REPORT ON FISH MIGRATION STUDIES IN FLATHEAD RIVER BETWEEN FLATHEAD LAKE AND THE CONFLUENCE OF THE SOUTH FORK WITH THE MAIN STEM

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The effects of Hungry Horse Reservoir discharges upon the biota of the Flathead River-Flathead Lake ecosystem have been a subject of much concern since 1952. The need to remove the problem from the arena of speculation and to determine the facts is imperative. The factors causing immediate concern are: 1) increased utilization of the sport fishery provided by the Flathead River-Flathead Lake ecosystem, 2) the real threat of increased energy development and its impact on the Flathead River Basin, 3) increasing knowledge of the importance of the interrelationships of those portions of the Flathead River affected by Hungry Horse Reservoir discharges and the entire Flathead ecosystem.

Hungry Horse Reservoir impounding the South Fork Flathead River near Hungry Horse, Montana, is a multipurpose reservoir operated primarily for flood control and power production. Water releases are generally heaviest during the late fall, winter and early spring. Power generation is usually on a seasonal and/or daily peaking operation, often resulting in changes of discharge from no-load to full-load (200 cfs to 10,000 cfs) and back to no-load several times a day or week. Turbine intakes are low-level and temperature of discharged water is about 39°F year-around.

The effects of the flow and temperature regimes emanating from Hungry Horse Reservoir are being examined by Montana Department of Fish and Game. Limited funding has severely restricted the scope of needed inquiries. Fields to which inquiry have been limited are studies of migration of westslope cutthroat trout from Flathead Lake into the river and a preliminary determination that river fluctuations effect kokanee spawning and egg survival at two known spawning areas in Flathead River. Other kokanee and lake whitefish spawning areas have been located coincidental to other activities.

This report will include data collected in 1974 through 1977, including the work funded in part by the Bureau of Reclamation in 1977. No previous study has dealt directly with the effects of Hungry Horse Reservoir operation upon the fish of the Flathead River-Flathead Lake ecosystem. Summaries of previous related reports have been summarized by Gaufin, Prescott and Tibbs[1]. Stanford[2] describes the effects of Hungry Horse Reservoir discharges on several unique species of aquatic insects in the lower Flathead River.

Flathead River downstream from the mouth of South Fork Flathead River is used by several species of game and non-game fish. Dolly Varden, cutthroat trout and kokanee move through this area on spawning migrations.

[1] Gaufin, Arden R., Gerald W. Prescott and John F. Tibbs. 1976 Limnological Studies of Flathead Lake, Montana: A status report. U.S. Environmental Protection Agency, Office of Research and Development, Corvallis Environmental Research Laboratory, Corvallis, Oregon 97330

[2] Stanford, J.A. 1975 Ecological Studies of Plecoptera in the Upper Flathead Rivers, Montana. Ph.D. Dissertation. University of Utah, Salt Lake City. 214p.

Kokanee, lake whitefish, mountain whitefish, pygmy whitefish, northern squawfish, peamouth and possibly other non-game species move into Flathead River for spawning. The young of all these species, including Dolly Varden, cutthroat trout, and kokanee rear for an unknown period of time in the river. Young of all species have to move downstream through the area from nursery areas to Flathead Lake to mature. Mountain whitefish and suckers are the most numerous residents of Flathead River.

METHODS

The Department developed boat-mounted electrofishing gear for use on the Kootenai River in 1969. This equipment was first used on the Flathead River in 1975 and has been modified to make it more effective. Boat-mounted sampling gear has been the primary fish sampling tool and most work is done at night. Some sampling of kokanee has been done effectively during daylight hours.

Movement or migration of most fish populations is best determined by a mark and recapture program. This method is being used to determine movements of cutthroat trout in the Flathead River system. Fish are captured by electrofishing, tagged with a numbered anchor tag, measured, sexed (if possible) and released. Location of capture efforts was limited to the Salmon Hole area and the Steel Bridge area of the Flathead River in both 1976 and 1977 (Figure 1). Two additional sections, Hungry Horse and Blankenship Bridge (Figure 1) were sampled in 1976 to determine temporal movement in the main stem Flathead River.

Monthly electrofishing in and around the Salmon Hole-Steel Bridge sections started in April, 1975 extending into February, 1976 indicated that adult cutthroat trout were most numerous in that area in the months of February through April. Capturing of adult cutthroat trout for mark and recapture studies was conducted in mid-February through mid-April, 1976 and 1977. Internal examination of gonads of cutthroat trout caught in 1975 and early 1976 indicated that most fish 12 inches total length or longer were mature and spawners. All cutthroat 12 inches or longer were tagged and released. Cutthroat less than 12 inches total length were tagged if possible and all were released. Scales for age and growth determinations were taken from a representative sample of each one inch group.

Tag returns were obtained primarily from anglers and secondarily from electrofishing. Media advertising asking anglers to return tags was done in both 1976 and 1977 but was most intense in 1977. Since part of the value of the mark and recapture program was as an aid to determine spawning locations in the Flathead River drainage, four streams tributary to the North Fork Flathead River were opened for a special angling season. These four streams: Big, Coal, Whale and Trail Creeks, had been closed to all angling for many years to protect Dolly Varden. This special season was open from May 23, 1977 through June 26, 1977. A creel census station was operated on the North Fork Flathead River during the weekends of this special season. Station personnel recorded numbers of fish caught by species, sex or maturity and tag numbers of fish caught according to area.

Location of kokanee spawning areas was coincidental to other sampling being done in the Flathead River. This other sampling included survey electrofishing and nighttime observations, efforts to collect fish for spawning by hatchery personnel, and collection of kokanee for electrophoresis analysis.

Measurements of three kokanee spawning beds were done in fall 1974 and winter 1975. Methods and findings are described by Domrose [3] in an unpublished report appended. Pertinent findings are included in Section 2 (backwater spring seep areas) and Section 3 (river side channels).

FINDINGS

Movements of adult cutthroat trout into main stem Flathead River

Main stem Flathead River is defined as that section from the junction of the North and Middle Forks at Blankenship Bridge downstream to the existing full pool elevation of Flathead Lake. Flathead Lake is regulated by Kerr Dam which raised the natural lake ten feet, pushing full pool elevation from a natural site near Holt Bridge to an artificial site immediately below the Salmon Hole sampling area.

Electrofishing has indicated that spawning cutthroat move out of Flathead Lake into lower main stem Flathead River as early as mid-February. Survey of tributaries in the North Fork Flathead River drainage in 1976 and 1977 indicated that these migrant cutthroat do not spawn until mid-May or later, some three months after entering Flathead River from Flathead Lake. By comparison, upstream movement of cutthroat from Lake Koocanusa and Hungry Horse Reservoir into spawning tributaries usually occurs about two to three weeks before actual spawning takes place. Minimum daily water temperature of these tributaries is usually about 40°F when spawning movement occurs.

It is likely that operation of Hungry Horse Dam may influence movement of adult cutthroat trout from Flathead Lake into lower Flathead River earlier than normal. Movement of these same fish into the upper reaches of main stem Flathead River has not been well documented. Monthly sampling done in February through early May, 1976 indicated that fish did not reach the Hungry Horse area until late April and the Blankenship Bridge area until early May.

Catch of cutthroat per boat-hour for the four areas sampled in 1976 is shown in Table 1. A boat-hour is defined as one boat actively sampling for one hour of time. These data seem to indicate that cutthroat trout were most numerous in the Salmon Hole area in February and declining in March,

3/ Domrose, Robert J. 1975. Notes on kokanee redd examinations and fry emergence in relation to Hungry Horse Reservoir discharge. Unpublished report, Mont. Dept. Fish and Game. Region One. Kalispell, Montana. 4pp.

