.7	.26	.97	91	105
Howell	.004	.71	1.8	BDL	9.0	48.7	.30	.53	149	170
Cabin	.011	1.60	3.2	BDL	10.9	39.5	1.4	1.5	135	170
Middle Fork drainage										
Strawberry	.004	.87	13.3	BDL	15.0	52.8	.64	2.3	146	240
Trail	.004	.76	4.7	BDL	15.3	45.7	.46	1.3	158	210
Gateway	.003	.54	21.4	.023	19.4	59.3	.73	1.8	163	275
Bowl	.003	.80	3.9	BDL	11.4	38.5	.56	1.6	145	195
Clack	.002	.77	1.9	BDL	10.1	41.7	.17	.18	140	200
Cox	.006	.83	5.3	BDL	7.5	29.5	.12	.74	102	145
Morrison	.006	.82	10.6	BDL	11.3	50.1	.51	1.5	138	220
Granite	.003	.65	1.3	<.01	10.8	33.1	.46	1.1	118	160
Ole	.003	.70	1.1	.018	6.3	19.8	.32	1.0	73	110
Stanton	.004	1.14	.90	0.36	7.7	26.8	.22	.49	103	295

3. Assessment of existing aquatic habitat in major tributaries and determination of the importance of habitat components in maintaining the existing fish populations.

Determining the relationships between the fish populations and habitat components is an important step in meeting these objectives. Habitat components which are critical in maintaining present trout populations must be identified. Once this is determined, the potential rearing capacity for juvenile trout in individual stream reaches can be predicted. The purpose of the following analyses was to identify these critical components of the habitat and determine the rearing potential of each tributary reach based on its habitat quality. A study of the micro and macro habitat preferences of juvenile cutthroat and bull trout is also in progress to identify important components of the habitat.

Simple Correlation of Habitat and Fish Densities

Chemical parameters measured for North and Middle Fork tributary reaches were not analyzed for their relationship to trout density because of insufficient sample size and because high ion concentrations did not seem to be associated with high fish densities within the range of ion concentrations sampled. Dissolved ion concentrations were about twice as large in the Middle Fork drainage, but average trout density was only half as large as the density in North Fork tributaries. Nutrient concentrations (phosphorus and nitrate) and total organic carbon varied little in tributaries of both drainages.

A total of 41 physical habitat variables or variable combinations were tested to determine their relationship to fish densities in 110 North and Middle Fork tributary reaches containing trout through the use of simple linear correlation. Of these 41 parameters, 12 were found to have significant relationships to trout densities at the 95 ($p < .05$) or 99 percent ($p < .01$) levels. These 12 variables and their associated simple correlation coefficients are presented in Table 37.

Variables or variable combinations associated with cover had the highest simple correlation coefficients. All cover variables tested had significant positive relationships to trout densities. The combination of the variables overhang and instream cover had the best correlation with trout densities ($r = .602$, $p < .01$). This variable combination was chosen as best representing trout cover in the tributary reaches. Overhang was measured for the habitat section and included material such as logs or vegetation extending over the stream at a height of one meter or less. Instream cover was measured in the snorkel section as overhang touching the water surface plus water depth, turbulence, debris and rocks. Canopy had the lowest significant correlation of all cover variables tested. The percent of run was also positively correlated ($p < .05$) with trout densities.

D-90, wetted width, average depth, stream order, and channel width were all negatively correlated at the 95 or 99 percent levels. This indicates

Table 37. Physical habitat variables or variable combination. Significant relationships ($p < .01$) with fish densities in North and Middle Fork tributary reaches ($N = 110$)

Habitat variable	Simple correlation coefficient
Overhang & instream cover	.602
Overhang	.570
Canopy, overhang & instream cover	.520
Canopy & overhang	.484
D-90	-.323
Instream cover	.307
Wetted width	-.288
Canopy	.272
Average depth	-.270
Stream order	-.266
Channel width	-.232 1/
Percent run	.220 1/

1: $P < .05$

that larger measurements of these variables in a reach were associated with lower trout densities. Although water temperature was an important variable affecting trout densities in other studies (Binns and Eiserman 1979), there did not appear to be a strong relationship between measured fish densities and maximum summer water temperatures in North and Middle Fork tributaries (r=.03).

The average measurements of the important habitat variables for North and Middle Fork tributary reaches and their associated average fish densities are presented by stream order in Table 38.

Multiple Regression Analysis of Habitat Variables and Fish Densities

Hynes (1972) suggested that the most important environmental factors interacting to affect fish distribution and abundance in streams were temperature, discharge, cover or shelter, and stream bed material. He states that these habitat variables are not independent of one another and should be considered in combination.

Platts (1974) has documented multivariate control of fish populations in streams. More recently Binns and Eiserman (1979) developed a model predicting trout densities in Wyoming streams based on 11 stream habitat variables or variable combinations.

In order to determine the interaction of physical habitat variables and trout densities in the Flathead drainage, multiple regression analysis was conducted using the measured densities of age I and older cutthroat and bull trout combined, age I and older cutthroat, age I and older bull trout, and the 12 associated habitat parameters found significant for each reach. The "step-up" and step-down" methods of multiple regression were used and both yielded the same results.

Age I and Older Cutthroat and Bull Trout

Trout cover, stream order, D-90, and percent run formed the best variable combinations, or "Model" (r=.653) describing the relationship between habitat variables and combined densities of age I and older cutthroat and bull trout (Table 39). After this four variable, preliminary model had been constructed, each remaining habitat parameter in the data base was individually added, but none increased model precision at the $p < .05$ level. A three variable model consisting of trout cover, stream order, and D-90 had a somewhat lower correlation coefficient (r=.60).

Trout cover had the highest partial correlation coefficient in the four variable combination, indicating it is probably the single most important habitat variable measured that affected trout densities in the North and Middle Fork drainages. Binns and Eiserman (1979), Platts (1979b), Cardinal (1980), and Lewis (1967) all reported cover was a critical component of stream habitat affecting trout density when considered in combination with other habitat variables.

Table 38. The mean and range (in parentheses) of major habitat parameters of 110 North and Middle Fork tributary reaches analyzed by stream order.

Parameter	Stream order 2(N = 32)	3(N = 61)	4(N = 17)
Total trout density (Age I & older cut-throat & juvenile bull trout)	12.0 (0.3 - 14)	6.8 (0.1 - 33.6)	2.5 (0.1 - 11.1)
Trout cover (% of surface area sheltered)	21 (5 - 62)	18 (4 - 55)	10 (5 - 24)
D-90 (Diameter (cm) of largest 10% of the substrate)	41 (10 - 121)	36 (8 - 86)	38 (21 - 80)
Channel width (m)	12 (3 - 39)	14 (2 - 50)	27 (7 - 63)
Wetted width (m)	4.6 (1.6 - 9.8)	5.5 (1.2 - 13)	10.7 (6.4 - 16.4)
Average depth (cm)	21 (10 - 45)	22 (10 - 50)	32 (20 - 53)
Percent feature			
Pool (%)	10 (0 - 45)	12 (0 - 73)	17 (0 - 58)
Run (%)	45 (0 - 82)	43 (10 - 75)	43 (15 - 74)
Riffle (%)	30 (5 - 60)	35 (0 - 75)	33 (11 - 60)
Pocket Water (%)	15 (0 - 65)	10 (0 - 56)	7 (0 - 26)

Table 39. Physical habitat variables which formed the best mutual relationship with trout densities (age I and older cutthroat and bull trout) in 110 North and Middle Fork tributary reaches ($r = .653$, $r^2 = .430$, $N = 110$)

Variable	R-Partial[1/]	Slope[2/]	P-Value[3/]
Trout cover (X_1)	.483	.499	.001
Stream order (X_2)	-.215	-2.82	.026
D-90 (x_3)	-.205	-.088	.034
Percent run (X_4)	.191	.089	.049

1: Correlation of a habitat variable to fish densities while other habitat variables are held constant.

2: Slope is a measure of the direction and magnitute of a change in fish numbers with an increase in the measurement of a habitat variable by one unit.

3: Level of significance of the relationship of a habitat variable to fish densitites when considered in combination with the other habitat variables.

Stream order is a classification (Platts 1979a) assigned to a reach based on its position in a stream drainage. Stream order is roughly indicative of certain physical habitat characteristics such as drainage area, discharge, and wetted width. A significant negative partial correlation coefficient was demonstrated by stream order in the model, indicating streams of lower order were associated with larger trout densities. Platts (1979a) also found a negative correlation of stream order with cutthroat and juvenile bull trout densities.

The D-90, or the substrate size which is larger than 90 percent, of the stream bed material also related negatively to trout density in the model, suggesting larger substrate sizes in association with the other habitat variables in the model reduce fish densities in a reach. The percent run was positively associated with trout densities in combination with the other variables. This may be due to the fact that most tributaries in both drainages were composed mainly of run-riffle habitats. When the percent run is large, riffles areas are less abundant. Riffles contain little cover and low trout densities (see the Fish Population section of this report). The second order stream reaches which supported high densities of trout had a moderate gradient and were mainly run habitats.

The slope associated with each variable in the model is a measure of the probable increase or decrease in trout densities with a one unit change in the measurement of the habitat variable (assuming a linear relationship). For example, trout cover was associated with a slope of +.483. This indicates that given an increase of one unit (1%) in trout cover, we may expect an increase in trout density by .483 fish per 100 m^2. This would mean that if trout cover were increased by 10 percent in a reach, it should result in an increase in trout density by 4.8 fish per 100 m^2. However, an increase or decrease in trout cover by adding more debris to a stream or logging operations in a drainage might also change the D-90 or percent run by altering the stream hydraulics or channel morphology. Because of this interrelationship of the variables, it is difficult to predict the exact nature of the effects of a change in habitat on trout populations. This model could be valuable to assess impacts of environmental changes by taking into account their combined effects on the stream habitat and associated fish densities.

Age I and Older Cutthroat Trout

The same variable combinations describing variations in cutthroat and bull trout densities combined also best described variations in cutthroat densities, with a slightly lower correlation coefficient ($r=.610$ $p<.001$). Cutthroat were generally found in much larger densities than bull trout and dominated the combined species variable combination, or model.

Age I and Older Bull Trout

Canopy, instream cover and the percent of class 1 pools was the best variable combination relating physical habitat to juvenile bull trout densities ($r=.472$, $p<.05$). This indicates that juvenile bull trout were closely associated with cover in North and Middle Fork tributary reaches.

Bull trout densities were generally low, and a good model for predicting their abundance could not be developed. Bull trout were found in only about half as many reaches as cutthroat and the small number of observations also limited development of a model.

Testing of Model Performance: Predicting the Potential Fish Densities of Each Reach Based on Habitat Quality

In order to test the four variable model and identify outlying observations, trout densities were predicted by the equation of the model based on habitat quality for each of the 110 North and Middle Fork tributary reaches. The equation used to predict the fish densities was:

$$Y = .499X_1 - 2.82X_x - .088X_3 + .089X_4 + 7.05$$

Where:

Y = Predicted Trout Density

X_1 = Trout Cover

X_2 = Stream Order

X_3 = D-90

X_4 = Percent Run

Y intercept = 7.05

The relationship of the predicted and actual fish densities is depicted in Figure 13. The scatter of points indicate the model is a better predictor for reaches of moderate trout densities. It was a poorer predictor in cases of exceptionally high or low fish densities.

The correlation between predicted and actual fish densities was .653, which is significant to the 99.9 percent level ($p<.001$). This correlation coefficient is acceptable when the number of reaches analyzed and number of variables in the model are considered. Binns and Eiserman (1979) obtained a much higher correlation coefficient (.977) in a model predicting trout densities in Wyoming; however, the model was based on ratings of 11 variables or variable combinations and constructed with only 20 observations. The variable combination for the North and Middle Fork tributary reaches consisted of the actual measurements of only four variables which are relatively easy to measure and was based on 110 observations (reaches). In addition, Binns' model was based on chosen observations from throughout the state of Wyoming, while our model is based on observations from only the Flathead drainage. A much higher correlation coefficient could probably be obtained if streams from other parts of Montana were included in the model, but this would not improve its predictive qualities for the Flathead drainage.

The four variable model for the North and Middle Fork reaches explained 43 percent (r^2) of the variation observed in trout densities. Snedecor

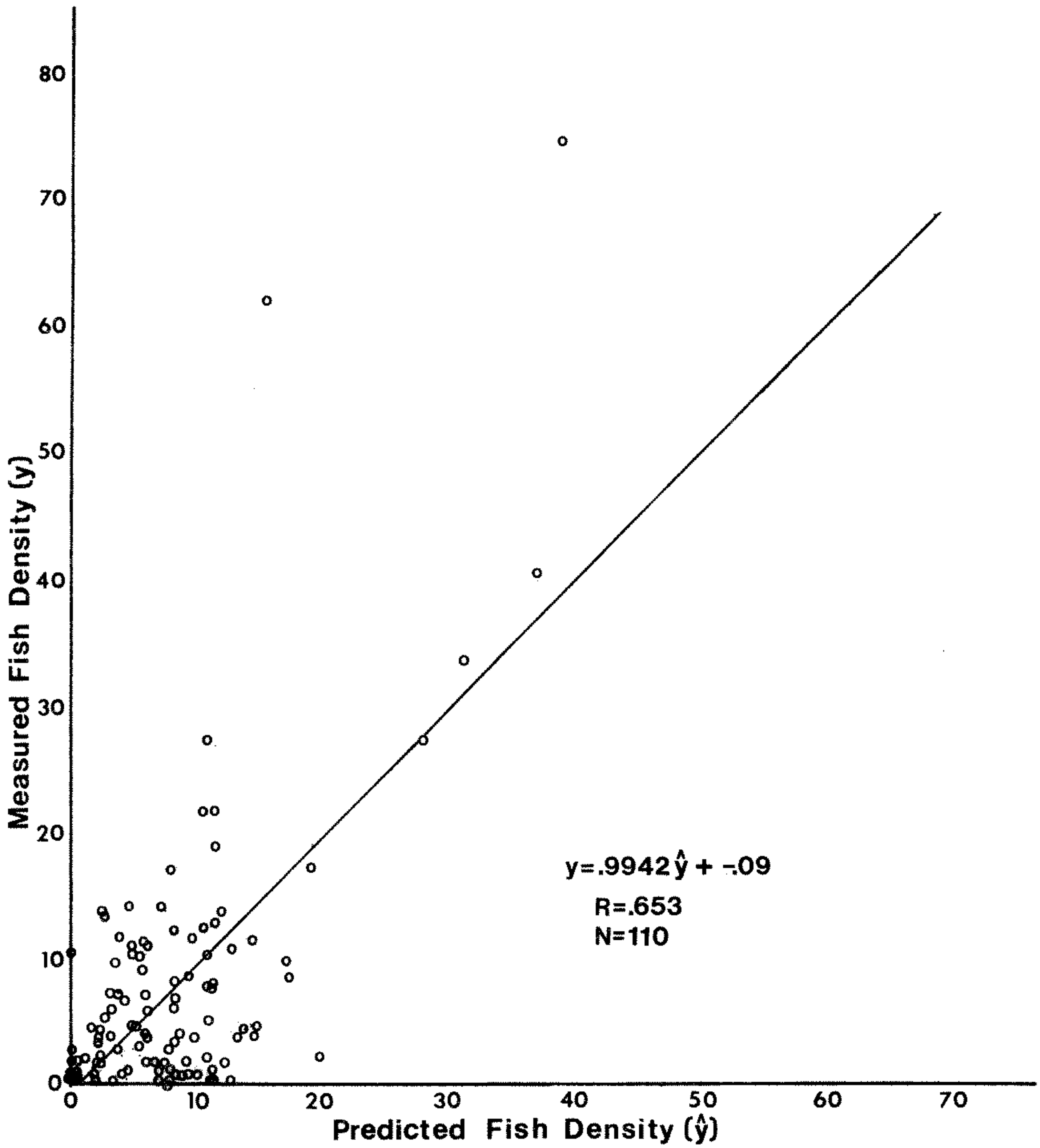


Figure 13. Relationship between measured trout densities and densities predicted by the four variable habitat model for 110 North and Middle Fork tributary reaches.

and Cochran (1969) state that reduction of significance of variable combinations of this nature could be caused by failure to include one or more important variables in the analysis or inaccurate measurements of included variables.

Physical habitat components and fish populations are variable and often difficult to measure. It is likely that the precision of our model is limited by the difficulty of obtaining accurate measurements for these variables in a reach of stream. Trout movements and multiple fish populations (resident, fluvial, and adfluvial) in the Flathead drainage create further difficulty in obtaining accurate relationships between trout densities and habitat variables. Also, it is a basic assumption that the North and Middle Fork tributaries were at carrying capacity for juvenile trout. Studies conducted by Graham (1977), Sekulich and Bjornn (1977), and Horner (1978) indicated that densities of some age classes of salmonids in several Idaho tributaries may not be at carrying capacity. Burns (1971) reported that juvenile salmonid populations were not always at carrying capacity in small California streams. He suggested carrying capacity of a stream may fluctuate from year to year.

Further expansion of the data base and refinement of the model is expected in 1981. Reaches in which fish densities predicted by the habitat model were extremely different than measured fish densities will be examined in the 1981 field season. An attempt will also be made to integrate the land type associations developed by the U.S. Forest Service into the habitat model in 1981 similar to that described by Platts (1979b).

INVENTORY OF BULL TROUT SPAWNING SITES

Distribution and Abundance of Spawning Sites

Enumeration of spawning sites (redd counts) can provide information on distribution of spawners within a drainage, relative importance of each tributary for spawning, and long-term trends in population abundance and stability. Accurate redd counts require good water clarity, knowledge of time and length of the spawning season, and the ability to discern actual spawning sites from false dips or depressions. Cutthroat trout spawn along the edge of the stream during high, turbid spring flows and make relatively small redds which are difficult to locate. In contrast, bull trout spawn in the fall when flows are low and stable. Their redds are large and often near mid-stream making them easy to locate and verify.

There were 688 kilometers of stream which were unrestricted to bull trout on their upstream spawning migration in our study area, excluding three Middle Fork tributaries in Glacier National Park and the Flathead River in British Columbia. Of this total, 270 kilometers were surveyed by ground crews in 1980, concentrating in areas where spawning was known to occur or suspected to occur based on previous spawning or fish population inventories. Redds were located in 78 kilometers of stream comprising 14 percent of the waters accessible to bull trout. Redds were present in 34 of the 142 stream reaches classified to date.

The survey in 1980 represents the most extensive drainage-wide effort to date. A total of 568 redds were located; 268 in the North Fork drainage, and 300 in the Middle Fork drainage. An estimate of the numbers of bull trout which entered tributary streams to spawn in 1980 was made using a ratio of the number of spawners per redd (based on trap records in selected North Fork tributaries) and our estimated efficiency in counting redds. We estimated that 80 percent of all redds present were counted in the Middle Fork and U.S. portion of the North Fork drainages. An estimated 60 percent of all redds present were counted in the Flathead River basin in Canada, based on our knowledge of the basin and communication with B.C. Research of Vancouver. Estimates of the number of fish entering a creek to spawn were obtained from trapping up and downstream migrants in Big, Coal, Red Meadow, Whale and Trail creeks in 1977 (Montana Fish and Game, 1979). The largest redd count for each creek drainage between 1977 and 1980 was used because only partial redd counts were made in 1977 (Table 40). The ratio ranged from 2.7 to 8.4 spawners per redd and averaged 3.9 fish/redd. A more conservative estimate could be made assuming only 80 percent of the redds were counted, giving a ratio of 3.2 fish per redd.

An estimate of the total numbers of bull trout reaching tributary or main stem areas to spawn in 1980 would be 2,400 to 2,925 fish. An estimated 1,200 to 1,462 fish entered streams to spawn in the North Fork, with 512 to 624 fish entering tributaries partially or wholly in Canada and 688 to 838 entering tributaries in the U.S. portion of the North Fork. An estimated 1,200 to 1,462 bull trout entered streams in the Middle Fork of the Flathead River drainage to spawn. The estimates for streams in Canada may be low because fishing for adult bull trout is allowed in spawning tributaries and could reduce the number of redds that would have been produced.

Spawning was concentrated in several major tributaries in both the North Fork and Middle Fork drainages (Tables 41 and 42). Although the total number of redds observed in a particular stream was variable between 1979 and 1980, the spawning population appears to be relatively stable. A comparison of the total redds counted in the North Fork for the same stream reaches surveyed during both years showed 171 and 168 redds in 1980 and 1979, respectively.

Spawning was also concentrated within a stream reach. The density of redds in reaches where spawning occurred ranged from 0.2 to 7.0 redds per kilometer (Table 41 and 42). Densities of redds in high-use areas within a reach were generally two to three times larger, ranging from 2.0 to 15.3 redds per kilometer. Howell Creek in British Columbia had 15.3 redds per kilometer in the high use area, the largest density in any tributary in the North Fork drainage (Table 41). Granite Creek had the largest density of redds in the Middle Fork drainage, with 11.2 redds per kilometer (Table 42).

Timing of Spawning

Adult bull trout may arrive in tributaries as early as July or as late as November (Graham et. al. 1980b). However, spawning occurs in a relatively short time of approximately two weeks.

Table 40. Estimated number of spawning bull trout in five North Fork tributaries in 1977, redd counts for those tributaries from 1977 to 1980, and a ratio of the number of spawners to the largest redd count during the four year period.

Drainage	Spawning population[1/]	Redd counts 80	79	78	77	Ratio of spawners to redds[3/]
Big Creek	120	23	24			5.2
Coal Creek	249	60	50			4.5
Red Meadow Creek	84	6	2	4	10	8.4
Whale Creek	261	51	77		14	3.4
Trail Creek	96	31	35		15	2.7
Total	810		206[2/]			
Mean						3.9

1: Obtained from up and downstream trapping of marked adult spawners in 1977.

2: Total reflects largest redd count for each stream from 1977 to 1980.

3: Ratio of the number of spawners estimated in 1977 to the largest redd count for each stream from 1977 to 1980.

Table 41. Numbers and densitites of bull trout redds (by reach) in North Fork tributaries surveyed in 1979 and 1980.

Stream	Reach	Number of redds 1980	Number of redds 1979	Density(#/km) (high use area) 1980	Density(#/Km) (entire reach) 1980
Cabin	II	2	*		
Howell[1/]	I	47	*	15.3	5.2
Couldrey[1/]	I	15	*		
Sage[2/]	I	6	*		
Kishenehn[2/]	I	16	*		
Flathead River[1/] (Howell Cr.-Pollock Cr.)		10	*		
Starvation	II	1	*		.3
Trail	I	31	35	7.75	3.6
Whale	I	12	10	4.10	1.5
	II	35	24	3.8	3.5
Shorty	I	4	33		.8
Red Meadow	II	6	2	3.0	.5
Coal	I	1	0		1.6
	II	47	40	7.2	6.2
	III	0	4		
South Fork Coal	I	2	4	2.0	.3
Mathias	I	10	2	10.0	4.0
Big	I	0	6		
	II	15	6	3.3	2.3
Hallawat	I	8	2	3.2	1.9
Total		268	168		

1: Results from survey by B.C. Research, Vancouver.

2: Combined for Canada and U.S.

* Not surveyed in 1979.

Table 42. Numbers and densities of bull trout redds by reach in Middle Fork tributaries surveyed in 1979 and 1980.

Stream	Reach	Number of redds 1980	Number of redds 1979	Density(#/Km) (high use area) 1980	Density(#/Km) (entire reach) 1980
Strawberry	I	4	*		.8
	II	9	*		1.2
	IV	4	*		1.8
Trail	I	31	*	5.9	2.6
Bowl	II	19	*	7.4	4.5
	III	7	*		4.4
	IV	3	*		.5
Clack	I	10	*		3.5
Schafer	I	10	15	5.3	2.2
	III	0	1		
Dolly Varden	I	21	20	3.6	1.6
Morrison	I	32	12	7.3	4.3
	II	4	9		1.1
	III	39	4	7.5	4.4
Lodgepole	I	14	32	8.1	2.1
Granite	I	0	2		
	II	34	12	11.2	6.1
Bear	II	9	*		2.1
Long	II	2	15		.7
	III	6	0		4.5
Charlie	II	7	3		4.1
Ole	II	19	*	5.0	4.0
Nyack	I	14	*		1.9
Lake	I	1	*		.4
Dirtyface	I	0	1		
Elk	I	1	*		.2
Total		300			

* Not surveyed in 1979.

Physical factors probably play an important role in triggering redd construction. Temperature data from thermographs on Trail, Coal, Big, and Red Meadow creeks were analyzed to examine the relationship between water temperature and onset of spawning. During peak spawning, mean maximum temperature for 1979 and 1980 was 8° C and 9° C, respectively. Water temperatures for the week preceeding spawning were similar to temperatures during the peak spawning period in 1979 and 1980. Other investigators have found water temperatures near 9° C associated with vigorous spawning activity (McPhail and Murray 1979; Needham and Vaughan, 1952).

On 4 September, 1980, habitat classification and underwater fish census was conducted on Granite Creek in the Middle Fork drainage. Nearly 20 mature bulls were seen but no redds were in evidence. The air temperature was 18-21° C and water temperature was 9-10° C. On 9 September, nearly 30 redds were counted, but few bulls were found indicating most spawning had occurred and most adult bull trout had emigrated. On 14 October, 34 redds were counted and some of these were difficult to discern.

Air temperature in the North Fork drainage was 21° C and water temperatures were 10° C on 14 September. A number of bulls were observed holding in tributaries that day. Overnight a cold front dropped air temperatures below freezing, and the next day, with the water temperature at 9° C, bull trout were observed actively building redds. The actual parameter(s) that trigger spawning activity have not yet been determined, but temperature may be a key.

North Fork redd surveys were not conducted until October 16 through 19 in 1979 because of late spawning activity. That autumn was warm and stream flows were low. Bull trout spawning during 1980 peaked in the third week of September, and the redds were counted from October 6 through 10. Some of these redds were already silting over. The Middle Fork survey began on October 3 and ended on October 31. Difficult access to streams in the wilderness is one problem that extended the time necessary to complete the survey.

Spawning Site Preference

A total of 465 redds were measured for length and width in the North Fork and Middle Fork drainages in 1980 (Table 43). Distance to cover, stream depth and wetted width were measured at each spawning site. The average length (2.1 m) and width (1.1 m) of redds were both 40 percent larger than for redds measured in 1979 (Graham eta. al. 1980b). Average of stream depth measurements at the head of the redd (0.27 m) was 35 percent larger than in 1979. Average distance to cover was 3.8 m compared to an average wetted width of 8.6 m at the redd site.

Frequency distribution curves were compiled for velocity and depth measurements taken at the head of 80 redds sampled in the North and Middle Fork drainages in 1979 and 1980 (Figures 14 and 15). Average water velocity was higher for samples taken in 1980 than in 1979 (Figure 14). Most were higher than 0.8 ft/sec., but none exceeded 2.0 ft/sec. The combined average was 0.95 ft/sec. Water velocity measured 1 cm above the gravel in the

Table 43. Average measurements of bull trout redds in tributaries of the North and Middle Forks of the Flathead River during 1980.

Drainage	Number of redds	Length (meters)	Width (meters)	Depth (meters)	Wetted width (meters)	Distance to nearest cover (meters)
North Fork						
Big Cr.	15	2.3	1.3	.32	8.5	4.6
Hallawat Cr.	8	2.0	1.0	.31	8.2	1.8
Coal Cr.	48	1.9	1.1	.26	9.6	4.0
So. Fork Coal Cr.	2	2.3	1.0	.31	6.1	.8
Mathias Cr.	10	1.9	.9	.30	5.3	2.1
Red Meadow Cr.	6	1.8	.8	.31	6.8	9.1
Starvation Cr.	1	3.0	1.0	.24	4.0	.5
Trail Cr.	31	2.4	1.5	.33	12.0	7.4
Whale Cr.	47	1.9	1.2	.30	11.2	2.9
Shorty Cr.	4	2.0	1.1	.19	9.5	4.3
Howell Cr.	18	1.9	.9	.35	10.0	1.5
North Fork average		2.0	1.2	.30	9.7	4.2
Middle Fork						
Bear Cr.	9	1.6	1.0	.26	6.7	5.2
Bowl Cr.	29	2.0	.9	.29	5.7	1.7
Charlie Cr.	6	2.2	1.3	.25	7.0	2.4
Clack Cr.	10	1.9	1.0	.23	5.2	4.1
Dolly Varden Cr.	21	2.2	1.0	.26	6.8	3.0
Granite Cr.	34	2.2	1.1	.27	6.4	2.7
Long Cr.	8	3.0	1.2	.20	6.5	3.1
Morrison Cr.	75	2.2	1.0	.27	8.2	3.1
Lodgepole Cr.	13	2.6	1.2	.23	7.2	4.1
Nyack Cr.	14	3.1	1.1	.34	15.6	5.7
Ole Cr.	19	2.5	1.1	.32	8.0	4.9
Schafer Cr.	11	2.0	1.1	.29	7.4	4.7
Strawberry Cr.	15	2.4	1.1	.20	6.1	3.7
Trail Cr.	31	1.8	.9	.24	5.1	3.3
Middle Fork average		2.2	1.0	.26	7.4	3.4
Overall average		2.1	1.1	.27	8.6	3.8

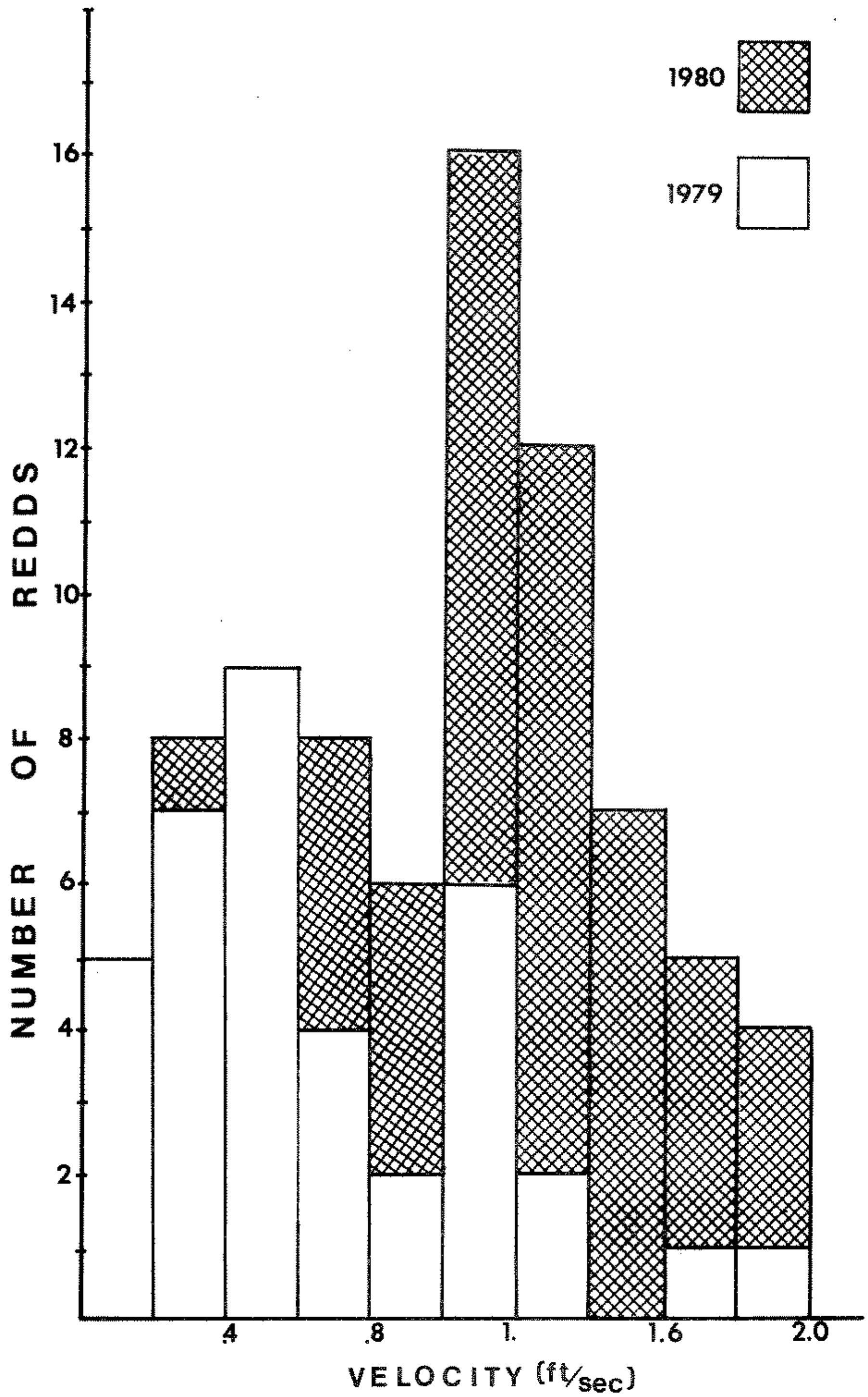


Figure 14. Velocities recorded at the head of 37 North and Middle Fork bull trout redds in 1979, and 43 North Fork bull trout redds in 1980. Velocities were determined proportionally 0.4 of the distance from the stream bottom. All measurements were taken with either Pygmy, Price AA, or Marsh McBirney current meters.

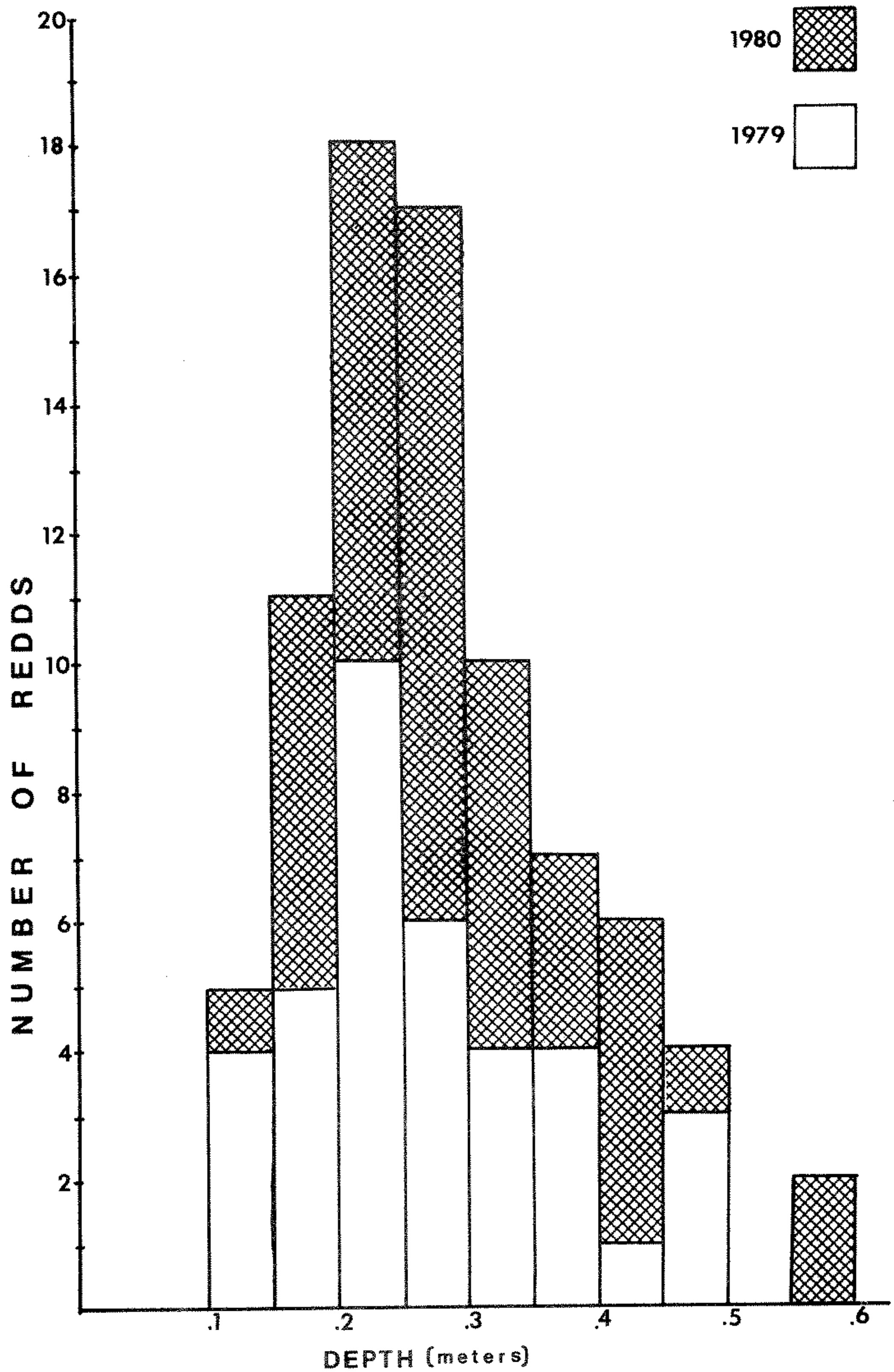


Figure 15. Depths recorded at the sites of 37 North and Middle Fork bull trout redds in 1979, and 43 North Fork bull trout redds in 1980.

