MONTANA DEPARTMENT OF FISH AND GAME REPORT

In Cooperation with U. S. Army Corps of Engineers

Contract No. DACW67-75-C-0004

FISHERIES DIVISION

Job Progress Report

July 1, 1974 - June 30, 1975

LAKE KOOCANUSA POST-IMPOUNDMENT FISHERIES STUDY

Lake Koocanusa, Montana

By

Joe E. Huston and Bruce May

Reservoir Investigations Project

October 1975

MONTANA DEPARTMENT OF FISH AND GAME
FISHERIES DIVISION

JOB PROGRESS REPORT
Project No. 2276

Project Title: Lake Koocanusa Post-Impoundment Fisheries Study

Period Covered: July 1, 1974 through June 30, 1975

ABSTRACT

Work done during fiscal-year 1975 was primarily a general survey. Data from this survey were used to design a program for future fish sampling that will determine the trend of changes in reservoir fish populations. A consulting statistician developed a nonparametric statistical analysis to compare gill net catches for this purpose.

Three areas of the reservoir in Montana and two areas in Canada were sampled with gill nets. The net catches are shown and discussed. Vertical and horizontal gill nets were fished in the Libby Dam forebay before and during reservoir spilling. Recommendations are made for future study operations designed to provide data for determining criteria of proper penstock intake levels and for monitoring changes in reservoir fish populations.

STUDY AREA

Lake Koocanusa is the reservoir created by Libby Dam impounding the Kootenai River near the town of Libby, Montana. At full pool elevation of 2459 feet msl the reservoir has a surface area of about 48,000 acres and is 90 miles long. Forty-eight miles of the reservoir are in Montana and 42 miles are in British Columbia, Canada. Maximum drawdown for the impoundment has been set at elevation 2287 (172 vertical feet). At this level the reservoir contains about 900,000 acre-feet of water. At full pool the reservoir contains about 5.5 million acre-feet of water. Drawdown for an average water-year is predicted to be at elevation 2340. Water can be released from the reservoir through the spillways opening at elevation 2405, through the turbines or through the sluiceways opening at elevation 2222. Releases through the turbines were not possible until August 1975. The standard penstock opening is at elevation 2272. A selective water withdrawal system is being constructed for each of the eight penstocks which will allow water to be drafted at any elevation from this level to the surface.

Libby Dam and reservoir was authorized for production of electrical power, flood control and recreation. Fish and wildlife were not included as a project purpose.

FINDINGS

Data from the general surveys is discussed under three subheadings - Forebay Sampling, Reservoir Fish Escapement and Reservoir-wide Sampling. The future sampling program which is based on these data is discussed under a fourth subheading titled Long-Term Sampling Program.

Libby Dam Forebay Sampling

Vertical and horizontal gill nets were fished in the Libby Dam forebay area a week prior to and two weeks after reservoir discharge was started through the spillways in late July 1974. Purpose of the vertical fish sampling was to determine depth distribution of fish in the forebay and to test the effectiveness of vertical nets in Lake Koocanusa. Purpose of the horizontal netting was to determine if any changes occurred in species composition and density in the forebay coincident with spillway releases.

Four level-mesh, vertical gill nets 150 feet deep and 6 feet wide (one each of 3/4-inch, 1-inch, 1¼-inch and 1½-inch bar measure) were borrowed from Montana's Bighorn Lake fisheries project. These nets were fished one night a week before start of spilling and one night a week for two weeks during spilling. Catch during this sampling indicated that rainbow trout (Salmo gairdneri), cutthroat trout (Salmo clarki subsp), largescale suckers (Catostomus macrocheilus) and northern squawfish (Ptychocheilus oregonsis) were most commonly caught in the upper ten feet of water. Mountain whitefish (Prosopium williamsoni) were most frequently caught in water 25 to 50 feet deep. No fish were caught at depths greater than 50 feet.