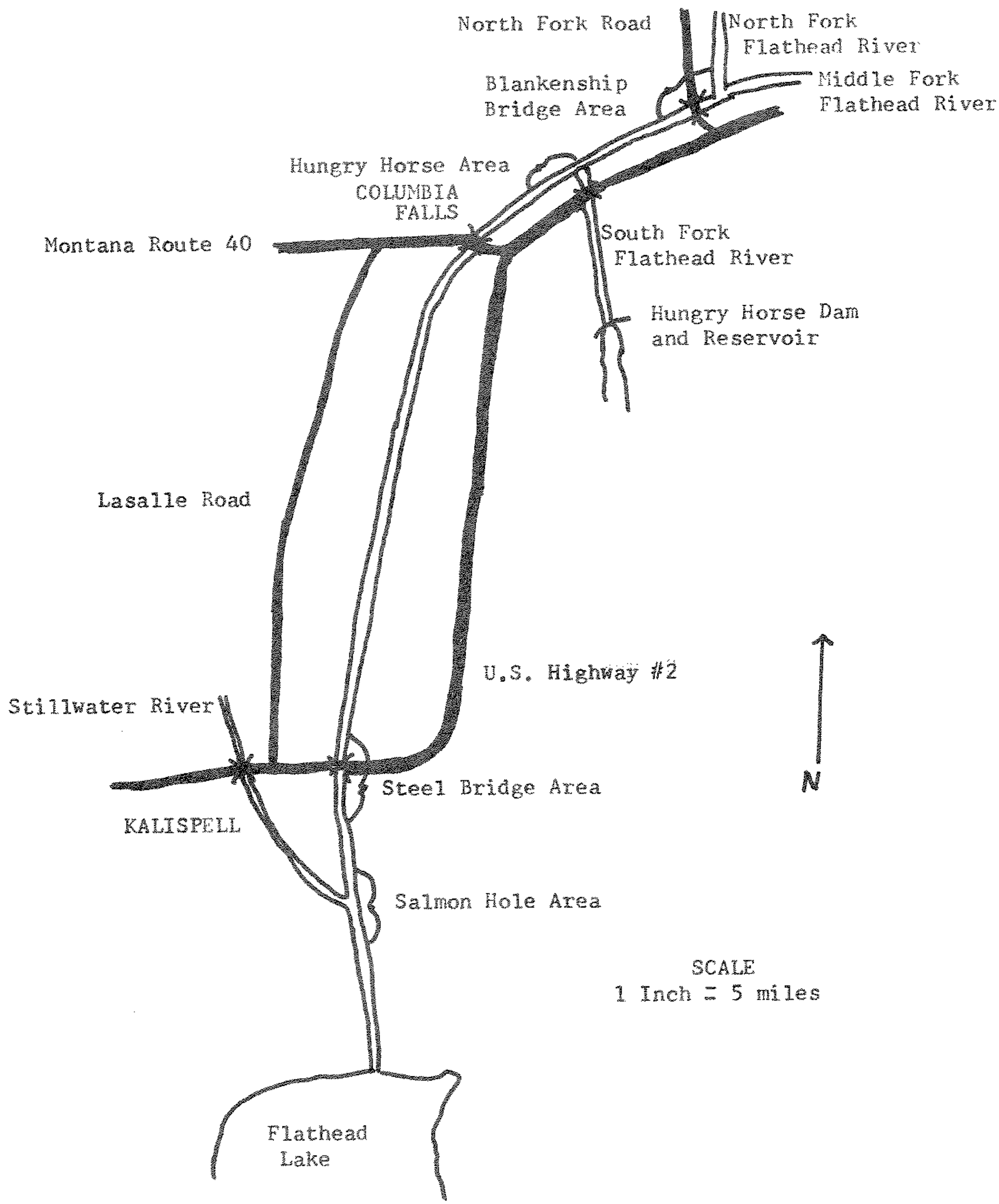


Figure 1. Map of main-stem Flathead River and location of sampling areas

April, and May. Catch of cutthroat trout was low at the Steel Bridge in February, increasing in March, highest in April and declining in May. No adult cutthroat were caught at Blankenship Bridge until May 3, 1976.

Table 1. Catch of cutthroat trout per boat-hour in four sections of the main stem Flathead River, February through May, 1976.

	Catch-Per-Boat-Hour			
River Area	February	March	April	May
Salmon Hole	11	6	5	-
Steel Bridge	2	5	7	1
Hungry Horse	0	0	1	-
Blankenship Bridge	0	0	0	2

Factors believed to influence movement of cutthroat trout out of Flathead Lake into the lower main stem river may include release of large volumes of water and temperature of the released water from Hungry Horse Reservoir. Volumes of water released in winter, 1976 and 1977 increased the natural flow of about 1,200 cfs to a total flow of 12,000 cfs. Temperature of the natural flow was generally about 35°F while temperature of released water was about 39°F. Unregulated flow (natural flow) and regulated flow (Hungry Horse releases) and temperatures for the Steel Bridge-Salmon Hole areas are shown in Figures 2 and 3 for February through April, 1976 and 1977.

Flow and temperature data for the lower main stem river were derived from Hungry Horse Reservoir discharge records, natural flows were obtained from a U.S.GS gauge at Columbia Falls, and temperature records by a recording thermograph located at this U.S.G.S gauge. These data were projected downstream to the lower area using a six-hour delay for water temperature and a seven-hour delay for releases from Hungry Horse Reservoir. Field observations have indicated volume changes originating at Hungry Horse Dam take about seven hours to arrive at a point between the Steel Bridge and Salmon Hole areas. Catch of adult cutthroat per boat-hour by date is also shown in these figures.

The data presented in Figures 2 and 3 do not appear to show any strong correlation between catch of cutthroat, flow and temperature. They do indicate that considerably greater sampling effort is needed if correlations are to be obtained. It is suggested that weekly sampling at both the Salmon Hole and Steel Bridge sections starting in mid-January and extending through mid-May may be a required minimum effort.

Spawning movements of cutthroat trout

A total of 493 adult cutthroat trout were tagged in 1976 and 1977 of which 103 were recaptured by anglers, traps or by electrofishing. The location of these returns by general area is shown in Table 2.