Arrow Lakes Study was 1.86-2.1 ft/sec. (McPhail and Murray 1979). The majority (70%) of the redds were in water 0.15 to 0.35 m in depth in 1979 and 1980 (Figure 15). Average depth of 0.28 m was similar to those reported by Block (1955) and Hunter (1973).

Flows during the fall spawning season were higher in 1980 than in 1979 for most North Fork tributaries (Appendix A, Figures 1 through 5). This may explain the larger redd size and increased depth and velocity at site of spawning in 1980.

Composition of material from bull trout redds in Trail, Whale, Coal, and Hallawat creeks in the North Fork drainage were consistent (Figure 16). The predominance of 2 to 16 mm, and 19 to 50 mm size gravel is evident in the composite graph for all creeks. Blackett (1968) studied substrate composition for Dolly Varden redds in Hood Bay Creek, Alaska, and found material primarily between 6 mm and 50 mm in diameter. In a tributary to Arrow Lakes, B.C., gravel size in bull trout redds centered around 25 mm (McPhail and Murray 1979). The composite graph for all bull trout redds from 1977 to 1979, although analyzed with different sieve sizes, shows a bimodal distribution for approximately the same size gravel most abundant in the 1980 composite (Figure 17). The percent of fine material in the sample is somewhat low because our sampling methods were not 100 percent efficient in flowing water conditions.

Gravel samples from cutthroat trout redds in two North Fork tributaries show the 2.36 to 9.5 mm size to be most abundant (Figure 18). However, the composite of samples showed a more heterogeneous mixture of gravels than that found in bull trout redds. Overall, bull trout selected areas with larger size gravel than cutthroat trout.

The average depth and velocity of a small sample of cutthroat redds was 20 cm and 0.37 m per second, respectively. Red size averaged 0.86 m x 0.4 m and were 0.9 m from the nearest cover. Most cutthroat redds measured were found in small tributaries, probably a result of better visibility than in larger streams.

Spawning Reach Classification

An attempt was made to classify stream reaches based on intensity of use for spawning by bull trout. The results from the regression analysis of redd numbers and habitat parameters were inconclusive. Stream order was the most promising of the parameters examined. There also may be a relationship between stream gradient and bull trout spawning areas. The average gradient for reaches where bull trout redds were found was 1.7 percent, while the average gradient for non-spawning reaches was 3.7 percent. This lack of correlation between most of the variables and redd numbers is probably due to the use of average habitat measurements for the entire reach. Since areas of redd locations were concentrated within a reach, measurements should have been taken only in these areas. For example, the D-90 for spawning areas was probably less than 20 cm, but average D-90 for bull trout reaches was 38 cm. A concerted effort will be made in 1981 to measure important parameters in the area of concentrated

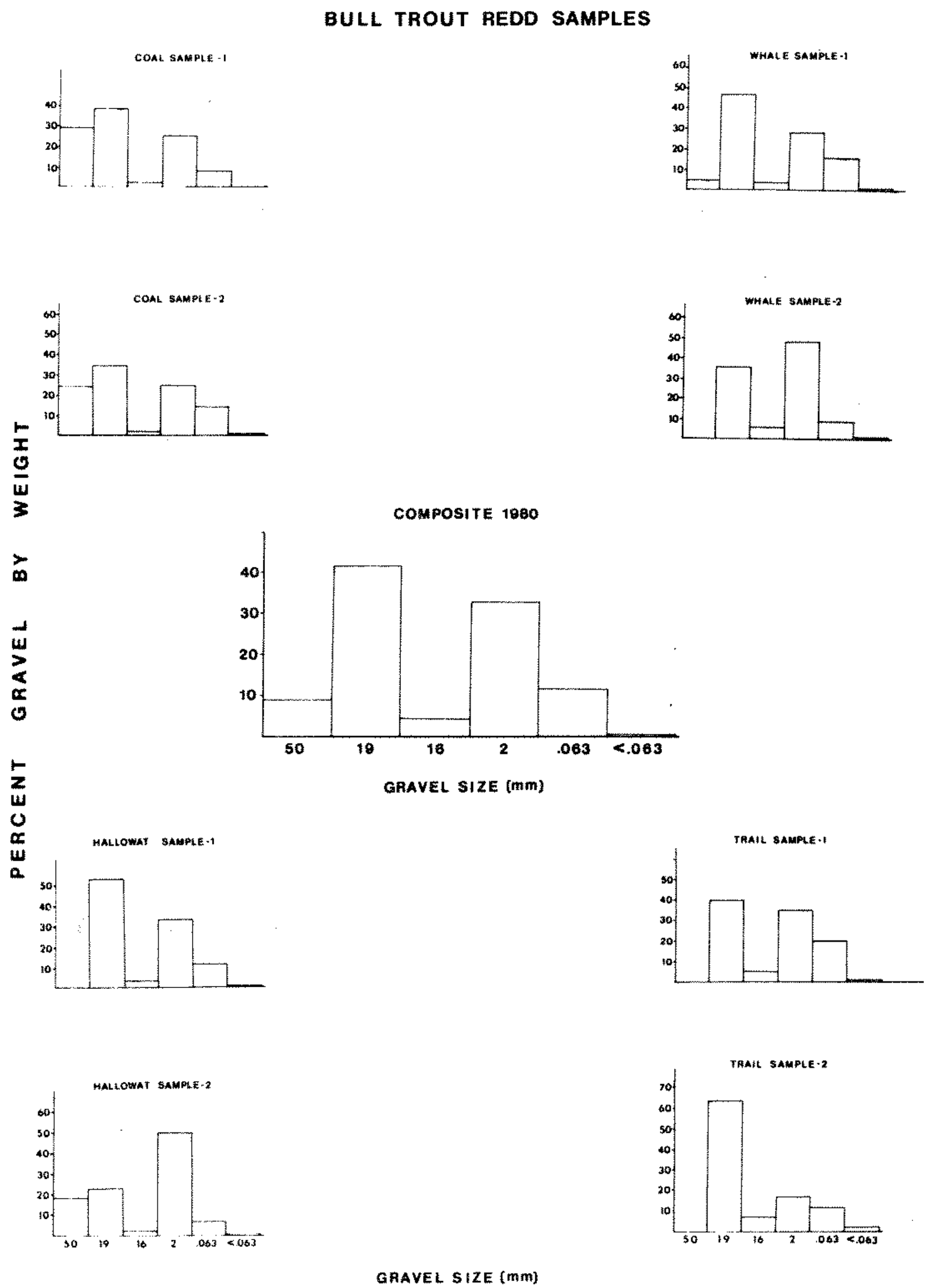


Figure 16. Bull trout gravel samples collected from North Fork tributaries in 1980. Each size gravel is expressed as percent of total gravel weight.

BULL TROUT REDD SAMPLES

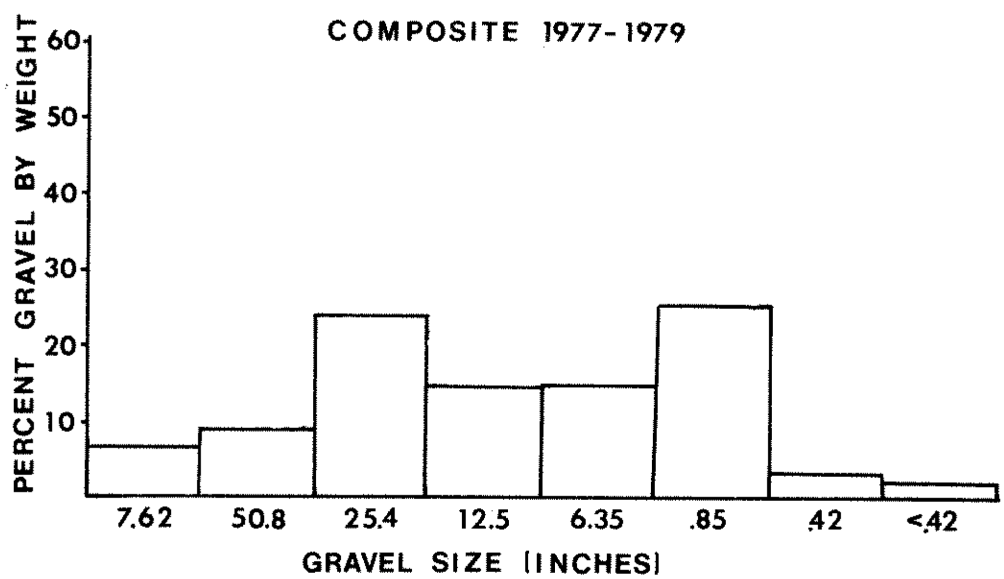


Figure 17. Size of gravels present in bull trout redds combined for 1977, 1978, and 1979.

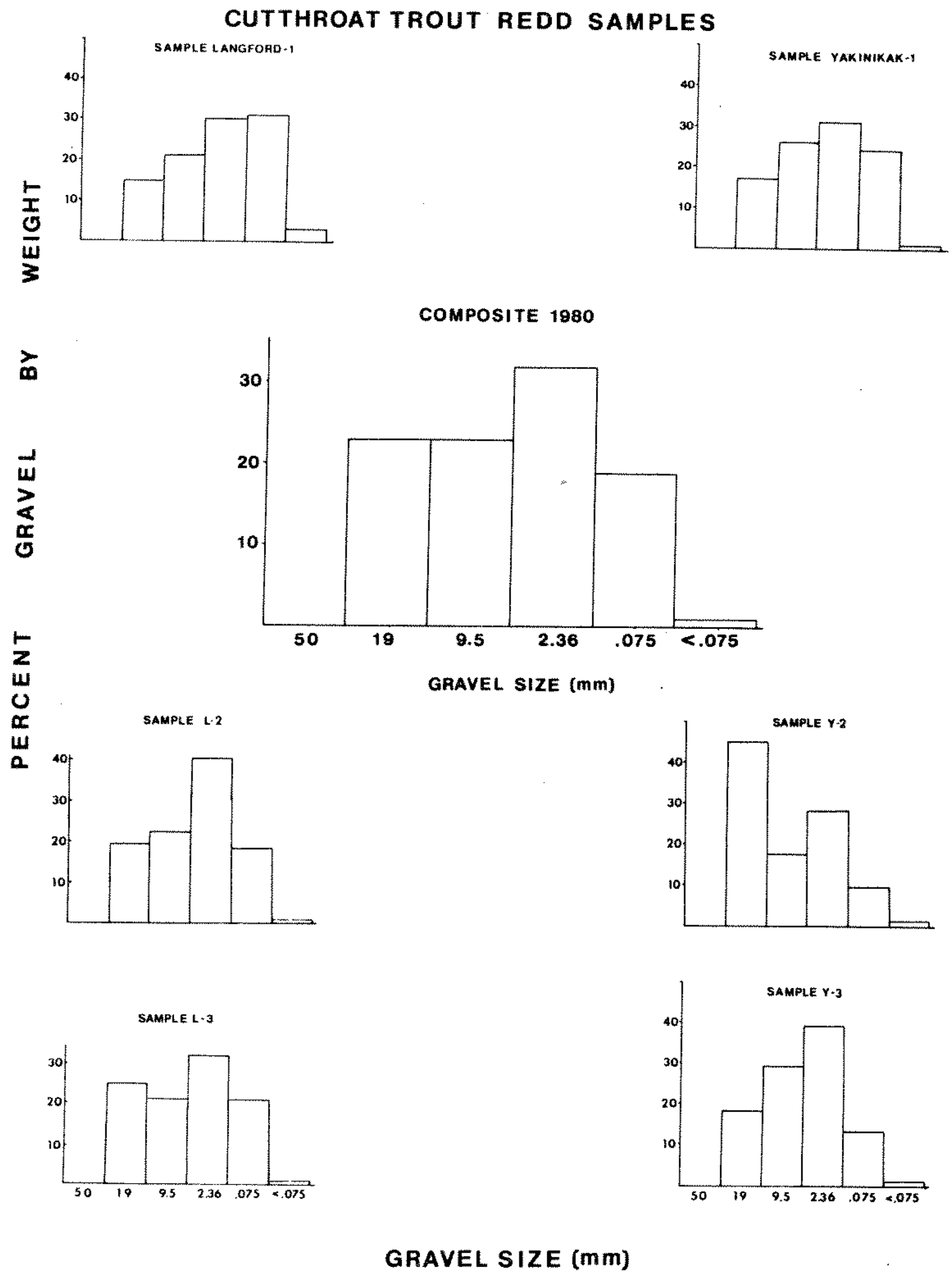


Figure 18. Cutthroat trout gravel samples collected from North Fork tributaries in 1980. Each size gravel is expressed as a percent of total gravel weight.

spawning in a reach.

FOOD HABITS OF CUTTHROAT AND BULL TROUT

Food habits information is important to the overall management of fish populations in the Flathead drainage. It is necessary to determine what types of organisms are consumed by various fish species. If a certain group of prey is heavily utilized in the diet, proper habitat management can be implemented to insure the continued presence of that prey in the food chain.

Major Fish Food Organisms

Results of the studies conducted in 1975-1976 by personnel of the Flathead 208 study indicate that Ephemeroptera (mayflies) were the dominant insect order seasonally in the North Fork of the Flathead River, comprising 45 percent (by number) of the total benthic community. Diptera (two-winged flies), Plecoptera (stoneflies), and Trichoptera (caddisflies) made up 30, 21 and 4 percent of the community. Peterson et. al. (1977) reported that the benthic communities of some North Fork tributaries were dominated by Ephemeroptera and Diptera. Further information on the North Fork drainage insect community, particularly the Trichoptera and Plecoptera, have been reported by the Flathead Research Group (Stanford et. al. 1979 and 1980).

Information has not been reported concerning the composition of the benthic insect community in the upper portion of the Middle Fork where trout stomachs were collected. In order to identify the composition of the major fish food organisms in the benthic community of the upper Middle Fork, samples collected from the river near Bear Creek and from Strawberry Creek (headwaters of the Middle Fork) were analyzed. The taxa and numbers of benthic invertebrates from these samples are presented in Table 44. The Middle Fork benthic samples collected near Bear Creek were dominated by Ephemeroptera and Diptera, which comprised 48 and 47 percent of the total numbers of insects, respectively. The dominant families of Ephemeroptera were Heptageniidae, Baetidae and Ephemerellidae. The dominant family of Diptera was Chironomidae. Plecoptera and Trichoptera made up 3 and 2 percent of the total numbers in the samples, respectively. Dominant families were Chloroperlidae (Plecoptera) and Hydropsychidae (Trichoptera).

Samples collected from Strawberry Creek were chosen to represent the benthic community of the third and fourth order tributaries of the upper Middle Fork basin. These samples were also dominated by Ephemeroptera (47%) and Diptera (39%). Plecoptera and Trichoptera comprised 9 and 4 percent of the samples, respectively. Major families of each order were Heptageniidae, Baetidae, and Ephemerellidae (Ephemeroptera), Chironomidae (Diptera), Perlodidae and Chloroperlidae (Plecoptera), and Rhyacophilidae (Trichoptera).

Adult aquatic insects were collected by Middle Fork field crews throughout the upper drainage during the summer of 1980. These adult collections

Table 44. Number of aquatic insects in benthic samples collected on the Middle Fork of the Flathead River during the summer of 1980. Total volume (ml) by family is in parentheses. Family totals include insects (small instars) from second picking of a 1/8 sub-sample. Type of substrate from which each sample was collected is indicated.

Taxa	Sampling sites: Middle Fork at Bear Cr. (Rubble) 7/9/80	Middle Fork at Bear Cr. (Gravel) 7/9/80	Strawberry Creek (Rubble) 8/9/80	Strawberry Creek (Gravel) 8/9/80
PLECOPTERA				
Chloroperlidae	*56 (.05)*	*57 (.07)*	*37 (.1)*	*49 (.05)*
Sweltsa sp.	25	11	27	23
Suwallia sp.	7	22	2	1
Paraperla sp.	—		—	1
Perlodidae	—	*5 (.05)*	*12 (.05)*	*40 (.05)*
Megarcys sp.	—	—	12	32
Kogotus sp.	—	5	—	—
Pteronarcidae	*1 (t)*1/	—	—	—
Pteronarcella badia sp.	1	—	—	—
Nemouridae	—	—	*23 (t)*	*9 (t)*
Zapada sp.	—	—	7	9
TRICHOPTERA				
Hydropsychidae	*4 (.4)*	*4 (.25)*	—	—
Hydropsyche sp.	1	—	—	—
Arctopsyche sp.	3	3	—	—
Rhyacophilidae	*5 (t)*	*2 (t)*	*17 (t)*	*41 (.05)*
Rhyacophila sp.	5	2	17	25
Brachycentridae	*3 (.05)*	*1 (t)*	*4 (.05)*	—
Brachycentrus sp.	3	1	4	—
Glossosomatidae	*1*	—	*16 (t)*	*1 (t)*
Glossosoma sp.	1 (t)	—	6	1

Table 44. (Continued)

Taxa	Sampling sites: Middle Fork at Bear Cr. (Rubble) 7/9/80	Middle Fork at Bear Cr. (Gravel) 7/9/80	Strawberry Creek (Rubble) 8/9/80	Strawberry Creek (Gravel) 8/9/80
COLEOPTERA				
Elmidae	—	—	*12 (t)*	*3 (t)*
DIPTERA				
Chironomidae	*316 (.15)*	*358 (.1)*	*433 (.1)*	*292 (.05)*
Ceratapogonidae	*6 (t)*	—	*2 (t)*	—
Simuliidae	*128 (t)*	*266 (.1)*	*2 (t)*	—
Tipulidae	*2 (.15)*	*4 (t)*	*2 (.1)*	*3 (.05)*
Hexatoma sp.	2	1	1	2
Antocha sp.	—	1	—	—
Tipula sp.	—	2	—	1
Blephariceridae	*10 (.1)*	*13 (.6)*	—	—
Deuterophlebiidae	—	*2 (t)*	—	—
Athericidae	*3*	*1 (t)*	—	—
Atherix variegata sp.	3	1	—	—
EPHEMEROPTERA				
Baetidae	*116 (.15)*	*155 (.2)*	*197 (.15)*	*67 (.1)*
Baetis sp.	66	105	112	51
Pseudocleon sp.	1	10	5	—
Callibaetis sp.	1	—	—	—
Heptageniidae	*406 (.9)*	*252 (.6)*	*205 (.3)*	*278 (.3)*
Epeorus sp.	96	82	39	15
Rhithrogena sp.	25	11	1	7
Cinygmula sp.	76	75	41	13
Ephemerellidae	*83 (.7)*	*103 (1.6)*	*86 (.15)*	*49 (.4)*
Ephemerella doddsi sp.	7	8	—	2

Table 44. (Continued)

Taxa	Sampling sites			
	Middle Fork at Bear Cr.(Rubble) 7/9/80	Middle Fork at Bear Cr.(Gravel) 7/9/80	Strawberry Creek (Rubble) 8/9/80	Strawberry Creek (Gravel) 8/9/80
Ephemeroptera - Ephemerellidae (continued)				
Ephemerella flavilinea	—	11	3	11
Ephemerella spinifera	—	11	8	—
Ephemerella tibialis	41	41	11	2
Ephemerella grandis	3	—	—	2
Paraleptophlebiidae	—	—	2 (*t*)	—
Paraleptophlebia sp.	—	—	2	—
Total No. of Insects	1,140	1,223	1,050	832
Total volume (ml)	2.7	3.6	1.1	1.2

1/ *t* = volumes less than .05 ml

are valuable in checking identifications of immature forms and as a basic partial species list for the upper drainage. Approximately 33 species of stoneflies, 20 species of mayflies, and 11 species of Trichoptera were collected (Table 45).

Particularly valuable records of Plecoptera were *Mesocapnia oeneone, Pictetiella expansa,* and *Neaviperla forcipata. Neaviperla forcipata* was collected from four tributaries in the drainage. This insect appears in Bauman, et. al. (1977) in a list of rarely collected Plecoptera of the Rocky Mountain area. All records of Ephemeroptera are highly valuable as data on this order in the upper Middle Fork drainage is not currently available.

Analysis of Cutthroat and Bull Trout Stomachs

Stomach contents from 80 westslope cutthroat and 28 juvenile bull trout from the North Fork drainage and 30 cutthroat and seven juvenile bull trout from the Middle Fork drainage were examined to determine food habits.

Data was organized by species and length to compare food habits of small and large fish of each species in tributaries of the North and Middle Fork drainages. The two size groups for each species were fish shorter than or equal to 110 mm and fish larger than 110 mm in total length. There was also a grouping for Middle Fork River fish.

The number and volume of insects in each taxa, frequency of occurrence of taxa, and Index of Relative Importance for all stomach contents were calculated and are presented in Appendix E , Table 1 - 12.

Cutthroat

The relative importance of insect orders in the diets of two size classs of cutthroat trout in North and Middle Fork tributaries and one size class in the Middle Fork river is depicted in Figure 19.

Ephemeroptera, Diptera and Trichoptera were the major orders in the diet of cutthroat less than or equal to 110 mm in length in tributaries of both drainages.

In the diets of cutthroat larger than 110 mm, Ephemeroptera was the dominant order with Trichoptera, Diptera, and Plecoptera well represented. Stomach samples collected in 1979 from North Fork tributaries were also dominated by Ephemeroptera (Graham et. al. 1980b). Hymenoptera (terrestrial adults), Diptera (adults) and Trichoptera were the major food items found in larger cutthroat in Middle Fork tributaries.

Stomach contents of Middle Fork river fish were dominated by winged adults of the orders Trichoptera, Diptera and Ephemeroptera, with other orders also represented. It appears that larger cutthroat trout in Middle Fork tributaries and in the Middle Fork River feed largely on the water surface for winged insects.

Table 45. Adult aquatic insects collected from the Middle Fork of the Flathead River and its tributaries during the summer of 1980.

Taxa	Date of collection	Location
EPHEMEROPTERA		
Heptageniidae		
Cinygmula par	11 July	Schafer Creek
" "	21 July	Surprise Creek
" "	17 July	Schafer Creek
Rhithrogena futilis	23 July	Cox Creek
" "	24 July	Clack Creek
" "	27 July	Bowl Creek
" "	14 July	Schafer Creek
Rhithrogena morrisoni	12 July	Dolly Varden Creek
Rhithrogena hageni	13 July	Dolly Varden Creek
Cinygmula gartrelli	12 July	Dolly Varden Creek
Cinygmula ramelyi	9 September	Morrison Creek
" "	11 August	Gateway Creek
Cinygmula tarda	10 August	Mid-Fk Schafer Creek
Rhithrogena sp. female	5 September	Morrison Creek
Unknown ♀ subimago	22 August	Mid-Fk-Gooseberry Park
Ephemerellidae		
Ephemerella grandis	28 July	Bowl Creek
" "	18 June	Mid-Fk Flathead below Schafer
" "	12 July	Dolly Varden Creek (upper)
" "	25 June	Mid-Fk Flathead below Schafer
" "	28 July	Bowl Creek
" "	8 August	Trail Creek
Ephemerella sp. female	25 July	Clack Creek
Ephemerella grandis ingens	5 September	Granite Creek
" " "	22 August	Lodgepole Creek
Ephemerella doddsi	10 August	Gateway Creek
Ephemerella flavilinea	6 September	Granite Creek
Ephemerella sp. female subimago	8 August	Gateway Creek
Ephemerella grandis ingens	23 September	Cox Creek

Table 45. (Continued)

Taxa	Date of collection	Location
Ephemeroptera - Ephemerellidae (continued)		
Ephemerella sp. female subimago	22 August	Lodgepole Creek
Siphlonuridae		
Siphlonurus columbiane	25 July	Basin Creek
" "	14 July	Schafer Creek
Siphlonurus occidentalis	26 July	Clack Creek
Siphlonurus sp. female	26 July	Clack Creek
Parameletus sp. female	28 July	Basin Creek
Ameletus sp. female	No date	Strawberry Creek
" sp. male	6 September	Granite Creek
" sp. female subimago	10 August	Gateway Creek
Baetidae		
Callibaetis doddsi	16 June	Mid-Fk at Schafer Meadows
" "	26 July	Clack Creek
" "	24 July	Clack Creek
Callibaetis sp. female	26 July	Clack Creek
Baetis sp. subimago	22 August	Mid-Fk-Gooseberry Park
" sp. subimago	10 August	Mid-Fk above Schafer Creek
PLECOPTERA		
Capniidae		
Capnia sp. female	17 June	Mid-Fk Flathead below Schafer
Mesocapnia oenone	5 September	Granite Creek
" "	7 September	Granite Creek
" "	11 August	Gateway Creek
Nemouridae		
Podmosta delicatula	14 July	Schafer Creek
" "	25 July	Basin Creek
" "	9 July	Morrison Creek

Table 45. (Continued)

Taxa	Date of collection	Location
Plecoptera-Perlodidae (continued)		
Megarcys signata	12 July	Dolly Varden Creek
Kogotus nonus	24 July	Mid-Fk -Gooseberry Park
" "	4 August	Strawberry Creek
Pictetiella expansa	10 July	Dolly Varden Creek
Kogotus modestus	10 August	Mid-Fk Flathead above Schafer
" "	5 September	Granite Creek
" "	22 September	Cox Creek
" "	5 September	Morrison Creek
Kogotus nonus	6 September	Granite Creek
" "	22 August	Lodgepole Creek
" "	10 August	Mid-Fk above Schafer
Perlidae		
Doroneuria theodora	28 July	Bowl Creek
" "	28 July	Bowl Creek-Grizzly Park
" "	12 August	Strawberry Creek
" "	10 August	Mid-Fk above Schafer
" "	10 August	Mid-Fk above Schafer
Hesperoperla pacifica	17 June	Mid-Fk - Spruce Park
" "	18 June	Mid-Fk - Spruce Park
Chloroperlidae		
Alloperla delicata	12 July	Dolly Varden at Argosy
Alloperla severa	27 July	Basin Creek (head)
" "	24 July	Bowl Creek
Alloperla pilosa	17 June	Morrison Creek
" "	18 June	Mid-Fk at Spruce Park
" "	18 June	Mid-Fk at Spruce Park
Paraperla frontalis	26 June	Clack Creek
" "	17 June	Mid-Fk Flathead below Schafer

Table 45. (Continued)

Taxa	Date of collection	Location
Plecoptera - Chloroperlidae (continued)		
Suwallia lineosa	24 July	Bowl Creek
" "	25 July	Clack Creek
" "	5 September	Long Creek
" "	22 August	Lodgepole Creek
" "	8 August	Gateway Creek
" "	5 September	Granite Creek
Suwallia pallidula	10 July	Trail Creek
" "	11 July	Schafer Creek
" "	3 September	Long Creek
" "	11 August	Gateway Creek
" "	10 August	Mid-Fk above Schafer
" "	22 August	Mid-Fk - Gooseberry Park
" "	5 September	Morrison Creek
" "	6 September	Granite Creek
Sweltsa albertonsis	19 July	Schafer Creek
" "	28 July	Bowl Creek
Sweltsa borealis	26 July	Basin Creek
" "	18 June	Mid-Fk Flathead below Schafer
" "	8 August	Trail Creek
" "	18 June	Mid-Fk at Spruce Park
" "	26 July	Clack Creek
Sweltsa coloradensis	12 July	Dolly Varden Creek
" "	18 June	Mid-Fk Spruce Park
" "	26 July	Clack Creek
" "	18 June	Mid-Fk Flathead below Schafer
" "	25 July	Mid-Fk at Switch-back Creek
Sweltsa fidelis	26 June	Clack Creek
" "	11 July	Schafer Creek
" "	12 July	Dolly Varden Creek - Argosy
" "	10 July	Dolly Varden Creek - Argosy

Table 45. (Continued)

Taxa	Date of collection	Location
Plecoptera - Nemouridae (continued)		
Zapada cinctipes	13 July	Strawberry Creek
Zapada cinctipes	6 September	Lake Creek
Zapada frigida	26 July	Basin Creek (head)
Leuctridae		
Paraleuctra vershina	18 June	Mid-Fk Flathead below Schafer
Paraleuctra occidentalis	24 July	Bowl Creek
Taeniopterygidae		
Taenionema pacificum	12 July	Dolly Varden Creek
Peltoperlidae		
Yoroperla brevis	27 July	Basin Creek (head)
" "	24 July	Bowl Creek (above Basin Cr.)
" "	25 July	Bowl Creek (above Basin Cr.)
Pteronarcidae		
Pteronarcella badia	18 June	Mid-Fk Flathead-Spruce Park
" "	18 June	Mid-Fk Flathead-Spruce Park
Perlodidae		
Megarcys watertoni	14 July	Dolly Varden Creek
" "	17 June	Mid-Fk Flathead below Schafer
" "	8 August	Trail Creek
" "	28 July	Basin Creek
" "	11 July	Schafer Creek
" "	8 July	Trail Creek
" "	25 July	Clack Creek
" "	24 July	Bowl Creek
" "	13 July	Dolly Varden Creek-Argosy
" "	28 July	Bowl Creek
" "	27 July	Basin Creek (head)

Table 45. (Continued)

Taxa	Date of collection	Location
Plecoptera - Chloroperlidae (continued)		
Sweltsa fidelis	13 July	Dolly Varden Creek - Argosy
" "	25 July	Clack Creek
" "	24 July	Bowl Creek
" "	27 July	Basin Creek
" "	8 August	Trail Creek
Sweltsa lamba	14 July	Dolly Varden Creek
Sweltsa revelostoka	14 July	Dolly Varden Creek
" "	25 July	Bowl Creek
" "	25 July	Clack Creek
Utaperla soplodora	18 June	Mid-Fk Flathead below Schafer
" "	14 July	Schafer Creek
" "	25 June	Mid-Fk Flathead below Schafer
" "	26 July	Clack Creek
Neaviperla forcipata	5 September	Granite Creek
" "	3 September	Long Creek
" "	11 August	Gateway Creek
" "	3 September	Long Creek
" "	6 September	Long Creek
" "	6 September	Lake Creek
" "	6 September	Granite Creek
" "	6 September	Lake Creek
TRICHOPTERA		
Rhyacophilidae		
Rhyacophila pellisa Ross male	28 July	Mid-Fk above Schafer Creek
Rhyacophila sp. female	25 July	Mid-Fk above Schafer Creek
Rhyacophila sp. female	24 July	Mid-Fk above Schafer Creek
Rhyacophila vocala Milne male	18 July	Mid-Fk above Schafer Creek
Glossosomatidae		
Glossosoma sp. female	18 June	Mid-Fk above Schafer Creek
Anagepetus debilis Ross male	11 July	Schafer Creek

Table 45. (Continued)

Taxa	Date of collection	Location
Trichoptera (continued)		
Hydropsychidae		
Arctopsyche grandis Banks male	26 July	Mid-Fk above Schafer Creek
" " male	18 July	Mid-Fk above Schafer Creek
" " female	25 July	Mid-Fk above Schafer Creek
Limnephilidae		
Lenarchus sp.	17 April	Mid-Fk at Gooseberry Park
Ecclisomyia maculosa Banks males	12 July	Dolly Varden Creek
Ecclisomyia sp. female	8 July	Trail Creek.
Ecclisomyia conspersa Banks male &	11 July	Schafer Creek
" " females	18 July	Mid-Fk above Schafer Creek
Oligophlebodes ruthae Ross male	26 July	Basin Creek
Limnephilus sp. female	8 August	Mid-Fk above Schafer Creek

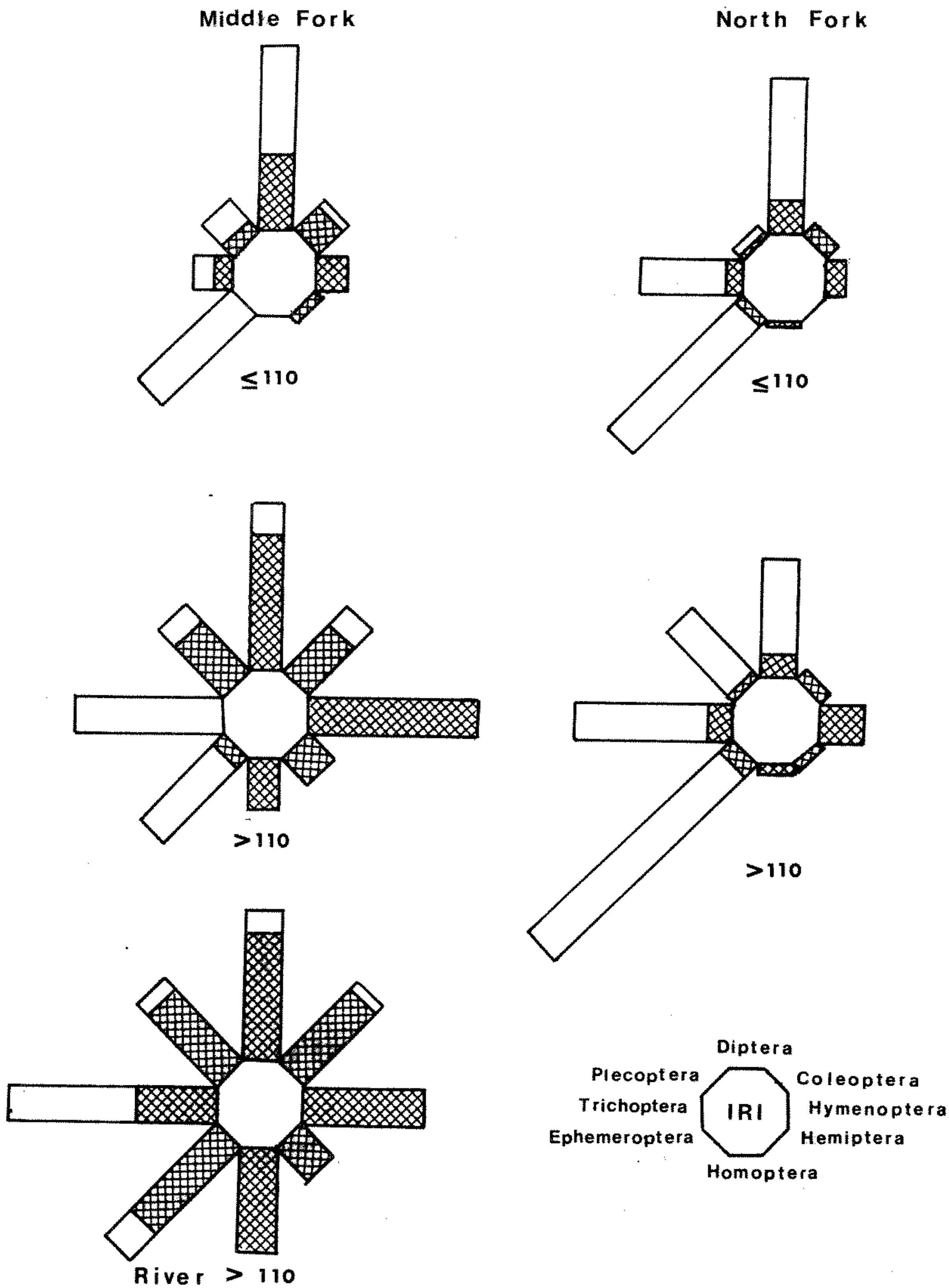


Figure 19. Relative importance (IRI) of insect orders in the diets of cutthroat trout ≤ 110 mm and > 110 mm in length from North and Middle Fork tributaries and cutthroat > 110 mm from the Middle Fork River. Shaded areas indicate winged adults. Stomachs were collected during the summer of 1980.

