1979 Sept.

Drainage Kootenai

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MONTANA DEPARTMENT OF FISH AND GAME

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FISHERIES DIVISION

FINAL JOB REPORT

March 1, 1976 - June 30, 1979

Status of Fish Populations in the Kootenai River below Libby Dam Following Regulation of the River

By

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Kootenai River Investigations

September, 1979

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ABSTRACT

The impoundment of the Kootenai River in 1972 altered flow regimes, temperature patterns and water quality. The aquatic insect populations has changed from a stonefly, mayfly, caddisfly, dipteran complex to one dominated by a few mayfly and dipteran taxa.

Spawning and nursery areas available in the tributaries from the Regulation Dam Site to Kootenai Falls are sufficient to maintain high levels of fishing success in the river. Pipe, Libby and Bobtail Creeks support the largest runs. The spawning runs of rainbow into Bobtail Creek increased over 200 percent from 1975-1979.

The lack of suitable spawning habitat and barrier problems in tributary streams downstream from Kootenai Falls are limiting trout populations. A small dam on O'Brien Creek was removed in 1978, providing Kootenai River salmonids access to about 16 miles of new spawning habitat.

Rainbow trout populations in the Flower-Pipe Section were higher in 1978 and 1979 than in previous years. Mountain whitefish numbers increased by about 400 percent from 1975-1978. Spawning runs of whitefish in Libby Creek and Fisher River increased markedly from 1975 to 1978. The increased densities of these species was reflected in slower growth rates in 1978 and 1979. Changes in aquatic insect populations may have also influenced the growth rates.

Fishing pressure has increased from about 116 angler-days per mile in 1968 to about 1600 per mile in 1978. The catch rates (.36 to .64 fish per hour) and average size of the rainbow trout creeled (11.4 inches total length) rank the Kootenai as one of the better wild trout fisheries in Montana.

The marked improvement in rainbow trout and mountain whitefish populations downstream of Libby Dam has been a result of the interaction of several environmental factors. These include: 1) improved water temperatures for trout growth, 2) reduction of sediment loads below Libby Dam and sediment pollution from a mine-mill operation on Rainy Creek, 3) higher flows from August through March, and 4) reduction of fluoride and ammonia pollution from a Canadian fertilizer plant.

INTRODUCTION

The Kootenai River, with an average flow at Libby of 12,100 cfs, is Montana's second largest river. Average peak flows before impoundment were about 67,500 cfs and average lows were about 1600 cfs. In the past, the river provided a good sport fishery for westslope cutthroat trout (Salmo clarki lewisi), rainbow trout (Salmo gairdneri), Dolly Varden (Salvelinus malma) and mountain whitefish (Prosopium williamsoni). The only white sutrgeon (Acipenser transmontanus) and native rainbow trout populations in Montana are found downstream from Kootenai Falls. Tributaries below the falls are used as spawning and nursery areas by rainbow trout and Kokanee (Oncorhynchus nerka) from Kootenai Lake in British Columbia. Brook trout (Salvelinus fontinalis) are occasionally found in the river near the confluence of tributaries. Other fish inhabitating the river include: burbot (Lota lota), largescale suckers (Catostomus macrocheilus), longnose suckers (C. catostomus), torrent sculpin (Cottus rhotheus), slimy sculpin (Cottus cognatus), redside shiner (Richardsonius balteatus), northern squawfish (Ptychocheilus oregonensis), peamouth chub (Mylocheilus caurinus) and longnose dace (Rhinichthys cataractae). Northern squawfish and peamouth are rare above Kootenai Falls and common below.

Water quality and insect data collected from 1967-72 (Bonde & Bush, 1975) showed that the Kootenai River was a cold water, fertile stream, but fluoride and ammonia pollution from a fertilizer plant on the St Mary's River in British Columbia were limiting aquatic insect populations. The standing crop of insects increased markedly after 1968 following a partial curtailment of pollution from the fertilizer plant. By 1971, the standing crop of insects had increased by 273 percent above Libby Dam and 392 percent downstream from the dam.

Fish population data have been collected in the Kootenai River and its tributaries since 1969. Prior to impoundment, the river supported fair numbers of trout and an excellent mountain whitefish population from the dam site to Rainy Creek. Below this point, sediment pollution from the zonolite mine-mill operation greatly reduced the production of aquatic insects and game fish until it was corrected in 1972.

Impoundment of the Kootenai in April, 1972 caused marked changes in water quality. Gas supersaturation levels were quite high until fall of 1975 when turbine installation was completed and water was run through the turbines rather than through the sluiceways or spillways An increase in periphyton production, primarily Ulothrix, was noted soon after impoundment. Warmer water temperatures during the winter, reduced turbidities and a lack of scouring spring flows have all contributed to the increased algae production.

The aquatic insect population changed from a mayfly, stonefly, caddisfly and dipteran complex to one dominated by a few mayfly and dipteran taxa (Graham, 1979). In pre-impoundment studies, 42 genera were collected compared to 26 genera in the Kootenai Falls area in 1978. The reduction in densities of caddisflies may be due to loss of suitable habitat. The net spinning *Hydropsyche* require current velocity for the nets to function properly. Sediments and organic debris have filled interstices in the gravel and rubble and reduced surface area for net spinners to attach. The lack of flood flows (which shift and resort bottom material and carry sediment downstream) contributes to the habitat loss. The sediment loads carried to the Kootenai by the Fisher River and Libby Creek during spring run-off are not being transported through the system because of low flows and velocities in the Kootenai during this period.

The longnose dace, torrent sculpin and mountain whitefish populations were reduced markedly for the first 15-20 miles downstream by gas supersaturation. Rainbow trout populations were also limited to below the carrying capacity of the river. The cutthroat trout population fluctuated considerably from year to year, in response to the number of cutthroat escaping from the reservoir.

The planned construction of the Reregulating Dam located ten miles downstream from the main dam, in the 1980's will further affect the river biota by 1) blocking spawning runs of mountain whitefish, Dolly Varden and rainbow trout from the Fisher River drainage, 2) by reducing the miles of free-flowing river above Kootenai Falls by 35 percent, leaving only 19 miles for fishing and recreation use, and 3) blocking insect drift from the upstream areas. Determination of damages and possible mitigation measures require pre- and post-impoundment data on the fishery resource.

OBJECTIVES

The purpose of this project is to obtain information on the best methods to maintain and manage the Kootenai River fisheries which have been impacted by Libby Dam and to aid in predicting fisheries impacts which will be caused by Libby Reregulating Dam. The specific objectives were: 1) obtain indices of fish abundance in the Kootenai River below Libby Dam, 2) determine age structure, growth rates and condition factors of major game species, 3) determine angler success rates and species composition of the catch, 4) determine response of fish populations to water quality changes, 5) determine the effect of fish leaving the reservoir on resident river populations, and 6) determine methods to replace and relocate spawning runs to maintain a wild trout fishery in the Kootenai River if the reregulating dam is built and the Fisher Drainage is lost as a spawning and nursery area.

PROCEDURES

Water Quality

This water quality data were collected and analyzed by the United States Geological Survey. The data are given for: 1) prior to impoundment (1970), 2) three years after impoundment (1975), and 3) the first year of operation of the selective withdrawal system (1977).

Creel Census and Tag Returns

Contact creel census information was collected from anglers fishing the Kootenai River from Libby Dam to below Kootenai Falls. Angler data were collected from both complete and incomplete trips. Anglers who had fished less than an hour were given a postal creel card to complete and return by mail. Newspaper articles advertising for tag returns were published in the local paper and tag return stations established at sporting goods dealers.

Fish Populations

The three fish population study sections in the Kootenai River were: 1) Jennings section, 13,500 feet long, two to five miles below Libby Dam, 2) Flower-Pipe section, 24,100 feet long, 17 to 22 miles below the dam, and 3) Throops Landing in Troy section, 21,000 feet long, 30 to 34 miles below the dam (Figure 1).

Fish were collected at night with boat-mounted electrofishing gear in the Kootenai River. Tributary streams were sampled with boat-mounted electrofishing gear or a backpack shocker using a 6 volt motorcycle battery. Methods described by Vincent (1971) were followed for electrofishing operatio s and for analyzing mark and recapture data.

Gill nets and set lines were used to collect white sturgeon from below Kootenai Falls.

Spawning runs into the tributary streams were monitored using box traps with poultry netting leads. The emigration of fry and juvenile fish was monitored using a fry trap designed by Northcote (1969). The leads were 1/4" square mesh hardware cloth.

Most fish collected during the study were anesthetized, measured, weighed, marked or tagged and released. Scale samples were taken from 30 fish per one inch length group to determine growth rates. Plastic impressions of the scales were made and these were read with the aid of a Bausch and Lomb microprojector. The outer edge of the scale was considered to be an annulus after January 1st until growth resumed in the spring. With collections made annually, a straight line nomograph was used to determine the fish length at the outer annulus only. This approach was first suggested by Carlander (1950) because it provides the most accurate picture of the size of fish in each year-class at the time the last annulus was formed. Length at each annulus was back calculated to determine the growth history of each year-class when annual collections were not made. Rainbow trout in the Kootenai River were assigned to migration class X_0, X_1, or X_2 on the basis of length of stream residency prior to emigration. For example, a 4_1 fish would be 4 years old at capture, having resided in a tributary stream for all of the first growing season, and lived in the river for three years.

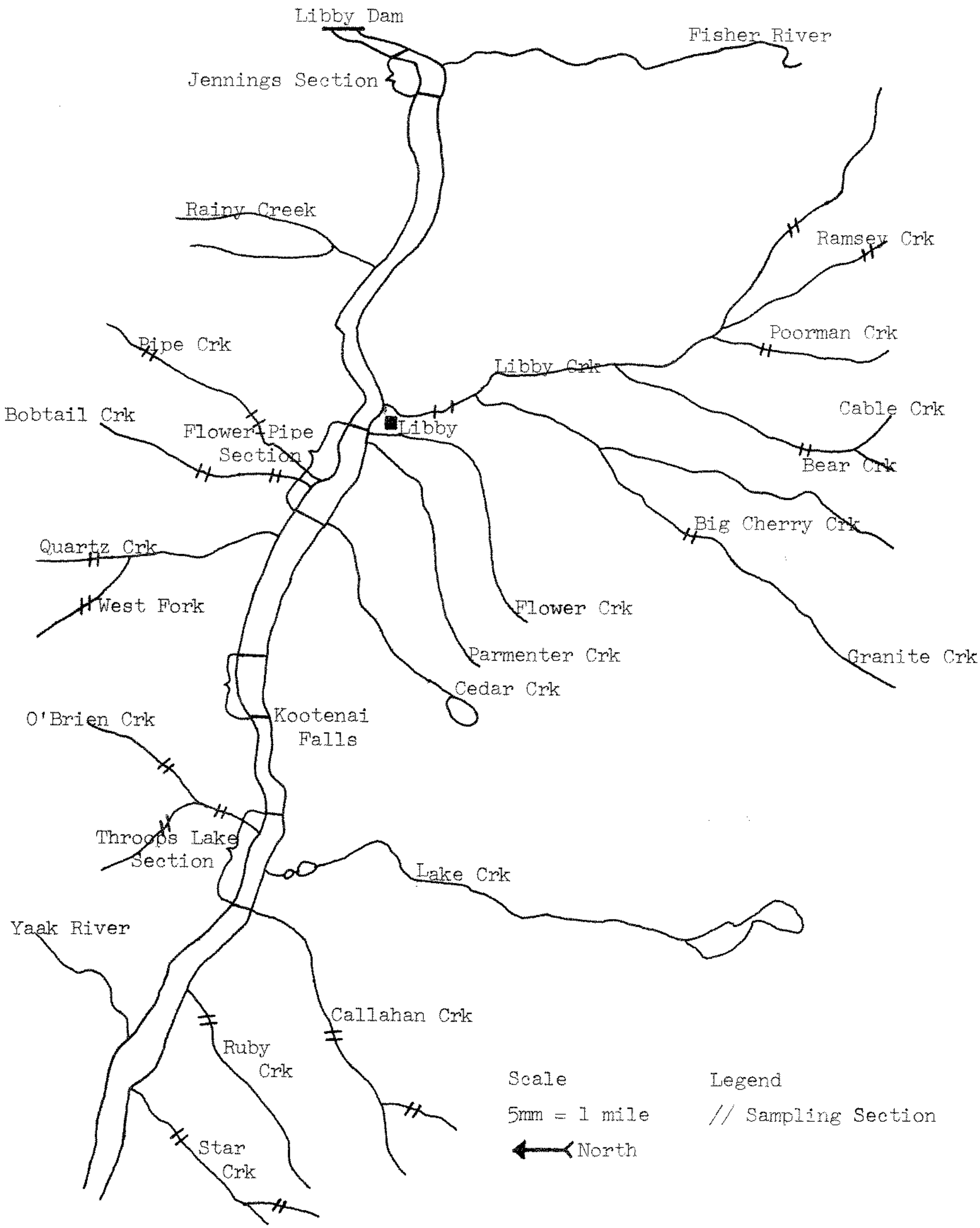

Figure 1. Map of Kootenai River and its major tributaries showing fish sampling sections.

Standard stream survey techniques used by the Kootenai National Forest were followed in evaluating the spawning habitat of tributary streams.

FINDINGS AND DISCUSSION

Water Quality

Changes in water quality and discharge patterns occurred after impoundment of the Kootenai River. To illustrate these changes, a comparison of discharge, sediment loads, water temperature, nutrient concentrations and specific conductance are given for 1970, 1975 and 1977. These were years of low flow being 75, 83 and 77 percent of normal, respectively.

The annual and daily pre-impoundment flow regime was altered from the natural pattern. Before impoundment largest flows occurring from April through July and lowest flows during winter and early spring (Figure 2). Following impoundment, high flows occurred from October through March with low flows occurring from April through August. Daily flows were stable under natural conditions and until 1975 when the first four generators began operation. Maximum fluctuations under discharge criteria were: 1) April through September, 4 vertical feet fluctuation per day and 1 foot per hour, 2) October through March, 6 vertical feet per day and 2 feet per hour. These changes in flow patterns have restricted and altered the seasonal and daily habitat available to aquatic organisms and allowed deltas to form at the mouths of downstream tributaries, due to the lack of high flows in the main river sufficient to move bedload.

Suspended sediment concentrations have dropped markedly since impoundment immediately downstream from Libby Dam. The sediment load in tons per year was 85 percent less in 1975 than in 1970 (Figure 3). Peak sediment loads occurred from April to July in response to natural high run off prior to impoundment. Peak loads following impoundment occurred from November to March when the reservoir was being drafted.

The concentrations of total phosphorus and dissolved orthophosphate decreased markedly from 1970 to 1977 (Figure 4). This reflects pollution control at a Canadian fertilizer plant and trapping of nutrients in the reservoir Specific conductance was more constant in 1975 and 1977 than in 1970 due to the lack of extreme high spring flows and low winter flows. Conductance is often used as an indication of potential productivity of aquatic systems. The values for the Kootenai classify it as a medium to high productive system. Conductance was highest prior to impoundment, from January through March, while following impoundment the conductance was highest during the low flow period of April through June. The operation of the selective withdrawal system appeared to have little effect on specific conductance (Figure 5).

Water temperature patterns have changed markedly since impoundment. Temperatures were cooler in 1975 and 1977 than in 1970 from April to late June

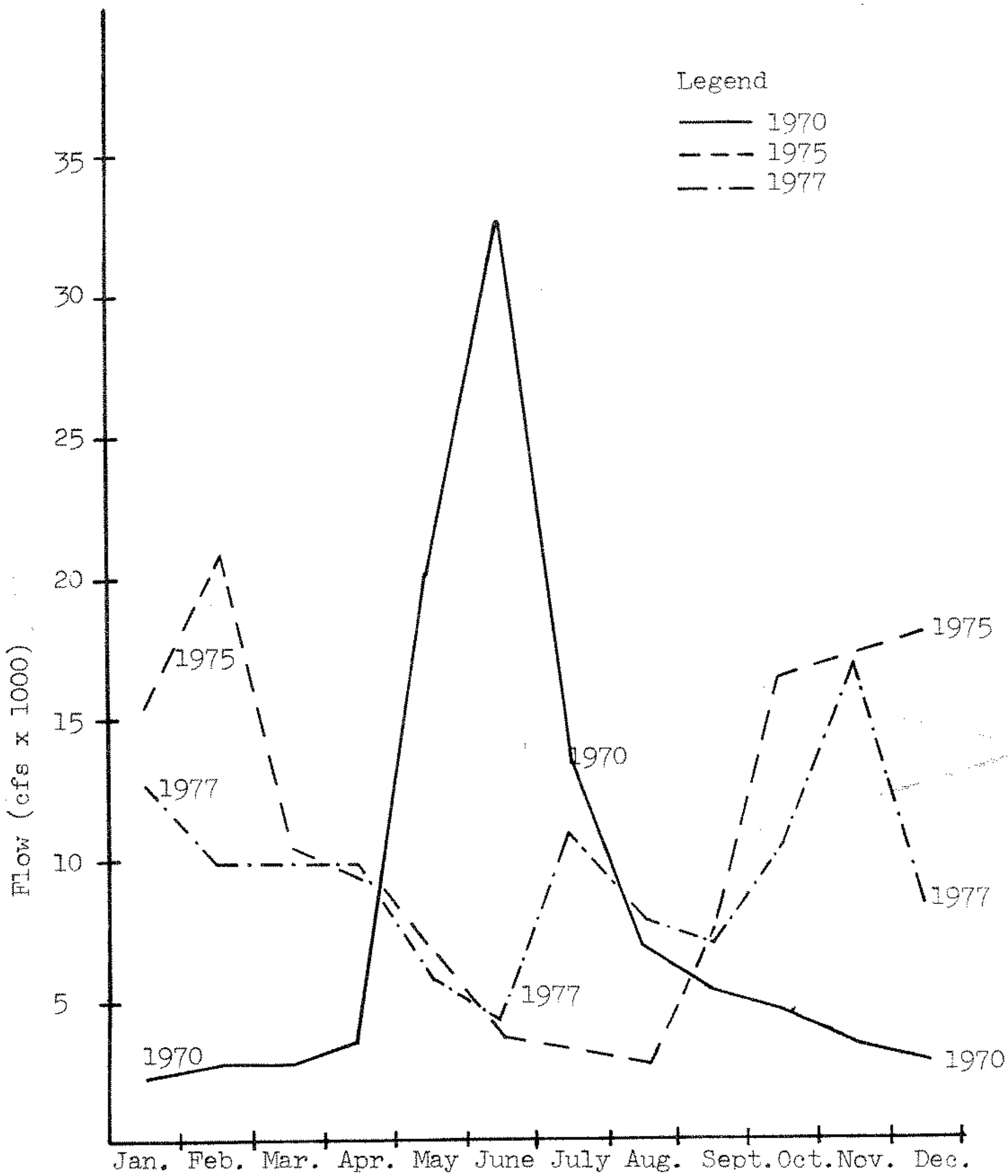

Figure 2. Monthly averages of mean daily discharge downstream from the Libby Dam site prior to impoundment (1970), following impoundment (1975) and following operation of selective withdrawal system (1977).