Reservoir elevation during the forebay netting was at full-pool level of 2459 feet msl. The spillway gates open at an elevation of 2405 feet. Spillway discharges were about 10,000 cfs. Temperature profiles were taken each time the vertical nets were fished. Surface temperature for the week before start of spilling was 67°F. It dropped to 64°F. within 12 hours after spilling started and increased to 70°F. after a week of spilling. Temperatures at 50 feet were in the mid-50's (°F.) throughout the sample period. Temperature profiles taken during the forebay sampling are shown in Section A of Figure 1.

Vertical fish distribution patterns and spillgate opening elevations indicate that mountain whitefish should be the most susceptible to moving out of the reservoir with the spill discharge. The temperature changes associated with spilling indicates a rapid mixing of water in the forebay area which has the potential to cause downstream escapement of fish.

Experimental surface and bottom gill nets were set overnight at the same time the vertical nets were fished. Average catch per net night for these sets are listed in Table 1. Montana's standard experimental gill net is 150 feet long and 6 feet deep with equal sections of 3/4-inch, 1-inch, 1¼-inch, 1½-inch and 2-inch bar measure mesh.

Table 1. Average gill net catch per net night (surface and bottom sets combined) before and during reservoir spilling, July 1974.

	Before Spilling	During Spilling	
Species	July 18	July 25	July 30
Mountain whitefish	6.3	1.0	0.5
Cutthroat trout	3.8	1.6	0.2
Rainbow trout	1.2	0.3	0.3
Largescale suckers	32.8	- -	56.7
Squawfish	7.3	- -	4.3