The major families of Ephemeroptera present in cutthroat stomach are presented in Figure 20. Heptageniidae and Ephemerellidae were the major mayfly families present in North Fork drainage cutthroat of both size classes. Heptageniidae and Baetidae were the major families found in small cutthroat in Middle Fork tributaries, while Ephemerellidae and Baetidae were the major families in the larger cutthroat.

Figure 21 depicts the important families of Trichoptera in the North and Middle Fork cutthroat stomachs. Brachycentridae, Limnephilidae, Hydropsychidae and Rhyacophilidae were the major Trichoptera families found in cutthroat from both drainages. The family Chironomidae was by far the most important dipteran in the cutthroat stomach samples.

A comparison between major food items found in the stomachs of small North and Middle Fork tributary cutthroat and available benthic insect food supply indicates feeding is opportunistic. Ephemeroptera and Diptera were the dominant insect orders in diets as well as in the available benthic food supply. This relationship was also present at the family level where the dipteran family Chironomidae, and the mayfly families Baetidae, Heptageniidae and Ephemerellidae were the most important individual families in both the stomach samples and in the available insect food supply. Griffith (1974) found that cutthroat and brook trout were opportunistic feeders in four small streams in northern Idaho. He found that Ephemeroptera, Coleoptera, Diptera, Trichoptera and Plecoptera made up more than 90 percent of both the invertebrate drift and the diets of cutthroat and brook trout.

Bull trout

Mayflies were by far the most important insect order in stomachs of both small and large bull trout in the North and Middle Fork drainages (Figure 22). Other important orders in bull trout diets were Diptera and Trichoptera in the North Fork drainage, and Plecoptera and Diptera in the Middle Fork drainage.

The relative importance of Ephemeroptera by family in bull trout diets is presented in Figure 23. Heptageniidae was the major family in bull trout diets in the North Fork drainage, followed by Ephemerellidae and Baetidae. These families were of similar importance in the available benthic food supply of the North Fork drainage.

Baetidae was the major family in bull trout stomachs collected in the Middle Fork drainage, followed by Ephemerellidae and Siphlonuridae. Siphlonuridae was not a major mayfly family in Middle Fork benthic insect samples, but its presence in bull trout stomachs indicated selection for this family. The "free swimming" habits of siphlonurids may make them easier prey for the juvenile bull trout. Although Heptageniidae was the major mayfly family in the Middle Fork benthic samples, it was not the predominant family in the stomachs of juvenile bull trout collected from the Middle Fork drainage.

There was a relative absence of winged adults in stomachs in small (less than 110 mm) bull trout compared to larger bulls or cutthroat. Armstrong and Elliot (1972) found that juvenile Dolly Varden obtained only 9 percent

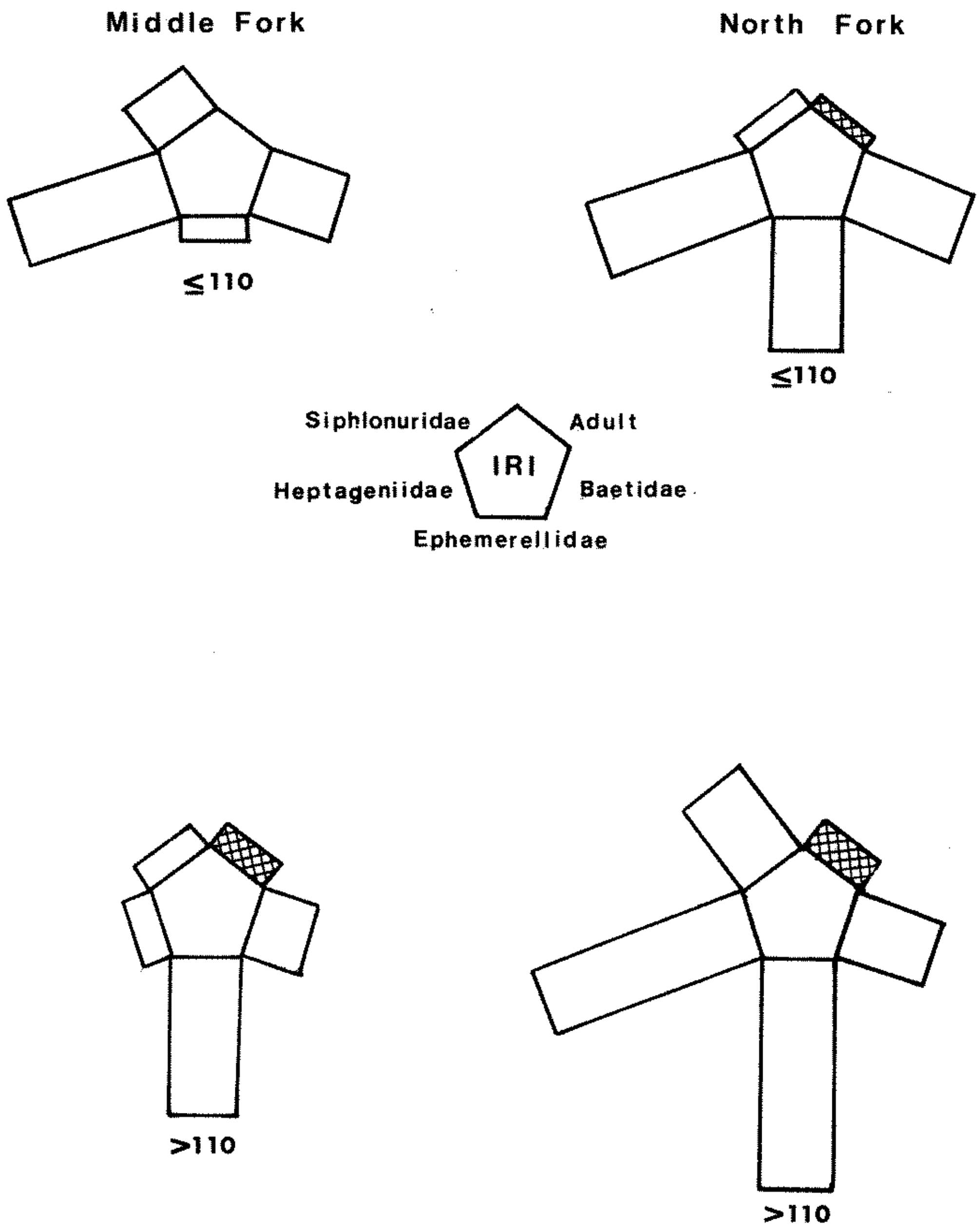


Figure 20. Relative importance (IRI) of Ephemeroptera nymphs by family and Ephemeroptera adults in the diet of cutthroat trout ≤ 110 mm and > 110 mm in length from North and Middle Fork tributaries. Stomachs were collected during the summer of 1980.

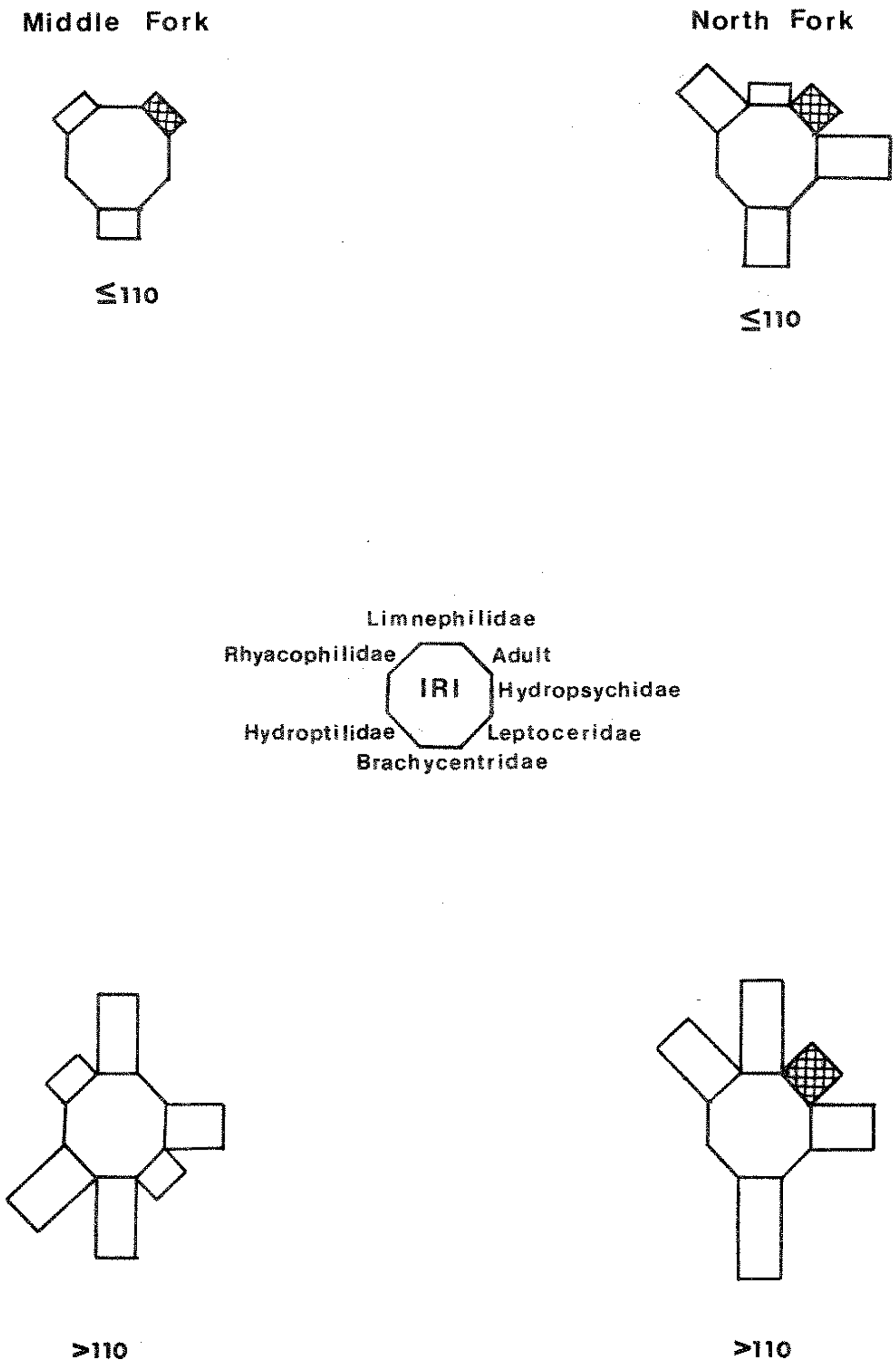


Figure 21. Relative importance (IRI) of Trichoptera larvae by family and Trichoptera adults in the diet of cutthroat trout $\leq$ 110 mm and > 110 mm in length from North and Middle Fork tributaries. Stomachs were collected during the summer of 1980.

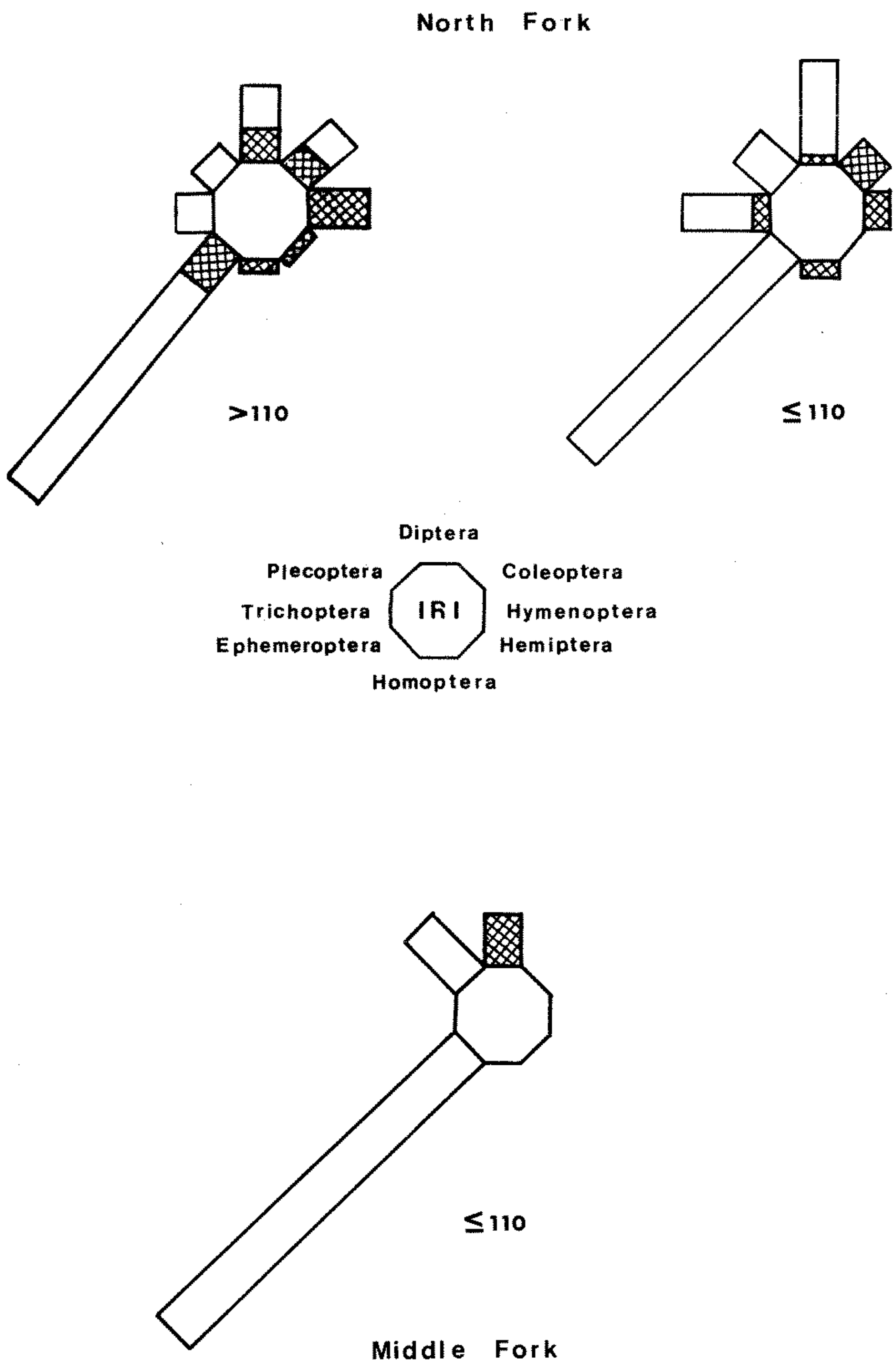


Figure 22. Relative importance (IRI) of insects by order in the diet of bull trout ≤ 110 mm and > 110 mm in length from North Fork tributaries and bull trout ≤ 110 mm in length from Middle Fork tributaries. Shaded areas indicate winged adults. Stomachs were collected during the summer of 1980.

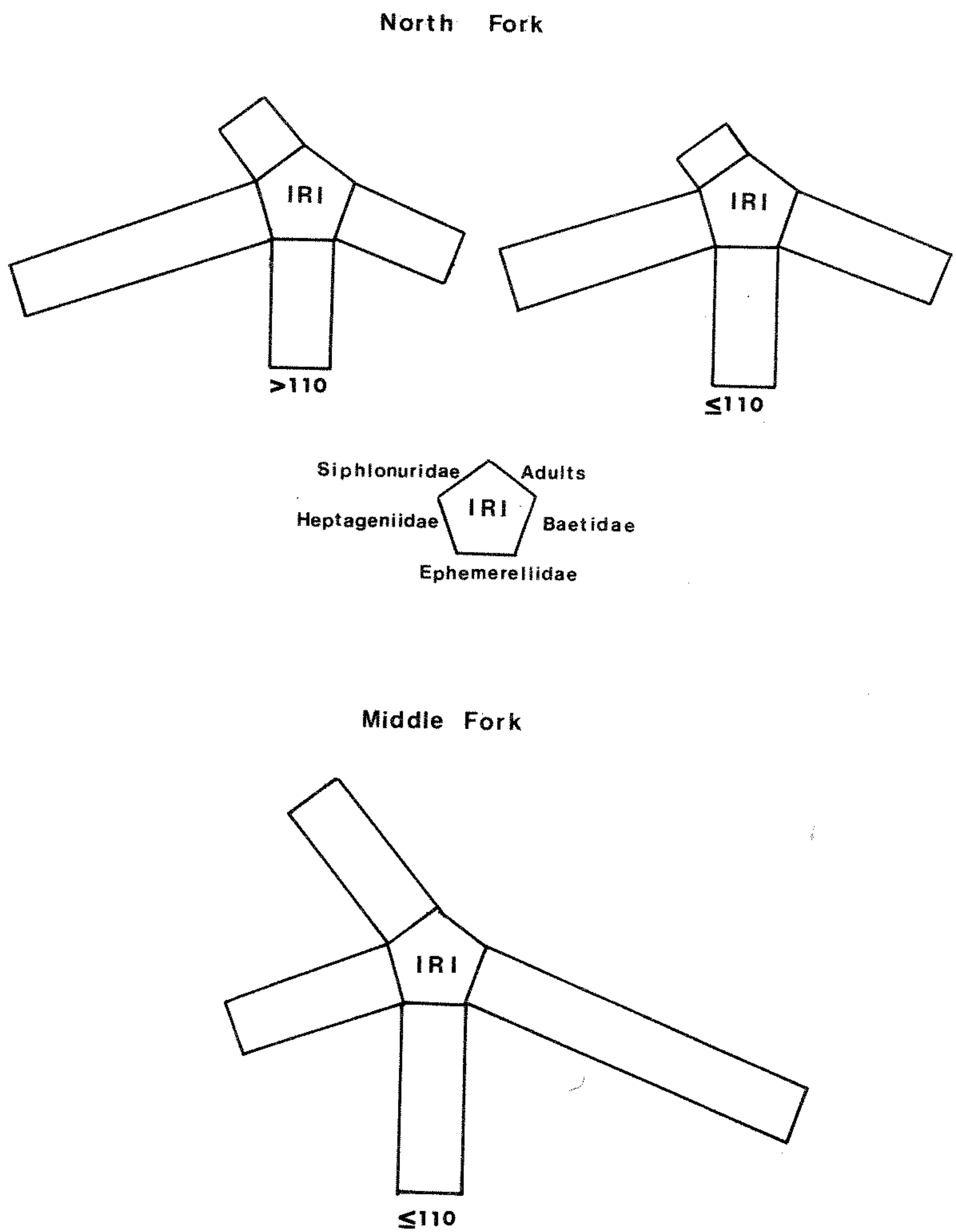


Figure 23. Relative Importance (IRI) of Ephemeroptera by family in bull trout ≤ 110 mm and > 110 mm in length from the North Fork tributaries and bull trout ≤ 110 mm in length from Middle Fork tributaries. Stomachs were collected during the summer of 1980.

of their food items from the surface, while 56 percent were gathered from the substrate in the form of immature aquatic insects. Murrell (1977) found Diptera, Trichoptera and Ephemeroptera most abundant in stomachs of juvenile Dolly Varden in streams near Glacier Bay, Alaska. Armstrong (1970) found immature stages of Diptera, Ephemeroptera, and Plecoptera predominated in stomachs collected from Hood Bay Creek, Alaska. Griffith (1974) reported immature stages of Ephemeroptera, Coleoptera, Diptera, Trichoptera and Plecoptera comprised 92 percent of the diet of brook trout in small streams in northern Idaho.

These food habit analyses represent a cursory examination of the summer diet of cutthroat and bull trout in the two drainages. Seasonal study and larger sample sizes would be needed to determine in depth the relationships between trout and their food supply in the North and Middle Fork drainages.

MIDDLE FORK CREEL CARD SURVEY

Creel Card Returns

A total of 15 creel census cards were returned during 1980. Most returns came from cards distributed by Fish, Wildlife and Parks, and U.S. Forest Service personnel. Six of the 15 cards were for one-day trips. The nine overnight trips average 6.8 days. The average number of anglers per trip was 2.7 and the angler success rate for all trips was 85 percent.

The number of anglers and composition of the catch for the summers of 1980 an 1979 are presented in Table 46. The numbers and percent composition of each species caught was similar for 1980 and 1979. Cutthroat dominated the catch with an average composition of 63 percent. Whitefish made up 35 percent of the catch, while bull trout comprised only two percent. In 1980, anglers released 45, 36, and 79 percent of the cutthroat, whitefish and bull trout caught. In 1979, anglers released 56 percent of the cutthroat trout, 90 percent of the bull trout and 83 percent of the whitefish that they caught.

Incidental Hook and Line Sampling

Results of hook and line sampling by Fish, Wildlife and Parks personnel conducted on the North and Middle Forks of the Flathead Rivers in 1980 were compared to results from 1962 and 1961 in order to identify changes or trends in species composition or catch rates (Table 47). Catch per hour for cutthroat was greater than for other species in the North and Middle Fork Rivers during 1961, 1962, and 1980. Mountain whitefish catch rates were smaller, while catch rates for bull trout were the smallest of the three species.

Cutthroat dominated the catch for all three years, averaging 90 percent in the North Fork and 77 percent in the Middle Fork. Bull trout and mountain whitefish comprised three and seven percent of the catch in the North Fork , and six and 17 percent in the Middle Fork, respectively. Hanzel (1977) reported a similar percent composition from a creel survey conducted

Table 46. Catch information from 15 voluntary creel cards returned in 1980 and 18 returned in 1979. Number of fish caught are in parentheses.

Year	Number of anglers	Total fisherman hours	Catch per hour: Cutthroat trout	Bull trout	Mountain whitefish	Total
1980	38	243	1.68(408)	.05(11)	.97(236)	2.70(655)
1979	44	228	1.61(367)	.08(19)	.91(197)	2.60(583)

Table 47. Catch information from hook and line sampling by Fish, Wildlife and Parks personnel on the North and Middle Forks of the Flathead River during the summers of 1980, 1962 and 1961. The number of fish caught of each species is in parentheses.

Year	Total fisherman hours	Catch per hour				
		Cutthroat trout	Bull trout	Mountain whitefish	Rainbow trout	Total
North Fork						
1980	120	2.15(259)	0(0)	.07(9)	.05(2)	2.24
1962	233	2.78(648)	.03(6)	.24(55)	.005(2)	3.06
1961	146	1.97(288)	.14(21)	.25(36)	.05(2)	2.41
Middle Fork						
1980	104	2.15(224)	.33(11)	.62(20)	0	3.10
1962[1]	164	.71(117)	.06(10)	.25(39)	0	1.02
1961[1]	170					

1: Data from 1961 and 1962 are from Hanzel, unpub. data.

Table 48. Catch information from hook and line sampling by Fish, Wildlife and Parks personnel in North and Middle Fork tributaries during the summer of 1980. Number of fish caught are in parentheses.

Drainage	Total fisherman hours	Catch per hour			
		Cutthroat trout	Bull trout	Mountain whitefish	Total
North Fork	34	3.03(103)	.06(2)	---	3.09(105)
Middle Fork	56.5	3.31(187)	.14(8)	.78(44)	4.0 (239)

on the North and Middle Forks during the summer of 1975. Angling was also conducted in North and Middle Fork tributaries during the summer of 1980 (Table 48). Catch rates were 40-50 percent higher in tributaries than in the rivers. Cutthroat made up 98 percent of the catch in North Fork tributaries and 78 percent in Middle Fork tributaries.

This catch rate and species composition data will be valuable in assessing changes in fish populations which may occur as development continues in the two drainages. Catch rates of each species are useful as general trend data when compared with angling by Fish, Wildlife and Parks personnel from other years. These catch rates are higher than catch rates reported by fishermen. This is probably due to the fact that Fish, Wildlife and Parks personnel are more experienced than the average angler.

CUMULATIVE IMPACT ASSESSMENT FOR THE NORTH FORK OF THE FLATHEAD RIVER: AN OVERVIEW

In the introduction, we wrote of the wild and scenic rivers, wilderness areas, Glacier Park, and all that contributes to the national recreational values of this area. What follows is a brief overview of resource developments which currently threaten those values. This section also serves to illustrate the importance of the Flathead River Basin Study for addressing the cumulative impacts of these developments. Much has been written about the resource conflicts in the Flathead. A summary of impacts on Glacier Park was written by Don Schwennesen (Missoulian, December 30, 1980, Glacier Under Siege, pp. 21-32).

RESOURCE DEVELOPMENT

Coal

Cabin Creek Coal Mine

Sage Creek Coal Ltd. owns 10,000 hectares of land along Cabin Creek, which enters the Flathead River nine miles north of the Canadian border (Figure 24). They expect to disturb 1,500 hectares of land by pits, roads, fill, etc., in the process of strip mining coal from two hills located immediately north and south of Cabin Creek. Their present scenario includes production of both metallurgical and thermal coal. Inital production at the Cabin Creek site would be 1.2 million tons of raw coal, converted to 0.8 million tons of clean coal per year. Crushing and washing would occur on site and the coal would be trucked approximately 63 km to a railroad. Production could be increased to 1.7 million tons of clean coal per year, which would put the mine life at 35 years. The two open-pit mines would be dug 100 meters below ground level, leaving two pits over 1.5 kilometers wide, and about 2 billion tons of waste. Original plans call for the diversion of Howell Creek, a tributary to Cabin Creek to make room for the waste. Sage Creek Coal Ltd. is in the process of securing a Stage II permit from the provincial government.

Lodgepole and Lily Bird Mine Sites

Crows Nest Industries, a subsidiary of Shell Canada, is completing a Stage I application to develop two coal deposits for surface mining approximately 40 miles north of the border. The largest site is the Lodgepole coal deposit near Foissey Creek which has an estimated 60 million tons of extractible coal. Similar in size to Cabin Creek and across the river is the Lily Bird coal deposit, between Squaw and Pincher creeks. They plan to develop another small coal deposit in the upper end of Cabin Creek when the main Cabin Creek site is developed.

Timber

The forest in the North Fork of the Flathead River drainage is largely a monotypic stand of lodgepole pine. An estimated 349,645 acres of federal, state, and private lands along both sides of the North Fork had been

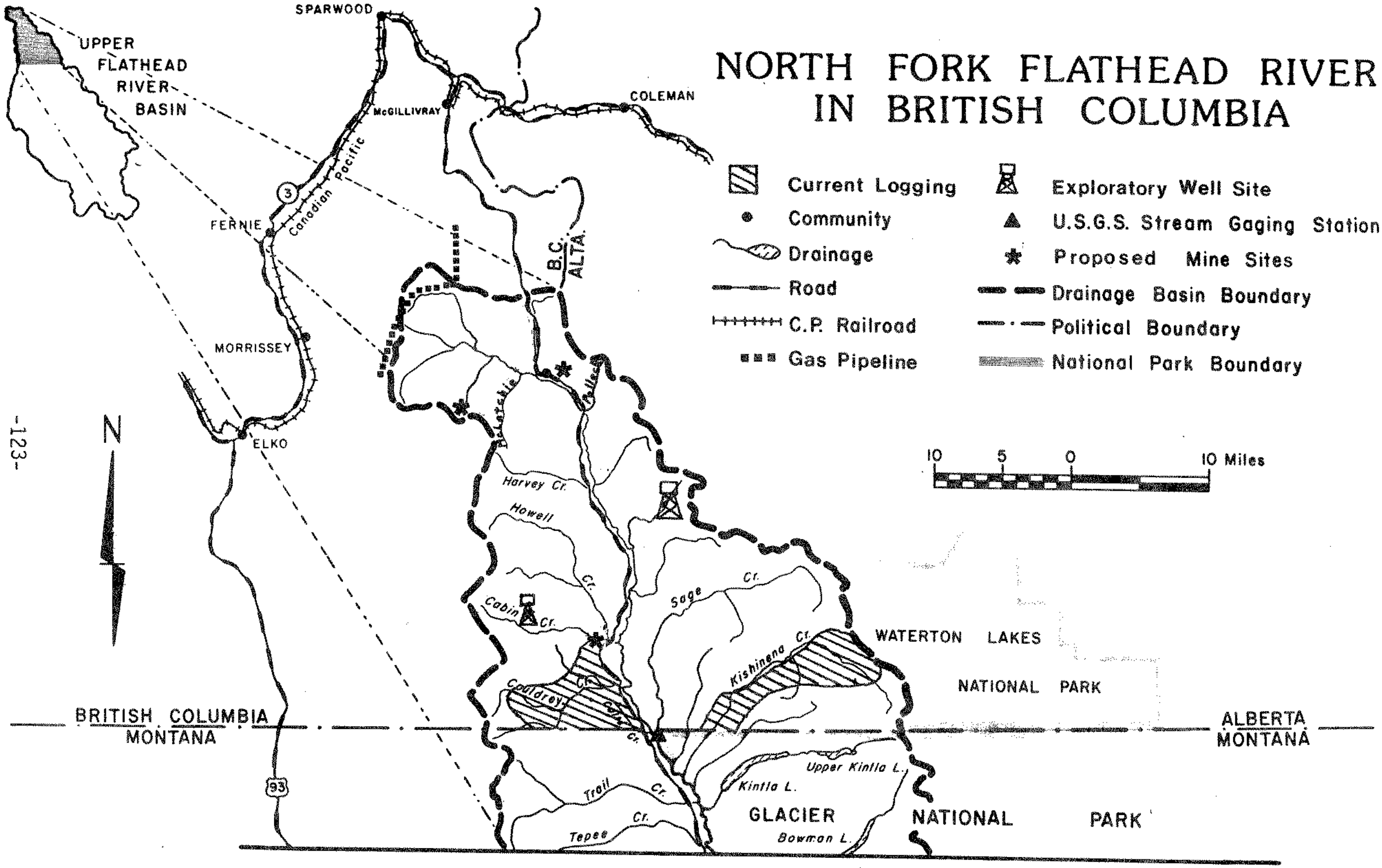


Figure 24. Drainage map of the upper North Fork of the Flathead River (adapted from Montana Dept. Natural Resources & Conservation (1977)

infested in the valley and foothills of the Flathead River drainage in British Columbia. Various management practices have been employed, ranging from no harvest of trees in Glacier Park to the plan by British Columbia forestry officials to clear half of the dead timber out and attempt reforestation. There is controversy surrounding all the management plans, and the cumulative impacts are merely speculative at this time. This management problem may prove to be the most significant of all in respect to its potential impacts on the aquatic resource. A brief review of the management plans of the three major land holders in the North Fork of the Flathead River drainage follows.

Glacier National Park

Glacier National Park controls the land along the east side of the North Fork, which comprises 53 percent (365,824 acres) of the total acres in the North Fork valley south of the Canadian border. The epidemic first noted in the Park in 1972, covered 164,492 acres by 1978 and has continued to spread through the valley. Glacier National Park manages the west side of the Park for its wilderness attributes allowing nature to take its course. However, some experimental research is planned for controlled burning of selected areas of dead lodgepole (Joe Shellenburger, personal communication, Glacier National Park). The policy of fire supression has interrupted natural cycles and this research is aimed at slowly phasing wildfires back in as part of the natural cycle of the Park. Selective burning is also being considered for safety purposes to prevent a fire, once started, from burning the entire east part of the North Fork drainage.

U.S. Forest Service (Flathead National Forest)

Most of the information in this section came from a recently prepared Cumulative Impact Assessment for logging on the Glacier View Ranger District. The Forest Service has 284,140 acres along the west side of the North Fork valley, interspersed with 22,520 (7%) of private and 16,226 (5%) of state-owned land. The U.S. Forest Service estimated beetle infestation has spread to 85,160 acres of lodgepole pine and 93,525 acres of whitebark pine by 1980 on their holdings in the North Fork. They expect to cut 10,000 acres over the next five years including salvage, clearcuts, shelterwood and seed tree units along the west side of the North Fork. Timber sales adjacent to major bull trout spawning areas include Ketchikan Creek (17 MMBF-FY81), Coal Ridge (10 MMBF-FY83), Coal Creek (1.8 MMBF-?), Koopee-Lookout Creek-Big Creek (3.7 MMBF-FY85), Forks Ridge and upper Hallawat Creek (5 MMBF-FY 83), Whale Creek and other drainages in the North Fork of the Flathead River.

The 10 MMBF sale on Coal Ridge would include 10 miles of new road. Forest Service personnel estimated road construction alone may double the sediment load in the stream from 1,440 tons to an estimated 3,100 tons per year. The Ketchikan Creek sale along Trail Creek has been approved at the regional level, but is under appeal at the National Level. This 17 MMBF sale is underlain by clay tills which could contribute to acceleration of run-off into Trail Creek. Timber sales in the Lookout Creek and Forks Ridge-Hallawat Creek areas in the Big Creek drainage are located in steep topography.

Private land in the North Fork has been extensively logged, and 17 percent (3,941 acres) of it has been subdivided.

B.C. Forest Service

B.C. government controls 93 percent of the 464,315 acres of land in the Flathead drainage north of the border. In 1977, an estimated 46,000 acres of forest had been infested by the mountain pine beetle and the beetle has continued to spread. The provincial government wants to harvest 100 percent of the beetle infested timber. An estimated 7,000 acres of infested timber remains. B.C. Forest Service expects to spend $4.5 million to knock down and clear out nearly half of the dead timber over the next four or five years (Gerry Ordway, personal communication, B.C. Forest Service, Fernie) Extensive logging is ongoing in the Kishenehn, upper Couldrey, and Sage creek drainages across the U.S. - Canadian border, primarily by Crows Nest Industries (a subsidiary of Shell Canada). In the Akamina-Kishenehn drainage adjacent to Glacier Park and draining through its northwest corner, B.C. Forest Service officials estimated a harvest of 37 acres/day and 46 haul trucks per day by Septmber, 1980. The cut was estimated at 5,500 acres/year over the next five years.

Oil and Gas

Nearly 1,000,000 acres on the Flathead National Forest are under application for lease of oil and gas rights. ARCO has been conducting seismic exploration using surface charges along Big and Trail creek tributaries to the North Fork. Shell Oil Company has an exploration permit for Trail Creek, and Amoco has exploration permits in the Whale, Moose, Red Meadow, Hay, Coal, and Big creek drainages on a total of 82 miles of road. Early exploration in the upper valley was for oil; today the exploration is primarily for natural gas deep in the overthrust belt. Two wells were punched in north of the border by Shell Canada last year. One located on Cabin Creek was capped after drilling over 12,000 feet, another well is still being drilled in the alpine zone of Middle Pass Creek and is scheduled to go down 18,000 feet. Presently 91 percent of the Forest Service land in the North Fork is under lease application. Shell Canada has 80 percent of the Flathead in Canada under lease.

Foothills natural gas pipeline has recently been laid in the upper Flathead River basin near McLatchie Creek in British Columbia. It crossed the headwall of the dendritic tributaries to McEvoy Creek, possibly causing sediment problems in the Flathead River during the fall and winter of 1980-81.