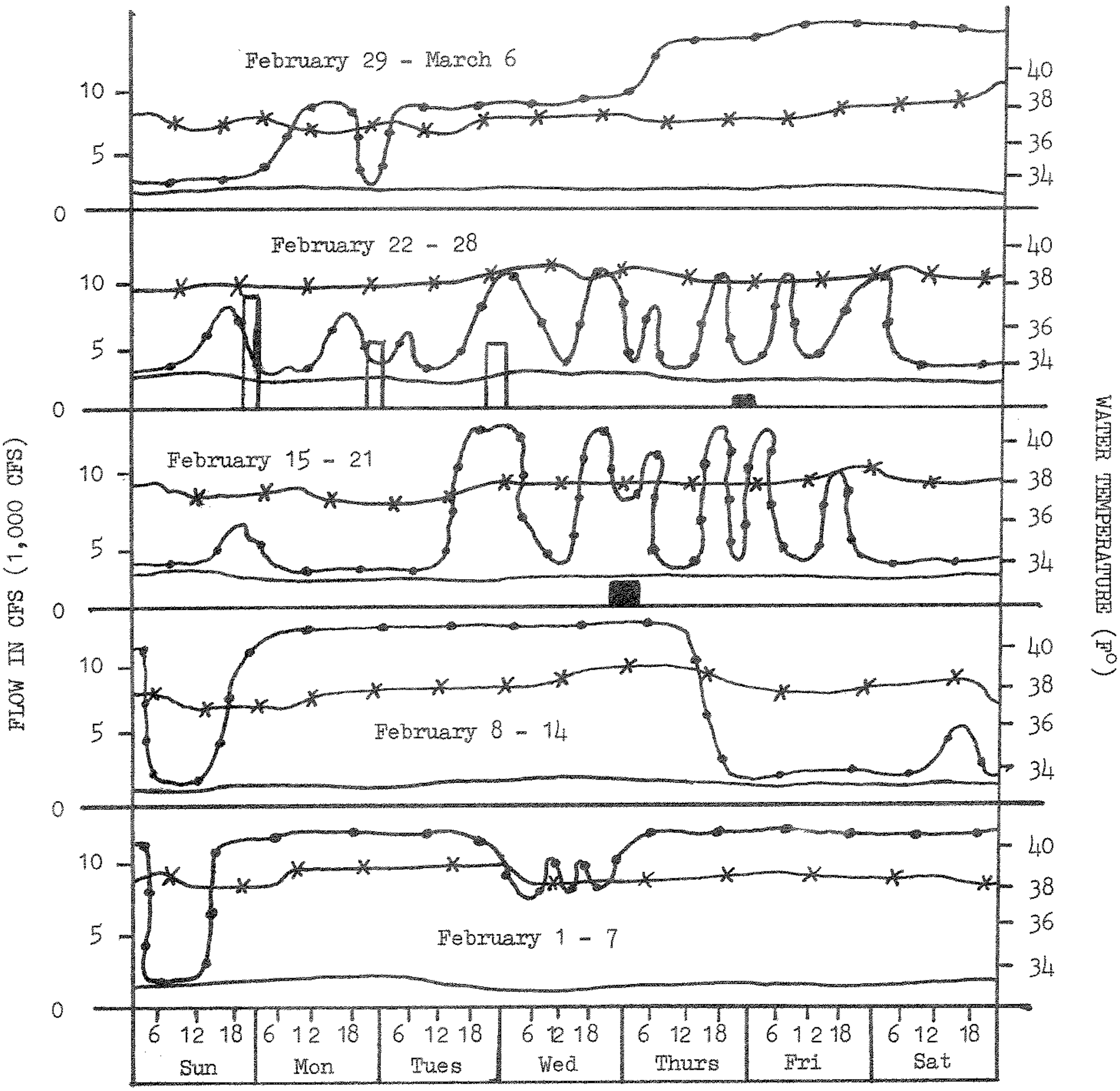
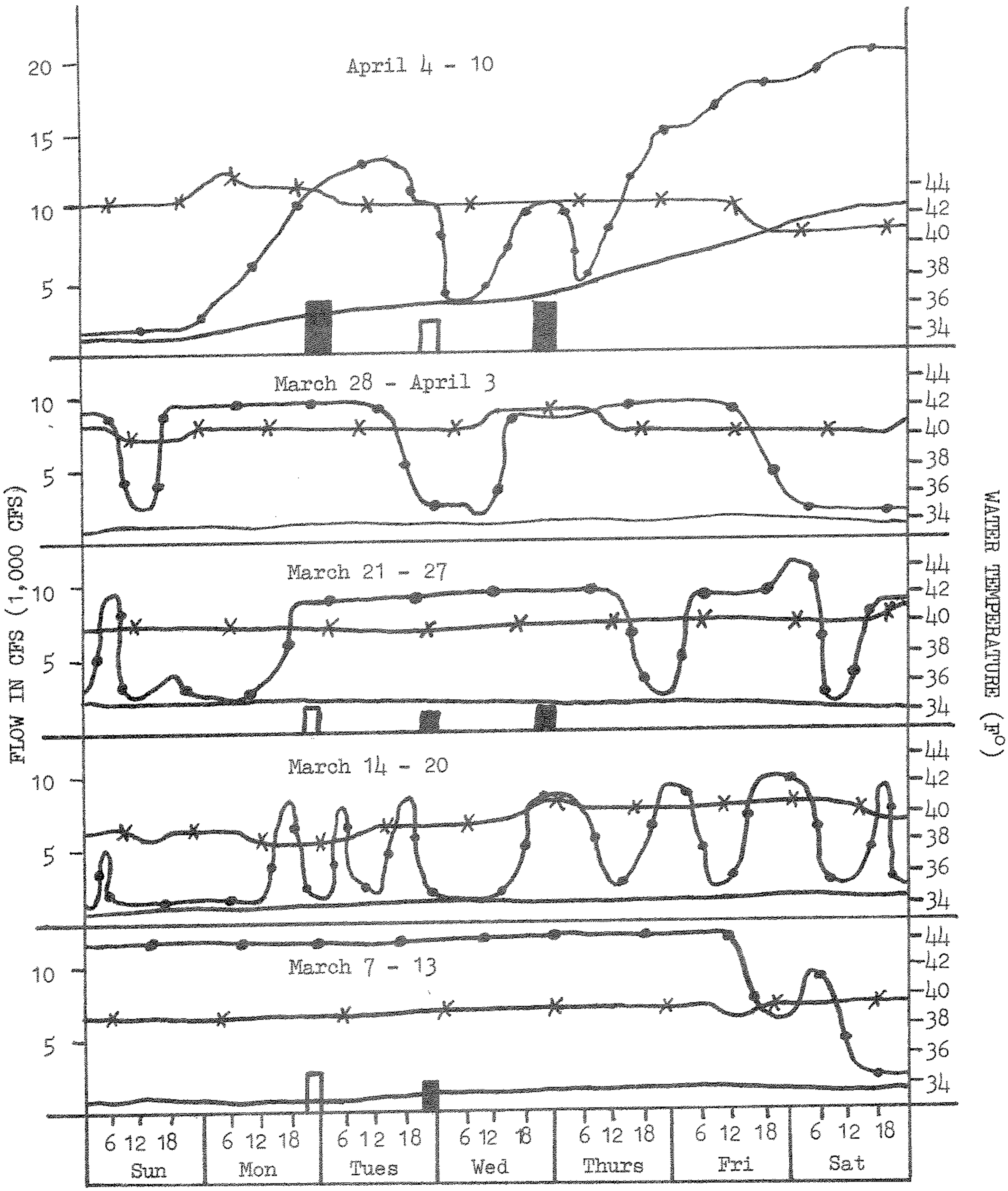


Figure 2. Natural flow (——), total flow (—•—), water temperature (—X—) and catch of cutthroat trout per boat-hour at Salmon Hole (■) and Steel Bridge (▭) February through April, 1976. (■ or ▭ equals three fish).