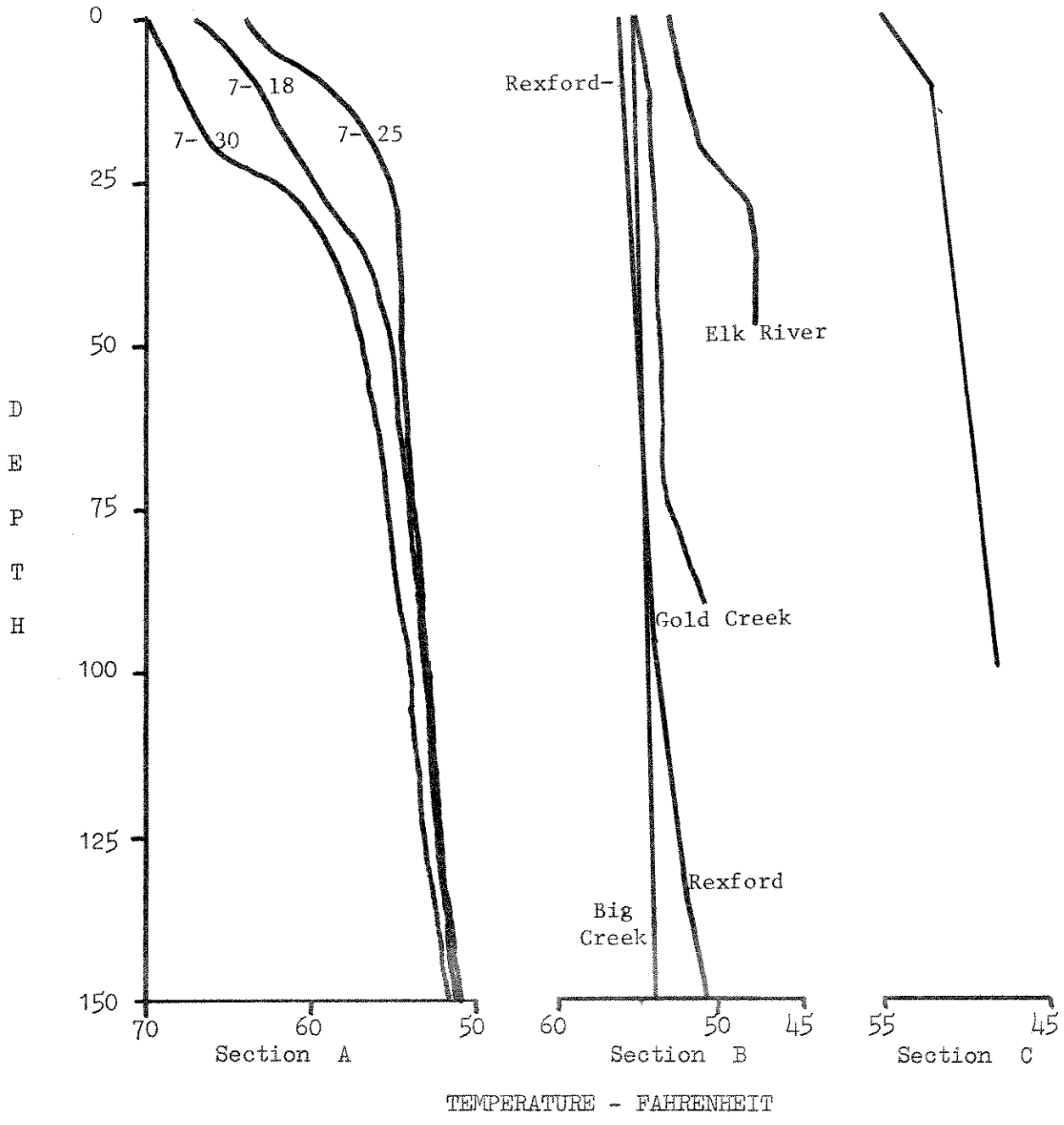

Figure 1. Temperature Profiles, Lake Koocanusa, Section A is forebay profiles, 1974; Section B is reservoir-wide profiles, 1974; and Section C is Rexford area profile in June 1975.

The marked decline in average catch of whitefish, cutthroat and rainbow trout from July 18 to July 30 shows that many of these species left the forebay area. Whether they moved downstream out of the reservoir or upstream out of the forebay cannot be determined from these netting data. Density change for squawfish also indicates that this species moved out of the forebay area. At the same time it appears the large numbers of suckers moved into the forebay area.

Reservoir Fish Escapement

Water releases from Lake Koocanusa were through the Libby Dam spillways from late July through mid-December 1974. Data presented in Table 1 indicate a change in density of whitefish and trout in the Libby Dam forebay coincident with the spill discharge but gives no indication whether they left the reservoir or merely moved upstream. Other evidence indicates that these fish moved out of the reservoir through the spillway and that they moved out throughout the entire period of spillway discharge.

Corps of Engineers personnel and construction workers reported seeing trout and whitefish in the spill discharge. Angler harvest of cutthroat trout immediately below the dam increased markedly following start of spilling. May and Huston [1] reported a marked increase in the whitefish spawning run from Kootenai River into Fisher River over previous years with most of the increase believed to be from fish that left Lake Koocanusa. Cutthroat trout leaving Young Creek either as spent spawners or juveniles were caught in Kootenai River below Libby Dam in fall 1974.[2] Cutthroat trout planted in Lake Koocanusa in 1972 should have contributed a large share of the total cutthroat gill net catch in 1974. Aging of these fish indicated that fish planted in 1972 were scarce in the 1974 net catch.

The number of cutthroat trout moving out of the reservoir into Young Creek to spawn in spring 1975 was much less than expected. Return of marked fish showed that many of the spawners were from juveniles emigrating to the reservoir in 1973 and size of unmarked fish indicated that they were also from the 1973 emigration or from hatchery fish planted in 1973.[3] The Young Creek spawning run should have included about as many fish from the 1972 hatchery plantings or 1972 juvenile emigration as from the 1973 stock.

Consideration of all of these facts, in addition to the forebay netting data, make it seem quite likely that the 1974 spillway discharges severely depleted Lake Koocanusa of both cutthroat planted in 1972 and of wild cutthroat that emigrated to the reservoir from tributary streams in 1972, and that other species also moved downstream out of the reservoir.