Roadways

Extensive forest roadways exist in nearly every drainage on the west side of the North Fork valley except in the Trail Creek drainage. Bridges over tributary streams along the North Fork road have been significantly upgraded during the past three years. The Federal Highway Administration plans to continue paving the North Fork road from Canyon Creek to Camas Creek, completing a loop into Glacier Park. Flathead County plans to pave the North Fork road from Camas Creek north to Polebridge. Road construction on the two projects is expected to be completed by 1986. Vehicle crossings at the U.S.-Canadian border over the past four years have averaged 662 northbound and 616 southbound from late spring through early fall. Apparently, in anticipation of much greater use, the U.S. customs just completed construction of a $180,000 border station in the North Fork. Presently the North Fork is relatively isolated and electric power lines have not been run into the valley.

CUMULATIVE IMPACT ON THE BULL TROUT FISHERY: NORTH AND MIDDLE FORK DRAINAGES

All signs indicate that a significant increase in access, use and development can be expected in the North Fork in the near future. Data on the bull trout fishery in the North Fork is used here to exemplify the cumulative impacts of resource development on the recreational and biological resource of the Flathead Basin. This is a preliminary and incomplete assessment, but serves to demonstrate the seriousness of the problem.

Bull trout, also called Dolly Varden, provide a trophy sport fishery in the Flathead Basin. An estimated 7,213 bull trout over 18 inches long were taken out of North, Middle and Main Flathead River in 1975 (Hanzel 1977). A large fishery also exists in Flathead Lake and will be censused in 1981-82. Restrictive measures were taken to preserve the bull trout fishery in the early 1950's. All the major spawning tributaries in the North and Middle Fork are closed to fishing. An 18 inch minimum size limit was also imposed to protect pre-spawners in the rivers and Flathead Lake.

A basin-wide inventory of bull trout spawning sites in the North and Middle Fork drainages was conducted in the fall of 1980. This survey, in conjunction with redd counts collected by B.C. Research in the Canadian portion of the North Fork, provided an index of relative importance of spawning areas in the basin. This data is presented in the section entitled "Inventory of Bull Trout Spawning Sites". With that information, we can evaluate the potential cumulative impacts of resource development on bull trout spawning.

The proposed diversion of Howell Creek as part of the Cabin Creek Coal development would eliminate as much as 18 percent of the total bull trout spawning in the North Fork of the Flathead River drainage included in the inventory. The diversion would dewater virtually all of the presently usable spawning habitat in Howell Creek. Extensive timber harvest is occurring in Sage, Kishenehn, and upper Couldrey creeks in Canada. These streams accounted for 12 percent of the bull trout spawning in the North Fork in 1980. Lower Sage Creek is also a critical rearing area for cutthroat trout. Fish densities in the Canadian stream reaches have not been evaluated to date.

Major timber sales in Trail, Coal, and Big creek drainages are adjacent to major bull trout spawning areas which accounted for 42 percent of the total observed spwning in the North Fork of the Flathead River drainages in 1980. The stream reaches are also critical rearing areas for juvenile bull trout, as defined by present high fish densities.

In summary, at least 72 percent of the prime bull trout spawning and over 30 percent of the critical rearing areas for juvenile trout could be directly impacted by resource development in the North Fork drainage over the next five years. Taken individually, these developments might seem insignificant or mitigatible; however, taken in total, they threaten the future of bull trout in the North Fork.

Bull trout spawning in 1980 was equally divided between the North and Middle Forks of the Flathead River. Historically, the South Fork also provided a significant proportion of the bull trout recruitment to Flathead Lake. Construction of Hungry Horse Dam in 1953 prevent bull trout coming out of Flathead Lake from entering the South Fork. Estimated loss of recruitment of bull trout to Flathead Lake from the South Fork was 40 to 60 percent of the total drainage based on estimates of available rearing areas. Degredation of spawning and rearing habitat in the North Fork would significantly affect the stability of the remaining population.

The Middle Fork of the Flathead River may not provide a secure refuge for the remaining bull trout population. The U.S. Forest Service is preparing an E.I.S. on leasing for oil and gas in the Bob Marshall and Great Bear Wilderness areas by the fall of 1981 (Figure 25). Attempts to conduct seismic exploration in those two wilderness areas is presently held up in appeals. The surface explosion exploration would parallel or intersect sections of six major tributaries in the Middle Fork drainage which accounted for 39 percent of the spawning in the Middle Fork drainage in 1980. Six of the 18 critical rearing areas for trout which have been identified to date in the Middle Fork parallel the proposed seismic routes. A timber sale (10 MMBF) is proposed for the upper Granite and Morrison creek drainages for 1983 (Doug Maryott, U.S.F.S personal communication). These two drainages contained 41 percent of all bull trout redds located in the Middle Fork drainage in 1980. The remaining bull trout population is threatened in the North Fork and its future is uncertain in the Middle Fork.

Restrictive regulations have existed for many years to protect spawning bull trout in tributary streams and pre-spawning size fish in the lake. Increased access and development in the North Fork will likely result in much more restrictive fish regulations for bull trout in the future. However, these restrictions will do little good in preserving the existing fishery unless attention is paid to the cumulative impacts of development on the bull trout population.

This section of the report was not prepared to present specific recommendations to minimize negative impacts of development on the fishery. Some of the impacts would be increased siltation in streams resulting in channel instability, reduced carrying capacity for fish food organisms, decreased survival of fish eggs in the stream bed, and fewer fish in both the Flathead River and Lake. Certain criteria already exist to regulate these disturbances. Too often these criteria are applied on a project by project basis. Only recently has any attempt been made to look at the cumulative affects of resource development on stream drainages. The significance of using cumulative impact assessment is illustrated with the bull trout spawning data. This can help put in perspective some of the complex problems involved in managing and mitigating our wildlife resources.

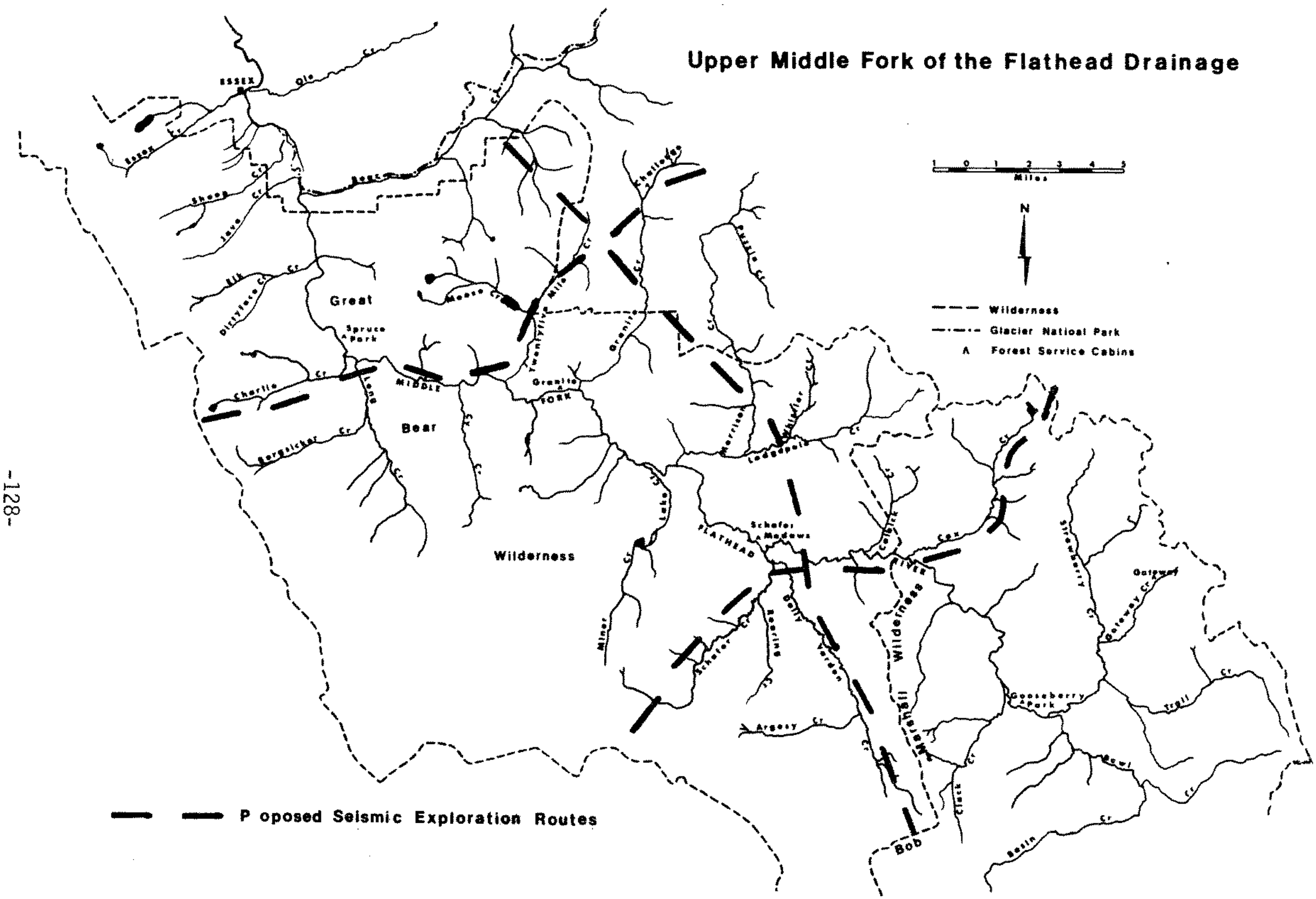


Figure 25. Proposed route of seismic exploration in the Bob Marshall and Great Bear Wilderness areas (U.S.F.S. Progress Report; Consolidated Georex Geophysics Prospecting Permit Environmental Analysis).

LITERATURE CITED

Armstrong, R.H. 1970. Age, food, and migration of Dolly Varden smolts in southeastern Alaska. J. Fish, Res. Board Can. 27:991-1004.

Armstrong, R.H. and S.T. Elliot. 1972. A study of Dolly Varden in Alaska. Alaska Dept. of Fish and Game, Federal Aid in Fish Restoration, Annual Progressive Report, 1971-1972, Project F-9-13:1-34.

Bauman, R.W., A.R. Gaufin, and R.F. Surdick. 1977. The stoneflies (Plecoptera) of the Rocky Mountains, Memoirs of Amer. Ent. Soc. 31. 208 p.

Binns, N.A. and F.E. Eiserman. 1979. Quantification of fluvial trout habitat in Wyoming. Trans. Amer. Fish. Soc. 108(3):215-228.

Bjornn, T.C. 1961. Harvest age structure and growth of game fish population from Priest and Upper Priest Lakes. Trans. Amer. Fish. Soc. 90(1):27-31.

Blackett, R.F. 1968. Spawning behavior, fecundity, and early life history of anadromous Dolly Varden (*Salvenlinus malma*) in southeastern Alaska. J. Fish Res. Board Can. 30:543-548.

Block, D.G. 1955. Trout migration and spawning studies on the North Fork drainage of the Flathead River. M.S. Thesis, University of Montana 68 p.

Burns, J.W. 1971. The carrying capacity for juvenile salmonids in some northern California streams. Calif. Fish and Game. 57(1):44-57.

Carlander, K.D. 1969. Handbook of fresh water fishery biology, Vol. I. Iowa State University Press. 752 p.

Cardinal, P.J. 1980. Habitat and juvenile salmonid populations in streams in logged and unlogged areas of southeastern Alaska. M.S. Thesis. Montana State Univ., Bozeman. 115 p.

Flathead Drainage 208 Project. The North Fork of the Flathead River: a baseline characterization. 89 p.

Graham, P.J. 1977. Juvenile steelhead trout densities in the Lochsa and Selway River drainages. M.S. Thesis, University of Idaho, Moscow. 91 p.

Graham, P.J., R. Penkall, and D. Burkhalter. 1980a. RTRN, a fish tag return program. Dept. Fish, Wildlife & Parks. 5 p.

Graham, P.J., D. Read, S. Leathe, J. Miller and K. Pratt. 1980b. Flathead River Basin fishery study. Mont. Dept. of Fish, Wildlife and Parks. 166 p.

Graham, P.J., S.L. McMullin, S. Appert, K.J. Frazer, and P. Leonard. 1980c. Impacts of Hungry Horse Dam on aquatic life in the Flathead River. Annual Rept., Mont. Dept. of Fish, Wildlife and Parks, Kalispell. 91 p.

Griffith, J.S. 1974. Utilization of invertebrate drift by brook trout and cutthroat trout in small streams in Idaho. Trans. Amer. Fish. Soc., 103(3):440-447.

Hanzel, D.A. 1966. Survey of cutthroat trout and Dolly Varden in the Flathead River and tributaries above Flathead Lake. Mont. Dept. Fish and Game. Project No. F-7-R-14, Job No. III. 8 p.

Hanzel, D.A. 1977. Angler pressure and game fish harvest estimates for 1975 in the Flathead River system above Flathead Lake. Fisheries Investigation Report, Mont. Dept. of Fish and Game, Helena. Project No. P-1-23.

Hesse, L. 1977. FIRE I, a computer program for the computation of fishery statistics. Nebraska Tech. Ser. No. 1. Nebraska Game and Parks Commission. Project No. F-10-R. 60 p.

Horner, N.J. 1978. Survival densities, and behavior of salmonid fry in streams in relation to fish predation. M.S. Thesis. Univ. of Idaho, Moscow. 118 p.

Hunter, J.W. 1973. A discussion of game fish in the state of Washington as related to water requirements. Wash. State Dept. of Game, Fisheries Mgmt. Div. 66 p.

Huston, J.E. 1972. Life history studies of westslope cutthroat trout and mountain whitefish. Mont. Dept. of Fish and Game. Project No. F-34-R-5. Job No. IIIa. pp. 1-7.

Hynes, H.B.N. 1972. The ecology of running waters. Univ. of Toronto Press. 555 p.

Johns, W.M. 1970. Geology and mineral deposits of Lincoln and Flathead counties, Montana. Mont. Bureau of Mines and Geology, Bulletin 36. 68 p.

Johnson, T.H., and T.C. Bjornn. 1978. Evaluation of angling regulations in management of cutthroat trout. Idaho Cooperative Fishery Research Unit, College of Forestry, Wildlife and Range Sec. Univ. of Idaho, Moscow. 153 p.

Lestelle, L.C. 1978. The effects of forest debris removal on a population of resident cutthroat trout in a small headwater stream. M.S. Thesis. Wash. State Univ.

Lewis, S.L. 1967. Physical factors influencing fish populations in pools of a trout stream. M.S. Thesis. Mont. State. Univ., Bozeman. 34 p.

May, B. and J.E. Huston. 1975. Habitat development of Youngs Creek, tributary to Lake Koocanusa. Mont. Dept. of Fish and Game. Final job rept. Contract No. DACW 67-73-E0002. 12 p.

McPhail, J.D. and C.B. Murray. 1979. The early life history and ecology of Dolly Varden (*Salvelinus malma*) in the upper Arrow Lakes. Report to B.C. Hydro and Power Authority and Kootenay Fish & Wildlife. 112 p.

Montana Dept. of Fish and Game. 1979. North Fork of Flathead River fisheries investigation. 73 p.

Mudge, R.M., R.L. Earhard and D.D. Rice. 1977. U.S. Geological Survey open end file rept. 77-25. 28 p.

Murrell, E.E. 1977. Growth and August food of juvenile and anadromous Dolly Varden (*Salvelinus malma*) and coho salmon, (*Onocorhymchus kisutch*) in the Boussole Valley of Glacier Bay National Monument, M.S. Thesis. Univ. of Alaska, Fairbanks. 66 pp.

Needham, P.R., and T.M. Vaughan. 1951. Spawning of the Dolly Varden, *Salvelinus malma*,, in Twin Creek, Idaho. Copeia, 1952, No. 3, pp. 197-199.

Northcote, J.G. and W.W. Wilkie. 1963. Underwater census of stream fish populations, Trans. Amer. Fish Soc. 92(2):146-151.

Nunallee, D.A. 1976. Summary of existing water quality data North Fork Flathead River above Flathead Lake, Montana. Dept. Health Env. Sci., Kalispell. 12 p.

Pacific Northwest River Basin Commission. 1976. River mile index. Clark Fork - Pend Oreille River. Washington, Idaho, Montana and British Columbia. 53 p.

Peterson, L.C., L. Randall, G. Gould, T. Hall, and D. Read. 1977. Fishery investigations, Glacier National Park, 1977 progress document. Dept. Interior, Fish and Wildlife Service, Kalispell, Montana. 322 p.

Platts, W.S. 1974. Geomorphic and aquatic conditions influencing salmonids and stream classification. U.S.F.S. surface environment and mining program report, Washington, District of Columbia U.S.A.

Platts, W.S. 1979a. Relationships among stream order, fish populations, and aquatic geomorphology in an Idaho river drainage. Fisheries (4)2:5-9.

Platts, W.S. 1979b. Including the fishery system in land planning. U.S.D.A. Forest Service Tech. Rept. INI-60. 37 p.

Ricker, W.E. 1971. Methods for assessment of fish production in fresh waters. Blackwell Scientific Publications. Oxford, England. 348 p.

Reiser, D.W. and T. Bjornn. 1979. Habitat requirements of anadromous salmonids. General Technical Report PNW-96. U.S.F.S. 54 p.

Sekulich, P.T. and T.J. Bjornn. 1977. The carrying capacity of streams for rearing salmonids as affected by components of the habitat. M.S. Thesis. Idaho Cooperative Fisheries Research Unit. Univ. of Idaho, Moscow. 79 p.

Snedecor, G.W. and W.G. Cochran. 1969. Statistical methods. Iowa State Univ. Press. 593 p.

Stanford, J.A., F.R. Hauer, and T.J. Stuart. 1979. Annual report of work completed during 1978-79 on limnology of Flathead Lake-River ecosystem. Flathead Research Group, Univ. of Montana Biological Station, Bigfork, Montana. 155 p.

Stanford, J.A., F.R. Hauer, T.J. Stuart, B.K. Ellis, and W.B. Perry. 1980. Limnology of the Flathead River-Lake ecosystem, Montana:Annual Report. Flathead Research Group. Univ. of Montana Biological Station, Bigfork, Montana. 443 p.

U.S. Geological Survey. 1979. Water resources data for Montana U.S.G.S. water data report. MT-79-1. 842 p.

Vincent, E.R. 1971. River electrofishing and fish population estimates. Prog. Fish Cult. 33(3):163-167.

APPENDIX A

Flow measurements, water temperature data and
reach description information for North and Middle Fork tributaries

Table 1 . Reach information for North Fork tributaries surveyed in 1980.

Drainage	Reach number	Drainage area(km^2)	Length (km)	Gradient (%)	Late summer flow (cfs)
Canyon Creek		76.9	14.2	4.7	--
	1	--	6.3	4.0	16.0
	2	--	7.9	3.2	10.7
McGinnis		--	6.7	--	--
	1	--	1.2	3.0	0.7
	2	--	5.2	--	--
Kimmerly			4.1	4.8	--
	1	--	4.1	4.8	3.1
Camas Creek		143.5	21.0	.6	--
	1	--	3.7	1.7	26.4
	2	--	8.6	N.S.	16.4
	3	--	8.7	<1	19.8
Dutch		71.2	18.1	1.8	--
	1	--	7.8	1.0	10.5
	2	--	5.5	2.0	10.6
	3	--	4.9	4.3	7.0
Anaconda Creek		101.5	14.0	2.2	--
	1	--	8.8	2.3	7.3
	2	--	6.3	4.0	3.6
Logging Creek		123.2	7.2	2.0	--
	1	--	7.2	2.0	60.1
Quartz Creek		135.9	12.7	2.2	--
	1	--	12.7	2.2	80.3
Cummings		--	5.1	2.8	--
	1	--	5.1	2.8	5.2
Moran Creek		23.6	13.0	4.0	7.3
	1	--	7.5	3.5	5.7
	2	--	1.6	8.0	2.9
	3	--	2.0	4.2	1.9
	4	--	2.0	25.0	3.2
Hay Creek		78.2	25.3	2.6	--
	1	--	8.5	3.3	21.3
	2	--	7.4	1.3	14.4
	3	--	7.5	2.6	8.6
	4	--	1.9	10.0	9.6

Table 1 . (Continued)

Drainage	Reach number	Drainage area(km²)	Length (km)	Gradient (%)	Late summer flow (cfs)
Bowman Creek		177.9	8.4	2.6	--
	1	--	8.4	2.6	26.4
Akokala Creek		120.2	16.8	2.0	--
	1	--	8.0	1.6	0.7
	2	--	8.8	2.2	35.3
Parke			7.7	5.7	--
	1	--	4.0	4.3	7.3
	2	--	2.3	1.0	10.4
	3	--	1.4	--	--
Long Bow			6.4	5.8	--
	1	--	6.4	5.8	7.3
Moose Creek		43.5	19.3	3.0	8.9
	1	--	5.1	2.6	10.8
	2	--	4.9	3.1	9.3
	3	--	9.2	3.5	6.7
Ford Creek		32.4	12.8	3.0	--
	1	--	6.9	2.0	3.2
	2	--	2.1	1.0	1.7
	3	--	3.8	5.0	1.7
Kintla Creek		138.0	4.7	1.7	--
	1	--	4.7	1.7	125.5
Starvation Creek		21.8	10.9	2.2	--
	1	--	7.7	2.5	17.1
	2	--	3.2	1.0	11.6
Kishenehn Creek		17.7	8.7	1.7	--
	1	17.7	8.7	1.7	67.4
Spruce Creek		7.6	5.4	2.0	--
	1	--	2.0	2.6	2.4
	2	--	3.4	3.1	4.2
Sage Creek		6.2	2.3	2.0	--
	1	--	2.3	2.0	48.3

Table 2. Reach information for Middle Fork tributaries surveyed in 1980.

Drainage	Reach number	Drainage area(km²)	Length (km)	Gradient (%)	Late Summer flow (cfs)
Long Creek		19.37	8.61	2.5	
	1		2.72	1.8	
	2		1.32	1.8	
	3		4.57	3.2	
Granite Creek		74.6	13.42	1.4	13.7
	1		7.89	1.7	
	2		5.53	1.0	
Lake Creek		19.37	7.43	1.6	21.4
	1		2.54	2.5	
	2		4.89	0.7	
Miner Creek		19.53	4.36	2.8	
	1		2.5	1.7	
	2		1.86	3.7	
Morrison Creek		133.1	22.39	2.0	28.5
	1		7.48	1.1	
	2		3.78	2.3	
	3		8.80	1.7	
	4		2.33	5.2	
Lodgepole Creek		49.2	10.66	1.1	
	1		6.53	1.1	
	2		4.13	1.0	
Whistler					
	1		3.12	1.6	
Schafer Creek		126.4	14.17	2.1	15.3
	1		4.60	0.4	
	2		1.13	2.1	
	3		4.78	1.0	
	4		3.66	6.0	
W. Fork Schafer					
	1		3.25	3.0	
Dolly Varden Creek		68.4	14.79	1.1	14.7
	1		13.05	1.0	
	2		1.74		
Argosy		15.4	5.19	3.5	
	1		1.46	5.8	
	2		3.73	2.7	

Table 2. (Continued)

Drainage	Reach number	Drainage area(km^2)	Length (km)	Gradient (%)	Late summer flow (cfs)
Calbick Creek		21.70	4.3	2.3	2.5
	1		4.3	2.3	
Cox Creek		51.57	11.56	1.5	1.4
	1		3.27	0.4	
	2		6.15	1.6	
	3		2.14		
Clack Creek		36.57	10.56	3.8	9.9
	1		2.82	1.0	
	2		2.67	1.0	
	3		5.07	7.0	
Bowl Creek		46.80	17.19	2.5	18.3
	1		2.59	2.1	
	2		4.20	2.5	
	3		1.6	0.5	
	4		6.4	3.3	
	5		2.4	3.6	
Basin		25.25	10.5	1.3	4.1
	1		2.1	1.3	
	2		6.6	1.1	
	3		1.8	3.1	
Strawberry Creek		71.04	19.75	1.2	15.2
	1		4.88	0.5	
	2		7.53	1.1	
	3		5.07	1.9	
	4		2.27	1.0	
E. Fork Strawberry			5.00	3.6	
	1		3.04	5.2	
	2		1.96		
Trail		49.91	11.74	2.0	9.6
	1		7.74	1.6	
	2		4.0	2.7	
Gateway		19.63	7.47	3.4	4.0
	1		2.49	2.9	
	2		2.16	4.0	
	3		1.77	4.8	
	4		1.05	1.2	
S. Fork Trail					
	1		4.79	2.5	

Table 3. Monthly averages of minimum and maximum water temperatures (°C) in the North Fork tributaries during 1980.

Month	Water temperature					
	Big Creek 1/	Coal Creek 2/	Logging Creek 3/	Red Meadow Creek 4/	Trail Creek 5/	River trap 6/
May						
Mean minimum	3.3	4.5	----	4.7	5.6	----
Mean maximum	5.2	6.0	----	5.1	6.7	----
Range	2.2-6.6	2.2-8.9	----	4.4-6.7	5.5-7.7	----
June						
Mean minimum	5.9	5.6	13.3	7.3	6.3	----
Mean maximum	8.5	7.2	15.4	7.9	8.4	----
Range	3.3-11.6	2.2-10.5	11.6-17.2	4.44-10.0	5.6-11.1	----
July						
Mean minimum	8.7	8.1	14.8	10.6	8.36	12.1
Mean maximum	12.9	12.2	19.0	12.1	11.5	17.8
Range	7.2-16.1	8.9-13.8	12.2-22.2	8.3-15.5	7.8-16.1	10.0-17.4
August						
Mean minimum	8.1	8.7	14.7	10.3	7.1	10.3
Mean maximum	11.5	11.5	18.7	11.8	11.1	13.8
Range	6.1-14.4	6.1-12.7	11.6-21.1	7.7-13.8	6.7-13.8	9.4-16.6
September						
Mean minimum	6.4	6.1	----	8.1	7.3	----
Mean maximum	8.7	8.2	----	9.6	9.3	----
Range	4.4-10.5	3.9-11.1	----	6.1-11.1	5.6-11.6	----
October						
Mean minimum	3.0	3.9	----	5.27	5.4	----
Mean maximum	5.2	4.4	----	6.3	6.4	----
Range	2.2-7.8	3.3-7.7	----	2.77-9.44	3.9-9.4	----

Table 3. (Continued)

Month	Water temperature					
	Big Creek 1/	Coal Creek 2/	Logging Creek 3/	Red Meadow Creek 4/	Trail Creek 5/	River trap 6/
November						
Mean minimum	3.7	3.9	----	4.02	4.6	----
Mean maximum	3.9	4.4	----	3.88	5.2	----
Range	1.1-5.0	2.8-5.0	----	2.2-5.5	3.3-6.1	----

1: Thermograph - in: May 1- out: May 17; in: May 28 - out: November 12
2: Thermograph - in: May 7- out: August 14; in: August 26 - out: November 12
3: Minimum-maximum thermometer - in: June 19 - out: August 31
4: Thermograph - in: May 21-out: August 13; in: August 23 - out: November 12
5: Thermograph - in: May 14-out: November 12
6: Minimum-maximum thermometer - in: July 27 - out: August 27

Table 4. 1980 discharges for North Fork tributaries representing relatively high and low flows. All measurements were taken near the North Fork road bridges.

Drainage	High water[1/]			Low water		
	Date	Discharge (cfs)	Gauge (cm)	Date	Discharge (cfs)	Gauge height (cm)
Big Creek	5/26	780[2/]	129.2	11/5	57.40	67.0
Coal Creek	6/5	373.93	55.4	11/5	65.45	17.6
Moran Creek	5/5	70.70	33.8	11/5	6.30	10.4
Hay Creek	6/9	68.21	34.4	11/5	23.45	19.8
Red Meadow Creek	5/5	218.25	57.9	11/5	18.90	20.4
Moose Creek	5/5	66.13	39.6	11/5	5.95	15.8
Whale Creek	6/9	197.02	46.0	11/5	71.40	31.1
Teepee Creek	5/5	35.05	39.9	11/5	.70	15.5
Trail Creek	6/9	162.43	32.3	11/5	51.20	10.9

1: Peak flow occurred sometime between May 5 and June 9, 1980.
2: Flows were obtained from U.S.G.S. records.

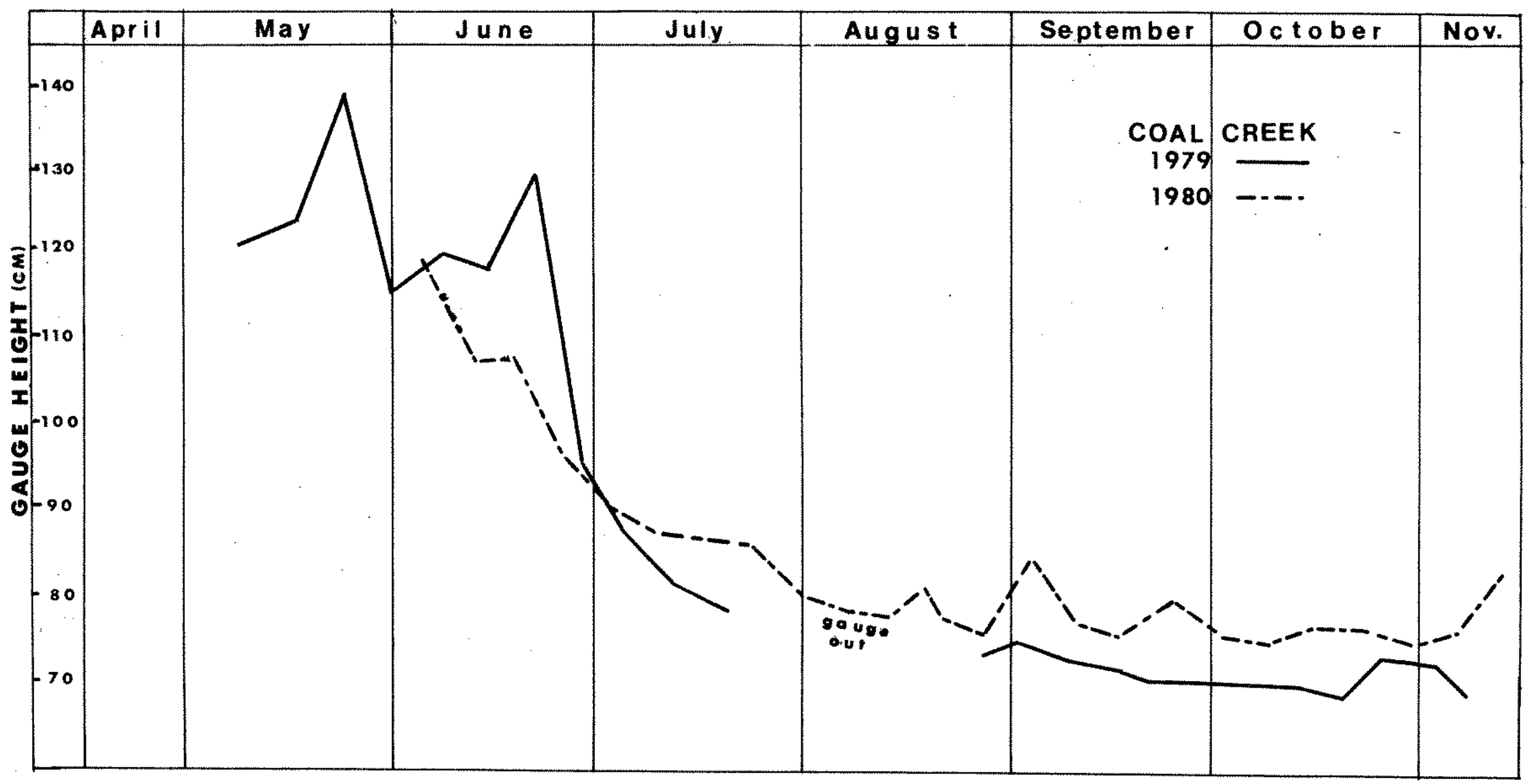


Figure 1. Seasonal water level fluctuation in Coal Creek during 1979 and 1980.

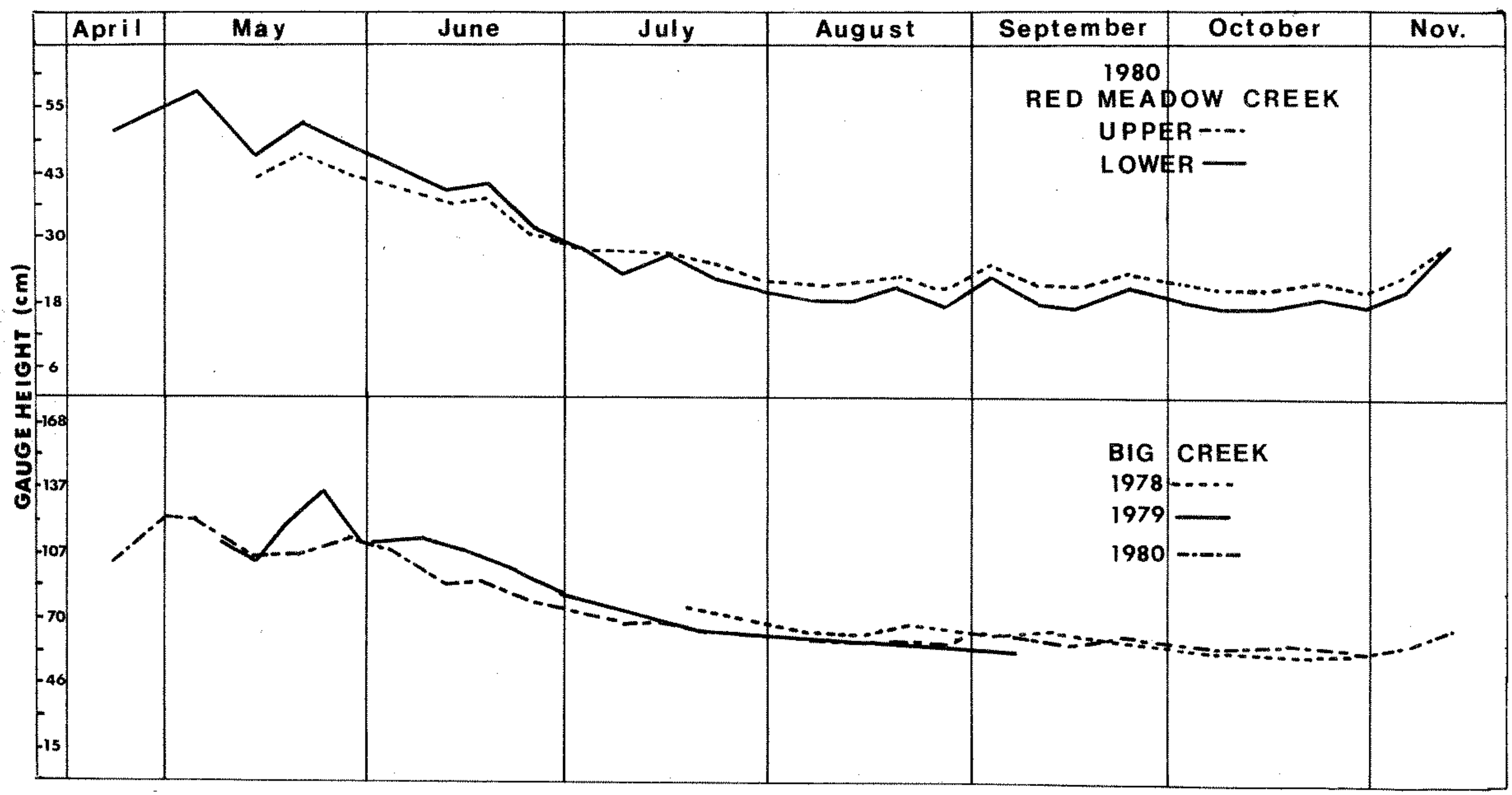


Figure 2. Seasonal water level fluctuations in Big Creek during 1978, 1979, and 1980, and two locations on Red Meadow Creek in 1980.