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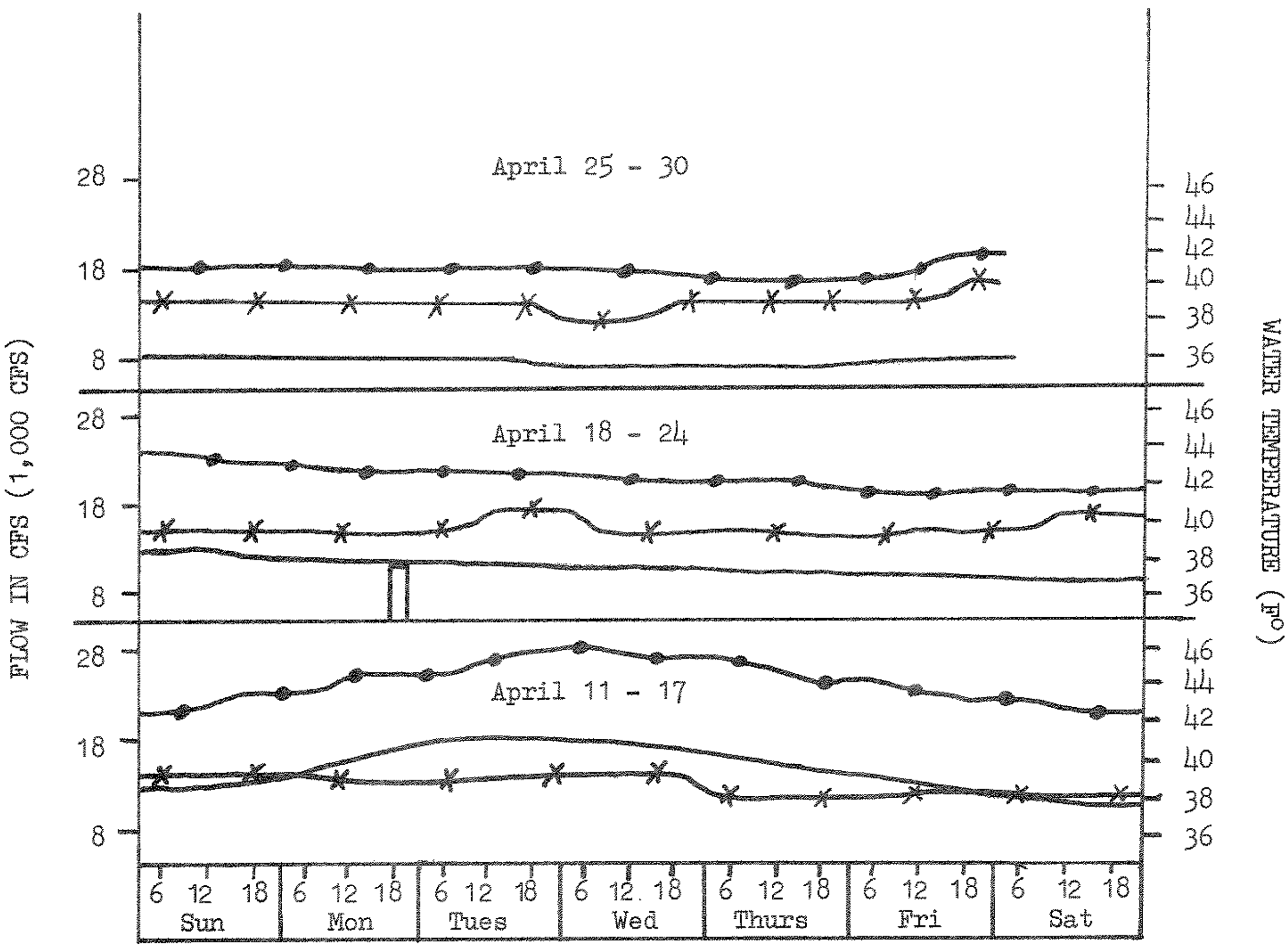

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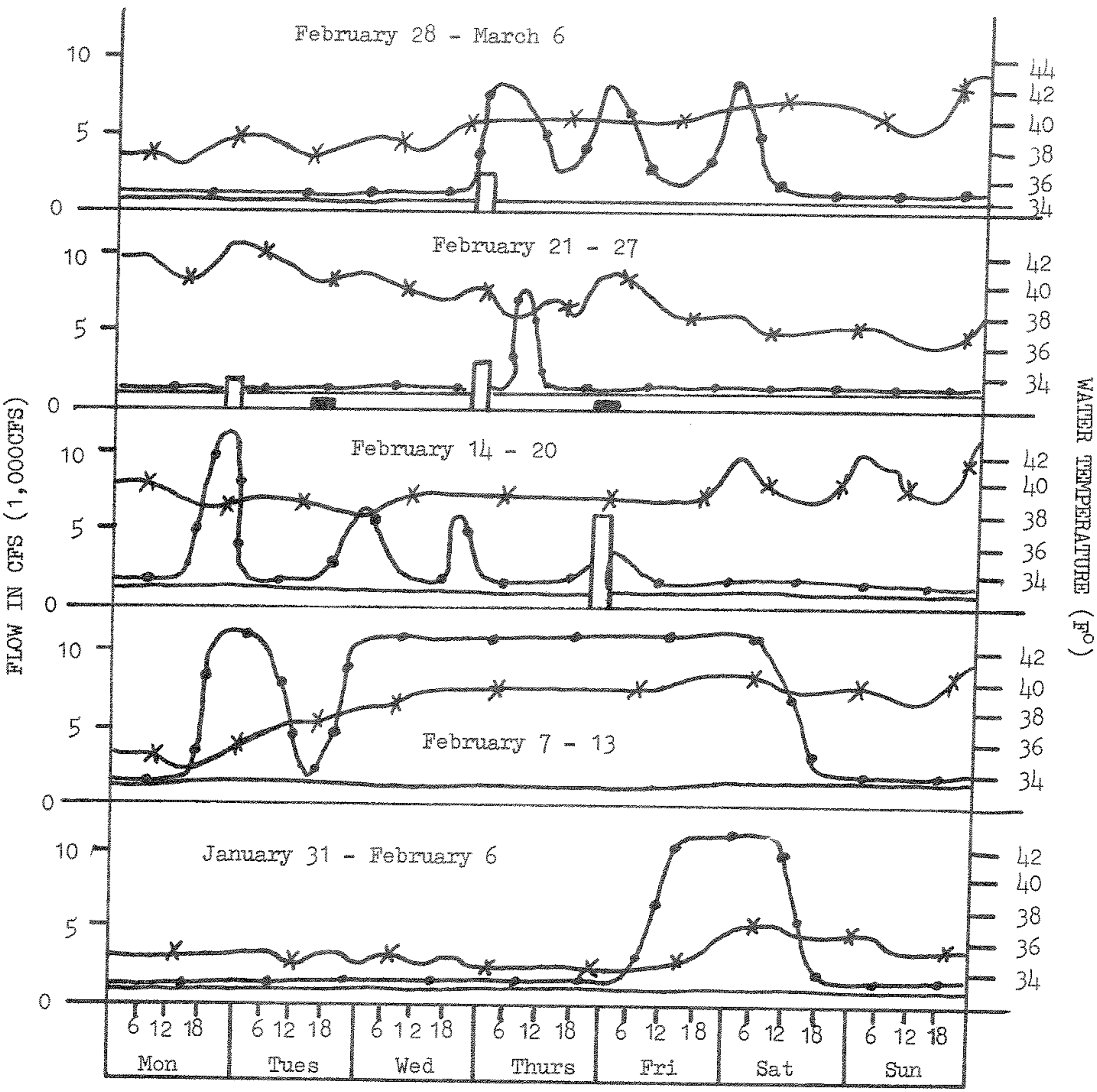
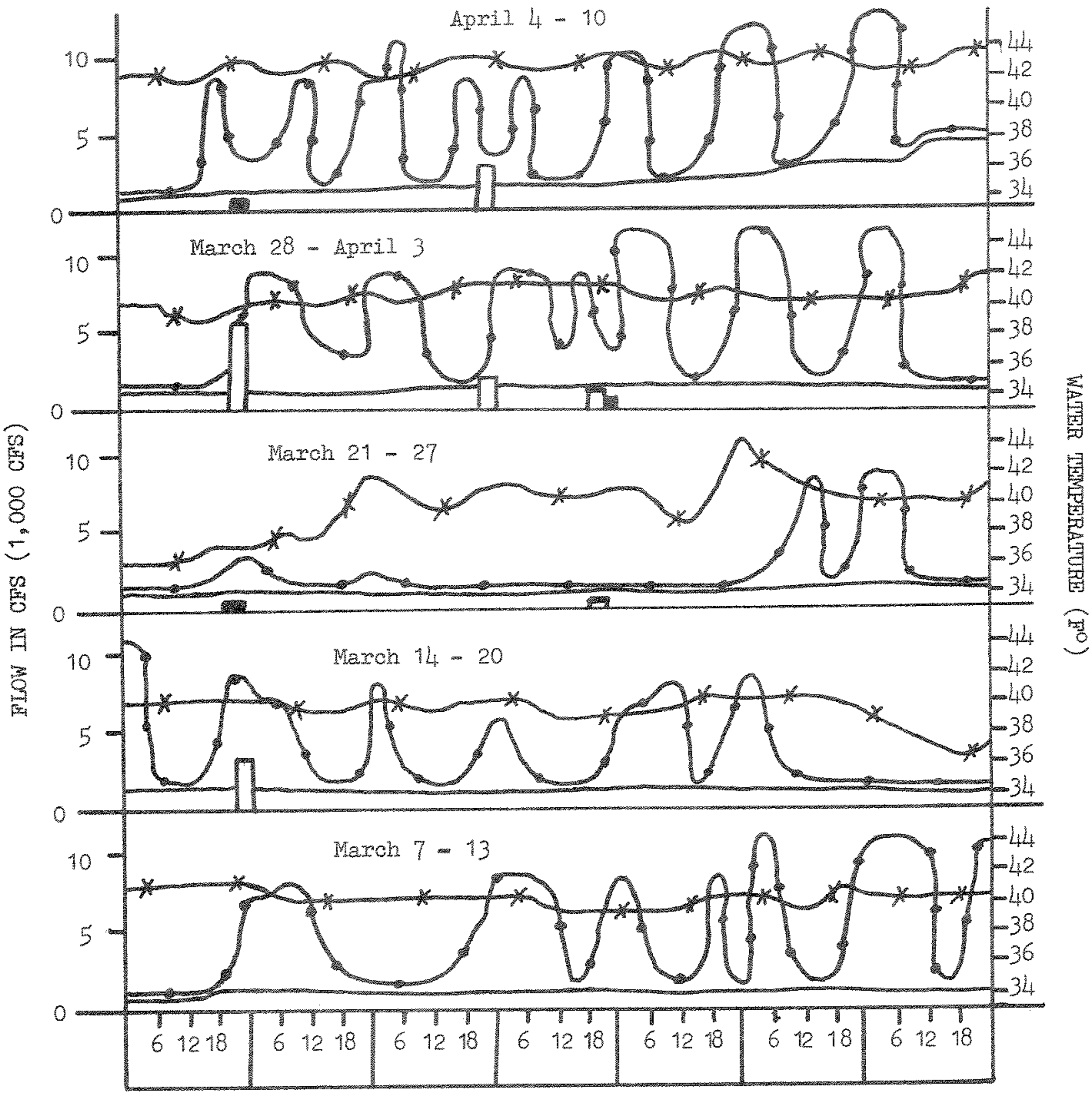