Even though some of the game fish leaving the reservoir are eventually taken by anglers fishing Kootenai River, angling in the entire Libby Project Area will be improved if this downstream movement can be reduced. An unknown portion of these fish do not survive the fall into the stilling basin. Some succumb from mechanical damage and some from gas supersaturation in the river below. Also, fish leaving the reservoir for the river are moving from a fairly fertile habitat in the new reservoir to an area where gas saturation levels presently create rather poor fish habitat. In other words, they would grow better and provide more angling in the long run if they stayed in the reservoir. Also, we believe most of the cutthroat that survive the fall continue on downstream searching for a lake environment which they cannot find until they reach British Columbia.

A continual, large, downstream escapement of squawfish into Kootenai River could result in an increased population of this species in the river between the dam and Kootenai Falls. Squawfish were rarely caught in Kootenai River above the falls prior to impoundment. A large squawfish population could have serious impacts on the river's sport fishery since they are competitors with the predators on salmonid species of fish. Escapement of suckers should have little effect on either river or reservoir game fish populations.

Reservoir-wide Sampling

Five areas of the reservoir were gill net sampled during the period of September 26 through October 23, 1974. Purpose of this sampling was to obtain an over-view of fish distribution throughout the entire reservoir at a time when temperature regimes were similar in all parts. Each of the areas were sampled using a combination of surface and bottom experimental gill nets. The areas sampled are shown in Figure 2 and temperature profiles are shown in Section B of Figure 1. The average catch per net night for both surface and bottom nets is given in Table 2.

Table 2. Average catch per net night for bottom and floating gill nets at Cripple Horse, Big Creek, Rexford, Gold Creek and Elk River areas, Lake Koocanusa, 1974.

Area	Date	Type and number of nets*	Average catch per net night by species**							
			Rb	Ct	DV	MWf	CSu	FSu	Sq	CRC
Cripple Horse (Montana)	9/26	B-12	1.4	1.0	0.6	4.1	44.3	0.2	3.7	1.7
		S-14	4.1	1.5	0.0	2.9	1.0	0.0	2.7	0.4
Big Creek (Montana)	10/17	B-4	2.0	0.0	3.5	2.0	3.2	1.5	6.0	2.2
		S-4	5.8	3.5	2.5	1.5	0.7	0.0	3.8	0.0
Rexford (Montana)	10/10	B-12	3.3	0.3	3.2	5.4	12.0	3.3	3.4	1.8
		S-12	4.8	1.8	2.2	0.7	4.8	0.1	8.5	0.7
Gold Creek (Canada)	10/22	B-5	1.0	1.6	3.2	5.6	28.0	2.0	3.0	1.6
		S-7	2.0	5.1	0.5	1.0	1.1	0.0	1.1	0.6
Elk River (Canada)	10/23	B-7	1.9	2.3	4.3	15.6	26.0	6.6	2.1	2.6
		S-8	3.7	7.8	1.0	1.9	2.4	0.1	3.1	3.5

* Letter abbreviations are B for bottom nets and S for surface nets. Numeral after letter is number of net sets.

** Species abbreviations are: Rb=rainbow trout, Ct=cutthroat trout, DV=Dolly Varden, MWf=mountain whitefish, CSu=largescale suckers, FSu=longnose sucker, Sq=northern squawfish, CRC=peamouth.

Several generalizations about fish distribution throughout the length of the reservoir and in surface versus bottom nets can be made from the data presented in Table 2.