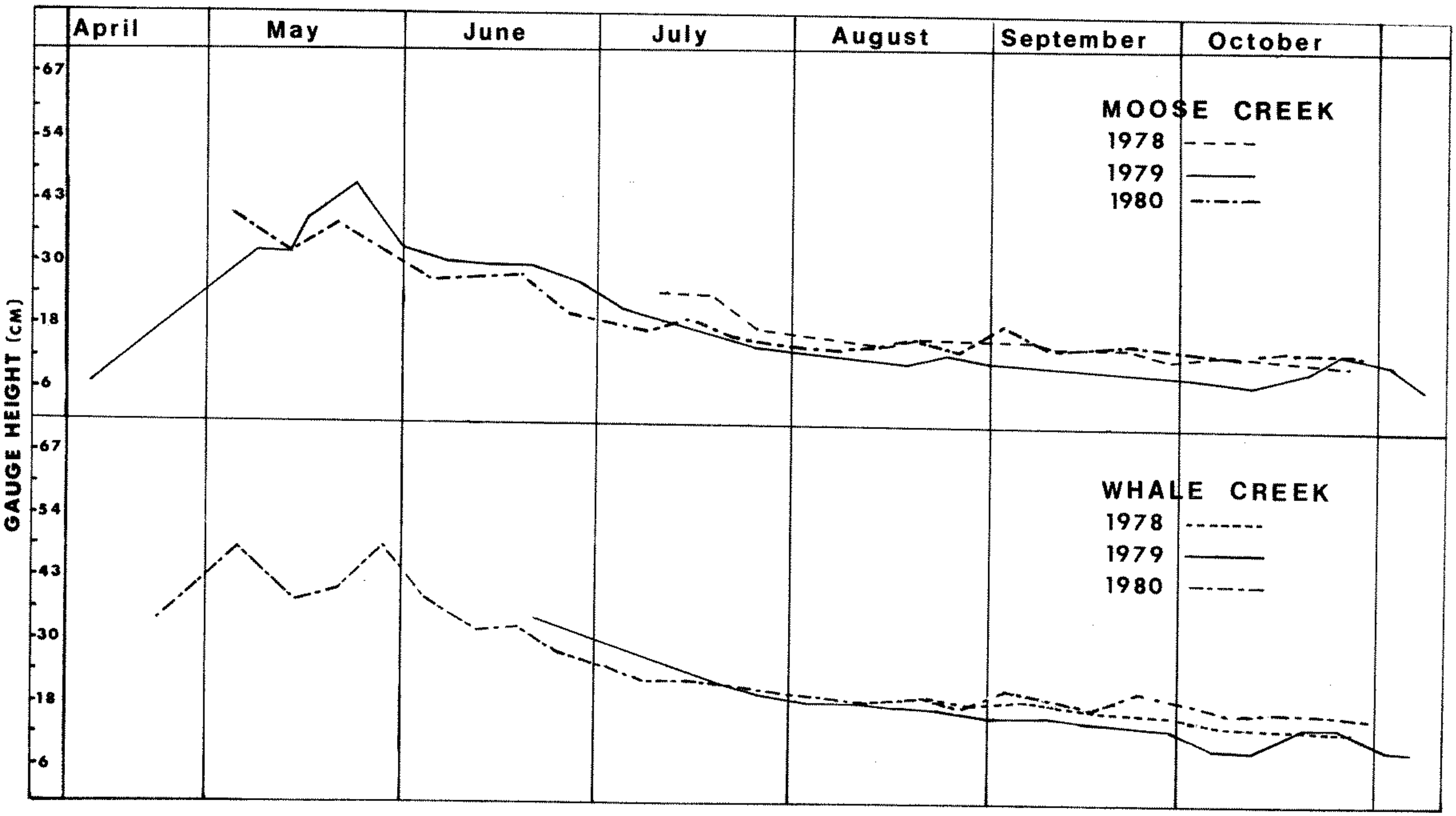


Figure 3. Seasonal water level fluctuations in Moose and Whale Creeks during 1978 and 1979.

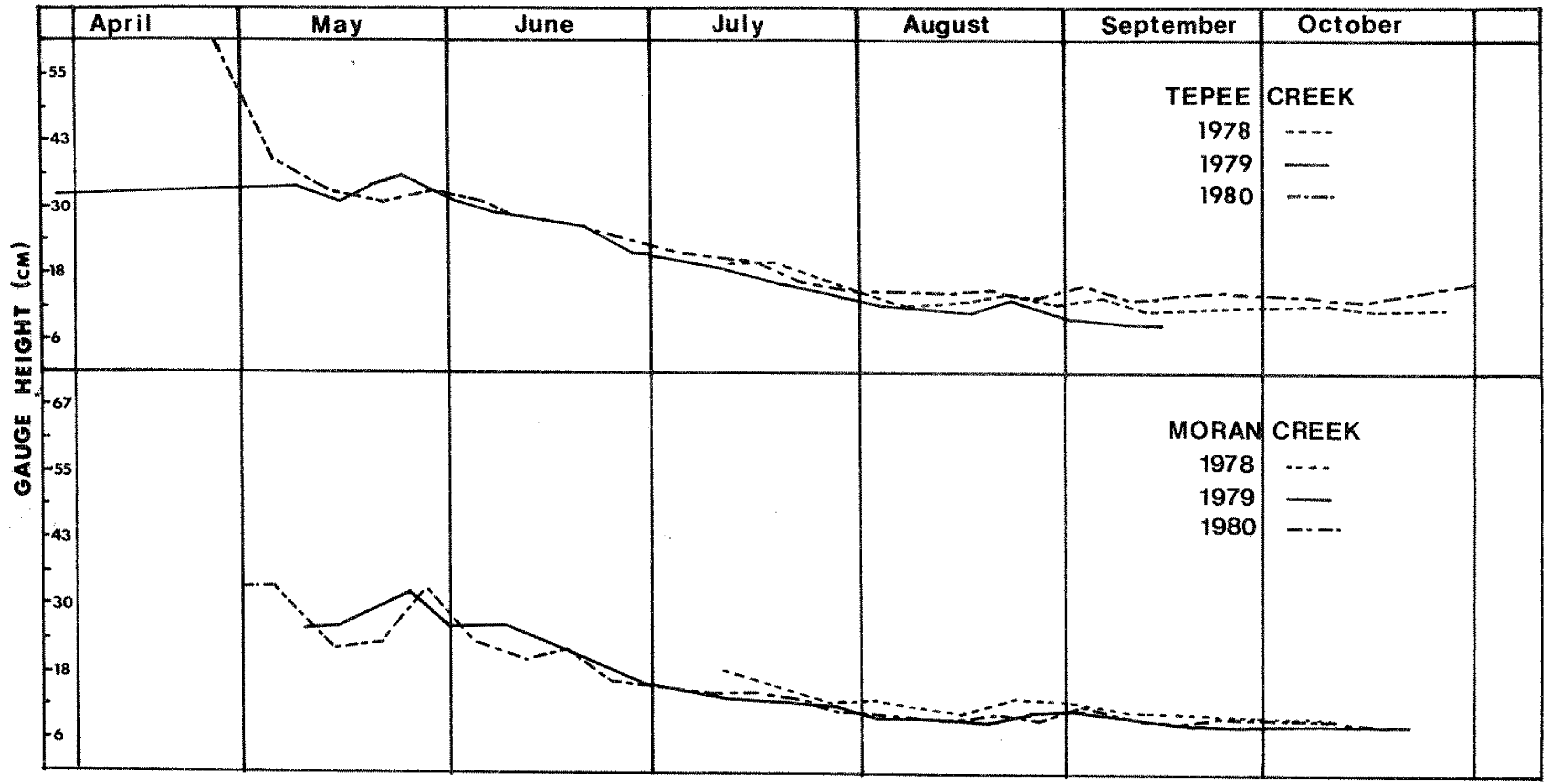


Figure 4. Seasonal water level fluctuations in Teepee and Moran Creeks during 1978, 1979, and 1980.

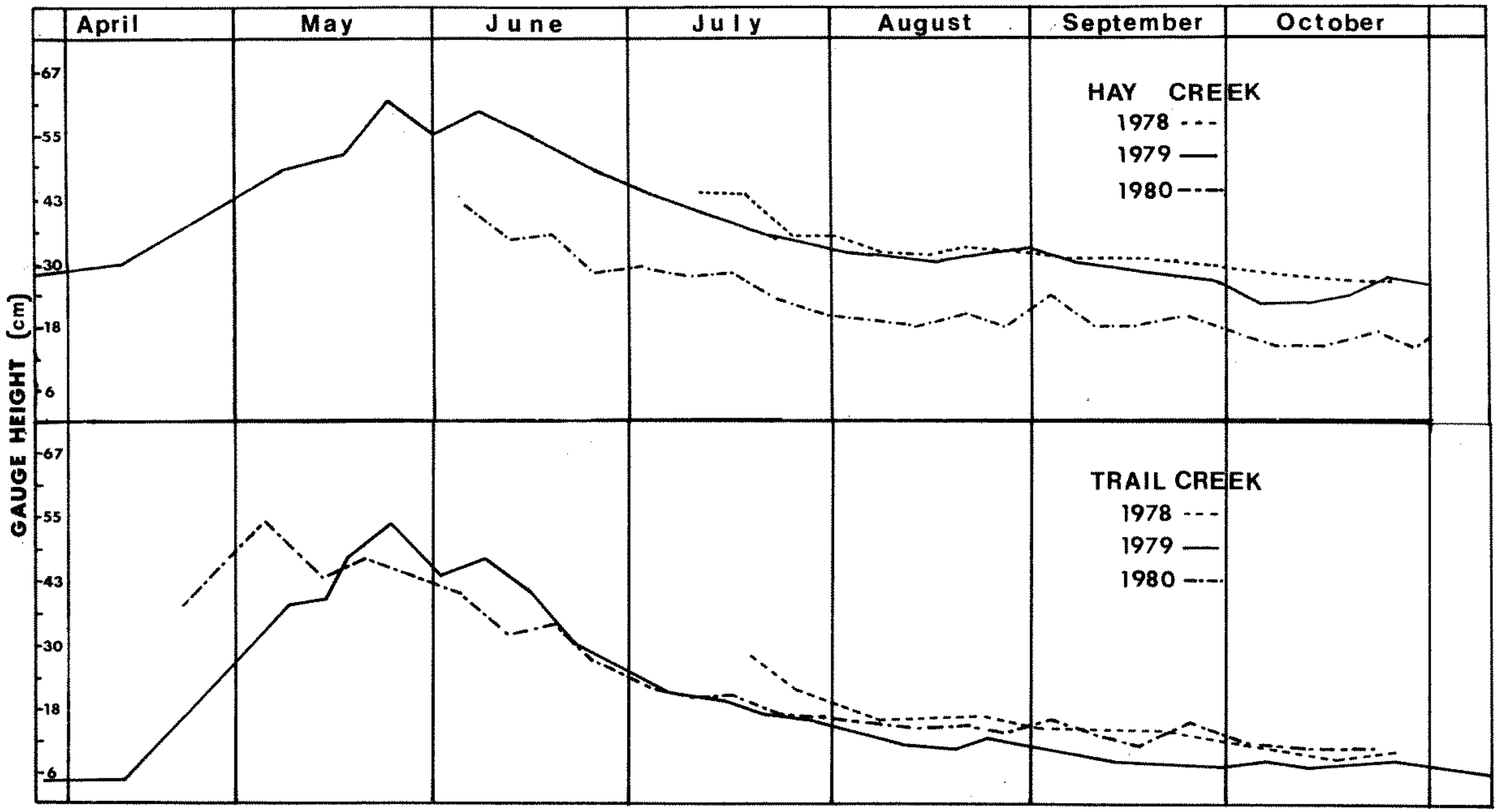


Figure 5. Seasonal water level fluctuations in Hay and Trail Creeks during 1978 and 1979.

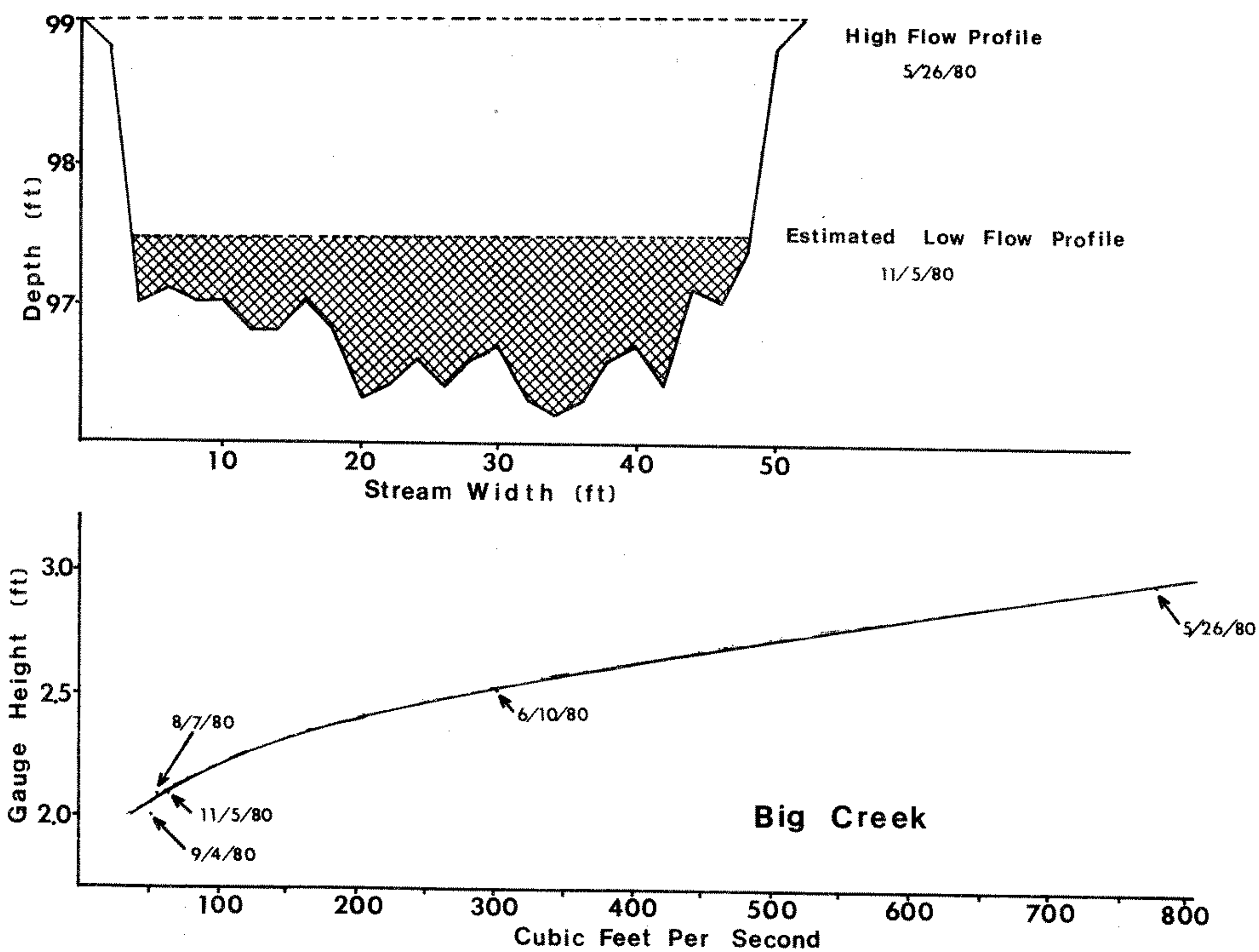
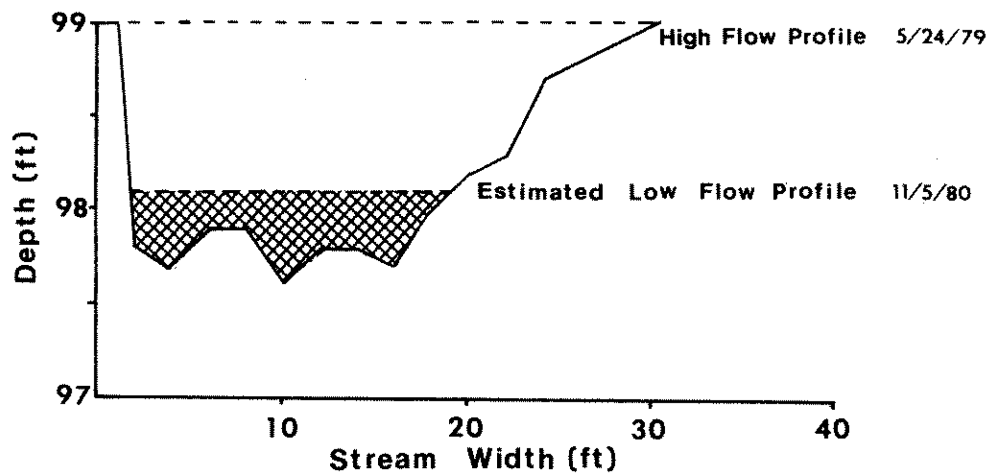


Figure 6. Gauge height and flow relationship for Big Creek. Dates of flow measurements are indicated along the discharge curve.



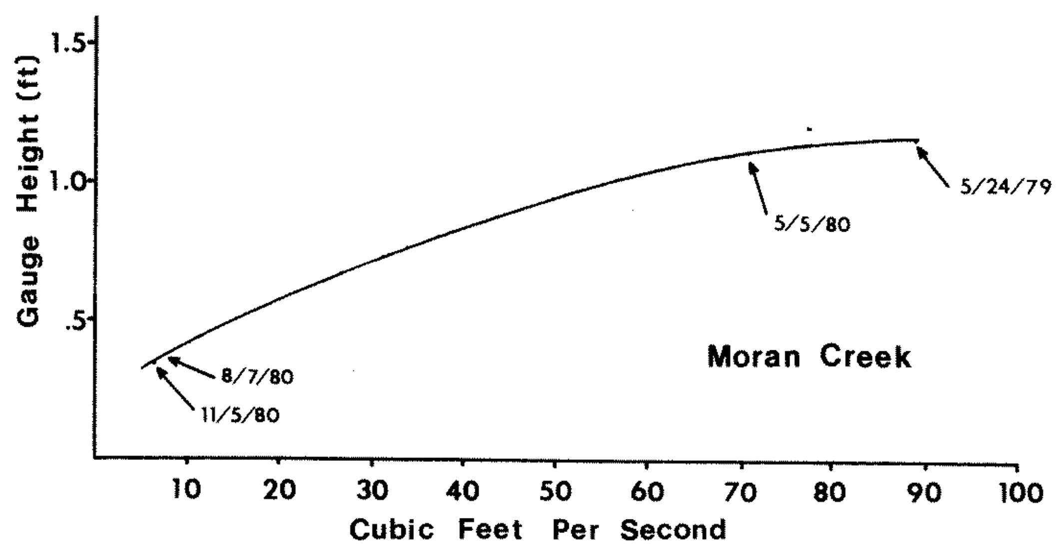


Figure 7. Gauge height and flow relationship for Moran Creek. Dates of flow measurements are indicated along the discharge curve.

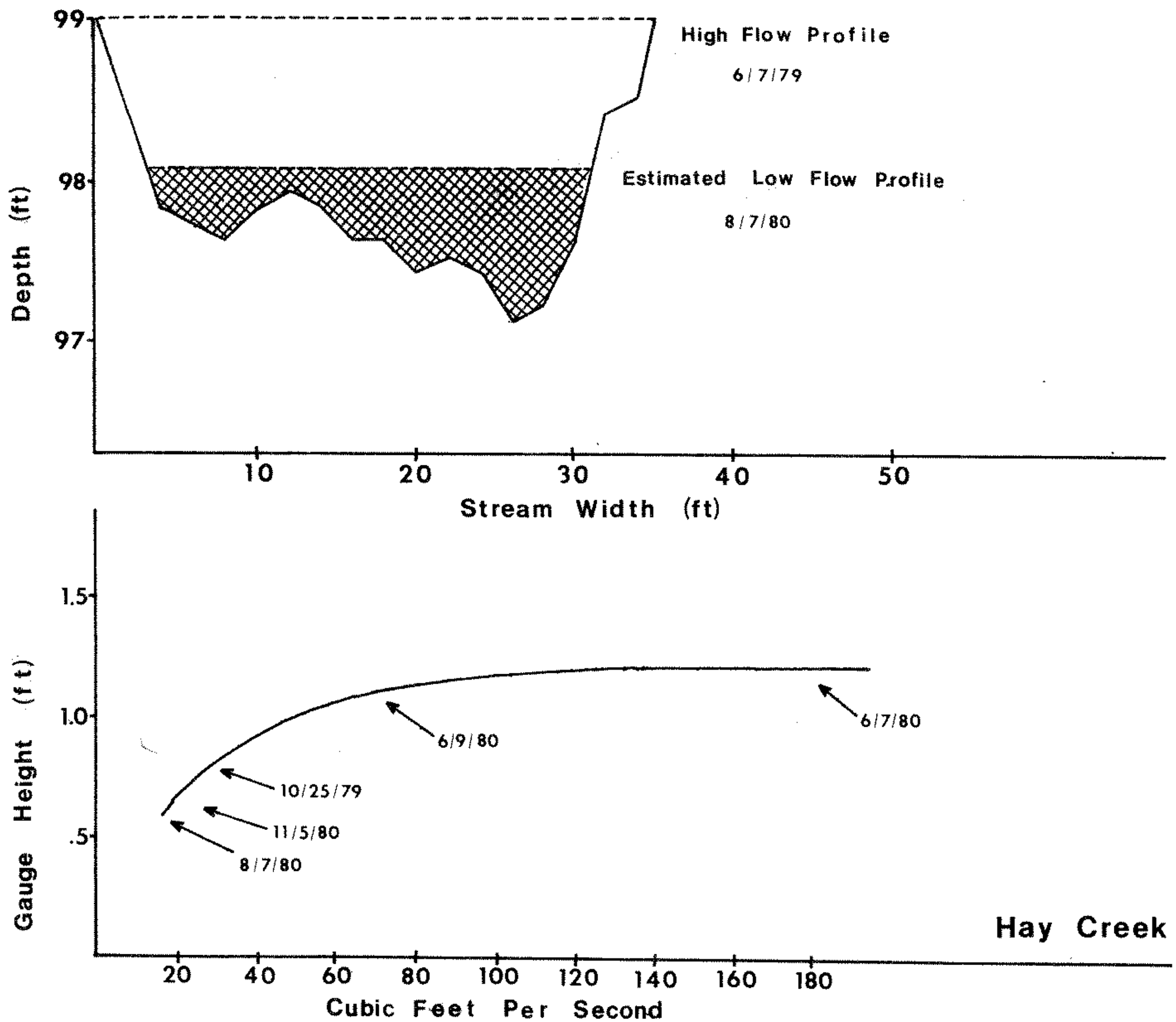


Figure 8. Gauge height and flow relationship for Hay Creek. Dates of flow measurements are indicated along the discharge curve.

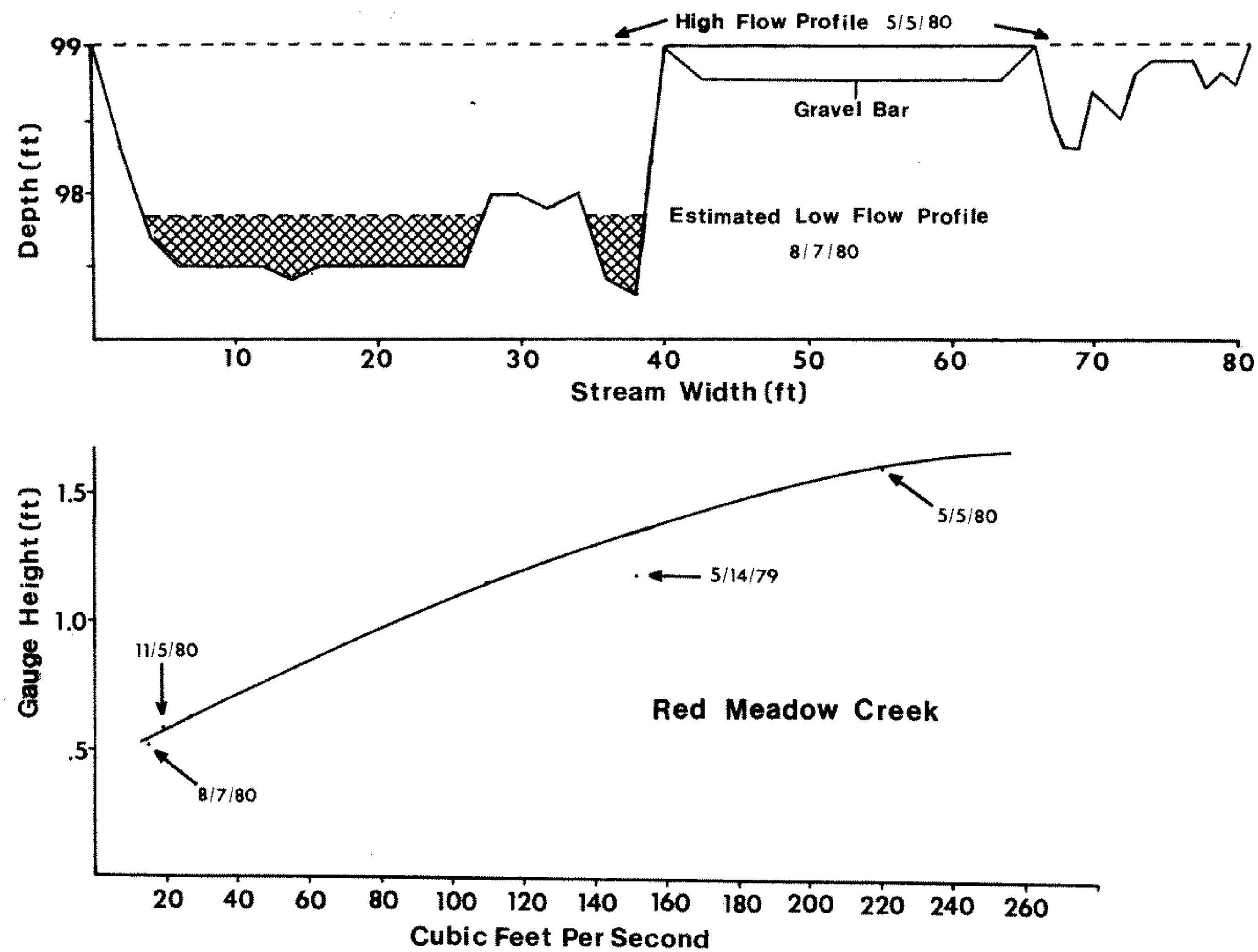


Figure 9. Gauge height and flow relationship for Red Meadow Creek. Dates of flow measurements are indicated along the discharge curve.

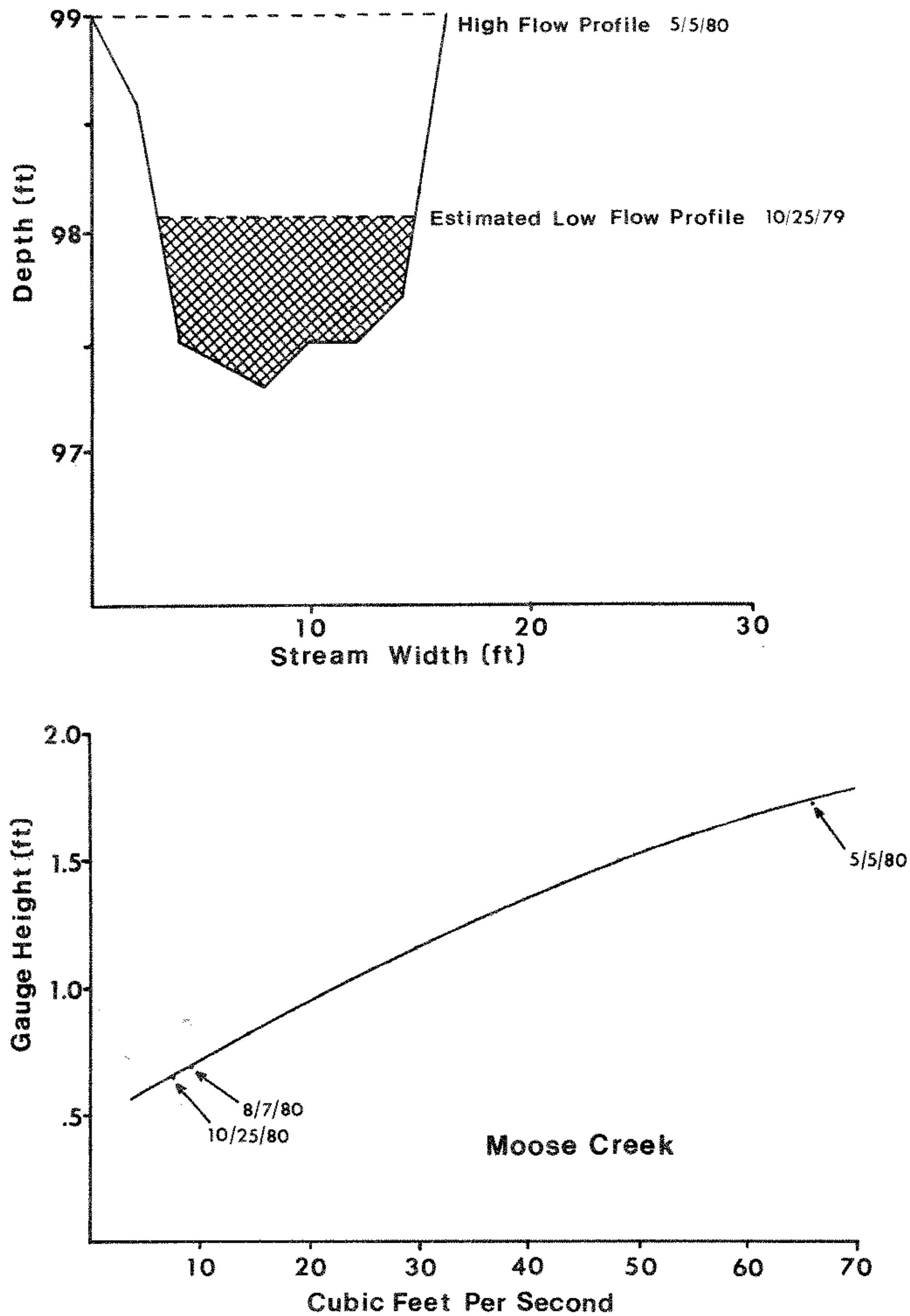


Figure 10. Gauge height and flow relationship for Moose Creek. Dates of flow measurements are indicated along the discharge curve.

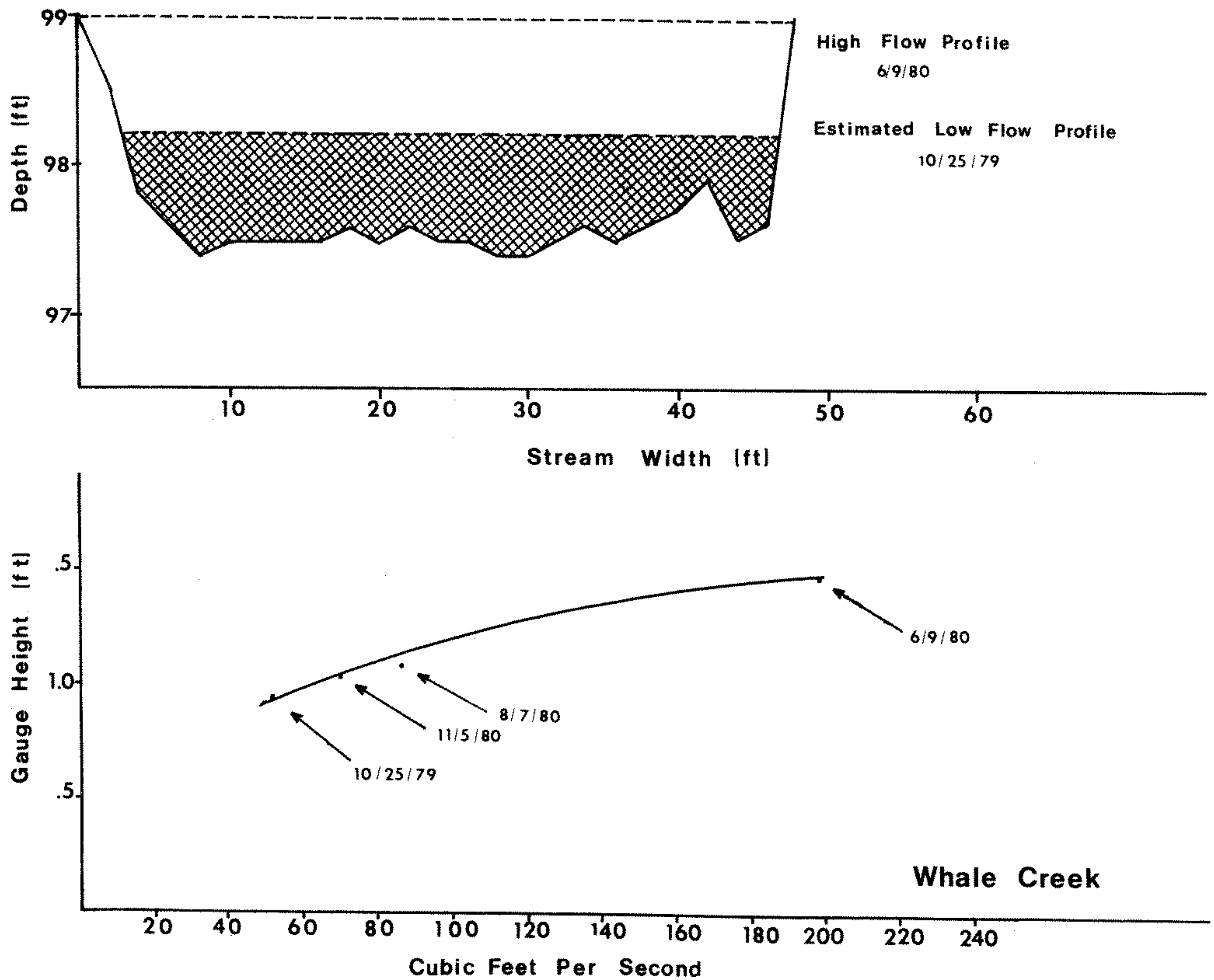
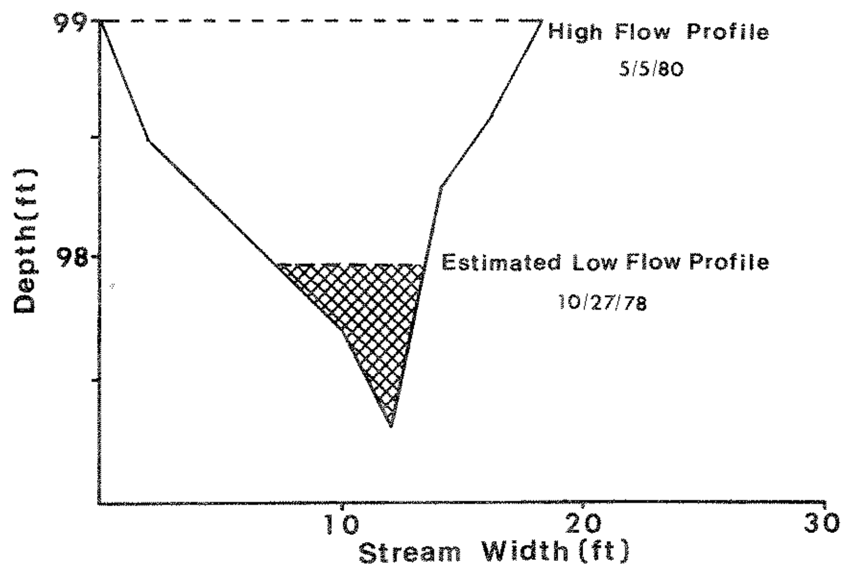


Figure 11. Gauge height and flow relationship for Whale Creek. Dates of flow measurements are indicated along the discharge curve.