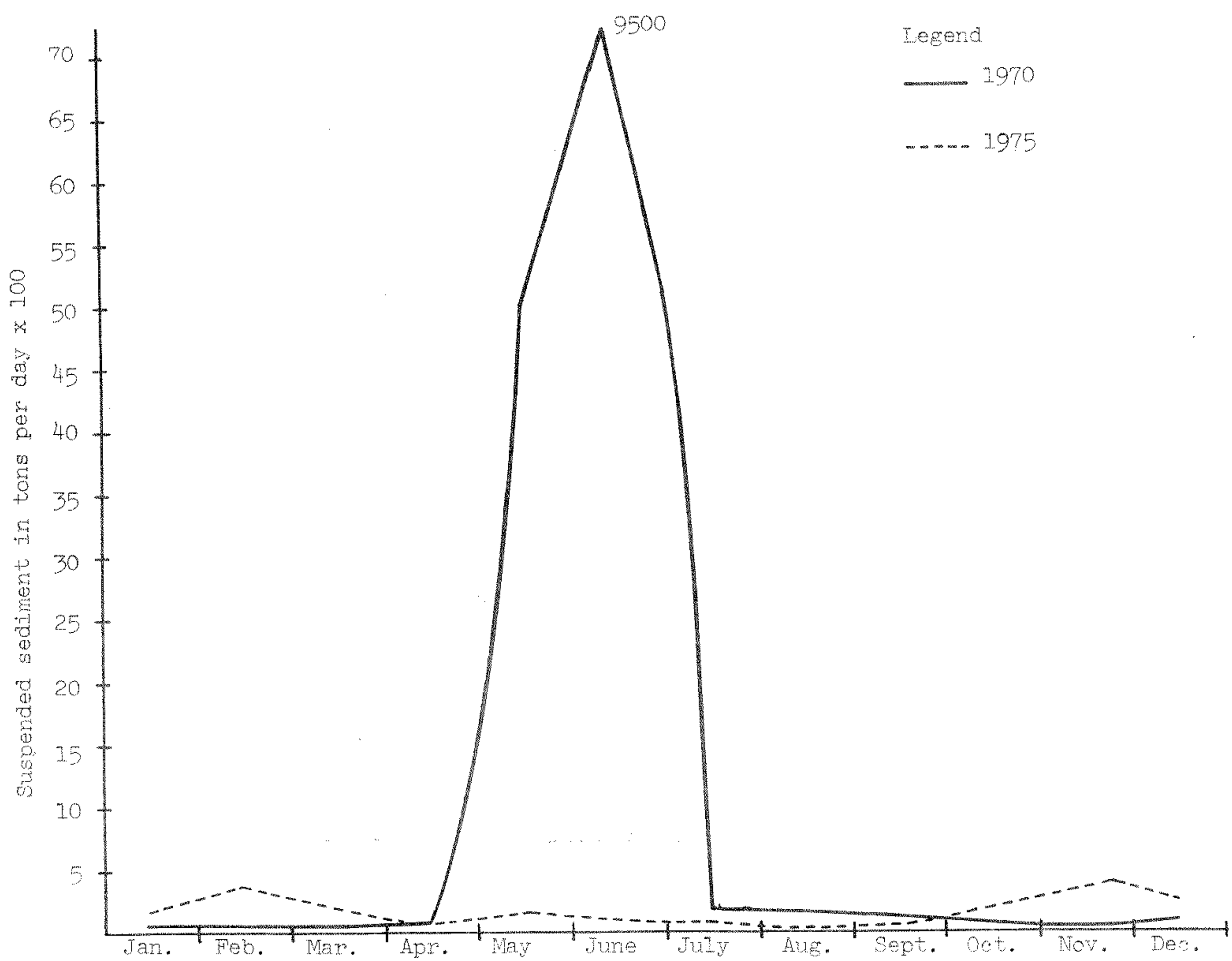

Figure 3. Average monthly suspended sediment loads in the Kootenai River prior to impoundment (1970) and 3 years after impoundment (1975).

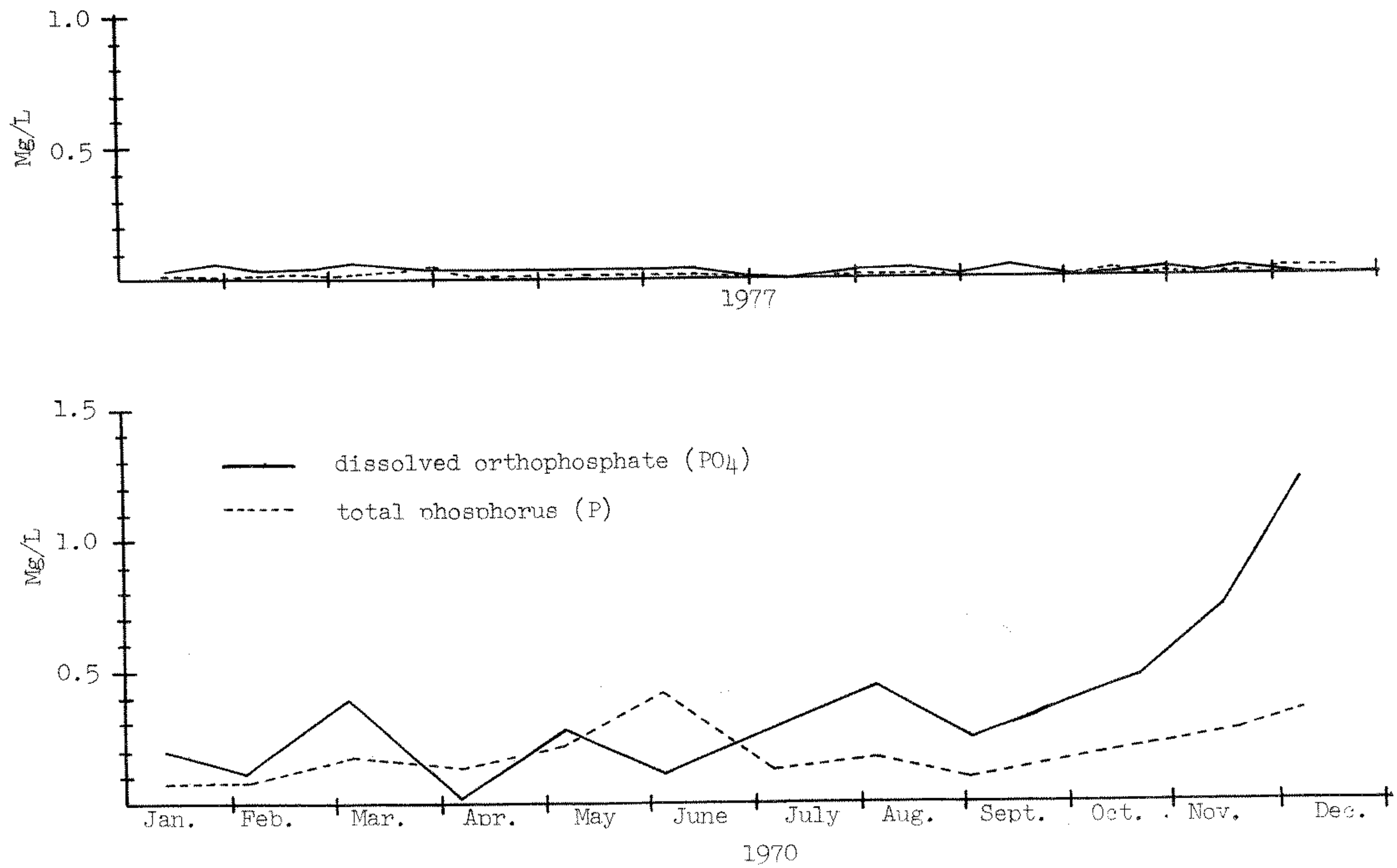

Figure 4. Total phosphorus and dissolved orthophosphate measured downstream from the Libby Dam site prior to impoundment (1970) and following impoundment (1977).

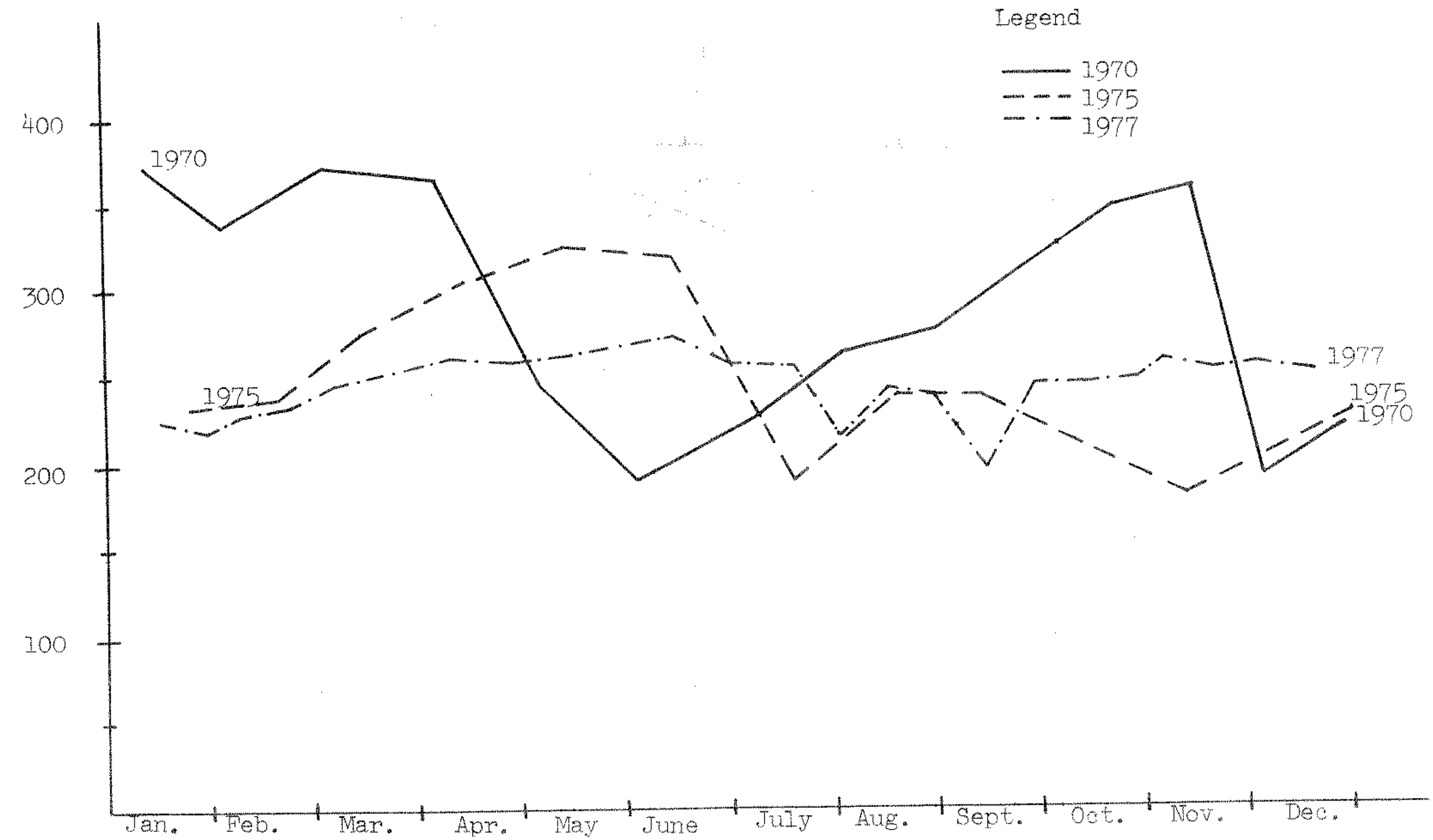

Figure 5. Specific conductance measured in the Kootenai River downstream from the Libby Dam site prior to impoundment (1970), following impoundment (1975) and following operation of the selective withdrawal system (1977).

when the spillway was used to release water (Figure 6). Temperatures were variable in 1975 due to water release patterns which included sluiceway, spillway and turbine releases. The temperatures were warmer in 1975 and 1977, than in 1970 from October through March.

The selective withdrawal system began operation in 1977. One objective of the system was to provide temperatures which would optimize trout production in the river. An annual rule curve was established in 1977 by the U.S. Army Corps of Engineers and Montana Department of Fish and Game as a guide for daily water temperatures in the Kootenai River. This plan will increase the number of degree days above 32°F by approximately 30 percent.

Temperatures were cooler in 1977 than in 1970 from April through September, but were in the range for trout growth (45-60°F) most of the time. During the fall and winter, water temperatures were markedly warmer in 1977 than in 1970. (Personal communication, Tom Bonde).

Tributary Stream Surveys

Spawning habitat and barrier surveys were conducted in the following drainages: Libby Creek, Pipe Creek, Quartz Creek, Flower Creek, Bobtail Creek, Parmenter Creek, Granite Creek, Cedar Creek, O'Brien Creek, Callahan Creek, Star Creek, Ruby Creek and Yaak River. Barriers to upstream migration of adult spawners were found in most drainages (Figures 7 and 8). A total of 62 log and debris jam barriers, 11 falls and cascades, five culverts and three dams were determined to be blocking or inhibiting upstream movement of spawning fish. Not all of the log jams were barriers, but could develop into blocks in the future. The most severe passage problems were found in the streams below Kootenai Falls. Lake Creek and O Brien Creek had dams near the mouths. The dam in O'Brien Creek was removed in October, 1978 and approximately 16 miles of spawning and nursery habitat were made available. Natural falls block fish passage in the Yaak River (8 5 miles from the mouth), Callahan Creek (4.1 miles from the mouth), Ruby Creek (0.3 miles from the mouth), and Star Creek (0.4 miles from the mouth).

The available spawning habitat to trout living in Kootenai River from Kootenai Falls to the Idaho state line, a distance of 23 miles, was approximately 29.3 miles (Table 1). This paucity of spawning habitat appears to be a major factor limiting trout populations in the river below the falls. A program to reestablish trout runs in O'Brien Creek was begun in 1978.

Passage problems in the tributaries above Kootenai Falls were found in the upper parts of the drainages surveyed. Log and debris jams accounted for most of the passage problems. Log jams prevent utilization of good spawning habitat in Quartz Creek and should be removed as soon as possible. Culverts prevent upstream fish movement near the mouths of Crazyman and Poorman Creeks in the Libby Creek Drainage and in Pipe Creek just above the mouth of the East Fork. The culverts in Pipe Creek and Poorman Creek will be replaced by the Kootenai

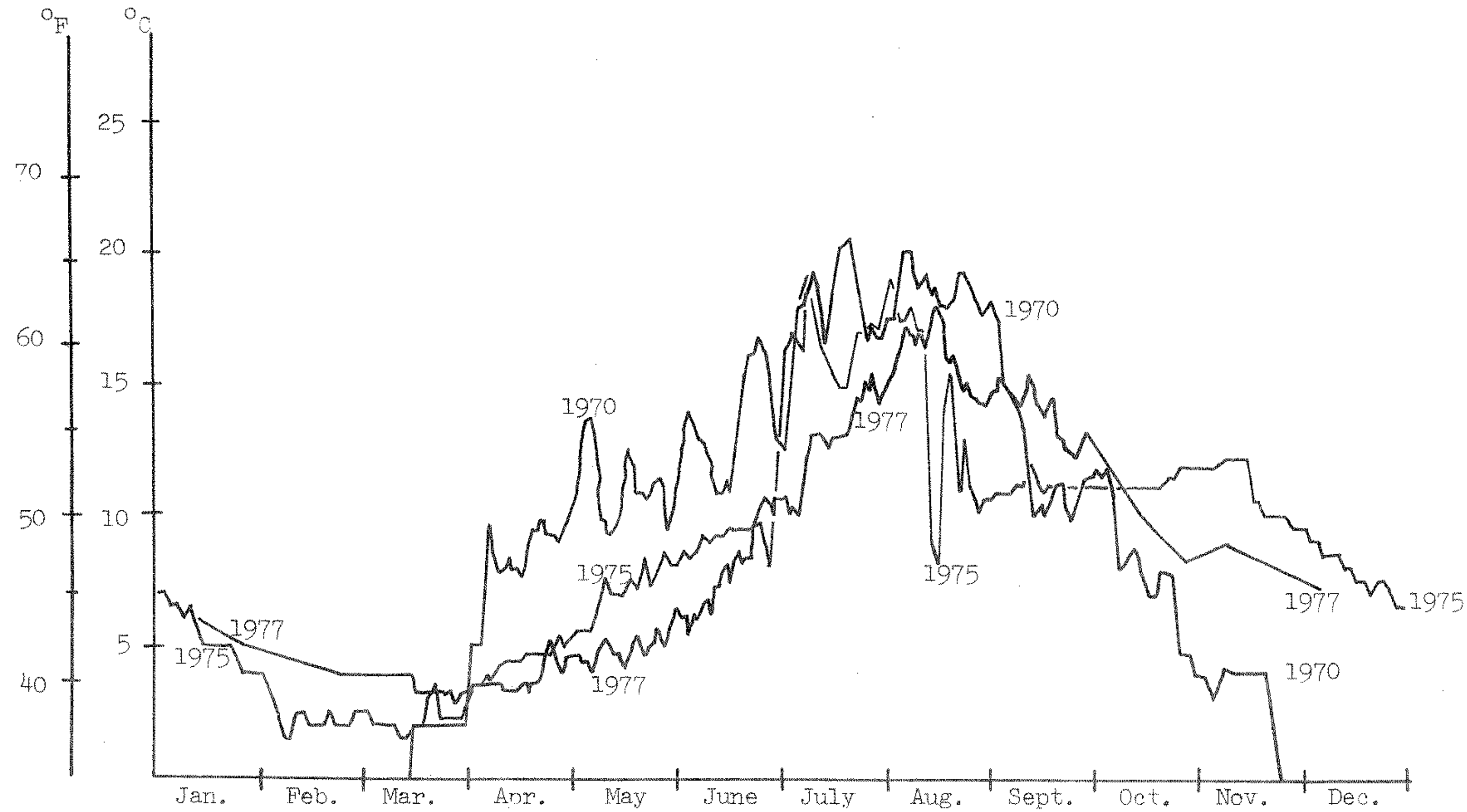

Figure 6. Mean daily water temperatures measured downstream from the Libby Dam site prior to impoundment (1970), following impoundment (1975) and following operation of the selective withdrawal system (1977).