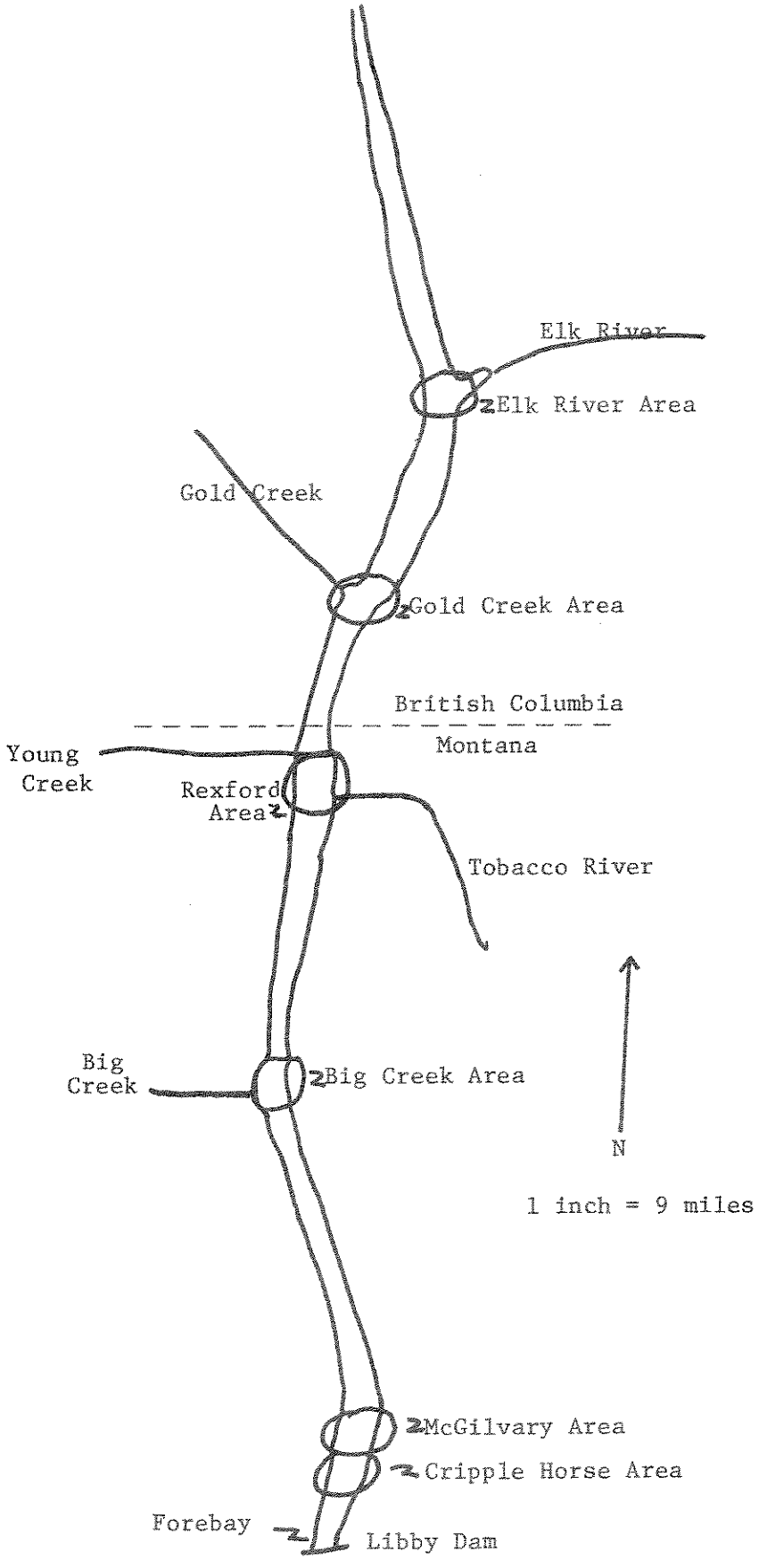

Figure 2. Map of Lake Koocanusa showing sampling areas.

Rainbow trout appeared to be most numerous in the Montana portion of the reservoir while cutthroat trout were most numerous in the Canadian part. The data also seems to indicate that of the two trout species, rainbow were the most numerous. Montana planted about one-million cutthroat trout into the reservoir in 1972 and 1973, but rainbow were all from natural reproduction.

It may be that the apparent higher population of rainbow than cutthroat is a result of the gill net sampling technique. Rainbow trout are a shoreline-oriented fish while cutthroat trout appear to be adapted to either shoreline or open-water living zones. Most of the gill nets used during this sampling (both surface and bottom sets) were set starting near the shoreline and extending out into the reservoir not more than 150 feet. Sets made in this manner were very likely selective for rainbow trout. Several open water surface sets have been made in the reservoir in the forebay area and in the Rexford area and these nets caught many more cutthroat than rainbow.