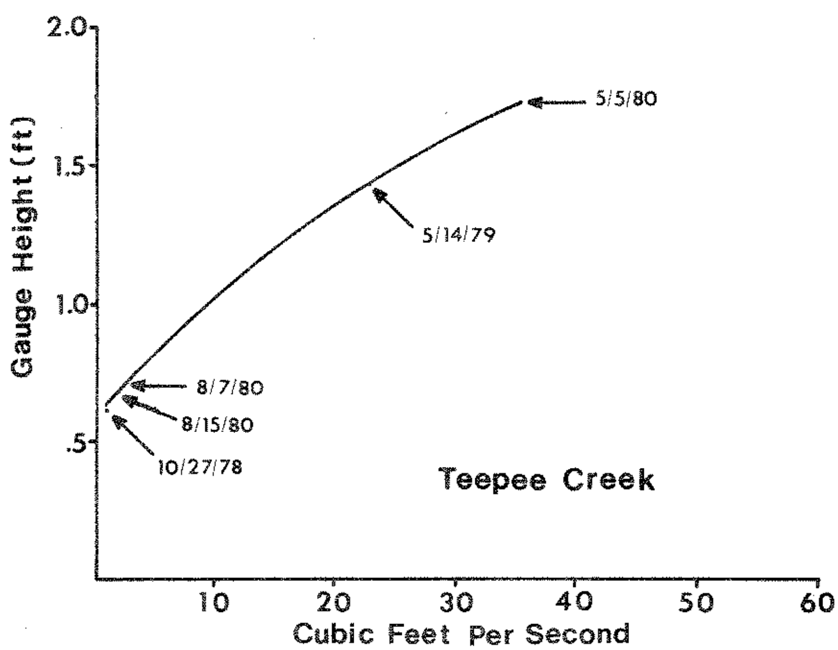


Figure 12. Gauge height and flow relationship for Teepee Creek. Dates of flow measurement are indicated along the discharge curve.

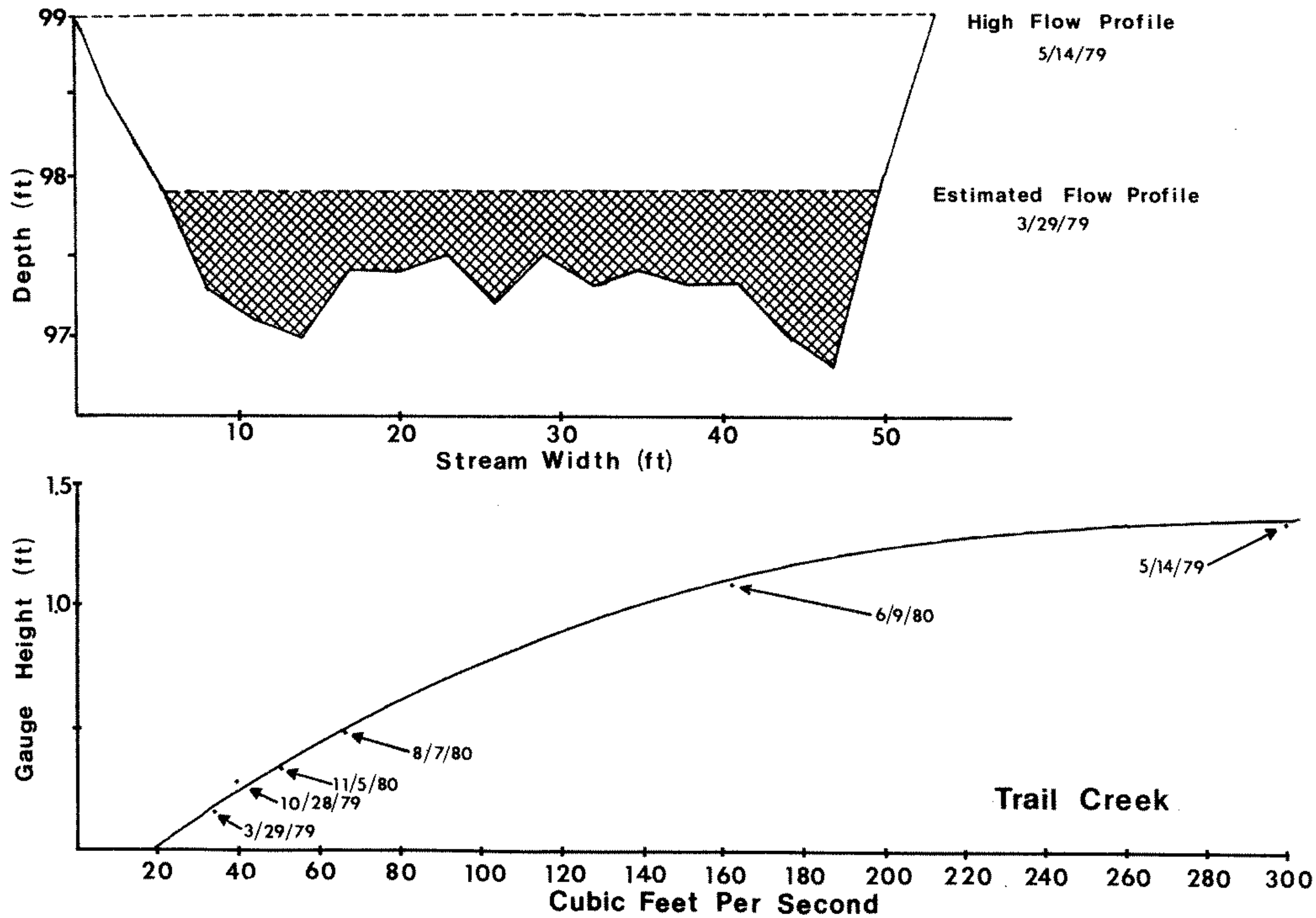


Figure 13. Gauge height and flow relationship for Trail Creek. Dates of flow measurements are indicated along the discharge curve.

APPENDIX B

Data entry format and explanation for the Interagency Stream Fishery Data Input Form for cards 1-22. Format, instructions and example forms for additional cards 30-38.

INTERAGENCY STREAM FISHERY DATA INPUT
FORM INSTRUCTIONS FOR DATA ENTRY CARDS 1-22

CARD 1:

Serial Number: This number will be controlled by regional or state office or agency entering information.

State: The code for Montana is 30.

Hydrologic Unit Code: This entry designates the drainage. Regional and state office of each agency have these codes.

Stream Order: A numerical class identification assigned to a tributary based on its location in the drainage. Two first order streams meet to form a second order stream, etc.

State Water Code and Water Type: State water code and water type are obtained from a list furnished by the Montana Department of Fish, Wildlife, and Parks. Stream water type codes are 01 - 19, with 19 being a stream unable to sustain a population of fish.

Reach: Portion of a stream with a distinct association of physical habitat characteristics. Gradient is the major factor in reach delineation.

Reach Number: The reaches are numbered consecutively from the mouth, up the stream.

CARD 2 AND 3:

Reach Boundaries: Brief description of upper and lower boundaries and map coordinates for these boundaries.

Elevation: Upper and lower elevation of reach boundaries in meters.

Average Wetted Width: Average of measurements from one water's edge to the other, taken at random intervals within the habitat section.

Tributary To: U.S.G.S. map name of stream or river into which the study stream converges.

County: All Flathead County streams are 029.

CARD 5:

Fish and Game Region: All Flathead County streams are in Region One.

Percent Pocket Water: A series of small pools that do not calssify as pools individually, but in combination create fish habitat. Pocket waters are usually found in boulder or cascade areas.

Ingress: Legal availability of public access to the stream.

CARD 8:

Flow During Survey: The instream flow (m^3/sec) during the survey and the date of observation.

Normal Low Flow: Lowest flow expected during an average year from past records or as can be estimated. Note: This is not the historic low flow.

Valley Flat: The area of a valley bottom which may flood, including low terraces. Relic terraces which cannot be flooded by the present river are excluded from the valley flat.

Channel Width: The width of the channel from rooted vegetation to rooted vegetation.

Average Maximum Pool Depth: The maximum depth measured in the deepest pool in the habitat section.

Gradient (%):

$$= \frac{\text{Difference in elevation (meters) from upper to lower end of reach}}{\text{Length of reach (meters)}}$$

This is usually measured with a clinometer or is calculated from a topographic map.

Pool-Run-Riffle Ratio: The estimated percent of each type, for a portion of the stream at low water. In combination with pocket water, equals 100%.

- Pool - Usually deeper, quiet water, although pools may be at the base of falls.
- Run - Moderately moving water with the surface not turbulent to the extent of being broken. Intermediate between pool and riffle.
- Riffle - Shallow, fast moving water where the surface is turbulent and broken.

CARD 9 AND 10:

Bottom Type: Entered under Run. Percent make-up of bottom substrate (the bed material).

Average Peak Water Temperature: The highest water temperature measured during the summer.

Spring Creek: A spring creek or spring stream is identified by its fairly constant temperature, flow, and clear water. Watercress will often be present.

Affected by Lake: When lake or impoundment significantly affects water temperature, flow pattern, fish food, or fish runs within the reach or stream.

Inundated by Beaver Ponds: The percent of the reach length presently impounded by beaver ponds is entered.

D-90: The diameter of bed material which is larger than 90 percent of the remaining material. Measured by length of intermediate axis.

Total Alkalinity and Specific Conductance: Alkalinity and conductivity values are measured at the lower end of individual drainages during the low flow period.

Floating: Recreational use by boaters.

Special Value: Importance as a trout recruitment stream.

CARD 11:

Channel Stability Rating Elements: Nine ratings of bank stability combined with six ratings of bed stability for a stream reach. U.S. Forest Service stability evaluation field forms were used.

Pool Classes: The percentage of the pools in the reach in each pool class. Total = 100 percent. Pool classes are determined as follows:

Size: Measurements refer to the longest axis of the intersected pool

3 - Pool larger or wider than average width of stream
2 - Pool as wide or long as average stream width.
1 - Pool much shorter and narrower than average stream width.

Depth Ratings
3 - Over 3 feet
2 - 2-3 feet
1 - Under 2 feet

Cover Ratings
3 - Abundant cover
2 - Partial cover
1 - Exposed

Total Ratings	Pool Class	
8-9	1	
7	2	
5-6[1]	3	
4-5	4	
3	5	Pocket water

1: Sum of 5 must include 2 for depth and 2 for cover.

CARD 13 AND 14:

Habitat Value for Fishes of Special Concern: A judgement value of habitat for spawning and production of westslope cutthroat.

Fish Population: List of game fish species present, their abundance and dominant use.

CARD 19:

Imbeddedness: The filling of the interstitial spaces of a gravel or rubble stream bottom with sand or fines.

Habitat Trend: All man-caused activities in or adjacent to the stream as well as dynamic natural processes.

Esthetic: Description of the pristine qualities of the reach.

CARD 20:

Channel Alterations: Cause, type, and length of artificial and natural changes occuring in the stream channel.

Bank Encroachment: Description of structure or activities that interfere with natural stream or flood plain hydraulics.

CARD 21:

Data Source: Month, year, field person, and agency to be contacted concerning data and agency.

CARD 22:

Information on the reach not contained on other cards.

ADDITIONAL INFORMATION:

Parameters were rated based on the following criteria:

1-3 means the data rated were based on judgement estimates.

4-6 means the data rated were based on limited measurements.

7-9 means the data rated were based on extensive measurements.

INTERAGENCY STREAM FISHERY DATA INPUT
FORM INSTRUCTIONS FOR DATA ENTRY CARDS 30-38

Cards 30-35 are optional, but any module that has entries must be complete, i.e., species (codes) and densities must be filled out.

CARD 30 - POOLS

Column 6-7: Method of estimating (see code sheets for method abbreviations)

Column 8: Rating, enter 1-9

Column 9-11: Enter species code (Enter 3 digit number) (012)

Columns 12-27: Enter density (0-999.9) per 100 m^2 for each age class.

Columns 28-30: Enter species code (005)

Columns 31-46: Enter densities (0-999.9) per 100 m^2 for each age class

Columns 47-49: Species code (085)

Columns 50-57: Densities (0-999.9) per 100 m^2

If a species is not present, leave species code and density columns blank.

CARD 31 - 34 - RUNS, RIFFLES, POCKET WATER, COMBINED FEATURES

Same as Card 30

CARD 35

Same as card 30 except enter Biomass (g/100 m^2) (0-999.9) instead of density.

CARD 36

Option, but any module that has entries must be complete, i.e., number, density, year and rating must be filled out.

Columns 6-8: Number of bull trout redds in reach, enter 0-999

Columns 9-11: Density of redds (No/Km) (0-99.9)

Columns 12-13: Year of redd survey (1950 to 1980)

Columns 14: Rating 1-9

Sequence repeated through column 41.

CARD 37 - ADDITIONAL PHYSICAL HABITAT DATA

Columns 6-8:	Average depth (0-999 cm)
Column 9:	Rating (1-9)
Columns 10-11:	Percent cover, overhang (0-99 or blank)
Columns 12-13:	Percent canopy (0-99 or blank)
Column 14:	Rating (1-9)
Columns 15-17:	Wetted cross sectional area (m^2) .1-99.9
Column 18:	Rating (1-9)
Columns 12-25:	Drainage area (1-999999.9 or blank)
Column 26:	Rating (1-9)
Column 27:	Barrier Type (see code sheet for abbreviations)
Columns 28-31:	Bariers (0-999.9 or blank)
Column 32:	Rating (1-9)
Columns 33-42:	Percent cover in features (0-99, or blank)
Column 43:	Rating (1-9)
Columns 44-46:	Blank
Columns 47-48:	Flow Characteristics (see code sheet for abbreviations, Alpha code - dominant in Col. 48)
Column 49:	Blank
Columns 50-51:	Valley - channel ratio (1-99)
Column 52:	Rating (1-9)
Column 53:	Confinement (see code abbreviations)
Column 54:	Pattern (see code abbreviations)
Column 55:	Flood Plain debris - N L M H
Column 56:	Channel debris - N L M H
Columns 57-59:	Percent of stable debris (0-100)
Column 60:	Rating (1-9)

Column 61: Bank Form (see code abbreviations)

Column 62: Bank Process (see code abbreviations)

Column 63: Type of Genetic Mat'l. (see code abbreviations)

Column 64: Rating (1-9)

<u>CARD 38 - OPTIONAL</u>

Chemical parameters and ratings, optional, all can be blank

Lines 6-9: Total Carbon (.01-9.99) Rating 1-9

Lines 10-13: Total Phosphorus (.001-.999) Rating 1-9

Lines 14-17: No_3 - (.01-9.99) Rating 1-9

Lines 18-21: SO_4 - 2 (.1 - 99.9) Rating 1-9

Lines 22-25: Na^+ (.1-99.9) Rating 1-9

Lines 26-29: K^+ (.01-9.99) Rating 1-9

Lines 30-33: Ca^{+2} (.1-99.9) Rating 1-9

Lines 34-37: Mg^{+2} (.1-99.9) Rating 1-9

Line 38: Turbidity - N L M H, (Nil, Low, Moderate, High)

CODE ABBREVIATIONS

METHOD - THE METHOD OF OBTAINING FISH INFORMATION

BS:	Boat Electroshocking
DN:	Dip Netting
EL:	Electroshocking (Back pack)
SN:	Seining
GN:	Gill Netting
AG:	Angling
TP:	Traps
SW:	Swimming with face mask
VS:	Visual observations from above water
SP:	Spearing
CL:	Clubbing
HC:	Hand Capture
PS:	Poison
EX:	Explosives

FLOW CHARACTERISTICS

P:	Placid - Tranquil, Sluggish
S:	Swirling - Eddies, Boils, Swirls
R:	Rolling - Unbroken wave forms numerous
B:	Broken - Standing waves are broken, rapids, numerous hydraulic jumps
T:	Tumbling - Cascades, usually over large boulders or rock outcrops

BARRIER TYPES

A:	Complete barrier to all fish passage
B:	Barrier to spawning bulls
C:	Possible barrier to all fish passage
D:	Possible barrier to spawning bulls

CONFINEMENT

Confinement (R) - the degree to which the river channel is limited in its lateral movement by terraces or valley walls. The channel is either:

E:	Ent	Entrenched - The stream bank is in continuous contact (coincident with) valley walls.
C:	Conf	Confined - In continuous or repeated contact at the outside of major meander bends.
F:	Fr	Frequenctly confined by the valley wall.
X:	Oc	Occasionally confined by the valley wall.
U:	Un	Unconfined - not touching the valley wall.
N:	N/A	Not Applicable (e.g., where no valley wall exists.)

Confinement Classification

Entrenched

Confined

PATTERN

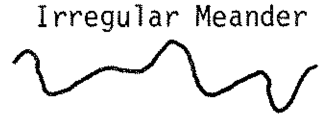
Pattern (R) - The channel pattern for the reach is described in terms of curvature. The channel is either:

S:	St	Straight - Very little curvature within the reach.
N:	Sin	Sinuous - Slight curvature within a belt of less than approximately two channel widths.
P:	Ir	Irregular - No repeatable pattern.
C:	Im	Irregular Meander - A repeated pattern is vaguely present in the channel plan. The angle between the channel and the general valley trend is less than 90°.
R:	Rm	Regular Meanders - Characterized by a clearly repeated pattern.
T:	Tm	Tortuous Meanders - A more or less repeated pattern characterized by angles greater than 90°.

Typical Meander Patterns

Straight

Irregular Meander



Sinuous

Regular Meander

Typical Meander Patterns, Cont.

Irregular

Tortuous Meander

TURBIDITY

H: High

L: Low

M: Moderate

N: Nil

BANK PROCESS (P)

The current fluvial process the bank is undergoing.

F: Failing - Active erosion and slumping is taking place.

S: Stable - The bank is composed of rock has very high root density, or is otherwise protected from erosion. Artificially stabilized banks should be noted in the comments.

A: Aggrading - Continuous sediment deposition is taking place, causing the river channel to migrate away from the river bank. Common on the inside of meander bends where it may be accompanied by the presence of a range of early to late seral vegetation.

BANK FORM

The range of bank forms is arbitrarily separated into four classes which reflect the current state of river processes. These are:

F: Flat - The river bed slopes gently to the beginning of rooted vegetation, frequently with overlapping bar deposits.

R: Repose - The bank is eroded at high water levels, but is at the angle of repose of the unconsolidated material (usually 34° - 37°).

S: Steep - The bank is nearly vertical, due to consolidation by cementation, compaction, root structure, or some other agent.

U: Undercut - The bank has an undercut structure caused by erosion. When undercut banks are stabilized by vegetation this should be indicated in the comments.

GENETIC MATERIALS (P)

Materials are classified according to their mode of formation. Specific processes of erosion, transportation, deposition, mass wasting and weathering produce specific types of materials that are characterized chiefly by texture and surface expression. For added detail, consult the Terrain Classification Manual (ELUC - Sec. 1976). Subsurface layers are noted in a comment. Descriptive terminology:

A:	Anthropogenic - Man-made or man-modified materials; including those associated with mineral exploitation and waste disposal, and excluding archaelogical sites.
C:	Colluvial - Product of mass wastage; minerals that have reached their present position by direct, gravity-induced movement (i.e. no agent of transportation involved). Usually angular and poorly sorted.
E:	Eolian - Materials transported and deposited by wind action. Usually silt or fine sand with thin cross-bedding.
F:	Fluvial - Materials transported and deposited by streams and rivers. Usually rounded, sorted into horizontal layers, and poorly compacted.
K:	Ice - Glacier ice.
L:	Lacustrine - Sediments that have settled from suspension in bodies of standing fresh water or that have accumulated at their margins through wave action. May be fine textured with repetative annual layers (varves).
M:	Morainal - The material transported beneath, beside, or within and in front of a glacier; deposited directly from the glacier and not modified by any intermediate agent. Usually poorly sorted and angular to sub-angular. May be highly compacted and have significant clay content.
X:	Organic - Materials resulting from vegetative growth, decay and accumulation in and around closed basins or on gentle slopes where the rate of accumulation exceeds that of decay.
R:	Bedrock - Rock outcrop and rock covered by a thin mantle (less than 10 cm) of consolidated materials.
S:	Saprolite - Weatered bedrock, decomposed in situ principally by processes of chemical weathering.
V:	Volcanic - Unconsolidated pyroclastic sediments that occur extensively at the land surface.

Card 35 (g/100M2) (Fish Biomass, All Features Comb.)	Card 34 (All Features Combined) (Density)	Card 33 (Pocket Water)	Card 32 (Riffles)	Card 31 (Runs)	Card 30 (Pools) Fish Densities (No./100M2)
Method Rating	Method Rating	Method Rating	Method Rating	Method Rating	Method Rating
Species Code	Species Code	Species Code	Species Code	Species Code	Species Code
Age 0	Age 0	Age 0	Age 0	Age 0	Age 0
Age I	Age I	Age I	Age I	Age I	Age I
Age II	Age II	Age II	Age II	Age II	Age II
Age III+	Age III+	Age III+	Age III+	Age III+	Age III+
Species Code	Species Code	Species Code	Species Code	Species Code	Species Code
Age 0	Age 0	Age 0	Age 0	Age 0	Age 0
Age I	Age I	Age I	Age I	Age I	Age I
Age II	Age II	Age II	Age II	Age II	Age II
Age III+	Age III+	Age III+	Age III+	Age III+	Age III+
Species Code	Species Code	Species Code	Species Code	Species Code	Species Code
<150mm	<150mm	<150mm	<150mm	<150mm	<150mm
>150mm	>150mm	>150mm	>150mm	>150mm	>150mm

CARD 36

Number of Bull Trout Redds
Redd Density (No./KM)
Year
Rating
Number of Bull Trout Redds
Redd Density (No./KM)
Year
Rating
Number of Bull Trout Redds
Redd Density (No./KM)
Year
Rating
Number of Bull Trout Redds
Redd Density (No./KM)
Year
Rating

CARD 37

Average Depth(CM)	
Rating	
Overhang	% Cover
Canopy	% Cover
Rating	
Wetted X-Sec. Area(M^2)	
Rating	
Drainage Area (KM^2)	
Rating	
Type	Barriers
KM 0-9999	Barriers
Rating	
Pool	% Cover in Features
Run	% Cover in Features
Riffle	% Cover in Features
Pocket Water	% Cover in Features
Total % Cov.	% Cover in Features
Rating	
Flow Chara.	
Valley Ch. Ratio	
Rating	
Confin. Pattern	
Fldpl Chan.	
AMT in chan. 0-100	Debris
Rat.	Debris
% Stable	Bank
Form Process	
Type	Gen. Matl
Rat.	

CARD 38

Total Carbon	CHEMICAL DATA (mg/l)
Rating	CHEMICAL DATA (mg/l)
Total Phosphours	CHEMICAL DATA (mg/l)
Rating	CHEMICAL DATA (mg/l)
NO_3^-	CHEMICAL DATA (mg/l)
Rating	CHEMICAL DATA (mg/l)
SO_4^{-2}	CHEMICAL DATA (mg/l)
Rating	CHEMICAL DATA (mg/l)
Na^+	CHEMICAL DATA (mg/l)
Rating	CHEMICAL DATA (mg/l)
K^+	CHEMICAL DATA (mg/l)
Rating	CHEMICAL DATA (mg/l)
Ca^{+2}	CHEMICAL DATA (mg/l)
Rating	CHEMICAL DATA (mg/l)
Mg^{+2}	CHEMICAL DATA (mg/l)
Rating	CHEMICAL DATA (mg/l)
Turbidity	

CARD NO.

CARD NO.

CARD NO.

APPENDIX C

Figures 1-12   Stream Trapping Results for 1980

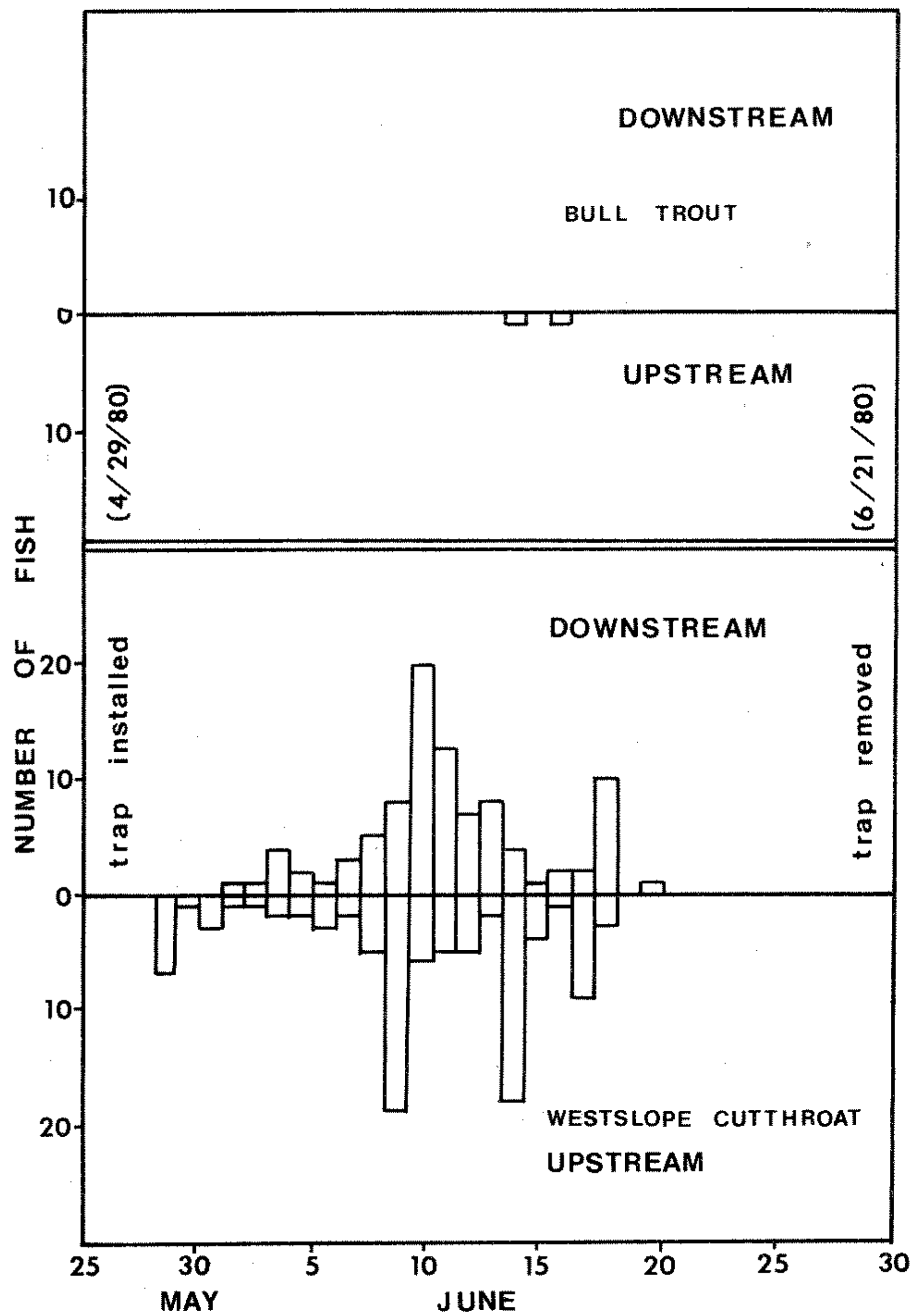


Figure 1. Upstream and downstream trap catches of westslope cutthroat and bull trout in Langford Creek for 1980.

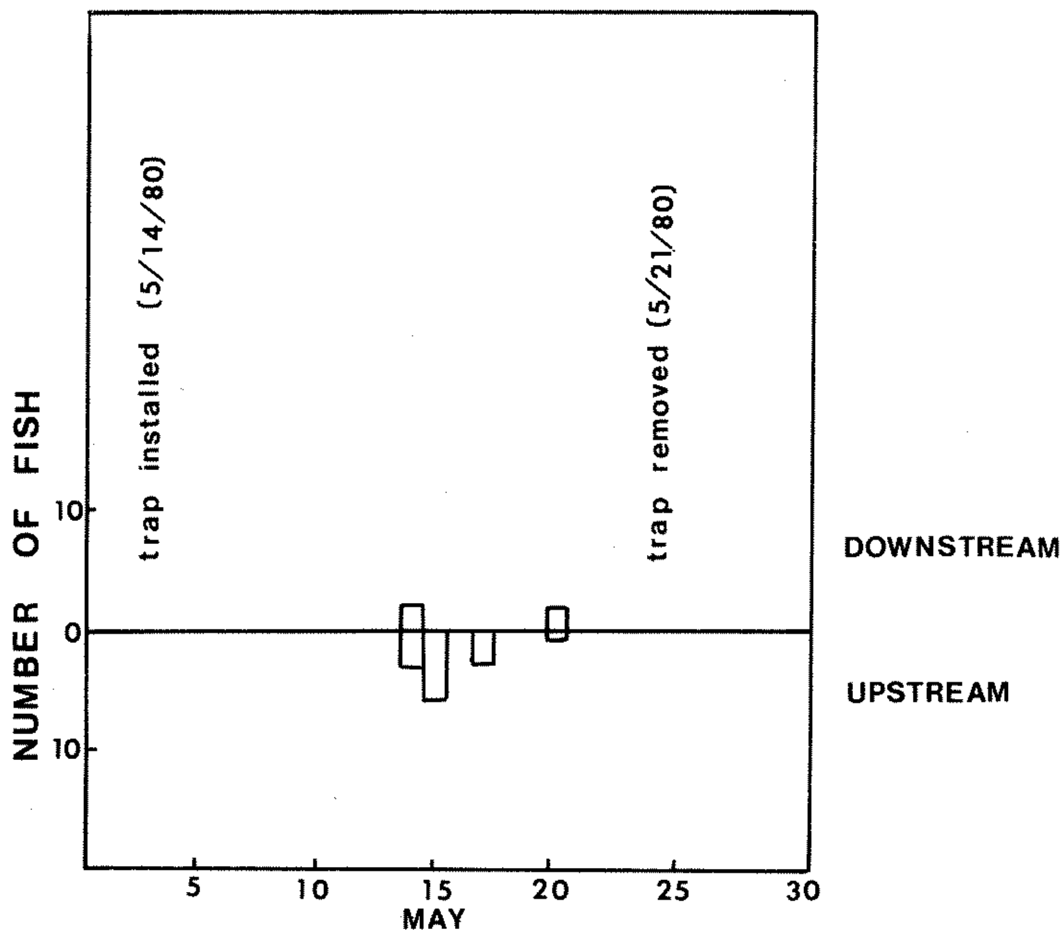


Figure 2. Upstream and downstream trap catches of westslope cutthroat in Cyclone Creek for 1980.

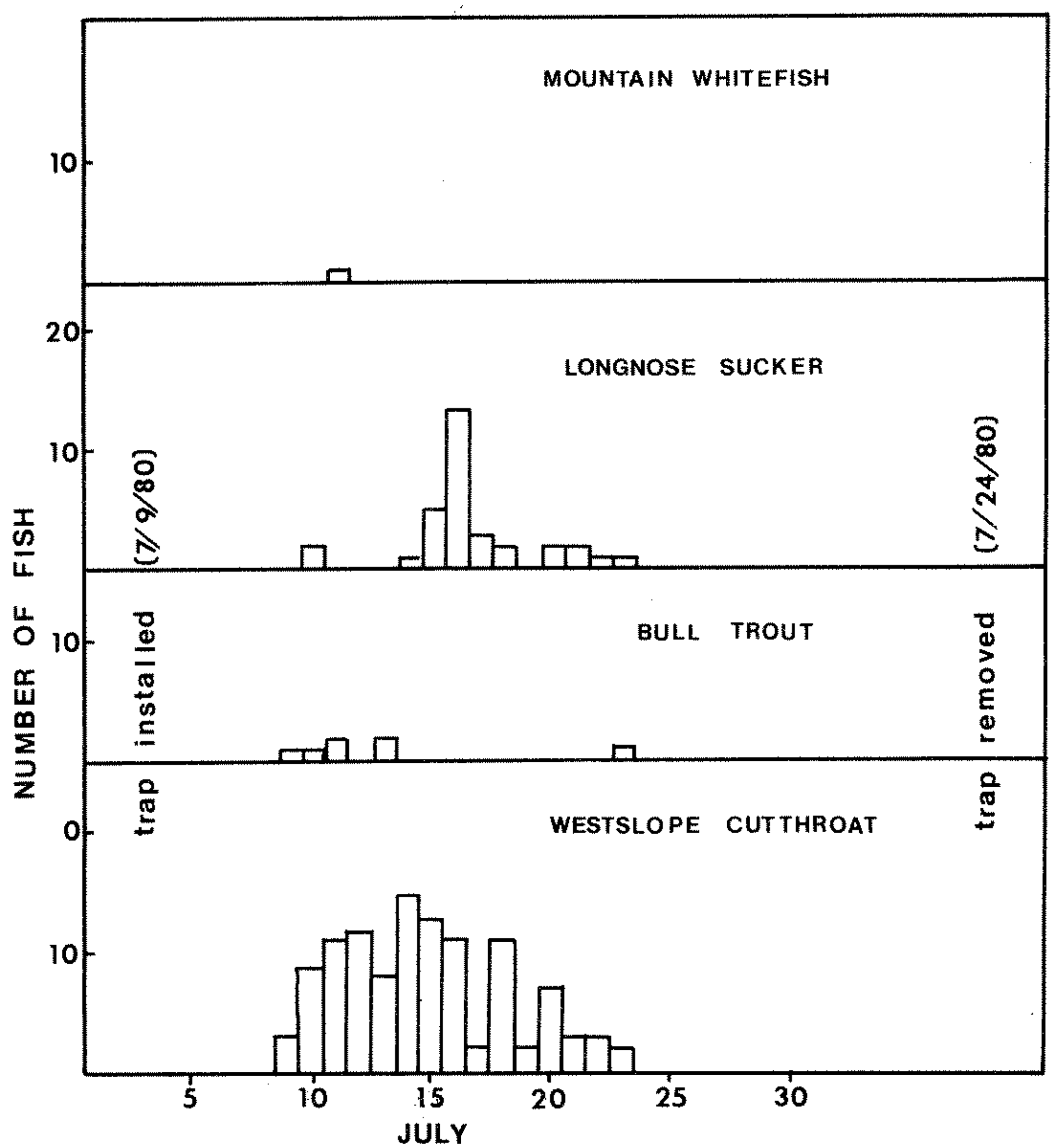


Figure 3. Downstream trap catches of westslope cutthroat, bull trout, mountain whitefish, coarse scale and longnose suckers in Moran Creek for 1980.