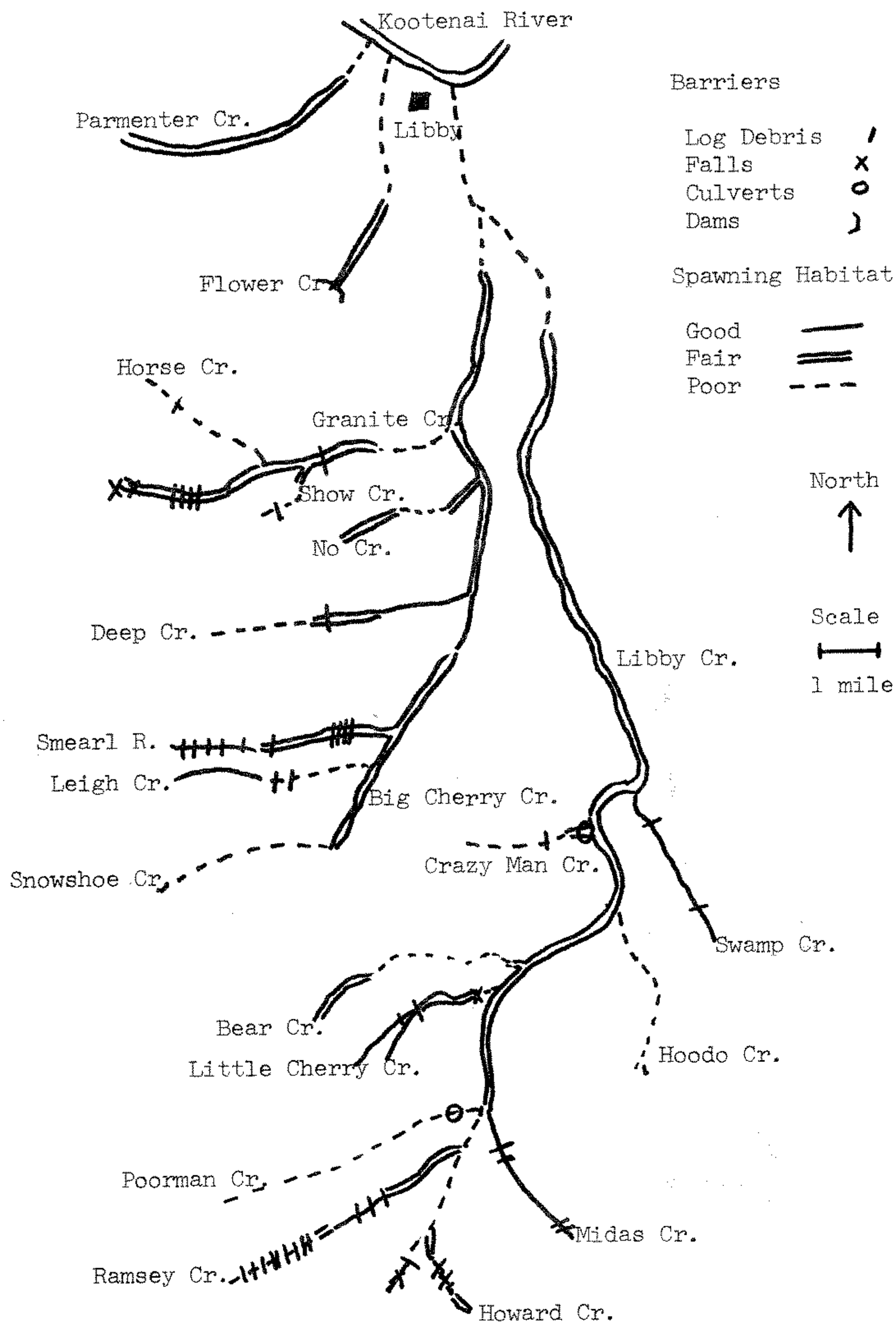

Figure 7. Spawning areas and barriers in Parmenter, Flower and Libby Creek drainages.

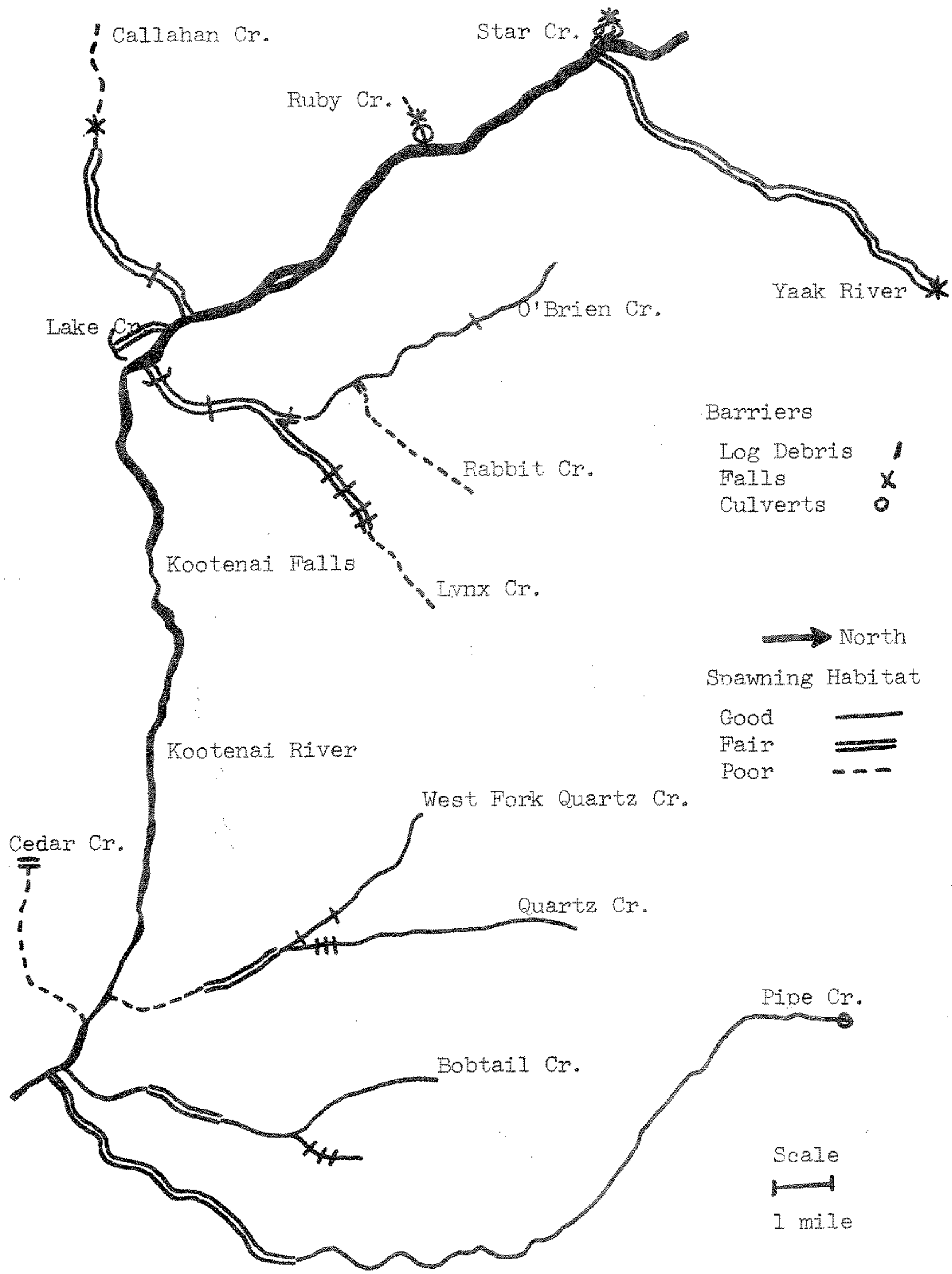

Figure 8. Spawning areas and barriers in Pipe, Bobtail, Quartz, O'Brien, Lake, Callahan, Ruby and Star Creeks and Yaak River drainages.

Table 1. Summary of trout spawning habitat survey in tributary streams of the Kootenai River downstream from the reregulation dam site 1976-78. Only stream lengths accessible to river fish are included.

Drainage	Miles of stream spawning habitat classified as Good	Fair	Poor
	"Rereg." to Kootenai Falls		
Libby Creek	9.5	38.1	37.1
Bobtail Creek	5.9	1.6	1.6
Pine Creek	12.0	7.1	--
Quartz Creek	8.6	1.5	1.8
Cedar Creek	--	--	3.3
Parmenter Creek	--	1.7	1.2
Flower Creek	--	2.0	2.5
Total	36.0	52.0	47.5
	Kootenai Falls to Idaho State Line		
Star Creek	--	--	0.3
Ruby Creek	--	0.2	--
Yaak River	--	8.8	--
Callahan Creek	--	4.1	--
O'Brien Creek	8.5	7.4	--
Total	8.5	20.5	0.3

National Forest when funds become available. Natural falls prevent upstream movement in upper Granite Creek, upper Libby Creek, Midas Creek and Little Cherry Creek. A municipal water supply dam, 4.5 miles from the mouth, prevents upstream movement of fish in Flower Creek.

A total of approximately 135.5 miles of tributary streams are accessible to migratory trout in the tributaries above Kootenai Falls (Table 1). Approximately 88 miles of the total were classified as possessing good to fair spawning habitat. Barrier removal work and culvert replacement would provide access into another 20-30 miles of stream. The data indicate that under proper management, these tributaries should provide adequate spawning and nursery area for rainbow trout inhabiting the 18 miles of the Kootenai River from the "rereg. site" to Kootenai Falls.

Electrofishing data collected from upper Libby, Granite and Quartz drainages are presented in Table 2. The efficiency of the gear was less than normal

Table 2. Summary of upper Libby Creek, Granite Creek and Quartz Creek electrofishing survey in summer, 1976. Sections were 500 feet in length in Bear, Poorman, Ramsey, Libby, and Granite Creeks and 1000 feet in Quartz Creek.

Species	Number Caught	Average Length	Average Weight	Range in Length	Location
		Bear Creek Section 1			
Rb[1/]	8	6.0	.08	4.4- 8.1	T38NR31WS22
DV	9	6.3	.09	3.6- 7.5	T38NR31WS22
		Poorman Creek Section 1			
Rb	12	5.6	.07	3.8- 7.0	T28NR31WS35
DV	2	4.9	.05	3.7- 6.1	T28NR31WS35
		Ramsey Creek Section 1			
Rb	7	6.3	.09	4.4- 7.3	T27NR31WS9
DV	2	6.1	.11	3.8- 8.4	T27NR31WS9
		Libby Creek Section 7			
DV	4	7.3	.17	3.1-10.0	T27NR31WS14
		Granite Creek Section 1			
Rb	17	5.2	.07	3.1- 8.1	T29NR31WS5
		East Fork Quartz Creek			
Ct	35	4.9	.05	2.4- 8.0	T32NR32WS27
Eb	4	6.0	.08	5.3- 7.6	T32NR32WS27
DV	3	4.8	.04	4.0- 6.2	T32NR32WS27
		West Fork Quartz Creek			
DV	17	5.4	.07	3.4- 9.6	T32NR32WS27
Ct	2	5.3	.07	4.2- 6.5	T32NR32WS27

1/ Rb=rainbow, DV=Dolly Varden, Ct=cutthroat, Eb=brook trout due to unusually high summer flows in 1976. The upper Libby Creek drainage (Poorman, Bear, and Ramsey) had a game fish population of rainbow trout and Dolly Varden, whereas the Libby Creek Section 7 contained only Dolly Varden. Dolly Varden over 7.0 inches in length were mature fish, indicating that they were a resident population. Most rainbow trout over 2 years old were also mature. Granite Creek below the falls contained a fairly dense population of primarily resident rainbow. Cutthroat trout comprised 83 percent of the fish collected in East Fork of Quartz Creek, whereas Dolly Varden comprised 89 percent of the West Fork sample. The fish appeared to be predominately residents, although a few cutthroat had the silvery appearance of juveniles in the smolt stage of development.

Fish data collected from Libby, Pipe and Bobtail Creeks are given in Table 3. Rainbow trout comprised the major part of the population in Section 1 of Libby Creek and Section 1 of Pipe Creek. Growth of trout is similar to that recorded in the Fisher River and Fortine Creek drainages (May, 1972). Cutthroat trout comprised 60 percent of the catch in Section 4 of Pipe Creek followed by brook trout (27 percent) and rainbow (13 percent). Rainbow trout comprised the majority of the population in Bobtail, Section 2. Another section sampled near the mouth contained nearly all rainbow trout.

The densities of small trout (249-448 fish per 1000 ft.) in all three streams were much higher than recorded in the Fisher and Fortine drainages (May, ibid.) and indicate that these streams are capable of producing numerous smolts for the mainstem Kootenai. Habitat and water quality protection should be intensified if these streams are to maintain their present fish production. Mining activities and water withdrawals for irrigation are especially serious threats to continued high productivity of these streams.

Electrofishing data collected on tributary streams downstream from Kootenai Falls are presented in Table 4. Cutthroat trout was the dominant species in Sections 5 and 32 of O'Brien Creek, whereas brook trout was most numerous in Section 10. Trout populations were highest in Section 32. Rainbow trout was the dominant species in both sections in Callahan Creek. Electrophoresis tests indicated that these fish were native rainbow trout (Espeland and Scow, 1978). Rainbow trout comprised all of the catch in Star Creek and 82 percent of the catch in Raymond Creek. Rainbow trout comprised 81 percent of the population in the Ruby Creek section.

The Yaak downstream from Yaak Falls was sampled by angling rather than electrofishing due to a lack of road access. The angling survey showed that this section of the river contained a good population of rainbow trout. The electrofishing and angling data indicate the tributaries below the falls would probably be capable of providing sufficient spawning and nursery areas for migratory trout from the Kootenai, if it weren't for barriers to upstream fish movement. The possibility of reestablishing rainbow runs in O'Brien Creek and constructing a spawning channel in the Yaak River in cooperation with the Kootenai National Forest is being investigated.

Table 3. Population estimates for Libby, Pipe and Bobtail Creeks, summer 1977. Estimates are given as number and weight of fish per thousand feet of stream for yearling and older fish. Eighty percent confidence limits are in parenthesis.

Species[1/]	Age	Average Length	Range in Length	Average Weight	Number per Thousand Feet		Number per Thousand Feet
			Libby Creek Section 1 - T30N R31W S36				
Rb	1+	4.7	3.4- 6.2	.04	222		9.0
Rb	2+	7.0	6.2- 8.0	.13	36		4.7
Rb	3 & older	13.0	8.9-15.6	1.07	1		1.1
			Total		259	(±18.9%)	14.8
			Pipe Creek Section 1 - T32N R31W S35				
Rb	1+	4.1	3.0- 5.1	.03	187		5.2
Rb	2+	6.3	5.3- 7.9	.10	56		5.4
Rb	3+	8.4	7.6- 9.3	.21	6		1.2
			Total		249	(± 7.9%)	11.8
			Pipe Creek Section 4 - T33N R31W S28				
Rb	1+ to 3+	6.2	3.3- 9.9	.11	29		3.2
Ct	1+ to 3+	6.0	3.0-11.6	.13	136		17.7
Eb	1+ to 3+	5.6	3.7- 9.1	.09	63		5.7
			Total		228	(±23.6%)	26.6
			Bobtail Creek Section 2 - T31N R32W S8				
Rb	1+ to 3+	4.9	3.1- 8.2	.05	246		12.3
Ct	1+ to 3+	5.3	3.0- 9.8	.07	66		4.6
Eb	1+ to 3+	5.8	4.2- 9.3	.08	136		10.9
			Total		448	(±22.0%)	27.8

1/ Rb=rainbow trout, Ct=cutthroat trout, Eb=brook trout

Table 4. Summary of electrofishing surveys in tributaries to the Kootenai River below Kootenai Falls, 1977. Sections were 500 feet in length except for the Yaak which was an angling survey conducted on 3 miles of stream.