Comparison of catch between bottom and surface nets shows that both rainbow and cutthroat were most numerous in the surface sets. It is also indicated that a larger portion of the rainbow were caught in the bottom sets than were cutthroat. Occurrence of food items in cutthroat and rainbow stomachs examined may account for rainbow being more frequent in bottom nets. Many rainbow trout stomachs contained insects and redside shinners (Richardsonius balteatus), a forage species living near the bottom along the shoreline. Cutthroat trout stomachs contained mostly plankton and few insects or shiners.

Dolly Varden (Salvelinus malma) were scarce at the Cripple Horse area but were taken in about equal numbers at the other four areas. Mature Dolly Varden were caught only at the Elk River area and all three caught were spawned-out females. This would indicate that Elk River is a spawning area for Dolly Varden.

Fair numbers of mountain whitefish were caught at all areas sampled. Most of the catch at the Gold Creek and Elk River areas were ripe or spent female fish. This is an excellent indication that both Elk River and Gold Creek are being used by mountain whitefish for spawning.

Largescale suckers were numerous at all areas except Big Creek. No explanation can be given for the low catch per net in the Big Creek area. Longnose suckers were scarce in the Elk River area. The longnose sucker (Catostomus catostomus) is a river-living fish and it is unlikely they will ever become abundant in Lake Koocanusa.

Squawfish were more frequently caught in Montana than in Canada. They were frequently caught in both surface and bottom sets. Peamouth (Mylocheilus caurinus) were most abundant in the Elk River area and were taken in about equal numbers in the remaining areas.

Squawfish and peamouth were most numerous close to shore and at depths less than 20 feet. Mountain whitefish and suckers were most frequently caught in depths greater than 20 feet. Depth distribution of Dolly Varden was probably related to depth distribution of their prey. Dolly Varden examined had eaten suckers, squawfish and mountain whitefish which accounts for occurrence of Dolly Varden in both bottom and surface sets.

Long-term Sampling Program

The primary objective of the gill net sampling done in Lake Koocanusa in summer-fall 1974 was to determine best areas, times, and methods of sampling for a long-term program of population trend determination. Factors to be considered for the long-term program included vertical fish distribution, horizontal distribution with respect to both length and width of the reservoir, different spawning times of the species and related in-reservoir movements, boat access into different sampling areas, time of year in which sampling could be done and reservoir pool levels.

Gill net catches do not exhibit a "normal distribution" pattern which is a requirement for application of most statistical analysis methods. A consulting statistician researched and developed a suitable method of analysis. He recommends the "Kruskal-Wallis Ranking Test", which utilizes a non-parametric analysis of data to provide a mathematically-sound method of comparison between gill net catches.

From the 1974 data it was determined that future sampling should be done both in the spring to determine trends for species that may leave the reservoir for summer and fall spawning. (DV, WF, Sq, CRC and Su) and in the fall to determine trends for species that spawn in the spring (Ct and Rb). It was also determined that sampling should be scheduled so that water temperatures and pool levels were similar from year to year. The number of net sets required for adequate reliability of data had not been determined by June 1975 so the maximum manpower available was applied to the 1975 spring sampling.

1975 Spring Sampling - Corps of Engineers has predicted an average annual drawdown to a pool elevation of 2340 feet msl. Spring netting should commence at pool elevation 2350 and terminate at pool elevation 2370. Temperature profiles at this time should show surface temperatures in the mid-50's (^{o}F.) extending down to the high 40's (^{o}F.) at 100 feet. The data shown in Table 2 and data from other impoundments indicate that the best catches of the summer and fall spawning species to be sampled by this spring netting program can be obtained from bottom gill net sets.

Rexford was picked as the sampling area. Gill netting started June 7 and ended June 13, 1975. Temperature profile, Section C of Figure 1, at the start of netting was 55^{o}F. at the surface and dropping uniformily to 48^{o}F. at 100 feet. Reservoir pool level at start of netting was 2355 feet msl and at end of netting was 2371 feet. A total of 132 overnight bottom sets were fished,of which 111 were included in the statistical analysis. The other 21 sets were eliminated primarily because of unusual type of bottom material or slope. Nets included in the analysis were those fished over silt or mud bottoms with the inshore end not less than 5 feet deep and the offshore end not more than 50 feet deep. The average catch per net night for the 111 nets is listed in Table 3.