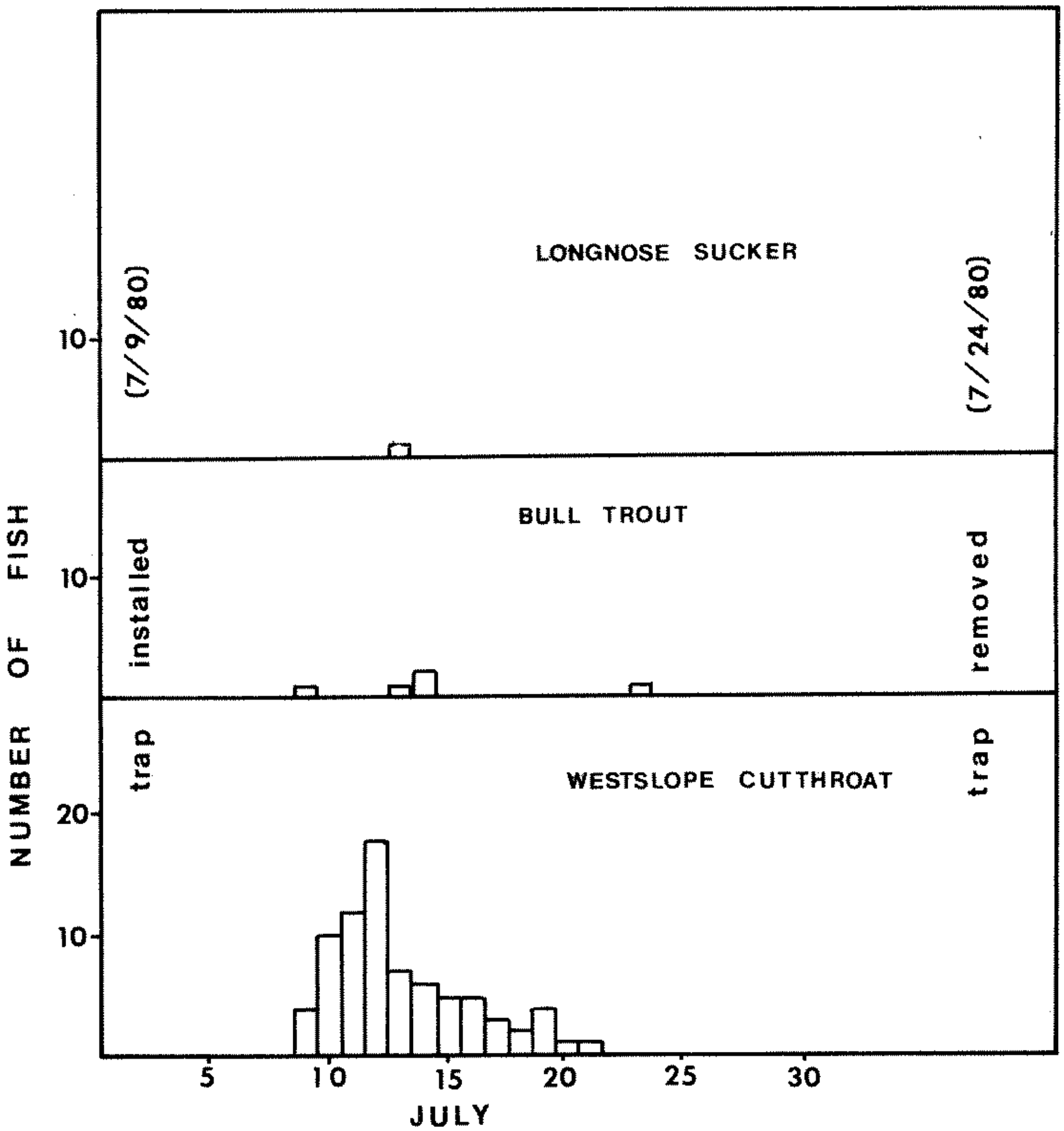


Figure 4. Upstream trap catches of westslope cutthroat, bull trout, and longnose suckers in Moose Creek for 1980.

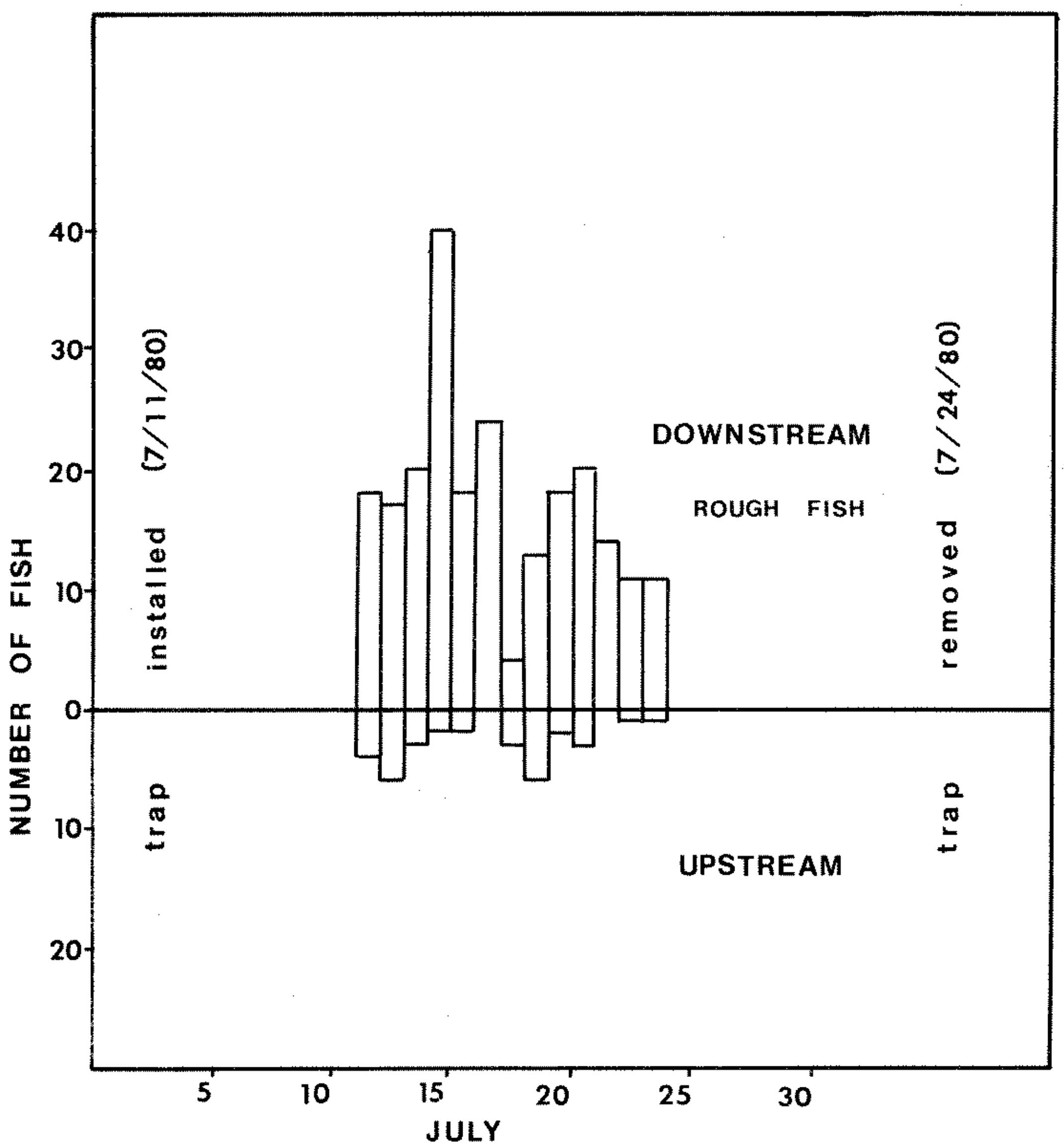


Figure 5. Upstream and downstream catches of non-game fish in Logging Creek for 1980. Species include coarse scale suckers, longnose suckers, northern squawfish, and redside shiners.

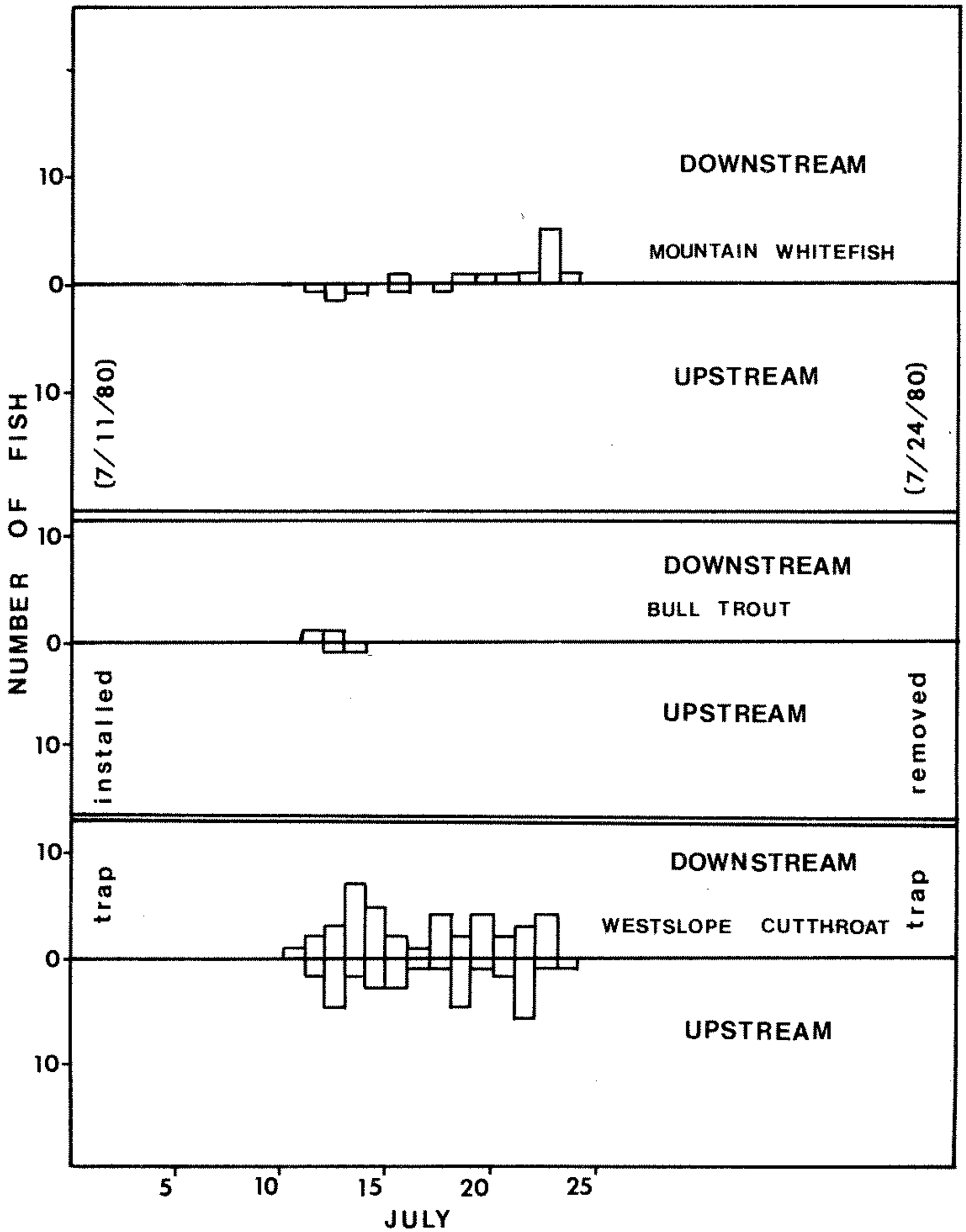


Figure 6. Upstream and downstream catches of westslope cutthroat trout, bull trout, and mountain whitefish in Logging Creek for 1980.

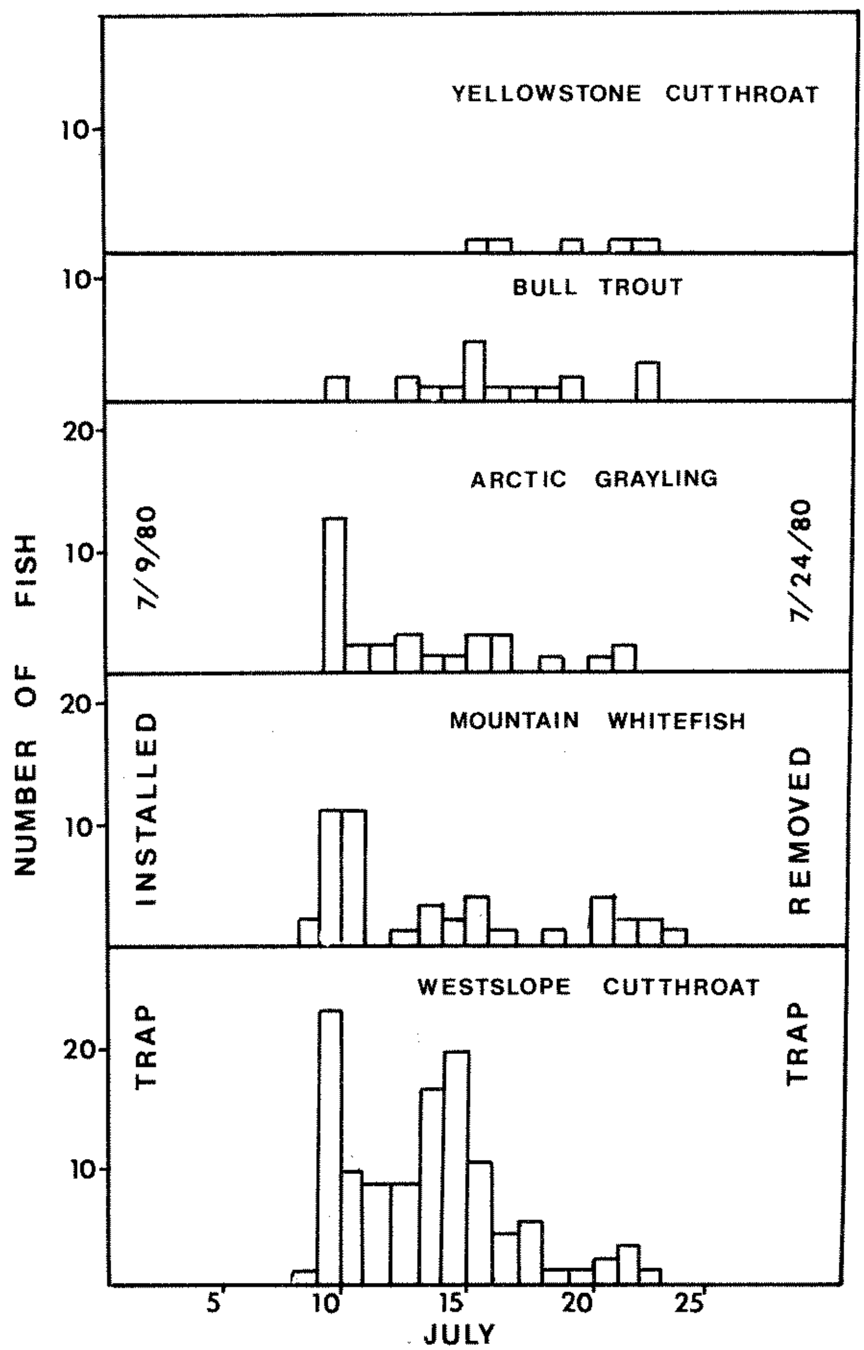


Figure 7. Downstream trap catch in Red Meadow Creek for 1980. Species include Yellowstone cutthroat trout, bull trout, Arctic grayling, mountain whitefish, and westslope cutthroat trout.

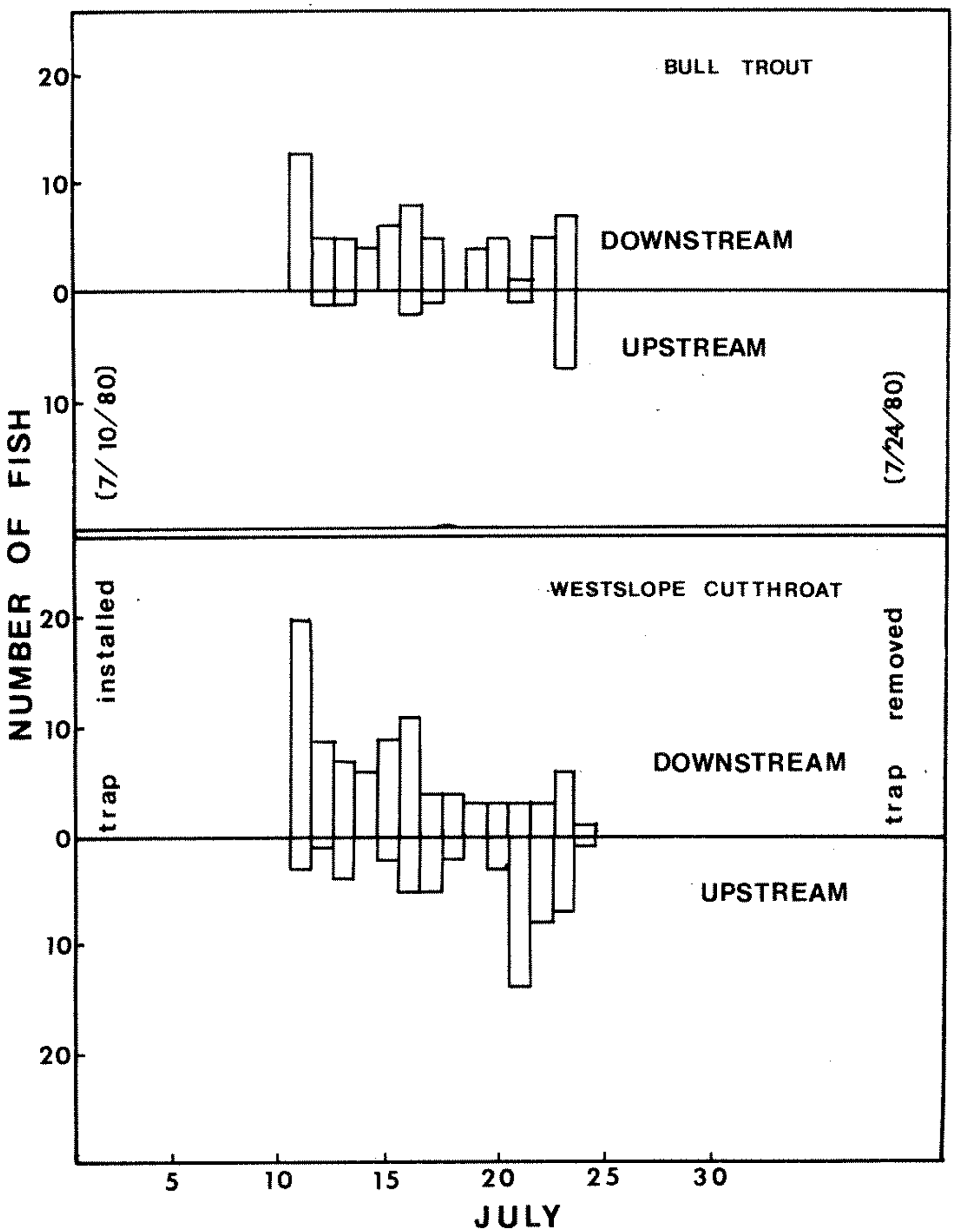


Figure 8. Upstream and downstream catches of westslope cutthroat trout and bull trout in Trail Creek for 1980.

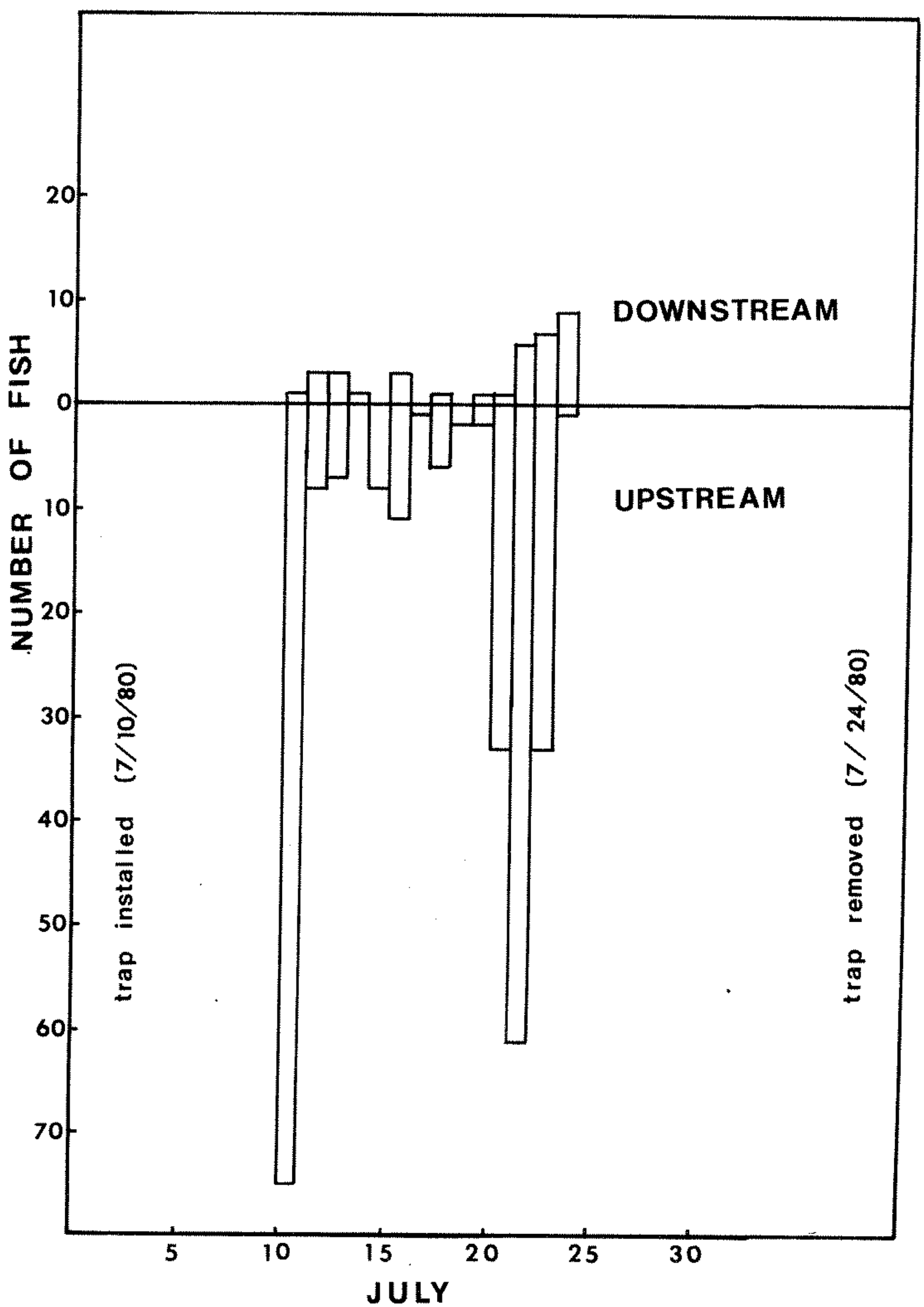


Figure 9. Upstream and downstream catches of mountain whitefish in Trail Creek for 1980.

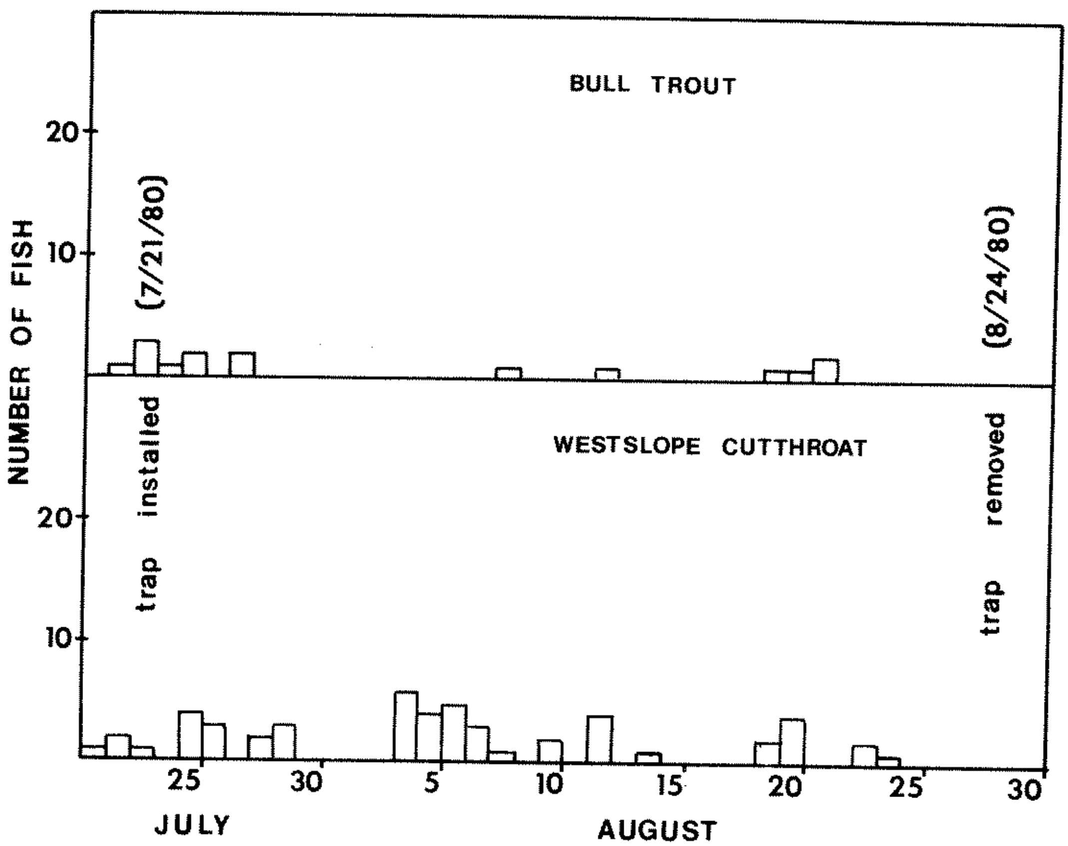


Figure 10. Downstream trap catch of westslope cutthroat trout and bull trout in the North Fork of the Flathead for 1980.

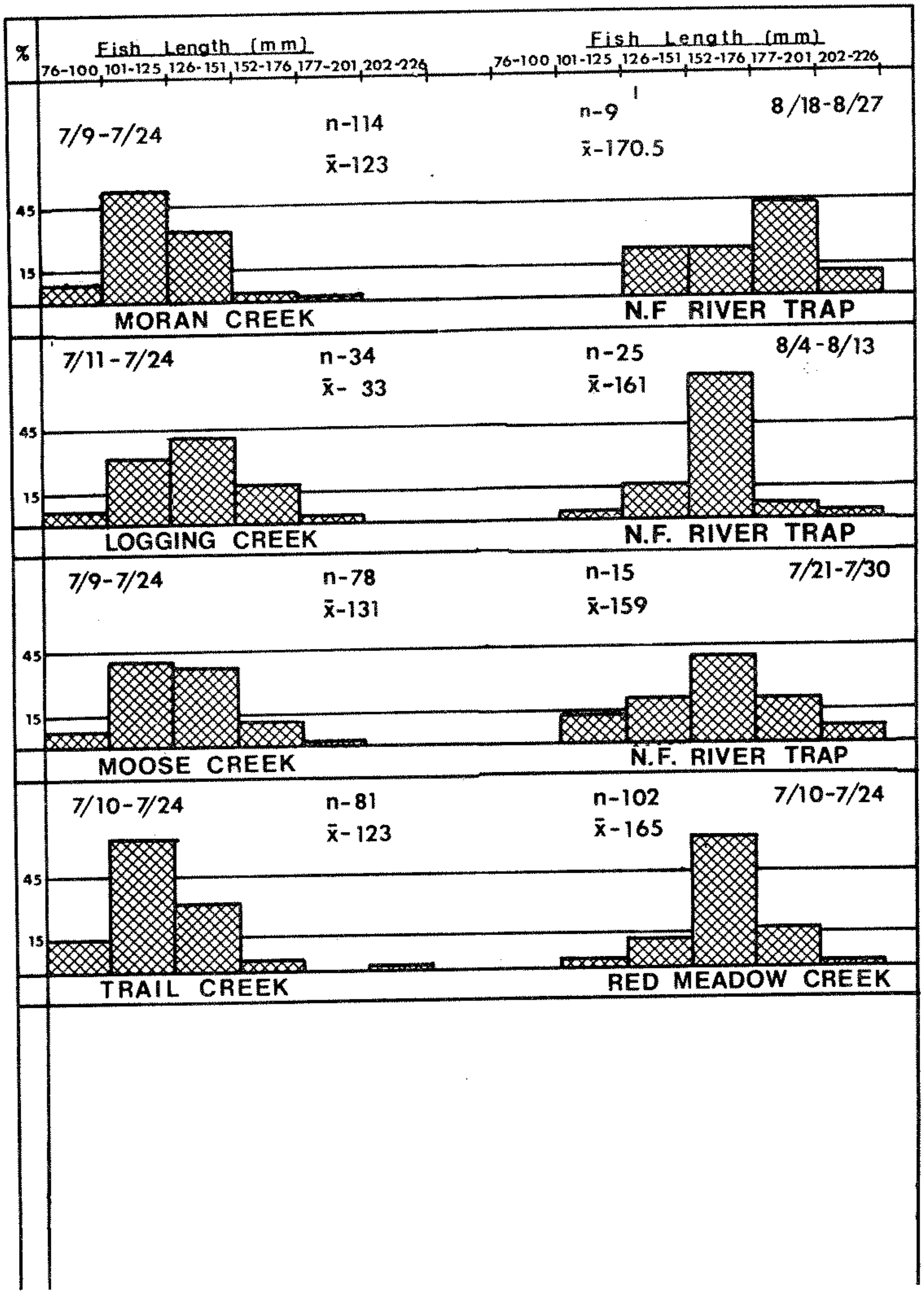


Figure 11. Percent abundance and lengths of juvenile westslope cutthroat trout emigrating downstream through Trail, Red Meadow, Moose, Moran, Logging creeks, and the North Fork River traps in 1980.

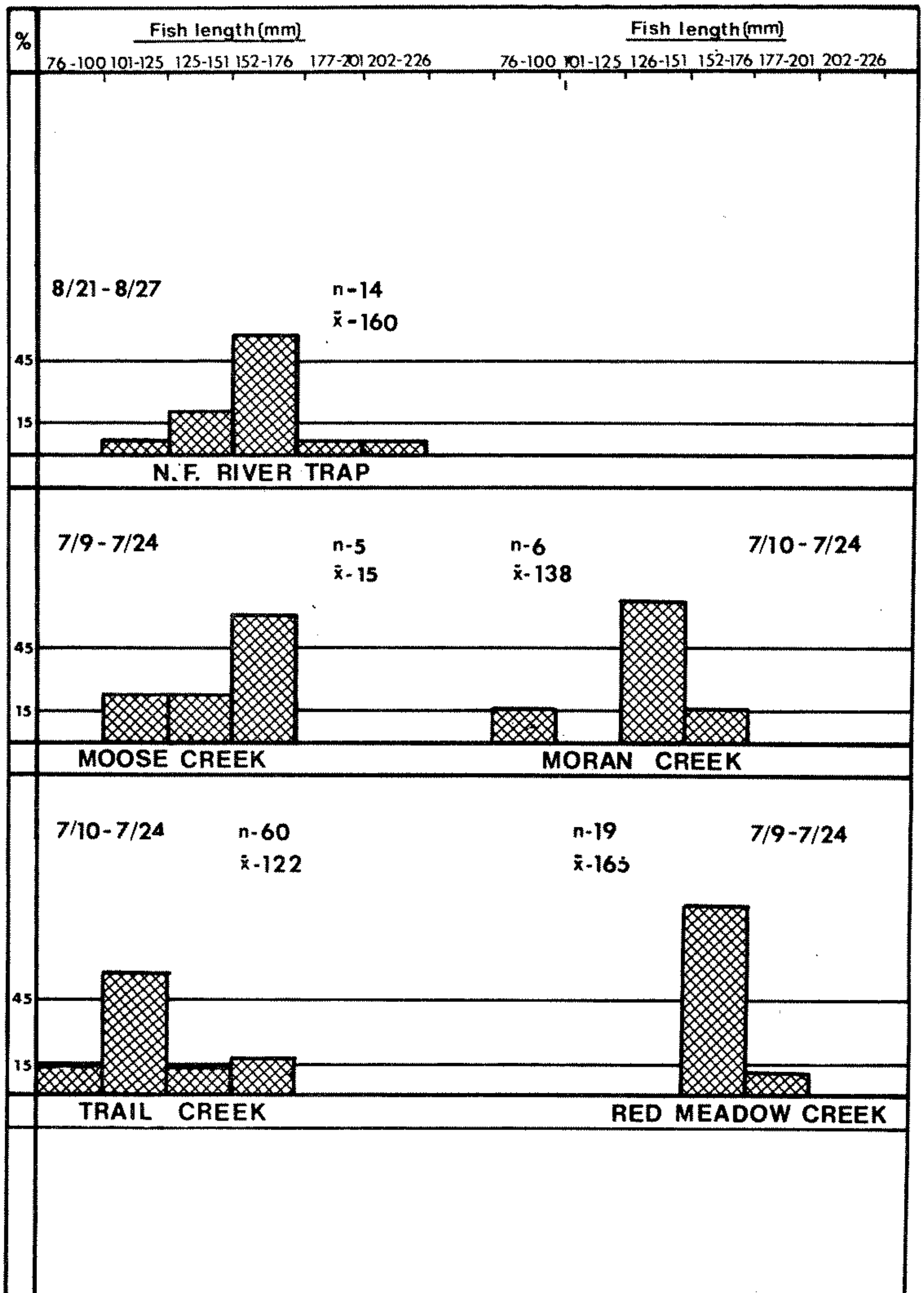


Figure 12. Percent abundance and lengths of juvenile bull trout emigrating downstream through Trail, Red Meadow, Moose, Moran, and North Fork River traps in 1980.

APPENDIX D

Example of stream reach description, inventory data, physical habitat map and fish population map for Trail Creek Reach I.

TRAIL CREEK REACH I

Reach Characteristics

Trail Creek is characteristic of lower reach 4th or 5th order tributaries in the North Fork drainage. Wetted width is 15 m, which is typical of many larger North Fork tributaries, and the average depth is 30 cm. Reach I of Trail Creek is predominantly a run-riffle habitat. The amount of channel debris was small and the debris present was generally unstable. Trout cover was also low, covering less than 10 percent of the water surface area. Stream gradient was relatively flat (2%), and the D-90 was 45 cm. There were few major slump zones in this reach.

Valley Characteristics

The upper bank slope gradient was 40-60 percent and the reach had a valley to channel ratio of 5:1. The average valley width for the reach was 115 m. Trail Creek was occasionally confined in this reach and it had a sinuous stream pattern. This portion of Trail Creek is a flood plain area that has parent rock consisting of fintla red-green argelite and Paleozoic limestone. Reach I flows through a mixture of Forest Service and private land and is paralleled along the north side by the Trail Creek road.

Fish Populations

Bull trout, westslope cutthroat, mountain whitefish, and slimy sculpins were found in Reach I. This is a critical rearing area for juvenile bull trout and also a major spawning area for adult adfluvial bull trout. An estimated 90 to 100 bulls spawn in this reach, which amounts to approximately 15 percent of the North Fork spawning population.

Stream habitat and fish population data

Location data

Stream name	Reach number	Serial number	Reach length	Tributary of	Upper reach boundary	Elevation (m)	Lower reach boundary
Trail Cr.	001	087	8.5	N. Fork	Btm of dry area	1254	Mouth of Trail Cr.