Species[1/]	Number Caught	Average Length	Average Weight	Range in Length	Location
		North Fork O'Brien Creek Section 5			
Ct	8	4.6	.04	3.0- 8.0	T32NR33WS5
		O'Brien Creek Section 10			
Eb	38	5.4	.07	4.0- 7.8	T32NR33WS10
Ct	8	4.7	.05	3.6- 8.4	T32NR33WS10
		O'Brien Creek Section 32			
Ct	84	4.5	.04	3.4-12.2	T32NR33WS32
DV	10	5.7	.12	2.2-12.8	T32NR33WS32
Eb	3	4.8	.04	4.1- 5.2	T32NR33WS32
CtXRb	2	4.6	.04	--	T32NR33WS32
		Callahan Creek Section 26			
Rb	31	4.5	.04	2.4- 7.8	T31NR34WS26
DV	5	5.5	.10	4.2- 6.0	T31NR34WS26
		Callahan Creek Section 20			
Rb	30	4.1	.04	2.7- 8.4	T31NR34WS20
		Star Creek Section 12			
Rb	31	5.4	.07	3.0- 8.3	T32NR34WS12
		Raymond Creek Section 3E			
Rb	18	3.7	.03	2.0- 7.9	T60NR3ES28
RbXCt	4	7.0	.20	4.4- 8.6	T60NR3ES28
		Ruby Creek Section 21			
Rb	60	3.7	.03	2.7- 7.0	T32NR34WS21
Ct	14	3.7	.03	2.7- 5.1	T32NR34WS21
		Yaak River - Angling Survey			
Rb	41	7.0	.14	4.5-10.5	T33NR34WS30&31
Eb	2	5.6	.07	--	T33NR34WS30&31

1/ Rb=rainbow trout, Ct=cutthroat trout, Eb=brook trout, DV=Dolly Varden, RbXCt=rainbow-cutthroat hybrid

Spawning Runs and Juvenile Emigration

The spawning runs of rainbow trout into Bobtail Creek were trapped annually from 1976 to 1979. The small size of the stream and the flow pattern enabled us to trap the runs quite efficiently from 1977-1979. The leads were down only 3 days for those three years (Table 5), and nearly all of the fish were trapped. The peak of the run in 1979 occurred almost two weeks later than in previous years (Figure 8). The spring of 1979 was unusually cool resulting in minimum water temperatures not reaching 40°F until the last week in April as compared to mid-April in 1978.

Table 5. Summary of rainbow trout spawning runs into Bobtail Creek from Kootenai River, 1976-79. Average weight of fish is in parenthesis.

Parameter	Year			
	1976	1977	1978	1979
Period trap operated	3/20-4/1	3/15-5/25	3/21-5/8	3/22-6/04
Peak of run	3/27-?	4/06-5/13	4/08-5/2	4/21-5/25
Days trap operated	18	66	33	72
Days leads up	12	65	33	70
Number males	30	53	117	188
Average length males, inches	12.7	13.8	11.7	11.3
Number females	9	78	38	190
Average length females, inches	15.8	17.2	16.3	14.0
Sex ratio male:female	2.9:1.0	1.0:1.5	3.1:1.0	1.0:1.0

The number of spawners trapped increased from 39 in 1976 to 378 in 1979. The average length of males varied from 13.8 inches in 1977 to 11.3 inches in 1979. A similar pattern of decreasing lengths was noted for females. The decline in average size was due primarily to a reduction in growth rates. Increasing fishing pressure and harvest of larger fish may also have contributed to the smaller size.

The age composition of the 1978 run is presented in Table 6. Migration class X_1 (fish that spent most of the first growing season in a tributary stream) comprised 73.5 percent of the males and 65.8 percent of females. Most X_1 males matured at age 2_1 after one year of tributary and one year of river growth, while most X_1 females didn't mature until age 3_1. The preponderance of males in 1978 appears to be the result of the different maturation rate between the sexes. The 1976 year-class was quite strong with most males entering the run in 1978, while most females spawned in 1979 for the first time.

Measurements were taken on redd habitat characteristics in 1978. The average depths and velocity of 20 redds were .37 feet and .76 feet per second, respectively (Appendix 1)

Table 6. Age composition of Bobtail Creek rainbow spawning run in 1978. The data are segregated by migration class.

Year Class	Age Class	Number in Each Class		Number in Each Class	
		Male	Female	Male	Female
		Migration Class X_0			
1976	2	1	--	20	--
1975	3	4	--	80	--
		Migration Class X_1			
1976	2	76	3	92	12
1975	3	5	15	6	60
1974	4	2	7	2	28
		Migration Class X_2			
1976	2	--	--	--	--
1975	3	22	6	88	46
1974	4	3	7	12	54

Smolt emigration from Bobtail Creek was monitored in 1978 and 1979 (Table 7 and Figure 9). The downstream trap was installed on July 28 in 1978 and on June 12 in 1979. High flows precluded earlier installation of the trap in 1978 and part of the emigration of smolts was missed. Migration of rainbow trout as yearlings and older juveniles generally occurs from May to late July when flows are decreasing from the annual spring flood (Wagner et al., 1963) (Shapovalor and Taft, 1954).

A total of 1479 young-of-the-year rainbow passed through the trap from July 28 to November 10, 1978. The estimated number of emigrants during this period was 4,700. Large numbers of fish were still emigrating the first week of November when the trap was removed due to ice formation.

A total of 359 juvenile rainbow trout passed through the downstream trap from June 12 to June 30, 1979 (Table 8). The trap efficiency for this period was 23 percent and the estimated number of smolts was 1561. The length frequency distribution of the catch indicates that nearly all of the fish were age 1+ with the remainder being age 2+. Young-of-the-year fish were first collected in the trap the last week of June. The age at migration for rainbow juveniles is quite variable from stream to stream (Northcote). He concluded that "rainbow trout emigrate shortly after emergence from streams with low summer discharge and high summer temperatures. The survival value of this type of behavior is obvious. On the other hand, streams in which most young remain

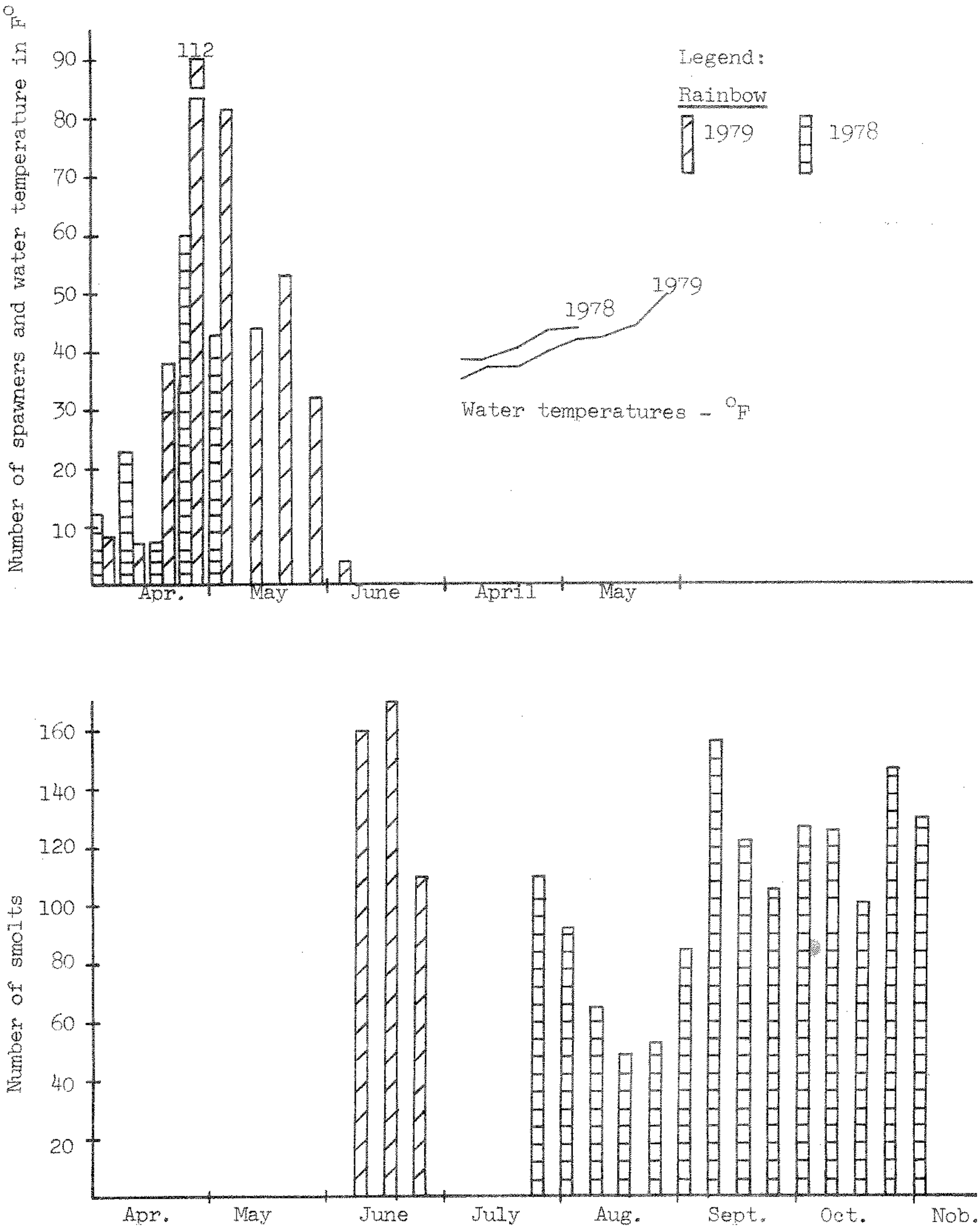

Figure 9. Number of adult rainbow and smolts caught per week in Bobtail Creek fish traps 1978 and 1979. Average weekly minimum water temperatures are given for April and May.

Table 7. A summary of the catch of young-of-the-year rainbow trout in the downstream trap in Bobtail Creek, 1978.

Parameter	Time Period 7/28-8/31	9/1-9/30	10/1-11/10	Total
Number caught	369	469	641	1479
Trap efficiency	25-35% 1/	25-35%	36%	
Estimated total number	1230	1600	1864	4700
Average length	1.8	2.1	2.3	
Range in length	1.3-2.5	1.5-3.0	1.7-3.2	

1/ Estimate based on trap efficiency in October

a year or longer before emigration maintain more stable flows as well as lower temperatures." Low flows and dense resident fish populations resulting in intense competition for food and space probably account for the mass migration of young-of-the-year rainbow from Bobtail. Daily maximum water temperatures were above 70°F three times in 1978 and minimums were always below 60°F.

Table 8. A summary of the catch of rainbow trout smolts in the downstream trap in Bobtail Creek, 1979

Parameter	Time Period 6/12-6/30
Number of yearlings or older fish	351
Trap efficiency	23%
Estimated number smolts	1561
Average length in inches	3.6
Range in length in inches	2.6-4.7

The data collected on Bobtail Creek show that spawning runs of rainbow trout have increased approximately two-fold from 1976 to 1979. Spawning success and production of juvenile fish was quite high for a comparatively small stream with flows of less than 2 to 3 cfs in the summer.

The spawning runs of rainbow trout entering Pipe Creek, Libby Creek, Quartz Creek, Granite Creek and Callahan Creek were monitored in 1977 (Table 9). Traps were also fished briefly in 1976 in Libby and Pipe Creek before high water forced their removal. The high flows precluded operation of fish traps in these larger streams during the peak rainbow trout run even in 1977 which was a low water year.

Table 9. Summary of data from rainbow spawning runs from Kootenai River into Libby Creek, Pipe Creek, Quartz Creek, Granite Creek and Callahan Creek, spring 1976-77

Time interval trap in operation	Days trap in operation	Number of fish	Average length in inches Male	Average length in inches Female	Sex Ratio ♂:♀
	Pipe Creek				
Mar. 18 - Apr. 5, 1976	18	54	14.2	18.3	3.5:1.0
Mar. 3 - May 20, 1977	46	78	14.1	17.4	1.0:1.3
	Libby Creek				
Mar. 24 - Apr. 5, 1976	13	49	16.1	18.6	1.5:1.0
Mar 14 - Apr. 27, 1977	23	49	16.2	19.1	1.0:1.5
	Quartz Creek				
Mar. 15 - Apr. 24, 1977	18	4	13.5	--	--
	Granite Creek				
Mar. 31 - Apr. 15, 1977	8	0	--	--	--
	Callahan Creek				
Apr. 4 - Apr. 11, 1977	5	3	17.4	--	--

Pipe Creek and Libby Creek probably have the largest rainbow trout runs of any tributaries below Libby Dam but few fish were trapped. A total of 78 and 49 spawners were trapped in 1977 in Pipe and Libby Creeks, respectively The average size of the fish was quite large with females in Libby Creek averaging 19.1 inches in length and 3.20 pounds. The largest fish collected was a 24.4 inch female weighing 7.10 pounds.

The Granite Creek trap was run for only eight days until high flows precluded further operation. No adult rainbow were caught even though they were collected in the Libby Creek trap during the same period. Granite is the largest tributary to Libby Creek and contains approximately 40 miles of perennial stream. The apparent lack of utilization of this drainage may be a result of heavy metals pollution from old mine tailings areas. One tributary, Snowshoe Creek, has zinc concentrations of 1.5 ppm which have made the stream unsuitable for aquatic insects and fish. A more detailed study of this drainage, especially Big Cherry Creek and its tributaries, is needed to determine the environmental factors limiting game fish production.

Only four rainbow trout were caught in the Quartz Creek trap during the 21 days of operation. Electrofishing data indicate that the fish population consists primarily of cutthroat and Dolly Varden. Rainbow were collected only from the lower half mile of the stream The trap was pulled in 1977 before the cutthroat run began, but several spent cutthroat from the Kootenai were collected on August 4 about 3 miles from the mouth. The numbers of cutthroat utilizing Quartz Creek are probably quite low, because electrofishing and creel data show that cutthroat trout populations are low in the Kootenai River from Libby to Kootenai Falls. Imprint plants of a fluvial strain of westslope cutthroat may be successful in increasing spawning runs in Quartz.

The upstream trap in Callahan Creek was fished for only 5 days before it was removed due to excessive flows. Three male rainbow were caught, averaging 17.4 inches in length.

The high flows of these larger streams during the rainbow trout run precludes the use of standard box traps and leads to quantify the runs. The use of mark and recapture data appears to be a feasible technique to quantify runs. Part of the run will be marked near the mouth using fyke nets and electrofishing gear. Recapture data will come from fyke nets and box traps fished in the tributaries. This technique may enable us to quantify the rainbow trout runs in the larger tributaries to the Kootenai below Libby Dam.

Data collected on the mountain whitefish run into Libby Creek are summarized in Tables 10 and 11. The peak of the run in 1977 and 1978 was approximately two weeks later than in previous years. This may be a result of the selective withdrawal system maintaining warmer water temperatures in the fall than previously The trap efficiency was quite high in both 1976 and 1978 as leads were down only 6 and 3 days, respectively, during the peak run. The number of fish collected increased from 3,403 in 1976 to 6,675 in 1978. The estimated run in 1978 was about 10,000 fish. The substantial increase in spawning runs was in accord with electrofishing data which showed large increases in Kootenai River populations from 1976-78 (Table 18).

Table 10. Summary of mountain whitefish data from spawning runs ascending Libby Creek from the Kootenai River, 1976, 1977 and 1978.

Parameter	Results		
	1976	1977	1978
Period trap operated	9/18-11/29	9/20-11/20	10/15-11/15
Peak of Run	10/4-10/8 and 11/1-11/18	10/21-11/19	10/17-11/4
Days trap in operation	51	54	31
Days lead up	45	39	28
Number fish captured	3403	2550	6675
Estimated run	4,000-5,000	4,000-5,000	8,000-10,000
Ave. length male	10.2	12.0	12.9
Ave. length female	14.5	12.4	13.8
Sex ratio ♂:♀	5.5:1.0	1.1:1 0	1.1:1.0

The growth rates and age composition of the run are presented in Table 11. The growth of mountain whitefish in the Kootenai River increased markedly from 1974 to 1977. Age 2+ fish in fall of 1974 averaged 10.2 inches (May and Huston, 1975) as compared to 12.6 inches in the fall of 1978. The rapid growth rates have resulted in males and females maturing at 1+ and 2+ age, respectively, rather than males maturing at 2+ and females 3+ prior to 1975.

Table 11. Length and age composition of mountain whitefish spawning runs from Kootenai River into Libby Creek, 1976, 1977 and 1978. Number of fish aged in parenthesis.

Year Class	Age Class	Average length in inches	% age composition of run Male	Female
		1976		
1975	1+	9.9(43)	89.7	2.5
1974	2+	13.1(23)	3.2	18.5
1973	3+	14.2(20)	3.8	33.3
1972	4+ & older	15.3(25)	3.3	45.7
		1977		
1976	1+	9.7(17)	5.7	0.5
1975	2+	12.2(88)	92.5	97.0
1974	3+	14.4(8)	1.6	1.5
1973	4+ & older	15.2(1)	0.2	1.0
		1978		
1977	1+	9.6(9)	7.7	--
1976	2+	12.6(28)	37.6	29.5
1975	3+	13.7(52)	48.7	61.9
1974	4+ & older	15.6(11)	6.0	8.6

The age composition of the run has varied considerably from 1976-1978. The strong 1975 year-class first entered the run as 1+ males in 1976 and comprised 90 percent of the male run that year. The same year-class accounted for 97.0 percent of the female run in 1977. The strong 1975 year-class still accounted for the majority of the run in 1978.