Table 3. Average catch per net night by species, Rexford area of Lake Koocanusa, June 7 - 13, 1975

Area	Number of Nets	Rb*	Ct	DV	MWf	CSu	FSu	Sq	CRC
Rexford	111	0.8	0.2	1.4	6.6	38.1	7.8	2.3	0.3

* Species abbreviations are the same as those listed in Table 2.

The spring sampling will be repeated the next year that pool elevations and temperature profiles are similar to those found in 1975. Only by netting during periods when these conditions are similar can a population trend comparison be made. It is predicted that correct spring netting conditions should occur about five to seven years out of ten.

Preliminary analysis of the 1975 data indicates that an acceptable reliability level can be obtained with less netting effort. Future spring nettings will be done using methods developed in 1975 but effort will be reduced to about 60 overnight net sets. This less intensive netting should require about one man-month of effort compared to the two and one-half man-months expended on the spring 1975 netting.

Fall Sampling - The predicted operational pattern for Libby Reservoir is for maintenance of near full pool elevations through the recreational season. Drafting for flood control and power production is expected to start in September most years. Gill netting to determine trends for spring spawning species (rainbow and cutthroat) should be done when pool elevations are between 2455 and 2445. The reservoir should be approaching an isothermal condition with surface temperatures near 60°F. Anticipated time these conditions will occur is in late September and early October.

The reduction of netting effort which can be allowed while still maintaining the necessary reliability of data needed for statistical analysis also applies to the fall sampling. Sixty to seventy surface nets will be fished in the Rexford and McGilvary areas.

Vertical and Linear Sampling - Specialized fish sampling will be required to obtain fishery management information needed to maintain an adequate sport fishery in Lake Koocanusa. Downstream fish losses through the spillways have dictated the immediate need for vertical and linear fish distribution patterns throughout the entire year in the forebay area. Reservoir Investigations has obtained four vertical nets, one each of 3/4-inch, 1-inch, 1¼-inch and 1½-inch bar measure, 150 feet deep by 12 feet wide. These nets will be used to determine vertical distribution at a semi-permanent sampling station located immediately upstream from the forebay logboom. Vertical sampling is scheduled to occur about every two weeks or at significant temperature profile changes throughout the time of year that boating access into the reservoir is available. Horizontal fish distribution will be determined by ganging surface nets from the shore out into the reservoir several hundred feet during those times of the year when game fish can be expected to be in surface waters. Acoustical sounding equipment will be used to supplement the vertical and horizontal net sampling in this area. Miscellaneous net sampling will be done at random times to check fish densities and vertical and horizontal distribution patterns in other areas of the reservoir.

Standard data will be collected from most of the fish collected by netting. This will include lengths and weights and collection of scales for age and growth analysis.

CONCLUSIONS

Data collected from this project and from the Kootenai River Investitations Contract Study strongly indicate that spillway discharge in the last half of 1974 caused heavy losses of cutthroat trout and mountain whitefish out of the reservoir. Continued releases of water through the spillway can be expected to result in additional downstream losses.

RECOMMENDATIONS

Investigational work should be continued as recommended in the "Long-term Sampling Program" section of this report. Special emphasis should be placed on obtaining vertical fish distributions and temperature profiles in the forebay area. This information can be applied to operation of the selective withdrawal system on the penstocks both to reduce or eliminate loss of fish from the reservoir and also to maintain acceptable water temperatures in the Kootenai River below Libby Dam.

1/ May, Bruce and Joe Huston. 1975. Unpublished final job report. Kootenai River Fisheries Investigations, Montana Department of Fish and Game.

2/ May, Bruce and Joe Huston. 1975. Unpublished final job report. Young Creek Development, Montana Department of Fish and Game.

3/ Ibid.