Figure 3. Natural flow (——), total flow (—●—), water temperature (—*—) and catch of cutthroat trout at Salmon Hole (□), and Steel Bridge (■), January 31 through May 15, 1977. (■ or □ equals 3 fish).



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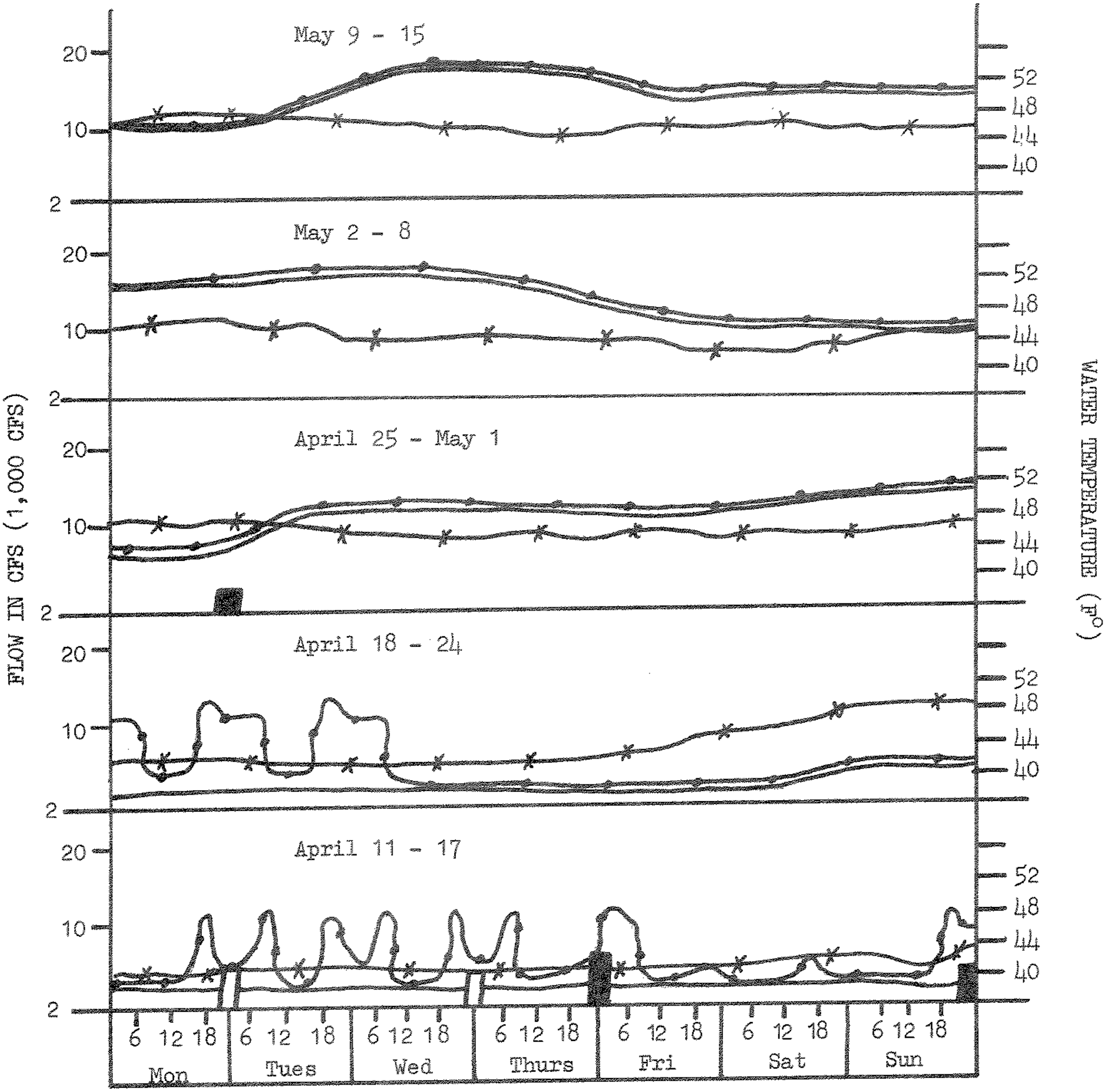

Figure 3. Continued.

Table 2. Recapture of adult cutthroat trout tagged near Kalispell, Montana in February, March and April, 1976 and 1977

	Month of Recapture						
Area of Recapture 1/	May	June	July	August	Sept.	Oct.-April	Total
North Fork Drainage	3	26	4	0	0	0	33
Middle Fork Drainage	0	3	1	0	0	0	4
Flathead River	3	3	17	3	5	1	32
Tagging Areas 2/	2	0	0	0	0	21 3/	23
Flathead Lake	4	2	4	1	0	0	11

1/ Areas are shown in Figure 4

2/ Tagging areas are Steel Bridge and Salmon Hole

3/ Includes 15 electrofishing recoveries and 6 angler recoveries

The number of recaptures from the North and Middle Forks of the Flathead River may be a measure of the relative strength of spawning runs in each drainage indicating that more fish spawn in the North Fork than in the Middle Fork. Part of the larger return of tagged fish from the North Fork may be due to greater angling pressure. Hanzel 4/ showed that summer fishing pressure was about twice as heavy in the North Fork as the Middle Fork. Three tagged fish from the North Fork were also caught in downstream traps fished in Akokala and Coal Creeks (Figure 4).

Adult-sized cutthroat examined by creel census personnel in 1977 were all spent fish, mostly females. Of the 122 adult cutthroat trout taken by anglers from the North Fork and examined by creel census personnel, only one fish was from a tributary stream, Coal Creek. The number of recaptures in June coupled with their spawned-out condition indicates that these fish spawned several days to several weeks before entering the creel, likely in May and early June.

Location of tag returns is shown in Figure 4. Included are the known spawning tributaries in the North Fork Flathead River drainage of migrant Dolly Varden and cutthroat trout from Flathead Lake. These data were derived from surveys done in the North Fork drainage in 1976 and 1977 by the Department of British Columbia Fish and Wildlife Branch.

Angler harvest of fish tagged in 1976 and 1977 is shown in Table 3. These data are divided into adult cutthroat, juvenile cutthroat and rainbow trout.