The lack of age 3+ and older fish in the 1977 run was due to extensive mortalities of spawners in 1976. A gill bacteria disease (Myxobacteria sp.) was determined to be the cause of the epizotic by the U.S. Fish & Wildlife Services Disease Lab at Bozeman, Montana. The five fish examined had massive infections of the disease which resulted in extensive proliferation of the epithlium covering gill lamellae to the extent that the gill surface was rendered nonfunctional. Myxobacteria is present in most waters, but only becomes virulent when the fish are in a stressed or weakened condition. The stress factors were originally thought to be related to spawning and temperature differences of over 10°F between the Kootenai River and its tributaries. However, extensive mortalities of spawners have not occurred at similar temperature differentials since 1976. Thus it appears that some unknown stress factor was present in 1976.

The mountain whitefish data for spawning runs into Fisher River are summarized in Tables 12 and 13. The peak run in 1978 began 10 days later and lasted 17 days longer than the 1975 run. Trap efficiency was low in both years. A total estimate of the run was obtained in 1978 by marking and releasing spawners and recapturing spent fish in a downstream trap. The point estimate for the run was 21,812 fish with the 80 percent confidence limit being ±12.4 percent of this estimate.

Table 12. Summary of mountain whitefish data from spawning runs ascending the Fisher River from the Kootenai River, 1975 and 1978.

Parameter	Results 1975	1978
Period trap operated	9/3-11/3	9/11-11/10
Peak of run	10/8-10/29	10/18-11/15
Days trap in operation	50	53
Days leads up	27	33
Number fish captured	512	1166
Estimated run	?	21,812 1/
Average length male	11.9	12.4
Average length female	12.3	13.6
Sex ratio ♂:♀	1.0:1.3	1.1:1.0

1/ Based on mark and recapture data. A downstream trap was fished from 10/30 through 11/10. The 80 percent confidence limit was ±12.4 percent.

The length of age 3+ fish was 2.6 inches longer in 1978 than 1975, a reflection of the better conditions for growth after the gas supersaturation problem was resolved. Approximately 28.2 percent of males in the 1978 run were 1+ as compared to only 9.5 percent in 1975.

Fisheries data from Libby Creek and Fisher River show that the spawning runs of mountain whitefish have increased markedly from 1975 to 1978. Spawning in the Kootenai River has also increased markedly from the rereg. site to Libby (May, et al., 1979). Seventeen spawning areas were found in 1979 as compared to only two in 1974. The data indicates that sufficient spawning areas exist in the Kootenai and Libby Creek to maintain mountain whitefish populations from the "rereg. site" to Kootenai Falls.

Table 13. Length and age composition of 1975 and 1978 mountain whitefish spawning runs from Kootenai River into Fisher River. Number of fish aged in parenthesis.

Year Class	Age Class	Average length in inches	% Age Composition of Run	
			Male	Female
		1975		
1973	2+	11.0(10)	9.5	7.0
1972	3+	11.6(36)	64.3	57.3
1971	4+ & older	13.0(24)	26.2	35.7
		1978		
1977	1+	9.9(19)	28.2	--
1976	2+	12.2(33)	17.5	25.1
1975	3+	14.2(53)	51.0	70.6
1974	4+	16.4(18)	3.3	4.3

River Populations

Flower-Pipe Section

This section has been sampled annually with electrofishing gear since 1973, except in 1976 when reservoir releases were not suitable. The population estimates are low due to the inefficient sampling of water deeper than 4-6 feet, but are useful in monitoring annual changes in relative abundance of trout and mountain whitefish. Graham (1979) found that the actual harvest of trout in the Kootenai Falls Section was 195 percent higher than the population estimate. The population estimates for trout represent only a part of the total trout population in a section.

The trend estimates of trout numbers increased from a low of 24.5 per thousand feet in 1973 to a high of 115.6 in 1978 and decreased to 84.5 in 1979 (Table 14 and Figure 10). The estimates from 1974 through 1977 varied between 63/1000 to 64/1000 feet.

A strong 1976 year-class accounted for most of the increase in numbers found in 1978. The 1978 estimate was comprised of only 40 percent as many fish over 15.0 inches as the 1977 estimate. The 1978 estimate was taken later in the spring than in previous years and some mature fish were still in the tributary spawning. The number of fish over 15.0 inches was also low in the 1979 estimate which was taken prior to spawning migrations. This reduction in larger fish was a result of reduced growth rates in 1978 and 1979 (Table 15).

The trend estimate of rainbow trout biomass increased from 18 pounds/1000 feet in 1973 to 43 pounds/1000 feet in 1974 and 1975, reaching a high of 74

Table 14. Trend population estimates of rainbow trout in the spring from the Flower-Pipe Section of Kootenai River.

	Rainbow Trout		
Length Group	Number/ 1000'	Weight/ 1000'	Condition Factor
	April 26, 1973		
7.0-10.9	9.5	3.2	38.1[illegible]
11.0-14.9	15.0	14.5	39.44
15.0-25.1	--	--	--
Total	24.5 (±24.5)	17.7	38.03
	April 13, 1974		
7.0-10.9	22.3	7.3	34.46
11.0-14.9	35.8	25.3	36.32
15.0-25.1	5.9	10.8	35.04
Total	64.0 (±13.0)	43.4	35.93
	April 11, 1975		
7.0-10.9	26.1	10.2	37.04
11.0-14.9	31.7	21.3	36.63
15.0-25.1	6.3	11.7	36.65
Total	64.1 (±11.7)	43.2	36.77
	March 18, 1977		
7.0-10.9	24.1	7.8	36.09
11.0-14.9	23.4	19.3	39.59
15.0-25.1	16.1	59.7	41.82
Total	63.6 (±15.6)	67.2	39.82
	May 10, 1978		
7.0-10.9	52.7	19.9	37.36
11.0-14.9	56.5	40.0	39.55
15.0-22.1	6.4	14.0	39.30
Total	115.6 (±19.7)	73.9	38.76
	March 30, 1979		
7.0-10.9	42.4	14.6	34.59
11.0-14.9	35.2	23.9	34.98
15.0-22.1	6.9	10.6	36.16
Total	84.5 (±12.7)	49.1	34.93

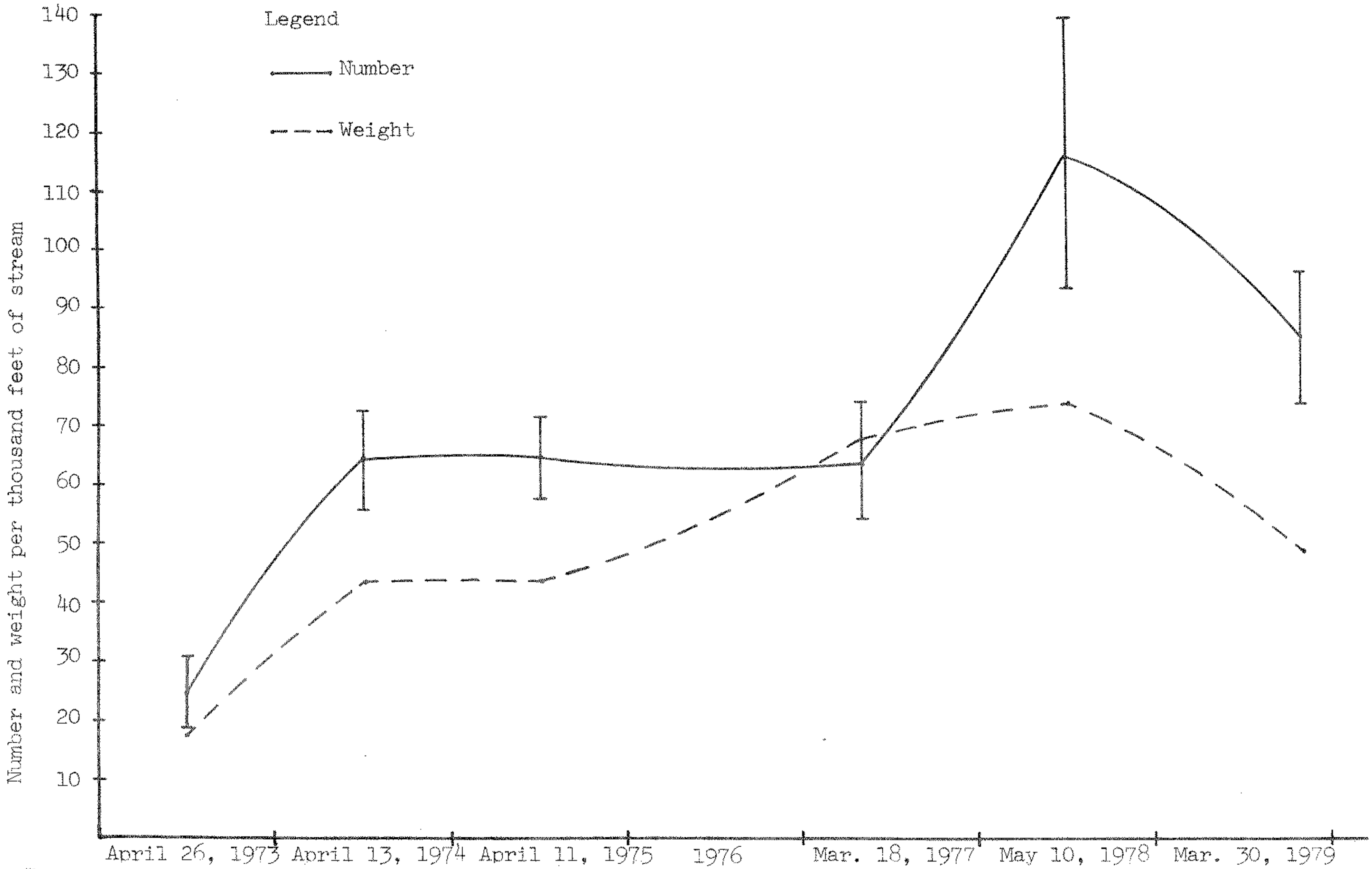

Figure 10. Trend population estimates for rainbow trout in the Flower-Pine Section of Kootenai River. Eighty percent confidence limits are given in brackets for number estimates.

pounds/1000 feet in 1978. The estimate dropped to 49 pounds in 1979. Biomass estimates of rainbow in the Kootenai Falls section were 95 percent higher in 1978 than in the Flower-Pipe Section (Graham, 1979). The actual biomass in the Flower-Pipe Section was probably about 200-300 pounds per 1000 feet which is higher than recorded for the Yellowstone River (Workman, 1976) and the Big Hole River (Peterson, 1975).

The trend estimates indicated that rainbow trout numbers increased markedly two years after impoundment, remained at the same level through 1977, increased markedly in 1978, and in 1979 were intermediate in abundance between 1977 and 1978. The biomass estimates show a similar trend to the number estimates, except the biomass in 1979 was less than in 1977 due to a decrease in average size of the fish. The Kootenai is currently classified as one of the most productive trout streams in Montana.

Growth data for migration class X_1 rainbow trout from the Kootenai River are summarized in Tables 15 and 16. Migration class X_1 comprised about 70 percent of the fish aged from 1975-79 as compared to 20 percent X_2, 7 percent X_0 and 3 percent X_3.

Table 15. Length in inches of migration class X_1 of rainbow trout year classes from Flower-Pipe Section of Kootenai River. Number of fish aged is given in parenthesis.

Year	Back calculated length in inches for each age class			
Class	1	2	3	4
1970	--	9.4(3)	11.4(14)	16.3(2)
1971	3.1(8)	9.8(12)	14.6(16)	15.5(15)
1972	2.7(56)	10.6(56)	13.5(32)	--
1973	2.7(94)	10.8(94)	16.5(4)	19.4(4)
1974	2.4(20)	11.7(20)	17.9(20)	--
1975	2.7(70)	12.0(70)	16.6(17)	16.2(4)
1976	2.8(52)	10.8(52)	14.6(29)	--
1977	2.8(75)	10.2(75)	--	--

The growth of rainbow trout increased markedly following impoundment from 1972 to 1976. Age 2 fish averaged 12.0 inches in 1977 as compared to only 9.4 inches in 1972. Growth decreased in 1977 and 1978 with age 2 fish in 1979 averaging 10.2 inches. The 1978 growth increments for age 1 and 2 fish were 7.4 and 3.8 inches, respectively, while the growth increments in 1972 for age 1 and 2 fish were 6.7 and 2.0 inches, respectively. The fastest growth was recorded in 1976 when increments were 9.3 and 6.2 inches for age 1 and 2 fish, respectively.

The initial increase in trout populations and growth rates following impoundment was due to interaction among environmental factors including: 1) reduction in chemical pollution in 1968 and subsequent increase in aquatic

Table 16. Yearly growth in inches of rainbow trout in Kootenai River following emigration from tributaries as one-year old fish.

Growth Year	First Year	Second Year	Third Year
1972-73 1/	6.7	2.0	--
1973-74	7.9	4.8	4.9
1974-75	8.1	2.9	0.9
1975-76	9.3	5.7	--
1976-77	9.3	6.2	2.9
1977-78	8.0	4.6	--
1978-79	7.4	3.8	--

1/ Growth year April 1 through March 31 of following year.

insect production, 2) control of sediment from a mine-mill operation in Rainy Creek in 1972 resulting in better conditions for insect production, 3) reduction in sediment loads below Libby Dam, 4) improved temperatures for trout growth, 5) higher flows in the fall and winter, and 6) reduction in mountain whitefish and sucker populations from gas bubble disease. The slower trout growth in 1977 and 1978 was a result of increased densities of mountain whitefish and trout and possible changes in the aquatic insect populations. The larger-sized insects which adult fish prefer was less abundant in 1978 (Graham, ibid.) than prior to impoundment. Condition factors of trout were also lower in 1979 than in previous years (Table 14).

The cutthroat populations have declined markedly since 1975 when an estimate of 25/1000 feet was attained (May and Huston, ibid.). The estimate in 1977 was 4/1000 feet (May and Huston, 1977). No estimates were possible in 1978 and 1979 since only six cutthroat were captured in 1978 and seven in 1979. Cutthroat numbers varied considerably from 1973-75 in the Flower-Pipe Section, depending upon movement of fish from Lake Koocanusa (May and Huston, 1975). The low numbers of cutthroat in the electrofishing catch and tag return data showed that few cutthroat have escaped the reservoir since turbine installation in 1975 and operation of the selective withdrawal system in 1977.

Five burbot ranging in total length from 13.4 to 19.5 inches were captured during electrofishing sampling in March, 1979. This species was common in the river until about 1955-60, when the population declined rapidly. Pollution from a pulp mill and fertilizer plant in Canada may have been an important factor in the decline of the burbot. If this is true, then recent control of these pollution sources should enable the burbot to increase.

Movements of rainbow trout tagged in the Flower-Pipe Section and returned by anglers are shown in Figure 11. There was little difference in movement from year to year. Eighty percent of the fish were caught within 1.9 miles of the tagging location. Some fish did move considerable distances. Five fish moved downstream over Kootenai Falls, a distance of about 18 miles. Six rainbow from the Flower-Pipe Section were caught six miles upstream near Zonolite and two were caught just above the "Rereg. Site". Rainbow exhibited

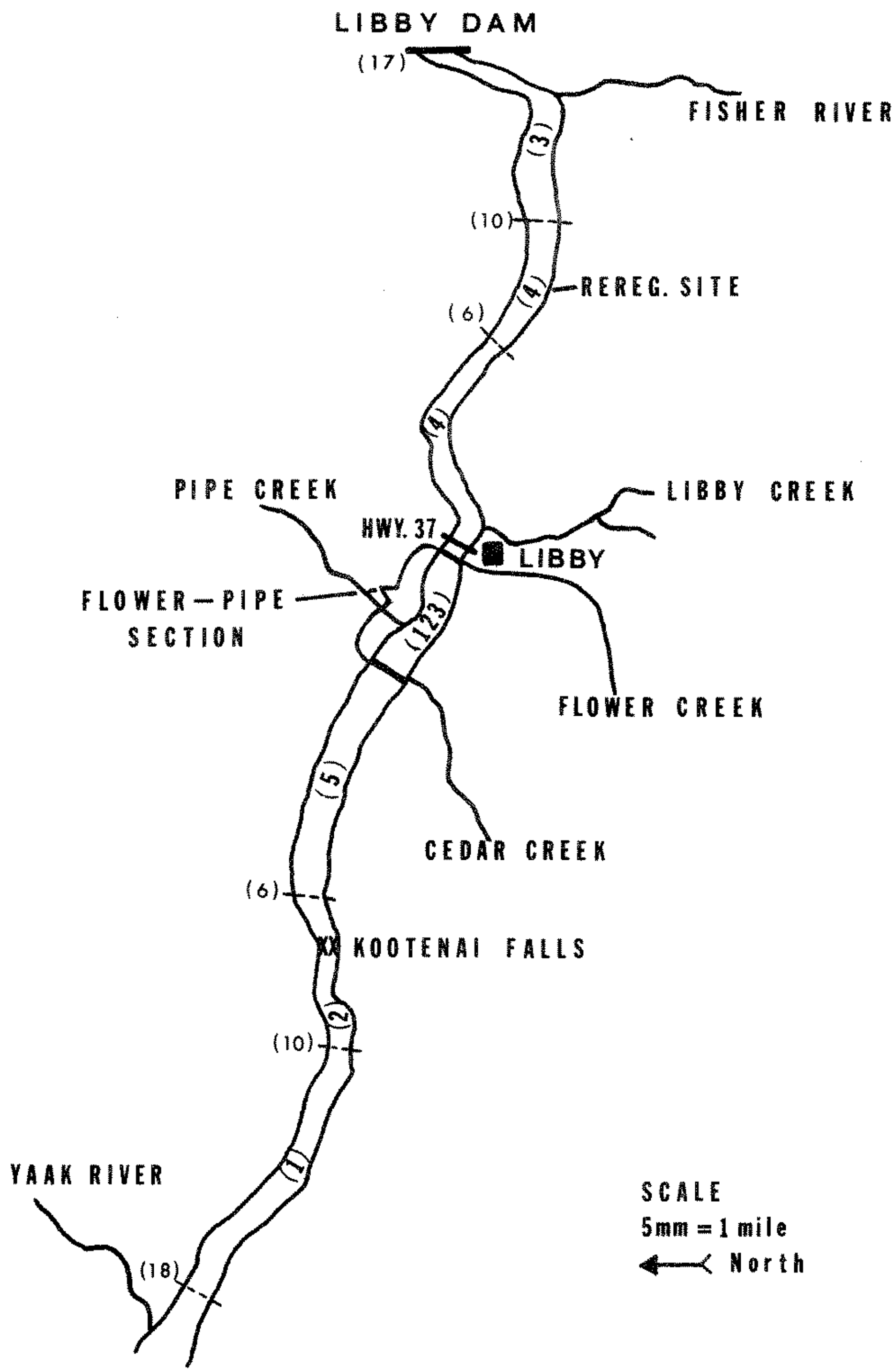

Figure 11. Locations of angler returns of rainbow trout tagged in Flower-Pipe section of the Kootenai River, 1975-1978. Numbers in parenthesis inside river channel are numbers of fish caught while number in parenthesis outside of river channel is mile-post from mid-point Flower-Pipe section.

little movement other than during the spring when they moved into tributaries to spawn. Nine fish tagged above Kootenai Falls in September, 1978 were caught in the Bobtail Creek fish trap in the spring of 1979.