Physical habitat data

Stream order	Drainage area (km^2)	Average wetted width (m)	Average depth for reach (m)	Average channel width (m)	Valley width (m)	Valley-channel ratio	Flow characteristics	Confinement	Pattern
05	186.1	15.0	30	20	115	5	Swirling Rolling	X	N

Side channel occurrence	Maximum pool depth (m)	% pool	% run	% riffle	% pocket water	% class I pools	% class II pools	% class III pools	% class IV pools
Medium	1.5	2	55	38	5	10	15	50	25

% class V pools	% bed material: % fines	% gravel	% rubble	% boulder	% bedrock	D-90 (cm)	% gradient	Stability rating	Bank form
0	30	30	20	19	1	45	2	94	Repose

Bank process	Bank genetic material	Flood plain debris	Channel debris	% stable channel debris	% cover-canopy	% cover-overhang	% cover-snorkel section	Average low flow	Flow during survey (m^3/sec)
Failing	Fluvial	Low	Low	1	1	10	10	--	1.47

Average peak water temp (C)	Turbidity
16°	Low

Water chemistry data

Conductance (umohs/cm)	Alkalinity (mg/l)	Total carbon (mg/l)	Total phosphorus (mg/l)	Nitrate (mg/l)	Ca^{++} (mg/l)	Mg^{++} (mg/l)	Na^{+} (mg/l)	K^{+} (mg/l)	SO_4 (mg/l)
--	--	.76	.008	<.05	21.7	6.2	--	--	13.2

Spawning data

Number of bull trout redds in reach	Redd density (no/km)	Year	Number of bull trout redds in reach	Redd density (no/km)	Year
31	3.6	80	35	4.1	79

Fish population data

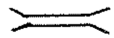
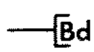
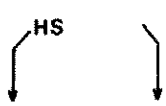
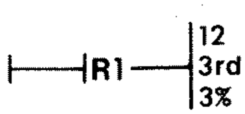
Density (no/100 m^2 surface area)

Cutthroat Age 0	Cutthroat Age I	Cutthroat Age II	Cutthroat Age III+	Bull trout Age 0	Bull trout Age I	Bull trout Age II	Bull trout Age III+	Mtn. whitefish <150mm	Mtn. whitefish >150mm
0	0	0	0.6	1.6	0.1	0.9	0.7	0.2	2.2

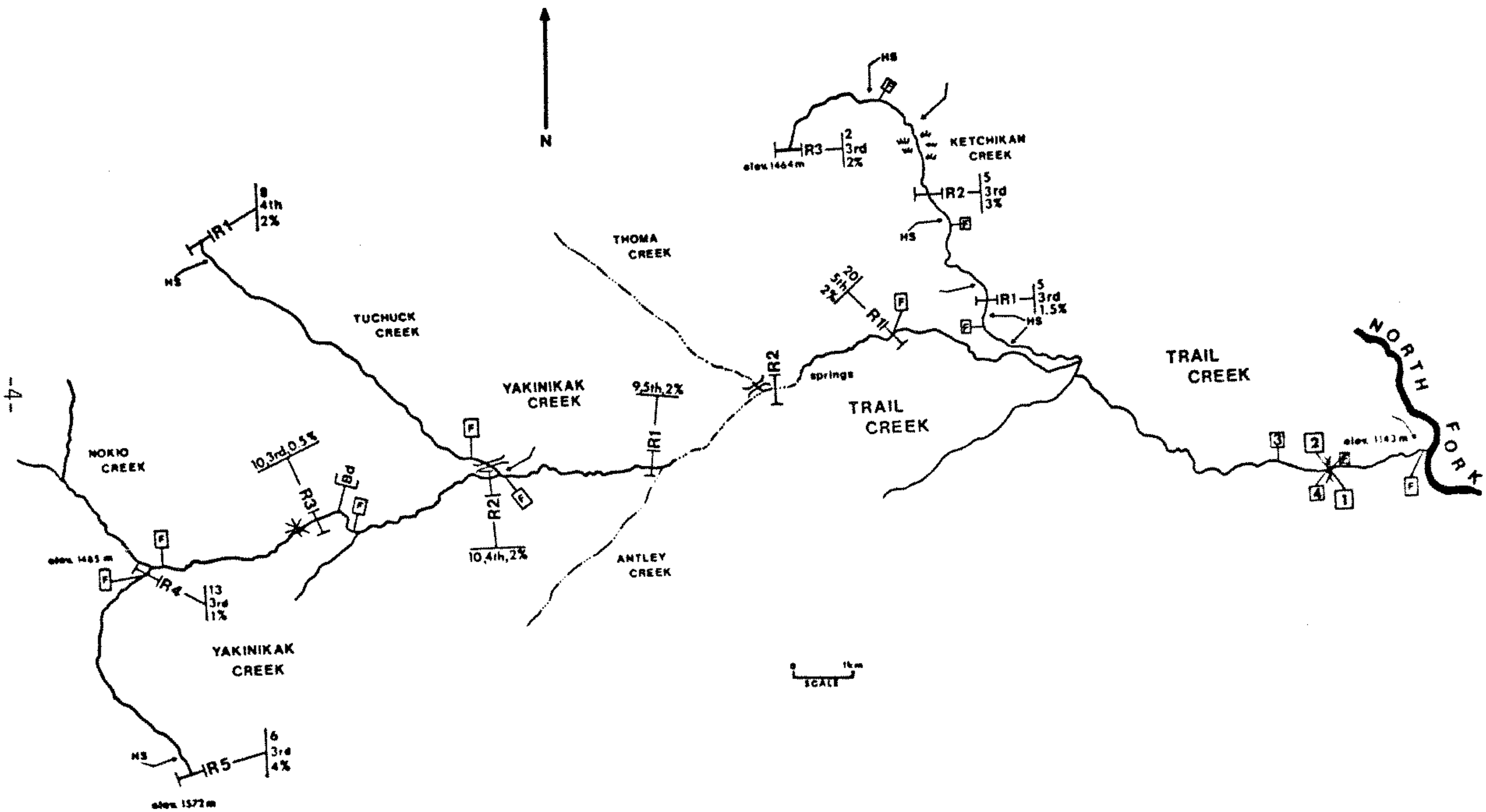
Biomass (grams/100 m^2 surface area)

Cutthroat Age 0	Cutthroat Age I	Cutthroat Age II	Cutthroat Age III+	Bull trout Age 0	Bull trout Age I	Bull trout Age II	Bull trout Age III+	Mtn whitefish <150mm	Mtn whitefish >150mm
0	0	0	1 9	0.2	0.1	1 1	2 2	0.3	30.8

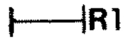
Legend for physical habitat map

	Bridge
	Intermittent stream
	Stream flow measured
	Stream gauge site
	Thermograph site
	Maximum-minimum thermometer site
	Water chemistry sampling area
	Major slump zone
X	Debris accumulation in stream channel
	Marsh
	Single beaver dam
	Series of beaver dams
	Habitat survey boundaries
	- Channel width (m) - Stream order - Percent gradient

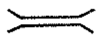
Physical habitat map



Legend for fish population map



Reach boundary
Reach number located at upstream boundary

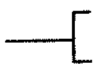


Bridge

Intermittent stream

Trap site

Fish abundance sections
E - electrofishing section
S - snorkel section



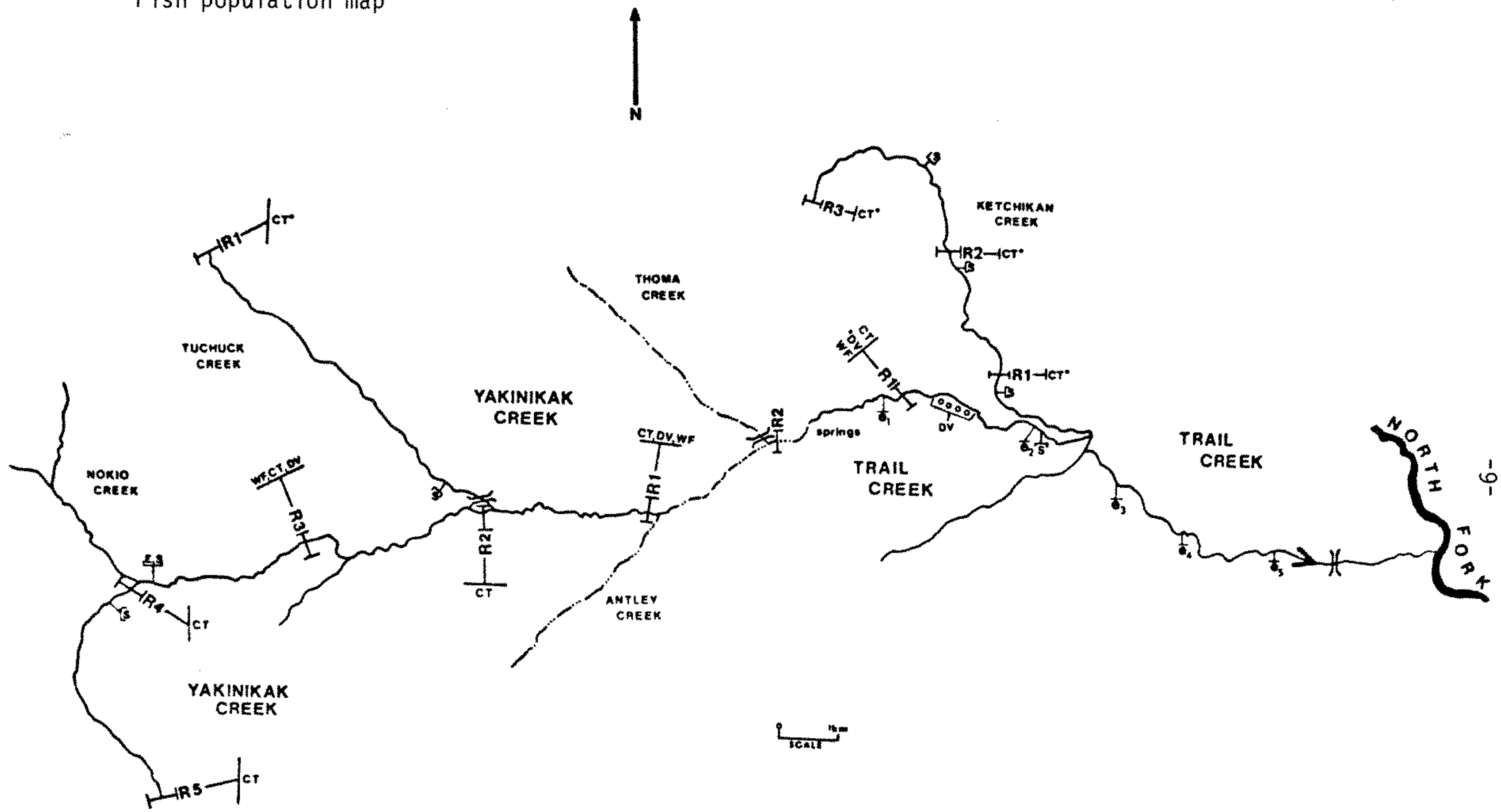
Fish migration barriers
height: (m)
type: L(logs), C(chute or cascade),
Bd(beaver dams), BR(bedrock)
length:
- indicates partial barrier

CT-westslope cutthroat
WF-mountain whitefish
DV-bull trout or Dolly Varden
* -indicates critical rearing area
for designated species

Bull trout (DV) spawning areas
Spawning area boundary A-A,B-B,...
Redd density (no/km)

High density spawning area

Fish population map



APPENDIX E

Tables 1-12. Food habits analysis of cutthroat and juvenile bull trout.

Table 1. Number, occurrence, volume and IRI (Index of Relative Importance) of items in stomachs of 46 cutthroat trout ≤ 100 mm collected in North Fork Tributaries during the summer of 1980. *= Aquatic.

Stomach contents	Number			Occurrence	Frequency of occurrence	Volume (ml)			IRI
	Total	Percent	Mean			Total	Percent	Mean	
Diptera (Adult*)	29	4.2	4.1	7	15.2	.19	1.5	.02	7.0
Chironomidae	64	9.1	4.0	16	34.7	.20	1.6	.01	15.1
Simulidae	17	2.4	2.4	7	15.2	.07	.6	.01	6.0
Tipulidae	19	2.7	1.5	13	28.2	.11	.9	.01	10.6
Coleoptera	15	2.1	1.4	11	24.0	.38	3.0	.03	9.7
Hymenoptera	44	6.3	2.8	16	34.7	.60	5.0	.03	15.3
Hemiptera	3	.4	1.0	3	6.5	.07	.6	.02	2.5
Homoptera	9	1.2	3.0	3	6.5	.03	.3	.01	2.7
Nematoda	4	.6	1.3	3	6.5	.03	.3	.01	2.5
Ephemeroptera (Adult*)	13	1.8	2.6	5	10.8	.33	2.7	.06	5.1
Baetidae	35	5.0	2.3	15	32.6	.19	1.5	.01	13.0
Heptageniidae	167	24.0	6.9	24	52.0	1.78	14.8	.07	30.2
Ephemerellidae	86	12.3	3.2	27	58.7	2.82	23.4	.10	31.4
Siphlonuridae	35	5.0	3.2	11	24.0	1.46	12.1	.13	13.7
Trichoptera (Adult*)	17	2.4	2.8	6	13.0	.40	3.3	.07	6.2
Brachycentridae	35	5.0	2.3	15	32.6	.62	5.2	.04	14.3
Hydropsychidae	17	2.4	1.8	9	19.5	.70	5.8	.08	9.2
Limnephilidae	9	1.2	2.3	4	8.6	.41	3.4	.10	13.2
Rhyacophilidae	27	3.8	2.3	12	26.0	.30	2.5	.03	10.7
Hydroptilidae									
Leptoceridae									
Plecoptera (Adult*)	1	.1	1.0	1	2.2	.01	.1	.01	2.4
Nemouridae									
Pteronarcidae									
Perlodidae	11	1.6	1.8	6	13.0	.72	6.0	.12	6.8
Chloroperlidae	18	2.6	2.0	9	19.5	.17	1.4	.02	23.5
Perlidae	2	.3	2.0	1	2.2	.01	.1	.01	.8
Terrestrial Larvae	20	2.8	6.6	3	6.5	.32	2.6	.10	3.9
Total	697					11.92			

Table 2. Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 34 cutthroat trout ≤ 110 mm collected in North Fork Tributaries during the summer of 1980. *= Aquatic

Stomach contents	Number			Occurrence	Frequency of occurrence	Volume (ml)			IRI
	Total	Percent	Mean			Total	Percent	Mean	
Diptera (Adult*)	8	3.5	1.1	7	20.5	.10	6.6	.01	10.2
Chironomidae	88	38.0	5.8	15	44.0	.18	12.0	.01	31.3
Simulidae	4	1.7	1.0	4	11.8	.04	2.6	.01	5.4
Tipulidae	4	1.7	1.3	3	8.8	.03	2.0	.01	4.1
Coleoptera	7	3.0	2.3	3	8.8	.03	2.0	.01	4.6
Hymenoptera	8	3.5	1.6	5	15.0	.05	3.3	.01	7.2
Hemiptera									
Homoptera	1	.4	1.0	1	2.9	.01	.7	.01	2.5
Nematoda									
Ephemeroptera (Adult*)	2	.9	1.0	2	5.9	.02	1.3	.01	2.6
Baetidae	23	10.0	2.0	11	32.3	.11	7.3	.01	16.5
Heptageniidae	29	12.6	1.8	16	47.1	.16	10.6	.01	23.4
Ephemerellidae	20	8.6	1.6	12	35.2	.16	10.6	.01	18.1
Siphlonuridae	4	1.7	2.0	2	5.9	.02	1.3	.01	2.9
Trichoptera (Adult*)	4	1.7	2.0	2	5.9	.06	4.0	.03	3.8
Brachycentridae	12	5.2	2.4	5	15.0	.05	3.3	.01	7.8
Hydropsychidae	4	1.7	2.0	2	5.9	.36	24.0	.18	10.4
Limnephilidae	2	.9	1.0	2	5.9	.02	9.3	.01	2.6
Rhyacophilidae	6	2.6	1.0	6	17.6	.06	4.0	.01	8.1
Hydroptilidae									
Leptoceridae									
Plecoptera (Adult*)	1	.4	1.0	1	2.9	.01	.7	.01	1.3
Nemouridae									
Pteronarcidae	1	.4	1.0	1	2.9	.01	.7	.01	1.3
Perlodidae									
Chloroperlidae	2	.9	1.0	1	5.9	.02	1.3	.01	2.6
Perlidae									
Terrestrial Larvae	8	3.5	1.6	5	15.0	.05	3.3	.01	7.2
Total	238					1.55			

Table 3 . Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 9 westslope cutthroat $\geq$ 110 mm collected in Middle Fork Tributaries during the summer of 1980. *= Aquatic

Stomach contents	Number Total	Number Percent	Number Mean	Occurrence	Frequency of occurrence	Volume (ml) Total	Volume (ml) Percent	Volume (ml) Mean	IRI
Diptera (Adult*)	153	24.0	17.0	9	100.0	1.22	9.1	.14	44.4
Chironomidae	3	.5	1.0	3	33.3	.03	.2	.01	11.3
Simulidae									
Tipulidae									
Coleoptera	39	6.1	7.8	5	55.6	.47	3.5	.09	21.7
Elmidae	9	1.4	9.0	1	11.1	.30	2.2	.30	4.8
Hymenoptera	328	51.4	65.6	5	55.6	8.37	62.4	1.67	56.5
Arachnida	4	.6	2.0	2	22.2	.20	1.5	.10	8.1
Hemiptera	4	.6	1.3	3	33.3	.12	.9	.04	11.6
Homoptera	25	3.9	6.3	4	44.4	.12	.9	.03	16.4
Nematoda									
Ephemeroptera (Adult*)	1	.2	1.0	1	11.1	.05	.4	.05	3.9
Baetidae	2	.3	1.0	2	22.2	.02	.2	.01	7.6
Heptageniidae	2	.3	2.0	1	11.1	.01	.1	.01	3.8
Ephemerellidae	27	4.2	5.4	5	55.6	.38	2.8	.08	20.9
Siphlonuridae	1	.2	1.0	1	11.1	.01	.1	.01	3.8
Trichoptera (Adult*)									
Brachycentridae	5	.8	1.7	3	33.3	.03	.2	.01	11.4
Hydropsychidae	2	.3	1.0	2	22.2	.16	1.2	.08	7.9
Limnephilidae	3	.5	1.5	2	22.2	1.40	10.4	.47	11.0
Rhyacophilidae	1	.2	1.0	1	11.1	.01	.1	.01	3.8
Hydroptilidae	3	.5	1.0	3	33.3	.03	.2	.01	11.3
Leptoceridae	1	.2	1.0	1	11.1	.01	.1	.01	3.8
Plecoptera (Adult*)	22	.1	3.7	6	66.7	.44	3.3	.07	23.4
Nemouridae									
Pteronarcidae									
Perlodidae									
Chloroperlidae	2	.3	1.0	2	22.2	.02	.2	.01	7.6
Perlidae									
Terrestrial Larvae	1	.2	1.0	1	11.1	.01	.1	.01	3.8
Total	638					13.41			

Table 4 . Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 12 westslope cutthroat $\leq$ 110 mm collected in Middle Fork Tributaries during the summer of 1980. *= Aquatic

Stomach contents	Number Total	Number Percent	Number Mean	Occurrence	Frequency of occurrence	Volume (ml) Total	Volume (ml) Percent	Volume (ml) Mean	IRI
Diptera (Adult*)	37	22.0	12.3	3	25.0	.17	24.6	.06	23.9
Chironomidae	72	42.9	10.3	7	58.3	.07	10.1	.01	37.1
Simulidae									
Tipulidae									
Coleoptera	11	6.6	5.5	2	16.7	.06	8.7	.03	10.7
Hymenoptera	5	3.0	2.5	2	16.7	.06	8.7	.03	9.5
Hemiptera	1	.6	1.0	1	8.3	.01	1.5	.01	3.5
Homoptera									
Nematoda	12	7.1	6.0	2	16.7	.02	2.9	.01	8.9
Ephemeroptera (Adult*)									
Baetidae	5	3.0	1.7	3	25.0	.03	4.4	.01	10.8
Heptageniidae	9	5.4	1.5	6	50.0	.06	8.7	.01	21.4
Ephemerellidae	1	.6	1.0	1	8.3	.01	1.5	.01	3.5
Siphlonuridae	2	1.2	1.0	2	16.7	.02	2.9	.01	6.9
Trichoptera (Adult*)	1	.6	1.0	1	8.3	.01	1.5	.01	3.5
Brachycentridae	5	3.0	5.0	1	8.3	.01	1.5	.01	4.2
Hydropsychidae									
Limnephilidae									
Rhyacophilidae	1	.6	1.0	1	8.3	.01	1.5	.01	3.5
Glossosomatidae	1	.6	1.0	1	8.3	.01	1.5	.01	3.5
Hydroptilidae									
Leptoceridae									
Plecoptera (Adult*)	1	.6	1.0	1	8.3	.01	1.5	.01	3.5
Nemouridae	2	1.2	1.0	2	16.7	.07	10.1	.03	9.3
Pteronarcidae									
Perlodidae									
Chloroperlidae									
Perlidae									
Terrestrial Larvae	1	.6	1.0	1	8.3	.01	1.5	.01	3.5
Terrestrial Adults	1	.6	1.0	1	8.3	.05	7.3	.05	5.4
Total	168					.69			

Table 5 . Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 9 westslope cutthroat $\geq$ 110 mm collected in Middle Fork River during the summer of 1980. *= Aquatic

Stomach contents	Number			Occurrence	Frequency of occurrence	Volume (ml)			IRI
	Total	Percent	Mean			Total	Percent	Mean	
Diptera (Adult*)	288	30.0	32.0	9	100.0	1.70	6.6	.19	43.4
Chironomidae	12	1.3	6.0	2	22.2	.02	.4	.01	7.9
Simulidae									
Tipulidae									
Coleoptera	80	8.3	10.0	8	88.9	1.32	5.5	.16	34.3
Hymenoptera	239	24.9	39.8	6	66.7	5.65	32.5	.94	41.4
Arachnida	2	.2	2.0	1	11.1	.20	6.9	.20	6.1
Hemiptera	18	1.9	4.5	4	44.4	.27	2.4	.07	16.2
Homoptera	25	2.6	2.8	9	100.0	.86	3.5	.10	35.4
Nematoda									
Ephemeroptera (Adult*)	146	15.2	18.3	8	88.9	3.68	15.9	.46	40.0
Baetidae	1	.1	1.0	1	11.1	.01	.4	.01	3.9
Heptageniidae	1	.1	1.0	1	11.1	.01	.4	.01	3.9
Ephemerellidae	2	.2	2.0	1	11.1	.10	3.5	.10	4.9
Siphlonuridae									
Trichoptera (Adult*)	20	2.1	2.9	7	77.8	.40	2.1	.06	27.3
Brachycentridae	17	1.8	2.8	6	66.7	.38	2.1	.06	23.5
Hydropsychidae	1	.1	1.0	1	11.1	.01	.4	.01	3.9
Limnephilidae									
Rhyacophilidae	2	.2	1.0	2	22.2	.02	.4	.01	7.6
Hydroptilidae	4	.4	2.0	2	22.2	.02	.4	.01	7.7
Leptoceridae									
Plecoptera (Adult*)	92	9.6	11.5	8	88.9	1.34	5.9	.17	34.8
Nemouridae									
Pteronarcidae									
Perlodidae									
Chloroperlidae	2	.2	2.0	1	11.1	.01	.4	.01	3.9
Perlidae									
Terrestrial Larvae	1	.1	1.0	1	11.1	.01	.4	.01	3.9
Terrestrial Adults	6	.6	6.0	1	11.1	.15	5.2	.15	5.6
Fish	1	.1	1.0	1	11.1	.15	5.2	.15	5.5
Total	960					16.28			

Table 6 . Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 7 bull trout ≤ 110 mm collected in Middle Fork Tributaries during the summer of 1980. *= Aquatic

Stomach Contents	Number			Occurrence	Frequency of	Volume (ml)			
	Total	Percent	Mean		occurrence	Total	Percent	Mean	IRI
Diptera (Adult*)	1	3.2	1.0	1	14.3	.01	5.0	.01	7.5
Chironomidae	1	3.2	1.0	1	14.3	.01	5.0	.01	7.5
Simulidae									
Tipulidae									
Coleoptera									
Hymenoptera									
Hemiptera									
Homoptera									
Nematoda									
Ephemeroptera (Adult*)									
Baetidae	11	35.5	1.6	7	100.0	.07	35.0	.01	56.8
Heptageniidae	7	22.6	2.3	3	42.9	.03	15.0	.01	26.8
Ephemerellidae	2	6.5	1.0	2	28.6	.02	10.0	.01	15.0
Siphlonuridae	6	19.4	2.0	3	42.9	.03	15.0	.01	25.8
Trichoptera (Adult*)									
Brachycentridae									
Hydropsychidae									
Limnephilidae									
Rhyacophilidae									
Hydroptilidae									
Leptoceridae									
Plecoptera (Adult*)									
Nemouridae	3	9.7	1.0	3	42.9	.03	15.0	.01	22.5
Pteronarcidae									
Perlodidae									
Chloroperlidae									
Perlidae									
Terrestrial Larvae									
Total	31					.20			

Table 7 . Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 9 bull trout ≥ 110 mm collected in North Fork Tributaries during the summer of 1980. *= Aquatic

Stomach contents	Number			Occurrence	Frequency of occurrence	Volume (ml)			IRI
	Total	Percent	Mean			Total	Percent	Mean	
Diptera (Adult*)	5	6.4	2.5	2	22.2	.02	1.1	.01	9.9
Chironomidae	1	1.3	1.0	1	11.1	.01	.5	.01	4.3
Simulidae	1	1.3	1.0	1	11.1	.01	.5	.01	4.3
Tipulidae	1	1.3	1.0	1	11.1	.01	.5	.01	4.3
Coleoptera	2	2.6	1.0	2	22.2	.02	1.1	.01	8.6
Hymenoptera	12	15.4	4.0	3	33.3	.16	8.4	.05	19.0
Hemiptera	1	1.3	1.0	1	11.1	.01	.5	.01	4.3
Homoptera	1	1.3	1.0	1	11.1	.01	.5	.01	4.3
Nematoda									
Ephemeroptera (Adult*)	9	11.5	4.5	2	22.2	.21	11.0	.10	14.9
Baetidae	8	10.3	2.0	4	44.4	.04	2.1	.01	18.9
Heptageniidae	19	24.4	4.8	4	44.4	1.03	53.9	.26	40.9
Ephemerellidae	6	7.7	1.5	4	44.4	.13	6.8	.03	19.7
Siphlonuridae	5	6.4	2.5	2	22.2	.02	1.1	.01	9.9
Trichoptera (Adult*)									
Brachycentridae	1	1.3	1.0	1	11.1	.01	.5	.01	4.3
Hydropsychidae	2	2.6	2.0	1	11.1	.10	5.2	.10	6.3
Limnephilidae									
Rhyacophilidae									
Hydroptilidae									
Leptoceridae									
Plecoptera (Adult*)									
Nemouridae									
Pteronarcidae									
Perlodidae	2	2.7	1.0	2	22.2	.02	1.1	.01	8.6
Chloroperlidae									
Perlidae									
Terrestrial Larvae	2	2.7	1.0	2	22.2	.10	5.2	.05	10.0
Total	78					1.91			

Table 8 . Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 19 bull trout $\leq$ 110 mm collected in North Fork Tributaries during the summer of 1980.
*= Aquatic

Stomach contents	Number			Occurrence	Frequency of occurrence	Volume (ml)			IRI
	Total	Percent	Mean			Total	Percent	Mean	
Diptera (Adult*)	1	1	1	1	5	.01	1	.01	2.3
Chironomidae	16	12	1.8	9	47	.09	7	.01	22.0
Simulidae	2	1	2	1	5	.01	1	.01	2.3
Tipulidae	2	1	1	2	11	.02	2	.01	4.7
Coleoptera	1	1	1	1	5	.01	1	.01	2.3
Hymenoptera	5	4	1.7	3	16	.02	2	.01	7.3
Hemiptera									
Homoptera	14	10	14	1	5	.05	4	.05	6.3
Nematoda									
Ephemeroptera (Adult*)									
Baetidae	24	18	2.7	9	47	.17	13	.02	26.0
Heptageniidae	30	22	2.5	12	63	.16	13	.01	32.7
Ephemerellidae	12	9	1.3	9	47	.13	10	.01	22.0
Siphlonuridae	4	3	2.0	2	11	.06	5	.03	6.3
Trichoptera (Adult*)	2	1	1.0	2	11	.02	2	.01	4.7
Brachycentridae	8	6	2.0	4	21	.04	3	.01	10.0
Hydropsychidae	1	1	1.0	1	5	.05	4	.05	3.3
Limnephilidae									
Rhyacophilidae	5	4	1.2	4	21	.04	3	.01	9.3
Hydroptilidae									
Leptoceridae									
Plecoptera (Adult*)									
Nemouridae									
Pteronarcidae									
Perlodidae	5	4	1.7	3	16	.17	13	.06	11.0
Chloroperlidae	3	2	1.5	2	11	.02	2	.01	5.0
Perlidae									
Terrestrial Larvae	2	1	2.0	1	5	.20	16	.20	7.3
Total	137					1.27			

Table 9 . Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 3 Westslope cutthroat ≥ 110 mm collected in Moose Creek during the summer of 1980. *= Aquatic

Stomach contents	Number			Occurrence	Frequency of occurrence	Volume (ml)			IRI
	Total	Percent	Mean			Total	Percent	Mean	
Diptera (Adult*)	1	2	1.0	1	33	.01	1	.01	12.0
Chironomidae									
Simulidae	2	3	2.0	1	33	.01	1	.01	12.3
Tipulidae									
Coleoptera	3	5	1.5	2	67	.25	13	.13	28.3
Hymenoptera	9	16	4.5	2	67	.16	8	.08	30.3
Hemiptera									
Homoptera									
Nematoda									
Ephemeroptera (Adult*)	3	5	3.0	1	33	.10	5	.10	14.3
Baetidae									
Heptageniidae	8	14	4.0	2	67	.20	11	.10	31.7
Ephemerellidae	5	9	2.5	2	67	.20	11	.10	30.0
Siphlonuridae	1	2	1.0	1	33	.01	1	.01	12.0
Trichoptera (Adult*)	10	17	5.0	2	67	.35	18	.18	34.0
Brachycentridae	1	2	1.0	1	33	.01	1	.01	12.0
Hydropsychidae	7	12	3.5	2	67	.41	22	.21	33.7
Limnephilidae									
Rhyacophilidae	3	5	1.5	2	67	.02	1	.01	24.3
Hydroptilidae									
Leptoceridae									
Plecoptera (Adult*)	1	2	1.0	1	33	.01	1	.01	12.0
Nemouridae									
Pteronarcidae									
Perlodidae									
Chloroperlidae	1	2	1.0	1	33	.05	3	.05	12.7
Perlidae	2	3	2.0	1	33	.01	1	.01	12.3
Terrestrial Larvae									
Fish	1	2	1.0	1	33	.10	5	.10	13.3
Total	58					1.90			

Table 10. Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 19 westslope cutthroat ≤ 110 mm collected in Moose Creek during the summer of 1980. *= Aquatic

Stomach contents	Number Total	Number Percent	Number Mean	Occurrence	Frequency of occurrence	Volume (ml) Total	Volume (ml) Percent	Volume (ml) Mean	IRI
Diptera (Adult*)	2	2	1.0	2	11	.02	2	.01	5.0
Chironomidae	35	33	5.0	7	37	.07	8	.01	26.0
Simulidae	2	2	1.0	2	11	.02	2	.01	5.0
Tipulidae	3	3	1.5	2	11	.02	2	.01	5.3
Coleoptera	3	3	1.5	2	11	.02	2	.01	5.3
Hymenoptera	6	6	2.0	3	16	.03	3	.01	8.3
Hemiptera									
Homoptera	1	1	1.0	1	5	.01	1	.01	2.3
Nematoda									
Ephemeroptera (Adult*)									
Baetidae	11	10	2.2	5	26	.05	6	.01	14.0
Heptageniidae	20	19	1.8	11	59	.11	12	.01	30.0
Ephemerellidae	11	10	1.6	7	37	.07	8	.01	18.3
Siphlonuridae									
Trichoptera (Adult*)	4	4	2.0	2	11	.06	7	.03	7.3
Brachycentridae	1	1	1.0	1	5	.01	1	.01	2.3
Hydropsychidae	4	4	2.0	2	11	.36	40	.18	18.3
Limnephilidae	1	1	1.0	1	5	.01	1	.01	2.3
Rhyacophilidae	1	1	1.0	1	5	.01	1	.01	2.3
Hydroptilidae									
Leptoceridae									
Plecoptera (Adult*)	1	1	1.0	1	5	.01	1	.01	2.3
Nemouridae									
Pteronarcidae									
Perlodidae									
Chloroperlidae	1	1	1.0	1	5	.01	1	.01	2.3
Perlidae									
Terrestrial Larvae									
Total	107					.89			

Table 11. Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 17 westslope cutthroat $\geq$ 110 mm collected in Red Meadow Creek during the summer of 1980. *= Aquatic

Stomach contents	Number			Occurrence	Frequency of occurrence	Volume (ml)			IRI
	Total	Percent	Mean			Total	Percent	Mean	
Diptera (Adult*)	6	2.0	2.0	3	18	.06	2.0	.02	7.3
Chironomidae	25	8.0	2.8	9	53	.09	4.0	.01	21.7
Simulidae	9	3.0	3.0	3	18	.03	1.0	.01	7.3
Tipulidae	9	3.0	1.1	8	47	.06	2.0	.01	17.3
Coleoptera	7	2.0	1.7	4	24	.08	3.0	.02	9.7
Hymenoptera	10	3.0	2.0	5	29	.14	6.0	.03	9.3
Hemiptera									
Homoptera	1	.3	1.0	1	6	.01	.4	.01	2.6
Nematoda	2	1.0	1.0	2	12	.02	1.0	.01	4.7
Ephemeroptera (Adult*)	2	1.0	1.0	2	12	.02	1.0	.01	4.7
Baetidae	24	8.0	2.7	9	53	.13	5.0	.01	22.0
Heptageniidae	73	24.0	6.1	12	71	.78	31.0	.07	42.0
Ephemerellidae	59	13.0	4.5	13	76	.21	8.0	.02	32.2
Siphlonuridae	9	3.0	1.8	5	29	.14	6.0	.03	12.7
Trichoptera (Adult*)	7	2.0	1.7	4	24	.5	20.0	.13	15.3
Brachycentridae	16	5.0	2.0	8	47	.08	3.0	.01	18.3
Hydropsychidae	2	1.0	1.0	2	12	.06	2.0	.03	5.0
Limnephilidae	2	1.0	1.0	2	12	.06	2.0	.03	5.0
Rhyacophilidae	18	6.0	3.0	6	35	.15	6.0	.03	15.7
Hydroptilidae									
Leptoceridae									
Plecoptera (Adult*)									
Nemouridae									
Pteronarcidae									
Perlodidae	1	.3	1.0	1	6	.01	.4	.01	2.6
Chloroperlidae	7	2.0	1.2	6	35	.06	2.0	.01	13.0
Perlidae									
Terrestrial Larvae	18	6.0	6.0	3	18	.22	9.0	.07	11.0
Fish	1	.3	1.0	1	6	.6	24.0	.6	10.0
Total	305					2.52			

Table 12. Number, occurrence, volume and IRI (Index of Relative Importance) of items in the stomachs of 6 westslope cutthroat $\leq$ 110 mm collected in Red Meadow Creek during the summer of 1980. *= Aquatic

Stomach contents	Number			Occurrence	Frequency of occurrence	Volume (ml)			IRI
	Total	Percent	Mean			Total	Percent	Mean	
Diptera (Adult*)	4	4	1.3	3	50	.03	10	.01	21.3
Chironomidae	56	63	9.3	6	100	.09	31	.02	64.7
Simulidae	2	2	1.0	2	33	.02	7	.01	14.0
Tipulidae	1	1	1.0	1	17	.01	3	.01	7.0
Coleoptera									
Hymenoptera	1	1	1.0	1	17	.01	3	.01	7.0
Hemiptera									
Homoptera									
Nematoda									
Ephemeroptera (Adult*)	1	1	1.0	1	17	.01	3	.01	7.0
Baetidae	5	6	1.7	3	50	.03	10	.01	22.0
Heptageniidae	2	2	2.0	1	17	.01	3	.01	7.3
Ephemerellidae	4	4	2.0	2	33	.02	7	.01	14.7
Siphlonuridae									
Trichoptera (Adult*)									
Brachycentridae	9	10	4.5	2	33	.02	7	.01	16.7
Hydropsychidae									
Limnephilidae									
Rhyacophilidae	3	3	1.0	3	50	.03	10	.01	21.0
Hydroptilidae									
Leptoceridae									
Plecoptera (Adult*)									
Nemouridae									
Pteronarcidae									
Perlodidae									
Chloroperlidae									
Perlidae									
Terrestrial Larvae	1	1	1.0	1	17	.01	3	.01	7.0
Total	89					.29			