4/ Hanzel, Delano A. 1977. Angler pressure and game fish harvest estimates for 1975 in the Flathead River system above Flathead Lake. Fisheries Investigations Report, Montana Department of Fish and Game, Helena, Montana. 23pp.

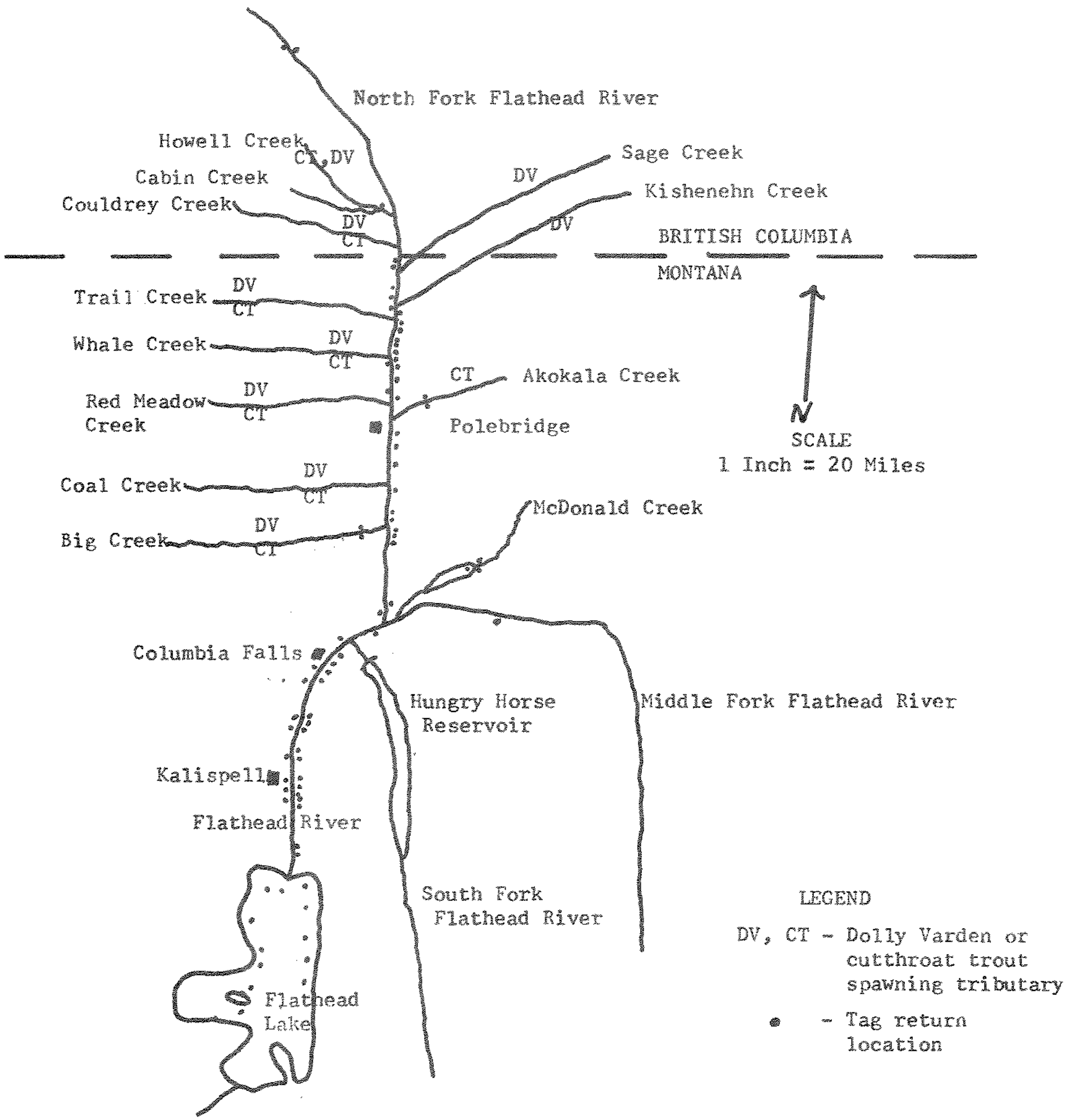

Figure 4. Map of Flathead River system showing known spawning tributaries of Dolly Varden and cutthroat trout in North Fork Flathead River drainage and tag recovery locations of cutthroat trout

Table 3. Angler harvest of cutthroat and rainbow trout tagged in Flathead River in 1976 and 1977

Year Tagged	Species	Number Tagged	No. caught By Anglers	Percent Harvest
1976	Adult cutthroat	162	25	15.4%
	Juvenile cutthroat	27	1	3.7
	Rainbow trout	4	0	0.0
1977	Adult cutthroat	331	61	18.4
	Juvenile cutthroat	30	6	20.0
	Rainbow trout	15	3	20.0

Angler harvest of adult cutthroat trout in both years has been good. The harvest coupled with expected spawning mortality rates of about 50 percent may indicate excessive total mortality rates in 1976 and 1977. Angler mortalities in past or future years with more normal runoff patterns would be expected to be lower. The total water yield and flows in the Flathead Basin were much less in both years than normal expectations during spawning runs. Both angler harvest rates and spawning population size will be subjected to intense investigations.

Rainbow trout have been collected for tagging and caught by anglers only in that portion of the Flathead River below the mouth of the South Fork Flathead River.

Creel census information collected during weekends of the 1977 special angling season of May 23 through June 26 is shown in Table 4. Generally lake-origin adult cutthroat trout can be differentiated from stream living adult cutthroat trout by size. Most lake-origin fish are at least 12 inches long while most stream-living fish are no more than 10 inches. Only one of the adult cutthroat trout examined by creel census personnel (a tagged fish) was caught from a North Fork tributary stream, Coal Creek. Three anglers who had fished tributaries during the week were contacted and reported catching large-sized cutthroat trout in Coal and Whale Creeks.

Table 4. Harvest from anglers contacted on the North Fork Flathead River drainage, May 23 through June 26, 1977

No. of Anglers	Hours of Effort	Adult Cutthroat	Juvenile Cutthroat	Dolly Varden
890	2,350	122(4)*	485	21

* Number of tagged cutthroat trout in parentheses

Sex ratio of male to female cutthroat trout tagged in the lower Flathead River was 1:2.3 and is presented in Table 5. Sex ratios were similar to those found in Hungry Horse Creek (a tributary of Hungry Horse Reservoir) 1:2 and Young Creek (a tributary of Lake Koocanusa) 1:5. Average size of tagged cutthroat (Table 6) in Flathead River was also comparable to fish in Hungry Horse Creek but smaller than Young Creek. Size range between the three populations shows little difference.

Table 5. Sex ratio of adult cutthroat trout from lower Flathead River 1976 and 1977

Year	No. of Males	No. of Females	Ratio
1976	59	99	1:1.7
1977	70	196	1:2.8
Combined	129	295	1:2.3

Table 6. Lengths in inches of adult cutthroat from lower Flathead River, 1976 and 1977

	Males		Females	
Year	Average Size	Range	Average Size	Range
1976	14.4	10.3 - 16.3	14.3	12.3 - 16.6
1977	14.3	12.2 - 18.2	14.3	12.5 - 16.4

Kokanee Spawning Areas

No extensive surveys have been done to locate all kokanee spawning areas in the South Fork Flathead River and main stem Flathead River below the mouth of the South Fork. Known and suspected kokanee spawning areas for this section of the Flathead River and South Fork Flathead River are shown in Figure 5. These spawning areas have been discovered during collection of creel census data, aerial flights over the river and daytime and nighttime electrofishing efforts. Very little information has been collected about the size of individual areas and none on numbers of kokanee utilizing each area.