The trend population estimates for mountain whitefish in the Flower-Pipe Section are presented in Table 17 and Figures 12 and 13. Populations dropped significantly from 1973 (467/1000 feet) to 1974 (165/1000 feet) and 1975 (246/1000 feet). Populations increased significantly in 1977 (441/1000 feet) and 1978 (711/1000 feet). The population in 1979 (546/1000 feet) was 23 percent less than in 1978.

A strong year-class was produced in 1975, the first year that the gas supersaturation problem was resolved and this year-class accounted for the large increase in numbers in 1977. The 1975 year-class comprised 53 percent and 75 percent of the biomass in 1977 and 1978, respectively. The whitefish population appeared to reach the carrying capacity of the river in 1978, three years after the gas supersaturation problem was resolved. The rainbow trout biomass also increased in 1977 and 1978, but dropped to 49 lbs/1000 feet in 1979 as compared to 43 lbs/1000 feet in 1975, indicating that gas supersaturation may have affected rainbow less than mountain whitefish populations.

The growth rates of mountain whitefish increased markedly from 1972 through 1976, than decreased in 1977 and 1978 (Table 18 and Table 19). Age 2 fish in 1972 averaged 7.2 inches as compared to 11.0 in 1976 and 9.8 in 1978. The growth reduction was largest in age 2 and 3 fish which grew only 2.0 and 0.8 inches, respectively, in 1978 as compared to 3.1 and 2.1 inches, respectively, in 1976. The condition factors in 1979 were markedly less than in 1977 and 1978. Environmental changes which produced better conditions for growth following impoundment for rainbow would, also, apply to mountain whitefish. Both species feed primarily on aquatic insects, although there is considerable habitat partitioning between the two species (Behnke, 1977). The increased densities of mountain whitefish in 1977 and 1978 were an important factor in reduced growth rates for whitefish and may also have influenced rainbow growth rates. The reduced growth in age 2 and age 3 fish was probably influenced by the low populations of caddisfly larvae in the river. Pontious and Parker (1973) found that caddisfly larvae were an important food item for larger whitefish.

Jennings Section

The Jennings Section was sampled annually from 1971 through 1975 and again in 1975 and 1977 (Table 20). Mountain whitefish populations decreased markedly in 1972 in response to high gas supersaturation levels (May and Huston, 1975). The population remained low in 1973 and increased slightly in 1974, remaining at approximately the 1974 abundance through 1977. The slight increase of mountain whitefish in 1974 was due to the escapement of large numbers of fish from Lake Koocanusa (May and Huston, 1975).

Rainbow trout comprised 73 percent of the trout catch in 1977 followed by cutthroat (23 percent) and Dolly Varden (4 percent). Approximately 82 percent

Table 17. Trend population estimates of mountain whitefish in the spring from the Flower-Pipe Section of the Kootenai River.

Mountain Whitefish

Age	Average Length	Average Weight	Number/ 1000'		Weight/ 1000'	Condition Factor
			April 26, 1973			
2	8.8	.22	196		44.2	--
3	10.2	.36	239		85.0	--
4+ older	11.7	.54	32		17.4	--
Total			467	(+20.0)	146.6	32.87
			April 13, 1974			
2	10.3	.39	44		17.1	--
3	11.3	.50	54		26.9	--
4+ older	12.2	.65	67		43.5	--
Total			165	(+22.4)	87.5	32.42
			April 11, 1975			
2	10.3	.39	94		36.2	--
3	11.3	.51	70		35.7	--
4	12.5	.71	76		54.3	--
Total			240	(+21.5)	126.2	35.09
			March 18, 1977			
2	10.5	.41	356		147.2	--
3	14.1	1.20	23		27.9	--
4	15.1	1.49	46		68.6	--
5	16.6	2.02	16		32.3	--
Total			441	(±12.8)	276.0	36.30
			May 10, 1978			
2	10.3	.40	113.3		45.1	--
3	12.6	.75	531.3		396.7	--
4	14.5	1.26	15.3		19.2	--
5+	16.1	1.71	50.9		87.3	--
Total			710.8	(±10.5)	548.3	37.41
			March 30, 1979			
2	9.8	.30	278		84.4	--
3	12.3	.63	89		55.6	--
4	13.4	.81	151		121.2	--
5+	16.4	1.53	28		43.1	--
Total			546	(± 7.1)	304.3	32.9

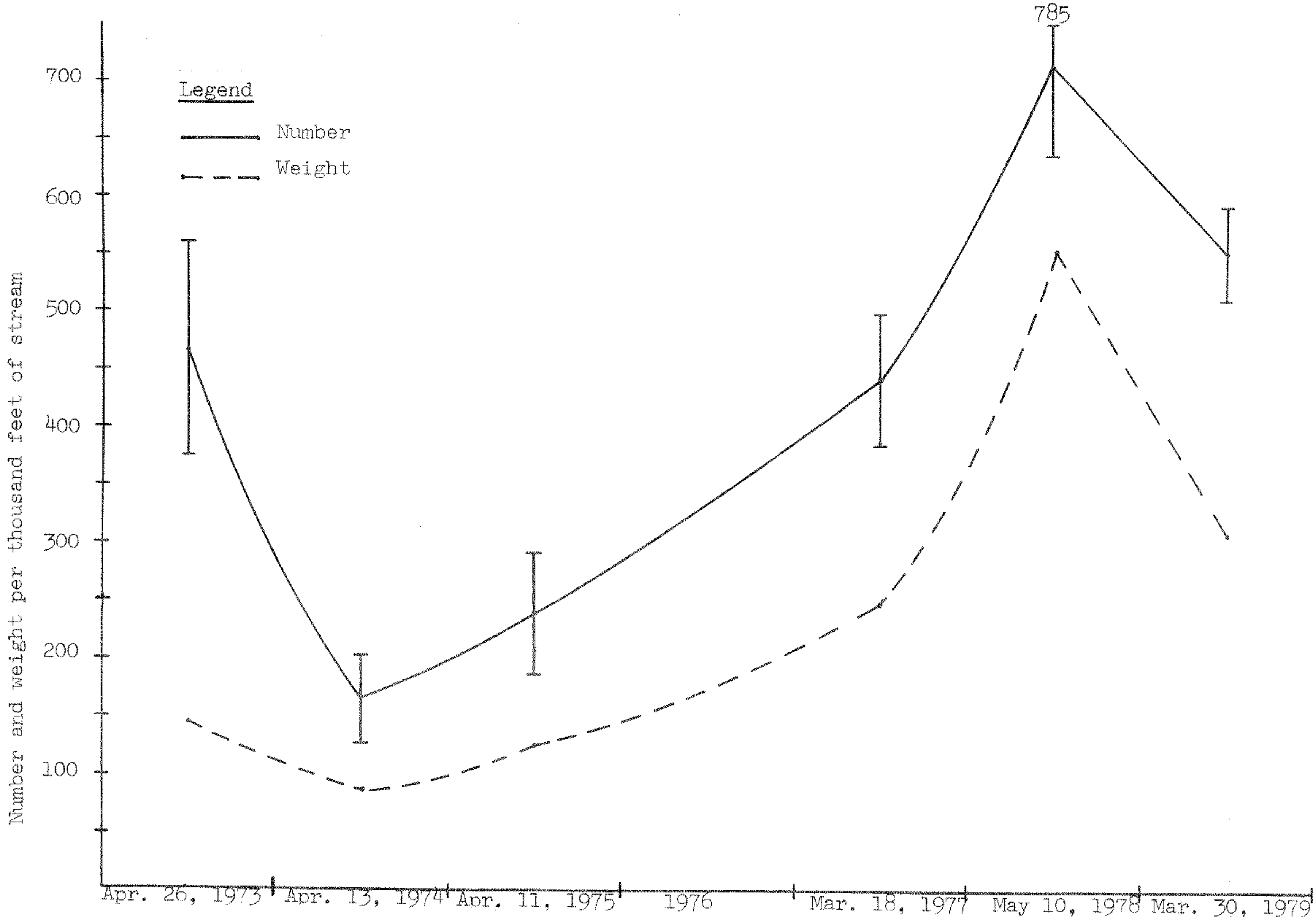

Figure 12. Trend population estimates for mountain whitefish in the Flower-Pine Section of Kootenai River. Eighty percent confidence limits are given in brackets for number estimates.

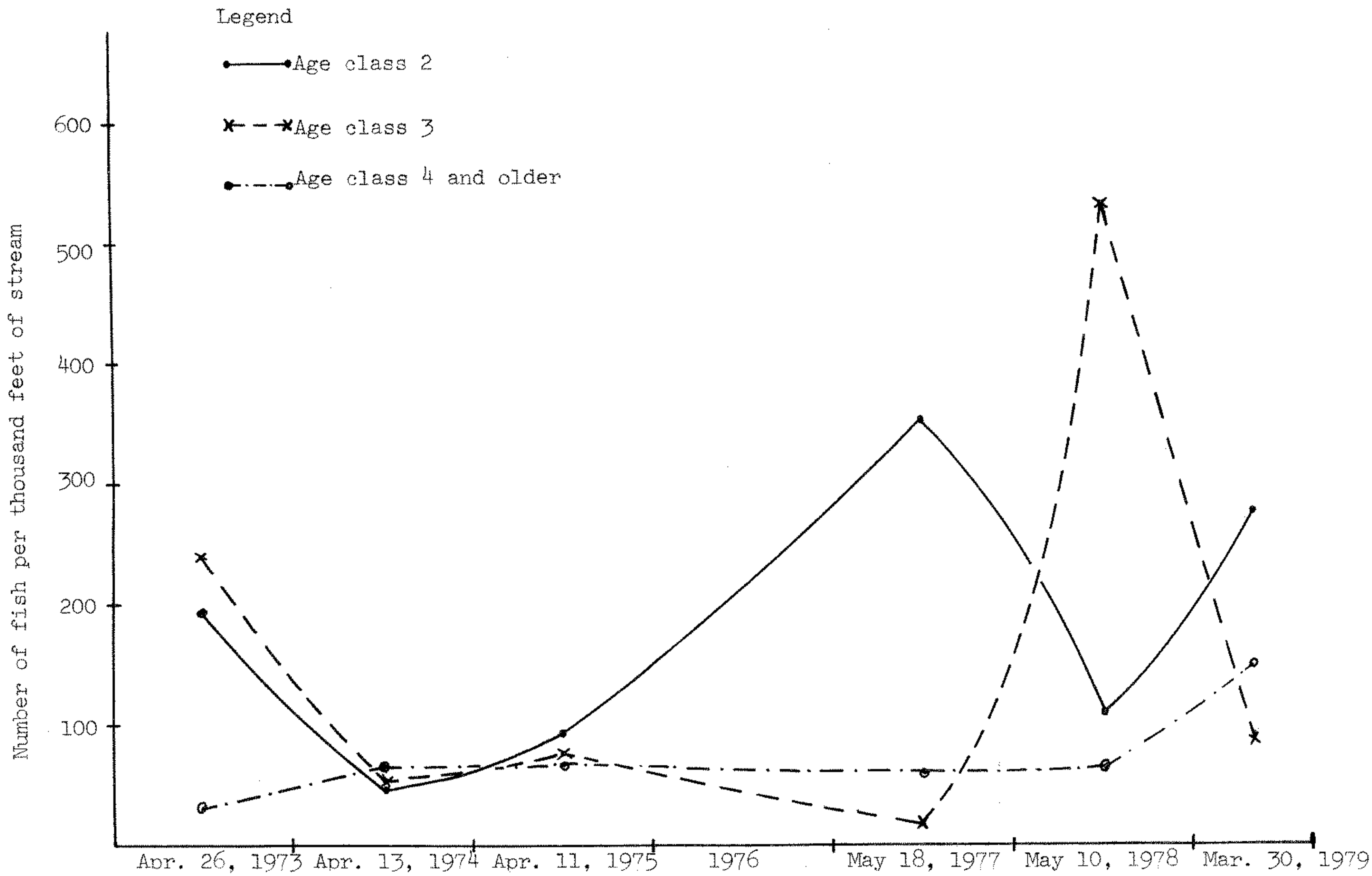

Figure 13. Trend population estimates of mountain whitefish age classes in the Flower-Pipe Section.

Table 18. Length in inches of mountain whitefish year-classes from Flower-Pipe Section of the Kootenai River. Number of fish aged is given in parenthesis.

Year Class	Back Calculated Length for Age			
	1	2	3	4
1970	4.4(41)	7.2(41)	9.8(53)	12.1(42)
1971	4.3(18)	8.8(29)	11.3(32)	12.0(25)
1972	4.1(33)	10.3(33)	11.3(25)	14.4(8)
1973	4.9(39)	10.3(39)	13.0(32)	15.1(32)
1974	5.6(24)	11.0(24)	14.1(24)	14.5(13)
1975	5.0(37)	10.5(37)	12.6(40)	13.4(54)
1976	4.6(9)	10.3(9)	12.3(28)	--
1977	5.0(17)	9.8(17)	--	--

Table 19. Growth increments in inches of mountain whitefish age classes in the Flower-Pipe Section of the Kootenai River, 1970-1978.

Growth Year	Age Class			
	0	1	2	3
1970	4.4	--	--	--
1971	4.3	2.8	--	--
1972	4.1	4.5	2.6	--
1973	4.9	6.2	2.5	2.3
1974	5.6	5.4	1.0	0.7
1975	5.0	5.4	2.7	3.1
1976	4.6	5.5	3.1	2.1
1977	5.0	5.7	2.1	0.4
1978	--	4.8	2.0	0.8

Table 20. Catch per boat-hour for largescale suckers, mountain whitefish and trout larger than five inches total length, Jennings Section, 1971-77.

Date	Catch per Boat-Hour		
	Largescale Suckers	Mountain Whitefish	Trout
Sept., 1971	100(43)[1/]	130(56)	1(1)
August, 1972	72(89)	9(11)	1(1)
July, 1973	143(89)	16(10)	2(1)
Sept., 1974	62(62)	34(34)	4(4)
August, 1975	38(60)	24(38)	1(2)
August, 1977	[2/]	36	4

1/ Percent species composition by year of the catch in parenthesis

2/ Suckers were not collected in 1977.

of the rainbow caught were fish under 10 inches in length. The increase in the rainbow catch in 1977 was probably due to recruitment of fish from natural reproduction into the population because escapement of fish from the reservoir had been quite low since 1975. None of the fish examined in 1977 had signs of gas bubble disease.

Largescale sucker populations remained high from 1972 to 1973, but dropped markedly in 1974 and 1975. Gas supersaturation during this period probably affected reproductive success and recruitment of juveniles into the population. Although suckers were not collected in 1977, it appeared that their abundance was still low and very few fish under 7.0 inches in length were observed. Low water temperatures in the spring and early summer may be affecting reproductive success. Largescale suckers spawn in the spring when water temperatures approach 50°F (Scott and Crossman, 1973). Prior to impoundment, the river approached 50°F in late April, but in 1977 it was mid-June before 50°F was attained. Nelson (1965) noted that lower water temperatures may have been a factor in the decline of white suckers (Catostomus catostomus) downstream from Kananaskis Reservoir in Alberta, Canada.

The growth of mountain whitefish in the Jennings Section has improved gradually from 1970 through 1976 (Tables 21 and 22). Age 2 fish from the 1970 year-class averaged 7.5 inches as compared to 9.3 inches for age 2 fish from the 1975 year-class. Age 2 growth increments were 30 percent higher in 1976 (2.6 inches), than in 1972. Growth increments of age class 0 fish were highest in 1971 (5.1 inches), lowest in 1973 (4.1 inches) and intermediate in 1975 (4.8 inches) and 1976 (4.6 inches). Growth increments of age class 1 fish were less in 1972 than in 1971, but increased in 1973 and 1974 to above the 1971 rate. It appears that gas supersaturation affected the growth of young-of-the-year fish more than older fish. This is in accord with May and Huston (1975), who noted that young-of-the-year fish are more susceptible to mortalities to gas bubble disease because they inhabit the shallow shoreline areas.

