MONTANA FISH AND GAME DEPARTMENT
FISHERIES DIVISION

JOB PROGRESS REPORT

State Montana

Project No. F-9-R-19 Title Inventory of the Waters of the Project Area

Job No. 1-a

Period Covered July 1, 1970 - June 30, 1971

ABSTRACT

Turbidity sampling in the Blacktail Creek, Clover Creek, Long Creek, and Ruby River drainages found average turbidity readings highest in the Ruby drainages. Trout biomass in selected sections of each drainage were low (12-24 pounds per acre) with the exception of the East Fork of Blacktail Creek, where biomass estimates were greater than 65 pounds per acre. The Middle Fork of the Ruby River had the greatest total exposed streambank.

Trout populations in the Big Hole River at Melrose showed little change between spring and fall sampling. The total biomass estimate remained the same. Tag return rates ranged from 9.3 - 14.0 percent, with the majority returned in the month of June. Hatchery rainbow trout were found to remain in the area around the planting site. Population estimates for the Yellowstone River, near Livingston, revealed excellent standing crops of wild trout. Rainbow trout predominated the trout population, making up 66.5 and 62.3 percent of the total number in the spring and fall, respectively. Tag returns by anglers averaged 5.4 percent from May through October. Estimates of the wild trout population for Armstrong Spring Creek revealed a standing crop of 785 trout and 381 pounds per acre.

Sampling stations were established in the Cataract Creek drainage to evaluate the effects of acid mine drainage. Aquatic insects were not present in Uncle Sam Gulch below the Crystal Mine and were not found in 3 of 4 samples obtained from Cataract Creek 3 miles below the confluence with Uncle Sam Gulch.

A study was initiated on Narrows Creek, a tributary of Elk Lake, to determine the number of fry that returned to the lake following emergence. The greatest migration of cutthroat and grayling fry occurred during the month of July with fry movement greatest during the night sampling.

Several lakes were surveyed to determine the status of game fish populations. A reproducing population of lake trout was discovered in Mystic Lake near Bozeman. Examination of scale samples indicated that the "lakers" taken were between 4 and 8 years old.

BACKGROUND

Within the bounds of Montana lie great segments of lands largely uninhabited and/or undisturbed by man. These isolated mountains, forests and deserts include some lasting remnants of primeval America. Even so, the continuing population growth and changes in technology are combining to destroy many of the outdoor recreational opportunities provided in these surroundings of optimum beauty. Overcrowding and overuse of our outdoor recreational resources poses a serious threat nationally. Recreationalists are thronging to many outstanding areas in ever increasing numbers, and in doing so are threatening the very purpose for which the lands are managed. In a great many areas, frustrated fishermen already struggle to find a quiet place to wet their lines on lake or stream.

In Montana fishing is the most important participating outdoor recreation activity with well over 25 percent of the people traveling for recreation being fishermen. Only through inventories of our unique natural resources, our lakes and streams, can the information necessary to provide a basis for sound management recommendations be gathered. Information obtained from these surveys is important in dealing with land and water development projects. If we are to maintain and enhance our sport fishery, we must continue to monitor changes in our lakes and streams so, where applicable, recommendations can be made for protection, restoration or improvement of the habitat or for other fisheries management measures.

OBJECTIVES

The purpose of this job is to determine the physical, chemical and biological characteristics of the waters of importance to the recreational fishery of the project area.

PROCEDURES

Fish populations were sampled by gill-netting and electrofishing. Electrofishing gear with an output of 0-500 volts variable direct current was utilized in censusing stream and river fish populations. The gear was fished either from a fiberglass boat with a stationary negative electrode attached to the bottom of the boat, or from the banks of smaller streams. The captured fish were anethesized, measured, weighed, marked and released near the capture site.

Population estimates were computed using Chapman's modification of the Petersen estimator (formula 3.9, Ricker, 1958). Confidence intervals at the 95 percent level were computed using formula 6 of the Michigan Institute for Fisheries Research (1960). Age composition and mortality rates for the fish populations were determined by the method outlined by Vincent (1971). A computer program was written and utilized to facilitate the estimation of population parameters. Where sample sizes necessitated the capture of more fish, multiple mark and/or recapture runs were used. Fish were marked with partial fin clips or tagged with Floy Tag Co. anchor tags inserted behind the dorsal fin.

Eyed Yellowstone cutthroat trout eggs were utilized in an attempt to determine the hatching success in the Shields River. Eggs were counted, poured into Vibert boxes, partially filled with gravel chips, and placed in the artificial redds. The redds were constructed by excavating a hole in the streambed approximately 3 feet long, 2 feet wide and 1 foot deep, as described by Peters (1967). Gravel obtained locally was washed prior to filling the redd. Hatching success generally realized at the Yellowstone River Trout Hatchery was used as a control figure. Turbidity measurements were taken with a Hach Water Testing Kit, utilizing the light penetration method, expressing turbidities in Jackson Turbidity Units (JTU).

Taylor seven-day recording thermographs were operated on the Shields River from May through September. The recording sheets were changed weekly and the daily maximum - minimum temperatures were tabulated. All water temperatures were recorded in Farenheit degrees.

Other techniques are presented as findings are discussed.