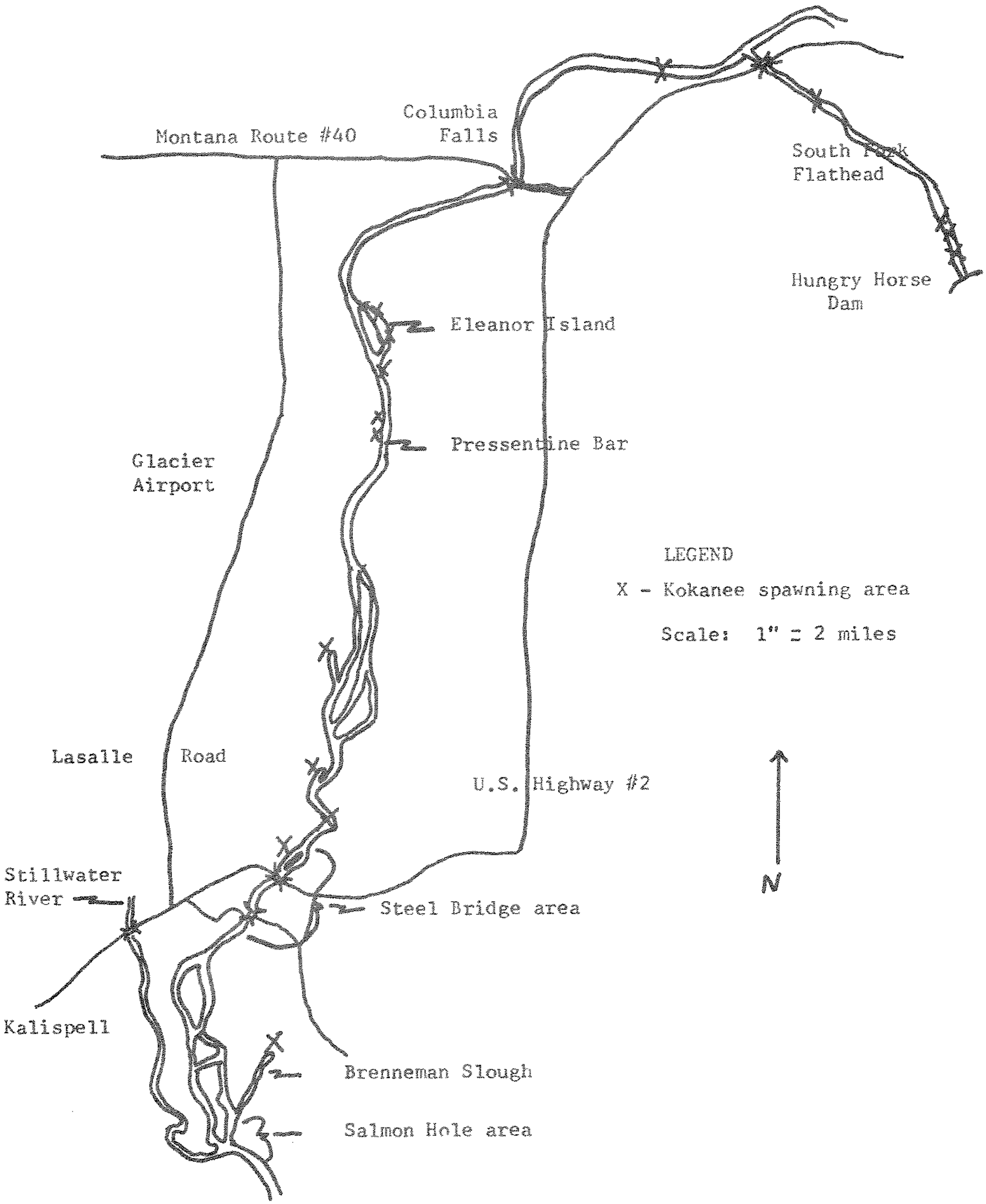

Figure 5. Known kokanee spawning areas in main-stem Flathead River and South Fork Flathead River

ADDENDUM

NOTES ON KOKANEE REDD EXAMINATION AND FRY EMERGENCE IN RELATION TO HUNGRY HORSE RESERVOIR DISCHARGE

By Robert Domrose

Kokanee begin their upstream movement in the Flathead River system above Flathead Lake in late July and early August. The main spawning migration begins in mid-September and continues through the middle of December. Peak spawning activity probably occurs in mid-November. Fluctuating flow releases affect the selection of spawning sites in the lower river below Hungry Horse Reservoir. Flow releases from Hungry Horse Reservoir during this peak spawning and early incubation period, October through mid-December, 1974, ranged from 2,800 to 10,100 cfs. During the late incubation period in March and April of 1975, Hungry Horse flows ranged from between 400 and 10,400 cfs.

Primary objectives of this study were (1) to check egg incubation progress to determine the time fry emerged and (2) measure a selected kokanee spawning bar to determine the wetted perimeter covering kokanee redds during minimum discharge (Hungry Horse Reservoir) in late winter and early spring, as compared to maximum discharge flows for the same period. Kokanee spawning redds were located in the vicinity of spawning concentrations observed the preceding fall.

Kokanee spawning areas in the Flathead System can be classified into four categories. These include: (1) outlet streams of lakes (McDonald Creek below McDonald Lake), (2) spring seeps in backwater sloughs, (3) the main river along the bank or side channels of the Flathead River and (4) lakeshore spawning (Flathead Lake). All, but the latter category, will be discussed.

(1) McDonald Creek (Apgar) --- McDonald Creek's flow remains at a fairly constant level from spawning through early egg incubation. Water temperatures in this outlet stream are influenced by the lake surface and are warmer than those of the Flathead River in late fall. Consequently, early salmon egg incubation occurs at a more rapid rate until the lake water cools to near freezing temperatures. Incubation is then slowed considerably.

Several redds were examined in the area above the Apgar Bridge on March 7, 1974. A cursory examination was made to determine egg development. About 90 percent of the eggs observed were in the late eyed-stage with approximately five percent hatched and in the early sac-fry-stage. The water temperature of McDonald Creek was 34° F. Outlet creek temperatures were probably influenced by the ice covering the lower end of McDonald Lake.

Redd locations in McDonald Creek were out of the main current in water depths from six to eighteen inches, at velocity flows less than 2 cfs. None were observed at depths greater than two feet. Selection of redd areas seemed to be determined more by stream substrate type than water velocities. Redd densities were greatest where loose gravel was deposited along the edge of the main current. These gravels can be easily turned with a shovel and range in size from one to two inches. Compacted gravel areas or cobble size gravel were not selected for spawning.

Further examination of McDonald Creek redds was made on April 3rd and April 11th. Observations made on the 3rd of April indicated a wide variety of egg development. Eggs developing in some redds were entirely in the late eyed-stage while others were one-half alvins and one-half late eyed-eggs. Stream temperatures had increased to 37° F., but ice cover at the lower end of McDonald Lake was still prevalent.

By April 11th, about 95 percent of the eggs had hatched with some of the fry beginning to absorb their yolk sac. Lake McDonald was completely free of ice on this date and stream temperature was 37° F. Several redds containing dead eggs were uncovered in loose gravel below riffle areas. It is believed that anchor ice formation, during extremely cold weather, was responsible for the failure of egg development.

On April 16th, a live trap designed for trapping downstream salmon smolts described by Craddock, 1961, was suspended from bridge pilings at the Quarter Circle Bridge. This bridge is located near the mouth of McDonald Creek where it enters the Middle Fork of the Flathead River and is approximately two miles below the major spawning area and the outlet of McDonald Lake. A tow net, a meter in diameter and covered with plastic window screen, was suspended in mid-stream adjacent to the live trap. Both traps were set at approximately 3:00 P.M. and were lifted the following day at 10:00 A.M.. The meter net collection represented about 60 percent of the total numbers collected, with an estimated 3,000 swim-up fry taken collectively from both traps. Aquatic weeds, lodged in the throat of the live trap, may have hampered the effectiveness of the trap. Fish collected from both traps were returned to the stream.