The growth of mountain whitefish in the Jennings Section has been less than in the Flower-Pipe Section throughout the study. Dense populations of suckers, escapement of large numbers of fish from the reservoir, high gas concentrations and changes in aquatic insect populations probably limited growth from 1972 through 1974 in the Jennings Section.

Differences in aquatic insect populations between the two sections may account for the differences in growth rates after 1975.

Throops Lake Section

The Throops Lake Section was sampled in May, 1978. Mountain whitefish were the most abundant game fish in this section, comprising 51 percent of the catch (Table 23), followed by rainbow trout (2 percent) and Dolly Varden and cutthroat less than 1 percent, respectively. Largescale suckers were the most abundant nongame fish with peamouth chubs, northern squawfish and finescale suckers comprising about 5 percent of the catch.

Table 21. Length in inches of mountain whitefish from the Jennings Section of the Kootenai River. Number of fish aged is given in parenthesis.

Year Class	Back Calculated Length at Annulus Formation for Each Age Class			
	1	2	3	4
1970	4.6(62)	7.5(100)	9.4(41)	11.4(22)
1971	5.1(16)	7.5(34)	10.0(25)	11.5(27)
1972	4.8(12)	8.1(42)	9.9(38)	13.2(8)
1973	4.3(13)	8.5(43)	10.6(8)	12.9(9)
1974	4.5(15)	8.8(15)	11.4(15)	--
1975	4.8(41)	9.3(41)	--	--
1976	4.6(40)	--	--	--

Table 22. Growth increments in inches of mountain whitefish age classes from 1970 to 1977 in the Jennings Section of the Kootenai River.

Growth Year	Age Class				
	0	1	2	3	4
1970-71	4.6	--	--	--	--
1971-72	5.1	3.9	--	--	--
1972-73	4.8	2.4	1.9	--	
1973-74	4.3	3.3	2.5	2.0	
1974-75	4.5	4.2	1.8	1.5	
1975-76	4.8	4.3	2.1	3.3	
1976-77	4.6	4.5	2.6	2.3	

Table 23. Number of fish caught per night of electrofishing, percent species composition and average size of fish in the Kootenai River, Throops Lake Section, 1978.

Species	No. fish per night	Species composition 1978	Species composition 1971[1]	Average length(range)
Mountain whitefish	530.5	51%	8%	12.3(5.4-18.7)
Largescale suckers	437.0	42%	59%	16.4(6.6-28.0)
Peamouth chubs	30.8	3%	26%	10.4(7.4-13.0)
Rainbow trout	16.8	2%	<1%	12.3(8.7-20.7)
Northern squawfish	12.2	1%	6%	13.7(9.7-21.0)
Finescale suckers	4.5	<1%	--	14.4(9.7-16.8)
Dolly Varden	2.0	<1%	--	19.1(13.3-25.4)
Cutthroat trout	0.2	<1%	<1%	11.5 --

1/ Species composition of an electrofishing sample taken October 5, 1971.

Mountain whitefish and rainbow trout were more abundant in the Throops Lake Section in 1978 than in 1971. Largescale suckers comprised less of the catch in 1978 (42 percent) than in 1971 (59 percent). Squawfish and peamouth comprised 32 percent of the catch in 1971 as compared to only 4 percent in 1978.

The limited data collected in the Throops Lake Section suggest that mountain whitefish and trout have increased in relative abundance since 1971, whereas peamouth, northern squawfish and largescale suckers have decreased in relative abundance. The apparent decrease in the nongame species may be related to low spring and summer water temperatures adversely effecting reproductive success. Northern squawfish and peamouth both spawn when water temperatures approach 55°F (Patten and Rodman, 1969) and (Brown, 1971), respectively. This temperature is now reached 6-8 weeks later than prior to impoundment (Figure 6). Spence and Hynes (1969) concluded that low spring and summer water temperatures were responsible for the absence of four species of cyprinid fishes downstream of a flood control dam in Canada.

White sturgeon are limited in Montana to the Kootenai River downstream from Kootenai Falls. We captured only 6 in 1975 and 2 in 1976 in 36 overnight net sets and 36 overnight setline sets (May and Huston, 1977). Graham (ibid.) caught only 3 sturgeon in an intensive sampling effort in 1978. Little earlier data is available on sturgeon. A catch of 15 sturgeon in 102 hours of angling was recorded in the spring of 1968 by two fishermen. Thus it does appear that populations were higher prior to impoundment. Sturgeon are still quite abundant in the Kootenai River above Kootenai Lakes (personal comm., Harvey Andrusak) and migrate upstream in the spring to Idaho or beyond to spawn.

Increasing flows and water temperatures in the spring trigger upstream spawning movements of white sturgeon (Scott and Crossman, ibid.). The changed flows and temperatures by Libby Dam could be a factor in the apparent reduction of sturgeon runs since impoundment.

Creel Census

Fishing pressure has increased significantly on the free-flowing part of the Kootenai River since 1968. Fishing pressure on the 99 miles of Kootenai River in Montana was estimated to be 11,549 man-days (116 per mile) for the 1968-69 season. A similar postal card survey for the 1975-76 season produced an estimate of 20,352 man-days (406 per mile) for the remaining 50 miles of free-flowing river. Graham (ibid.) estimated the fishing pressure in 1978 at 1,630 man-days per mile for the four miles of river upstream from Kootenai Falls. He used the Lee and Neuhold (1957) count method to determine the total pressure.

Exploitation of the rainbow trout population was comparatively low in the Flower-Pipe Section from 1975-78, even though fishing pressure had increased markedly from previous years. Anglers turned in 12 percent of the fish tagged in 1975, 14 percent of the fish tagged in 1977 and 8 percent of the tagged fish in 1979. The harvest figures are minimum estimates due to tag loss and nonreturn of tags by anglers.

The percent of successful anglers varied considerably from season to season (Table 24). Fishing success was lowest in the spring and highest in the fall when about 60 percent of the anglers caught fish. The catch per man-hour of effort was also highest in the fall and lowest in the spring. The percent of successful anglers was approximately the same in 1975 (45 percent) and 1978 (46 percent), while the lowest success was recorded in 1977 (37 percent). The catch rate in 1978 was .48 fish per hour as compared to .36 per hour in 1977 and .39 fish per hour in 1975. The increase in catch rates in 1978 was in accord with the increased population estimates for rainbow trout in the Flower-Pipe Section. The catch rate in the Kootenai Falls area in 1978 was 0.64 fish per hour (Graham, ibid.). These catch rates were intermediate when compared to Montana's blue ribbon trout streams. Catch rates ranged from 1.2-2.7 fish/hr. in the upper Madison River (R. Vincent pers. comm.) to 0.6-1.0 fish/hr. in the Big Hole (Peterson, 1973) and .7 fish/hr. in the upper Yellowstone River (D. Workman, ibid.).

Table 24. A summary by season of a personal contact survey of anglers in the Kootenai River from Libby Dam to Kootenai Falls. The average sizes of the rainbow creeled are given in parenthesis. The catch per man-hour of effort is for trout only.

Year/Month	Number of Anglers	Percent Successful Anglers	Catch per Man-Hour of Effort	Catch			
				Rb	Ct	DV	Mwf
Summer, 1975	53	45	.39	18	19	--	8
Winter, 1977	76	32	.30	36(12.2)	15	--	6
Spring, 1977	26	15	.08	4(14.1)	--	--	3
Summer, 1977	197	37	.34	148(13.5)	5	2	1
Fall, 1977	53	57	.64	78(10.7)	1	--	--
Total, 1977	352	37	.36	266(12.2)	21	2	10
Winter, 1978[1/]	95	53	.47	103(11.8)	1	1	20
Spring, 1978	123	35	.17	50(12.8)	6	1	24
Summer, 1978	275	46	.58	308(11.1)	10	3	8
Fall, 1978	56	61	.87	110(10.9)	7	2	11
Total, 1978	549	46	.48	571(11.4)	24	7	63

1/ Does not include river from Kootenai Falls upstream four miles.

Rainbow trout comprised 49 percent of the trout catch in 1975, 92 percent in 1977 and 95 percent in 1978. The percent of cutthroat dropped from 51 percent in 1975 to 4 percent in 1978. Electrofishing data also indicated a marked decline in cutthroat populations during this period due to reduced escapement from the reservoir. Mountain whitefish comprised 10 percent and 16 percent of the catch in the 1977 and 1978 winter fishery, respectively. Prior to impoundment mountain whitefish comprised 99 percent of the winter fishery catch (May and Huston, 1975). Releases of warm water (39°F) from the reservoir in the winter have resulted in conditions in which trout feed actively year round. Prior to impoundment, most of the winter fishery was directed towards mountain whitefish.

The average size of the rainbow trout creeled dropped from 12.2 inches in total length in 1977 to 10.9 in 1978. This was a result of reduced growth rates in 1978 and a strong 1976 year-class which entered the fishery as 2 year olds in 1978. The largest fish creeled to date was an 18 pound 1 ounce rainbow caught near the mouth of the Fisher River in 1977 by an angler from Columbia Falls, Montana.

A majority of the anglers were from Lincoln County in 1977 and 1978. Nonresidents comprised 21 percent of the anglers in 1977 and 12 percent in 1978 (Table 25). The percent of fly fishermen was 47 percent in 1977, but dropped to 21 percent in 1978. Bait fishermen comprised 42 percent of the anglers in 1978. The high percentage of fly fishermen in 1977 was due to the record low water year which produced ideal flows for fly fishing. The larger numbers of nonresident fishermen in 1977 was probably due to better fishing conditions. Graham (Ibid.) found that fishing success was higher at flows below 10,000 cfs than at flows of over 10,000 cfs.

Table 25. Fishing method and angler origin of fishermen contacted during 1977 and 1978 creel census on the Kootenai River.

	Percent anglers fishing with				Percent of anglers		
Year	Natural	Lures	Flies	Combination	Local Resident	Montana Resident	Nonresident
1977	19	18	47	16	65	14	21
1978	42	4	21	33	82	16	12

SUMMARY

Sufficient spawning and nursery habitat for rainbow trout exists in Kootenai River tributary streams from the "rereg. site" to Kootenai Falls to maintain desirable population levels in the Kootenai River. Mountain whitefish also have adequate spawning areas in the Kootenai River and its tributaries to maintain present population levels. Removal of barriers to upstream migration of spawners in cooperation with Kootenai National Forest will provide access into about 30 additional miles of tributary streams. Water quality and habitat protection in Libby, Quartz, Pipe and Bobtail Creeks should be intensified to protect these valuable spawning and nursery areas. The information needed to file for flow reservations should be gathered.

Natural and man-made barriers are preventing spawning fish from utilizing tributaries below Kootenai Falls. Low recruitment of juveniles into the river appears to be limiting rainbow trout populations. An old dam at the mouth of O'Brien Creek was removed in the fall of 1978, opening about 15-20 miles of spawning habitat. Establishment of rainbow trout runs in this drainage has begun. The feasibility of establishing a spawning channel in the Yaak River for rainbow trout from the Kootenai is being studied with the Kootenai National Forest.

Data collected during the study have isolated many of the factors limiting rainbow trout reproduction in tributary streams and have already been used to manage these streams for increased production of rainbow, resulting in better fishing for anglers in the Kootenai River. The data have also shown that a fish ladder in the "rereg. dam" would not contribute significantly to populations in the Kootenai River above or below the rereg. site.

The interaction of numerous environmental factors in the Kootenai River below Libby Dam has produced good adult habitat for rainbow trout and mountain whitefish. Factors positively affecting game fish populations include: 1) reduction of sediment loads below Libby Dam by about 85 percent, 2) control of sediment pollution from a mine-mill operation on Rainy Creek, 3) control of fluoride and ammonia pollution from a fertilizer plant on the St. Mary's River in Canada, 4) higher fall and winter flows than prior to impoundment, 5) better water temperatures for trout growth in the fall and winter and 6) a possible reduction in reproductive success of largescale suckers, peamouth chubs and northern squawfish.

Factors which may in the future limit game fish production include: 1) trapping of nutrients in the reservoir, 2) lack of dominant discharge flows (Leopold, et al., 1974) which move bedload and flush silts from gravels, 3) flow fluctuations, and 4) reduced aquatic insect diversity. Increased fishing pressure for and harvest of trout, coupled with reduced harvest of dense mountain whitefish populations may also be limiting rainbow populations by giving whitefish a competitive edge.

The large number of variables and the complexity of their interactions make it extremely difficult to determine which factors have been most influential in increasing or limiting production of rainbow trout. For example, the operation of the selective withdrawal system in 1977 and 1978 provided improved temperatures for growth yet trout growth dropped markedly in these two years. Obviously, some other factor or combination of factors were operating to not only mask the beneficial effects of temperature change but also to produce a reduction in growth rates. The marked increased densities in mountain whitefish and more modest increases in rainbow trout densities probably caused more competition for the food resources, resulting in declining growth rates. Growth of most fish has an inverse relationship with densities. A change in aquatic insect populations could have also had an adverse affect on trout growth.

The factors which should be investigated because they have the potential for management opportunities include: 1) the effect of increasing fishing pressure and harvest on rainbow trout, 2) the effect of whitefish populations on rainbow trout production, 3) the effect of low spring and early summer water temperatures and flows on reproductive success of largescale suckers, peamouth chubs and northern squawfish, 4) the effect of the lack of dominant discharges of sedimentation rates in riffle areas, 5) the effect of flow fluctuations on aquatic insect populations and 5) effect of flow patterns on angler and recreational use of the river.

Mountain whitefish reproductive success could be reduced by trapping spawning runs entering tributary streams and/or by keeping flows in the 10,000-15,000 cfs range during the spawning period in the main river, then reducing flows to about 3,000 cfs during egg incubation. The selective withdrawal system could be used to alter spring and early summer temperature patterns to provide poor conditions for reproduction of largescale suckers, peamouth chubs and northern squawfish. Dominant discharge flows could be released several times a year to flush silts from the important food producing areas in riffles. Flow patterns below the main Libby Dam and reregulatory dam can be altered to provide better conditions for angler and recreational use. Fishing regulations can be altered to encourage the harvest of mountain whitefish. Trout harvest can be reduced, if necessary, by regulation changes.

The study has documented some of the changes that have occurred in the fish populations in the Kootenai River downstream from Libby Dam and defined some of the environmental factors which have influenced game fish production. A review of the factors indicates that several management opportunities exist which could increase rainbow trout production, thereby providing more fish for the angler.

RECOMMENDATIONS

We recommend continuation of fishery investigations on the Kootenai River because the biota of this river system is still very much in a state of flux. Gas supersaturation, fluctuating flows, temperature controls and the possibility of added generators, and/or a reregulation dam have had and will have both positive and negative factors on the biology of this river. The recommendations listed below define additional fishery data needed for the ultimate job of managing this river and its tributaries to obtain maximum recreation benefits.

1. Fish populations within the river should be monitored on an annual basis for several years before and after the reregulation impoundment is built.

2. Aquatic insects populating the Kootenai River should be quantified and qualified. The final job report for Section B Modification of this Kootenai River Investigations contract outlines a proposed aquatic insect study.

3. Food habits and distribution of rainbow trout and mountain whitefish should be determined. Data presented in this report show that competition for food and/or space may be occurring.

4. Methods to regulate populations of either or both rainbow trout and mountain whitefish must be examined. Several methods can be explored and include:

a. Removal of spawning adults as they enter spawning tributaries.

b. Manipulation of egg survival of eggs spawned within the Kootenai River proper by regulation of reservoir discharges.

c. Increasing spawning populations by planting within the Kootenai River proper.

5. Spawning runs of rainbow trout and mountain whitefish into selected tributary streams and within river spawning areas should be monitored.

6. Angler-use data from Kootenai River should be collected as needed.

7. Discharge rates should be evaluated for their effect on angler opportunity.

8. The effects of reservoir discharge temperatures on reproductive success of nongame fish such as suckers and squawfish should be evaluated. Data presented in this report indicate numbers have declined in recent years. Literature review suggests that cold water discharges from reservoirs will depress reproductive success of some species of suckers.

The recommendations listed below are considered outside the scope of the Kootenai River Investigations funded by the Corps of Engineers but should be considered by other federal and state of Montana agencies.

1. Future attempts at increasing tributary spawning by river fish will have to be coordinated with and through other agencies. Barrier removal programs should be the responsibility of the causal agencies or private organizations, i.e., barrier culverts should be repaired by the U.S. Forest Service if they were the ones doing the original installation. A prime example of this attitude was removal of a small dam blocking access into O'Brien Creek. Project personnel were able to have this dam removed by St. Regis Company since the dam was on St. Regis land. State of Montana will provide appropriate fish or fish eggs if planting is required to establish spawning runs.

2. The U.S. Forest Service in contemplating construction of a spawning channel in Yaak River below Yaak Falls. Beneficial or detrimental effects of this spawning channel will be borne by Montana, Idaho and British Columbia. Close coordination between all parties affected will be a necessity.

3. Big Cherry Creek, tributary to Libby Creek, is being affected by heavy metals pollution from old mine-mill operations. State of Montana should investigate methods to alleviate this problem with a stated aim of restoring a viable fishery within this drainage.

4. Increased human demands upon the water and land resource will generally result in reduced water quantity and quality and fishery habitat. State of Montana should intensify habitat and water preservation efforts.

5. Construction of a low-head hydroelectric impoundment at Kootenai Falls by Northern Lights, Inc. will affect the fishery of Kootenai River. State of Montana should be prepared to recommend proper mitigation for any expected losses. Editors' Note -- Montana Department of Fish, Wildlife and Parks has been and will continue to investigate the fishery and possible mitigative measures in this section of the Kootenai River.

VALUES OF KOOTENAI RIVER INVESTIGATIONS

This section of this report addresses questions about the value of the State of Montana and Corps of Engineers efforts on the fishery studies that have been carried out to date on the Kootenai River. To avoid repetition, the reader is referred to the section entitled "Value of Lake Koocanusa Investigations" in the Lake Koocanusa Post-Impoundment Fisheries Study, which is attached. That section deals with general aspects of the Libby Dam Project primarily affecting Lake Koocanusa. It also discusses some of the effects on the river below because the two areas are connected and much of what occurs on the lake affects the river downstream. This report deals only with actions affecting the Kootenai River below Libby Dam that were not discussed in the Lake Koocanusa report.

There are 50 miles of Kootenai River left in Montana. With release patterns based on the cooperative studies; releases through the selective withdrawal outlets; and water greatly improved by removal of silts, this 50-mile stretch of the Kootenai is now one of Montana's most productive rivers. Creel census done in 1968 (pre-impoundment) indicated angler use on this river section was about 6,000 days per year. In 1974, we estimated this section would receive an average of 65,000 fisherman days of use during the 100-year life of Libby Project. Creel census done on a small portion of the Kootenai in 1978 (after impoundment) showed an average per-mile use of 1,600 angler days. Projected to the entire river section, this gives an estimate of 80,000 angler days or well in excess of what we thought the 100-year average pressure would be.

This fishing pressure is a good indication of the quality and quantity of the fishery resource now provided by Montana's 50-mile stretch of the Kootenai River.

This quality is the result of biologists determining the requirements of fish, fishermen letting us know the best flow patterns for fishing and engineers operating Libby project in a manner that is as compatible as possible with these requirements and desires.

Without the contract studies on Kootenai River, fishing would be poorer because:

1. The selective withdrawal outlet would be operated to approach pre-impoundment temperatures and this would result in poorer growth rates and heavy fish losses out of Lake Koocanusa.

2. Although maximum fluctuations and minimum flow levels would be the same, the frequency of reaching those limits would be much greater.

3. Flows desired by anglers could be provided less frequently because biological data which allow some criteria changes to provide these flows would not be available.

Also the studies have shown that two large possible mitigation expenditures are unnecessary. These are restocking following the fish kill from gas supersaturation and constructing a fish ladder over the reregulating dam.

Fish sampling during and after the gas supersaturation problem showed sufficient survivors of all species to rapidly repopulate the available habitat when the problem was corrected. Although we have documented some spawning runs from the Kootenai into the Fisher River (which is above the rereg. dam site), we have found main river spawning areas for most game species as well. Also some of the streams tributary to the 40 miles of river below the rereg. site are used now by spawning game fish and their access to many of them can be improved. The cost of a fish ladder over the reregulating dam would probably be in the millions of dollars or far more than the cost of all the contract studies to date on both the river and the reservoir.

Construction of the reregulation impoundment and Kootenai Falls hydroplant will reduce the present 50 miles of river in Montana to about 36 miles, 10 miles inundated by the "rereg." and 4 miles by Kootenai Falls project. However, the angler will expect these fewer miles of river to produce the same quantity and quality of recreational opportunity as the original 50 miles.

The Department and Corps of Engineers have maintained an excellent river fishery throughout the construction of Libby Project; now both have a responsibility to maintain as good a quality/quantity fishery as possible in the face of continual rising demand upon a finite resource.

Several avenues of approach to this upcoming problem exist or will likely become possible within a few years as a result of fishery investigations. Some of these approaches are outlined below:

1. Regulation of the utilization of the existing fishery by changing limits, size of fish allowable, or times of fishing.

2. Increasing natural reproduction of manipulation of tributary stream populations and reservoir discharge patterns.

3. Selection of a preferred fish species, (such as rainbow trout) and manipulating other members of the fish population to favor this species. The

best example of this method would be control of mountain whitefish populations through changing river flows during spawning or trapping of spawning runs.

4. Education of the angling public to utilize less desirable fish species found in the Kootenai River, i.e., the mountain whitefish.

5. Stocking Kootenai River with fish from the Murray Springs Hatchery to augment natural reproduction if it is found to be a limiting factor.

LAKE KOOCANUSA POST-IMPOUNDMENT FISHERIES STUDY

Job Completion Report

Contract No. DACW 67-75-C-0004

July 15, 1979

VALUE OF LAKE KOOCANUSA INVESTIGATIONS

State of Montana and Corps of Engineers have spent considerable time and money on biological studies of Kootenai River and Lake Koocanusa formed by impounding Kootenai River. Reports written by biologists primarily for other biologists and fishery managers oftentimes leaves engineers and most other non-biological trained people with questions such as: "What does it all mean?", "How does this work relate to providing fishing?" and "What did the Corps of Engineers and the U.S. taxpayer get for the money spent?"

This section of this report addresses such questions AND STRIVES TO answer them for the non-biologist. At the start, we must make it clear that few biological questions can be answered with engineering precision. The results of good engineering is usually a visible structure which all people can easily see. Good biology is oftentimes the avoidance of ecological blunders which if made, may or may not be easily seen or understood by laymen. Good biology can also be the selection of the best course of action which will provide quality recreational benefits for the greatest length of time at the least cost.

Comparisons between impoundment projects will be made to illustrate some of the ecological errors made on other impoundments but which were avoided on the Libby project. Construction at all four impoundments (Libby, Hungry Horse, Noxon Rapids and Cabinet Gorge Reservoirs) was similar in their biological impacts: changing downstream flows and changing river into fluctuating lakes.

Hungry Horse Dam was constructed on the South Fork Flathead River by the Bureau of Reclamation being completed in 1952. No project funding was made available for either pre- or post-impoundment fishery studies by Bureau of Reclamation and Montana Department of Fish and Game had only one biologist to serve northwestern Montana during the preconstruction and construction era. Consequently, there were practically no fisheries data upon which to recommend mitigation measures to reduce damage to the fishery.

Unobstructed upstream movement of game fish into tributaries for spawning is a major concern in impoundment fisheries management. Roads constructed on both sides of Hungry Horse Reservoir crossed 28 streams suitable for game fish (cutthroat trout, Dolly Varden and mountain whitefish) spawning. Poor placement of culverts blocked access into 16 of these 28 streams. As a result of these culverts, fish reproduction was severely restricted. Starting in 1963 and continuing to the present time, the Department and U.S. Forest Service have had a continual program to alleviate fish passage problems at these road crossings. To date, permanent access (replacement of culverts with bridges) or temporary access (construction of gabion sills below culverts eliminating culvert outfalls) has provided complete or partial upstream fish passage at 14 of the original 16 blocked streams.

Loss to the fishery resource of Hungry Horse Reservoir and its tributaries through reduced spawning habitat has been great. Cost to the angler public and general taxpayer has been excessive. These fish passage problems would not have occurred if stream crossing had been designed by engineers and biologists working together when these roads were first constructed.

On the Libby project, pre-impoundment surveys done by biologists delineated potential spawning streams. Biologists working with Corps of Engineers designed stream crossings that would provide adequate passage for spawning fish. As a result, Lake Koocanusa game fish have access into all suitable spawning tributaries and potential for maximum natural reproduction is a reality. Spawning stream surveys in the Lake Koocanusa drainage has shown that game fish are using almost all the spawning habitat made available and has resulted in increasing game fish populations and angler use of the resource.

Libby project provided the Department with funding to clear potential spawning streams of natural barriers such as log jams. This made more spawning and rearing habitat available for use by spawning fish from Lake Koocanusa.

Hungry Horse Dam had no fishery oriented criteria for flow releases. Flows below this dam have varied from a minimum of 160 cfs to about 10,000 cfs several times a day. The six miles of South Fork Flathead River below Hungry Horse Dam to the confluence with main-stem Flathead River is truly a biological desert. Outflows from Libby Reservoir have fluctuated severely since impoundment but the minimum flow of 2,000 cfs is rarely reached. The larger minimum flows passed through Libby Dam has supported an excellent sports fishery downstream, while the sport fishery in the South Fork below Hungry Horse is essentially nonexistent.

Flows from Cabinet Gorge Reservoir have fluctuated the Clark Fork River in Idaho as much as 14 feet ranging from a few hundred cfs up to about 35,000 cfs. Impact of this wide range of flows on the Clark Fork River and Lake Pend Oreille severely affect the sport fishery. For the past several years, Washington Water Power Company has set a voluntary minimum flow of 3,000 cfs for the benefit of the fishery resource. No minimum flows are in effect for Noxon Rapids Reservoir since its tailwater is the headwater of Cabinet Gorge Reservoir.

Fluctuations in main-stem Flathead River from operation of Hungry Horse Reservoir have reduced spawning success of kokanee and whitefish. Fluctuations occurring at any time of the year also severely affect sport fishing opportunity. Fluctuations in Kootenai River caused by Libby Dam do affect game fish reproduction but not to the extent that Hungry Horse does in the Flathead River system. River fluctuations below Libby Dam affect fishing opportunity but again, not to the extent of Hungry Horse Reservoir operations. Corps of Engineers is trying to operate Libby Dam in a manner more compatible to angler opportunity, while Bureau of Reclamation has made little effort to alter their operations to benefit the angling public.

Fisheries management at Noxon Rapids and Cabinet Gorge Reservoir has had limited success due to rapid movement of most game fish out of the reservoirs into downstream waters. Wise operation of Libby Dam with a selective water release system has largely eliminated downstream escapement of game fish. The operational criteria for selective withdrawal outlets was developed by engineers and biologists working together. Downstream escapement out of Hungry Horse Reservoir is not a problem due to the very low level turbine intakes.

Temperature of water released from Hungry Horse Reservoir will range from 39°F to 42°F year-around. These low temperatures have greatly reduced aquatic insect biomass and species diversity in South Fork below the dam. The low temperatures and wildly fluctuating flow releases have affected fish movement, fish spawning and aquatic insect production in main-stem Flathead River downstream from the mouth of the South Fork to Flathead Lake, a distance of 46 miles. Turbine intakes for both Noxon Rapids and Cabinet Gorge Dams are high enough that warm water is released. Mid-summer water temperatures immediately below Noxon Rapids but in Cabinet Gorge Reservoir will oftentimes be isothermal in the mid-70°F temperature range at depths of 100 feet. Brown trout in Clark Fork River below Cabinet Gorge Reservoir have been observed spawning in mid-March compared to a normal spawning time of late October and November. This delayed spawning is thought to be the result of temperature changes brought about by Noxon Rapids and Cabinet Gorge Reservoirs.

Water released from Libby Dam is being regulated by operation of the selective withdrawal system to provide the best temperature pattern possible for Kootenai River without affecting the biota of Lake Koocanusa. Temperature control is expected to increase total biomass carrying capacity, particularly aquatic insects and fish, in Kootenai River downstream from Libby Dam. Increased biomass will result in more fish being available for anglers.

Corps of Engineers has been funding biological studies to determine best operation of Libby Dam with respect to factors such as the fishery and has always been concerned with most aspects of the environment. Washington Water Power Company has funded extensive pre- and post-impoundment studies on their Montana Reservoirs and has shown concern for water-based recreational activities. Bureau of Reclamation has recently started to fund fishery studies on the effects of Hungry Horse Reservoir operation on downstream waters.

In summary then, as a result of actions recommended by biological studies, fishermen have had excellent sport angling in Lake Koocanusa and Kootenai River since impoundment. Anglers fishing the other reservoirs and outflow waters have been shortchanged due to lack of ecological consideration.

There are other benefits to the fisheries and angling public utilizing this resource as a result of biological studies. These are listed and described below and will be limited to Lake Koocanusa and its tributary streams.

1. A report titled "Revision of 1965 Fishery Analysis, Libby Dam Project, Kootenai River, Montana" prepared by Montana Department of Fish and Game in April, 1974 stated that estimated annual fisherman-day-use of Lake Koocanusa without any mitigation would average 10,000 days over a 100-year period. Completion of all mitigation except the hatchery would increase angler use 6,000 man-days per year for a total use of 16,000 fisherman-day-use per year.

The 1975-76 angler pressure estimate listed angler use on Lake Koocanusa at about 18,500 man-days for a 12-month period. This angler-use was supported by some planted fish, but mostly by naturally reproduced rainbow and cutthroat trout. Population data collected since 1972 indicate that the present Lake Koocanusa game fish densities would support a fishery at least double that of 1975-1976. The present game fish densities are all from natural reproduction. Planting of the reservoir with cutthroat trout from the Murray Springs hatchery may increase the potential angler pressure several more times without damage to the resource.

2. The revision of 1965 fishery analysis report also stated that streams tributary to the reservoir would support 11,000 man-days of angler use without the project and that with the project, the same angler-use could be supported if all mitigation measures except the hatchery were done. Almost all stream mitigation measures have been finished on tributary streams. The Department does not have a current fishing pressure estimate on the tributaries but limited creel census and contact with anglers indicate that tributary fishing pressure is heavier now than prior to impoundment. Anglers appear to be very satisfied with the quality and quantity of fish caught from reservoir tributaries. Anglers have excellent chances of catching much larger fish (spawning fish from the reservoir) now than prior to creation of Lake Koocanusa. Examples of the above include Big, Barron, Bristow, Jackson, Canyon, Cripple Horse and Five Mile Creeks. Prior to impoundment, these streams were populated by resident rainbow or brook trout with few fish exceeding 8 inches in length. Fishermen are now catching spawning rainbow or cutthroat trout having average lengths of about 15 inches.

Much of the spawning run development and angler use of these fish can be attributed to the aggressive tributary development done in the early 1970's.

3. Quality of and quantity of spawning streams with good reproductive potential can easily be affected by land-use patterns. Spawning stream inventory of Lake Koocanusa tributaries on a continuing basis will provide current data for the Department and other agencies to maintain the integrity of these streams in the face of ever-increasing land use. Continued vigilance is required to insure maximum natural reproduction for Lake Koocanusa.

4. Page 9 of the 1974 revision of the 1965 fishery analysis states that westslope cutthroat trout were at one time considered an endangered fish species by the U. S. Fish and Wildlife Service. This species is no longer considered

endangered but is still a "species of special concern" by the State of Montana. This report also states that the Libby project would destroy considerable fluvial westslope cutthroat trout habitat but that Lake Koocanusa would provide an excellent opportunity to expand the range of adfluvial westslope cutthroat trout. Fish population data collected from tributary streams and Libby Reservoir indicate that adfluvial westslope cutthroat trout are thriving in the reservoir and that their range has been extended.

5. Data presented in this report show that rainbow trout populations have markedly increased in recent years. This can be attributed to natural reproduction or escapement from a fish hatchery in British Columbia. Study of the food habits of rainbow trout show that the larger fish switch to a fish diet during the summer months and that the principal prey species is redside shiners. The Departments' experience with redside shiners in other fluctuating impoundments has been that high populations occur for the first few years of impoundment followed by drastic declines in numbers. Redside shiners are shoreline spawners and reservoir fluctuations appear to limit spawning success. A decline in numbers of redside shiners in Lake Koocanusa would likely have marked effects on rainbow trout populations. We would expect reduced numbers of all sizes of rainbow trout since the larger fish feeding on shiners are also the spawning fish.

6. Study of the food habits of cutthroat trout showed that these fish were feeding almost entirely on plankton and terrestrial insects and, therefore, should be less susceptible to water level fluctuations than rainbow trout. Cutthroat trout in Hungry Horse Reservoir feed heavily on Diptera pupae found along the bottom. Populations of bottom-living aquatic insects should increase in time in Lake Koocanusa having potential as another major food source for cutthroat and rainbow trout.

7. Lake Koocanusa is one of the most productive reservoirs in the Northwest. To a large extent, this initial productivity is a result of Canadian-source phosphate pollution. Clean-up of this pollution should result in lower fish-food production in the reservoir and consequently lower numbers of fish. Greatest impact of lowered basic productivity will be felt by fish species highest on the food chain; i.e., game fish such as rainbow trout, Dolly Varden and burbot. It may be possible to increase basic productivity if that drastic a step is ever required.

8. Lake Koocanusa is rapidly gaining a regional reputation as an excellent fishing lake. Dissemination of information on horizontal and vertical distribution of game fish can improve fishing success. We know that anglers fishing near shoreline areas catch mostly rainbow trout, while fishing away from the shoreline yields mostly cutthroat trout. Burbot angling has been excellent in the spring and early summer at localized areas using special fishing tactics. Dolly Varden catch rates will vary with time of year, location fished and type of fishing method used. Summer angling on most large lakes and reservoirs is the least productive compared to other seasons. Vertical distribution of game fish is regulated by their preferred water temperature range. Some years anglers may have to fish at depths up to 80 feet before they are within range of the fish. Very few anglers fish Lake Koocanusa at night, but fish distribution shows that night angling may be more productive than daylight angling. Nighttime angling during the hotter summer months may be more productive when fishing surface waters than would be found fishing deeper waters during the daylight hours.

Appendix 1. Depth and velocity measurements from 20 rainbow trout redds in Bobtail Creek, 1978.

Redd Number		Water Depth in feet	Water Velocity-Feet per Second
1		.50	.38
2		.70	1.28
3		.35	.98
4		.35	.53
5		.30	1.03
6		.20	.59
7		.30	.55
8		.40	1.19
9		.20	.39
10		.30	.81
11		.25	.41
12		.45	.94
13		.55	1.03
14		.50	.99
15		.40	.84
16		.25	.54
17		.30	.70
18		.30	.81
19		.30	.77
20		.45	.42
	Average	.37	.76
Confidence interval for mean 95% level		.31 - .43	.63 - .89

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