(2) Backwater spring seep areas --- Two spawning areas in this category were examined. One area is located on the main Flathead River and upstream of the Reserve Drive fishing access area. Several redds were examined on March 14th and both eyed-eggs and sac-fry were uncovered. The water temperature on this date was 41° F. with river flows at 1300 cfs. Flows at low stage exposed an estimated 20 percent of the available spawning area. Numerous spawning pockets in the water were observed in an area approximately 120 feet by 90 feet. A heavy layer of silt settling in this backwater area probably renders additional spawning gravel unsuitable for redd construction.

All, but one of the several pockets of eggs uncovered above the low water mark, were dead. In this case, viable eyed-eggs were found approximately two and one-half feet vertically from the water edge in moist, sandy gravel.

Brenneman's Slough, located in the lower river, was the second backwater spring seep area selected for kokanee redd observations. Water levels in the lower river are influenced by Kerr Dam at the outlet of Flathead Lake. In late winter and early spring, water levels near the mouth of the Flathead River recede when Flathead Lake is drafted down to minimum pool elevation (2,883 ft). Consequently, about one-half of the redds constructed in the fall at maximum pool elevation (2,893 ft.) were dry when observed in early spring (March 13, 1975). Eggs in redds covered by more than two inches of water were successful in hatching and producing alvins. The water temperature in Brenneman's Slough was 46° F. on March 13th. It is believed that the majority of fry had emerged and become free-swimming by this date.

(3) River side channels -- Flathead River (approximately three miles below Columbia Falls). Three spawning sites approximately three miles below Columbia Falls were selected for redd inspection. On March 19th, viable eggs in the late eyed-stage were collected from redds uncovered in the water of the stream channel near the south end of Eleanor Island. Cursory measurements at this site, at low flow releases, indicated a suitable spawning area (200 x 50 feet) was dry. It was estimated that 90 percent of potential spawning area at this site was dry when flow releases from Hungry Horse are at 400 cfs.

About one-fourth mile upstream from this point, several isolated redds were observed approximately four feet from the edge of the river bank and 150 feet from the wetted perimeter of the channel. Excavation of these redds revealed eggs in a deteriorated condition. This would indicate utilization of spawning gravels, during maximum flow releases, along the bank edge and the ensuing effects of spawning habitat loss at minimal flow discharge.

At a third site, where extensive spawning had taken place in 1974, stream cross sections of suitable spawning gravels were measured. This area is adjacent to a small side channel near the north side of Eleanor Island. The spawning area was measured at minimum Hungry Horse flow release. Figure 1 shows the relation of wetted perimeter comprising suitable spawning gravels where viable eggs were uncovered to spawning gravels in the dry outside the wetted perimeter. At this particular site, 54 percent of suitable spawning area was dry at a flow of 1,358 cfs (400 cfs Hungry Horse Reservoir discharge). The toal spawning area lost by reduced flows on this site comprised an estimated 11,600 square feet.

SUMMARY

Water released from Hungry Horse Reservoir is used for power generation, flood control and storage capacity for downstream uses. These widely fluctuating flows have undoubtedly taken a drastic toll on kokanee fry production in the lower Flathead River above Flathead Lake. High flow releases maintained during spawning migration have induced kokanee to utilize gravels that will be dry during reduced flows in late winter. The subsequent wetting and drying of these outside perimeter spawning areas greatly reduce kokanee fry production.

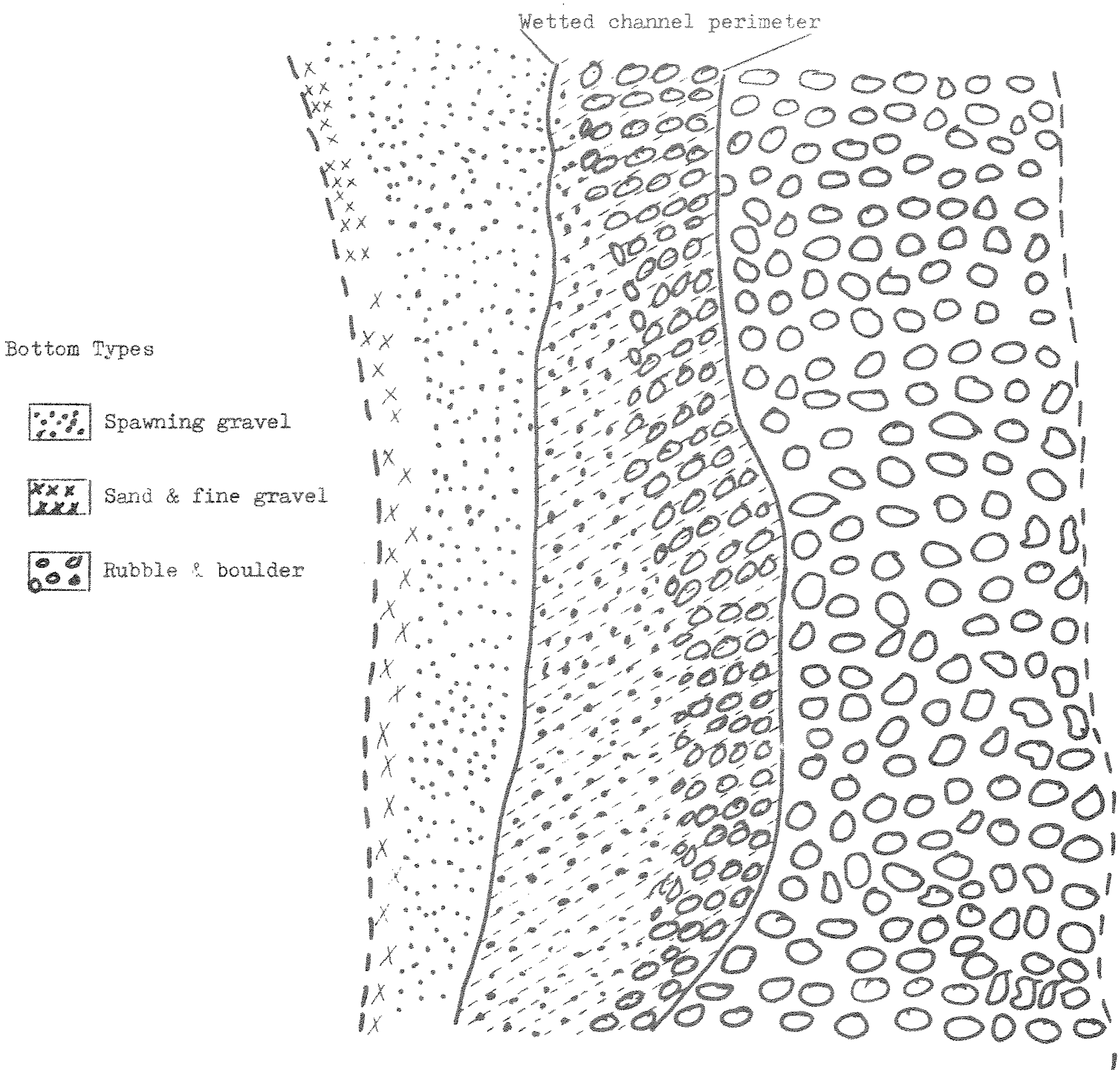

Figure 1. Diagramatic view of bottom types comprising a 330 foot kokanee spawning channel above and below the wetted channel perimeter at low flow.

Recommendations for further study:

1. Investigate the major elements effected on the aquatic community of the Flathead River from storage and discharge of Hungry Horse Reservoir water.

    A. Determine the percent of the total spawning type gravels between Foy's Bend and the South Fork, exposed at 1300 cfs; 1800 cfs; 2300 cfs and 2800 cfs gauge stages.

    B. Determine the quantities of these other gravels used.

    C. Determine, for study year, the percent of redds with dead eggs from exposure at flow volumes of 1300 cfs; 1800 cfs; 2300 cfs and 2800 cfs.

    D. Establish criteria for estimating optimum recruitment from other areas adequately covered with water to insure hatching.