FINDINGS

Effect of Sediment on the Aquatic Environment

Background and Methods

The Ruby River arises in the Beaverhead National Forest in Southwestern Montana. Headwater tributaries arise chiefly in the Gravelly and Snowcrest Mountain Ranges. The river flows through narrow valleys and into a broad floodplain above Ruby Reservoir situated five miles south of Alder. The Ruby River joins the Beaverhead River about 35 miles downstream from Ruby Dam. Primary land use above the reservoir is grazing. Extensive sagebrush removal by spraying herbicides occurred in the 1960's.

Ruby Reservoir, which had a capacity of 38,850 acre-feet when constructed, has large-scale sediment deposition in its upper reaches. This rate of deposition, if allowed to increase or continue at its present rate, will soon render Ruby Reservoir useless, both as a fishery and in its water holding capacity. At present, an excellent trout population thrives downstream from Ruby Dam. This population will be threatened if sediment movement in the Ruby drainage is not minimized.

Sediment deposition has been shown to directly affect trout reproduction in a Montana stream (Peters, 1967). Cordone and Kelly (1961) found that sediment deposition harms a fishery by suppressing its food supply.

The identification of problem areas provides the key to establish rehabilitory measures. Although turbidity measurements do not directly follow the amount of sediment carried in a stream, they do provide a method whereby a comparison of streams can be attained in a drainage. The accessibility by road of the Ruby River, Long Creek, Clover Creek, and Blacktail Creek drainages provided an ideal study area to obtain base information for future comparison using turbidity determinations and fish population information.

The purpose of this survey was to determine the status of streams in the

Ruby River, Clover Creek, Long Creek and Blacktail Creek drainages with respect to spring turbidity readings and to determine the physical parameters and trout populations of selected sections within the study drainages.

Turbidity measurements in Jackson Turbidity Units were obtained weekly for seven weeks from May 25th to July 9th. A Hach DR-EL chemical kit was used for all determinations. Thirty-nine stations (Figure 1-4, Table 2) were sampled, 33 of which were sampled for the full seven weeks. The sampling day began in the Blacktail drainage and terminated in the Ruby drainage below Ruby Reservoir. Stations near bridges were always located upstream from roadways.

Trout population estimates were obtained on sections of the East Fork of Blacktail Creek, Long Creek, and the East Fork, Middle Fork, and West Fork of the Ruby River during July and August.

A mark-and-recapture method utilizing an initial marking run followed by a single recapture run was the basis for all estimates. Trout, age group 0 and older were estimated for each section with the exception of the East Fork of Blacktail Creek where trout under 6.0 inches were excluded due to inefficient sampling. A single estimate using the Chapman modification of the Peterson estimator (Ricker, 1958) was made for trout within each section with the exception of the East Fork of Blacktail Creek where substantial sample sizes of trout over 6.0 inches made 2-inch grouping possible.

Whitefish populations were estimated in sections where they were encountered.

Transects perpendicular to the stream flow were placed at 50-foot intervals on each study section. Depths were taken at one-foot intervals at each transect.

Cover area was measured for 3 feet on each side of a transect on both banks to the nearest 0.5 square foot. Cover consisted of overhanging shrubs and grasses and debris. It was classified as to height above the water surface with distinctions from 0 to 2, 2 to 5, and 5 to 10 feet. The area of each cover classification for a subsection was computed by totaling the cover area of each classification from the transects.

The area of undercut bank was determined by computing the area of undercut for 3 feet on each side of the transect on both banks.

Exposed bank measurements were made at each transect by totaling the number of feet from the waters edge to the defined stream bank.

On sections less than 2000 feet in length, transect measurement totals were weighted for a 2000-foot comparison between sections.

Results - Turbidity

Blacktail Creek Drainage. Average turbidity readings were slightly higher in the West Fork of Blacktail Creek with the lower readings occurring in the

East Fork of Blacktail Creek drainage (Figure 5). Highest readings were recorded on June 8th at station 2 on the East Fork and station 9 on the West Fork where a reading of 68 occurred.

Clover Creek Drainage. The highest readings from the two stations in the Clover Creek drainage were 20, with an average of 10 and 11 for the Clover Creek and East Fork of Clover Creek stations, respectively.

Long Creek Drainage. Jones Creek (station 17), a major tributary of Long Creek, had the highest average reading (25.4). There was an increase in turbidity from station 13 to station 12 on all but one sampling day. Piute Creek and Crow Creek had consistently low readings both averaging under 7.

Ruby River Drainage. Average turbidity readings for the seven-week period were over 100 for station 25 on the East Fork of the Ruby River and Cottonwood Creek (station 31). Lazyman Creek (station 33) and Coal Creek (station 22) had averages of 90 or more. Readings over 300 occurred on Basin Creek, Coal Creek, East Fork of the Ruby River (station 25), Cottonwood Creek, Lazyman Creek and station 36 on the Ruby River.

Drainage Comparisons. Turbidity readings were lowest in the Blacktail, Clover Creek and Long Creek drainages and highest in the Ruby drainage (Figure 5).

Results - Trout Populations

Trout population estimates were compared on the basis of the number and pounds per surface acre of stream and also the number and pounds per 1000 feet (Table 1).

Table 1. Comparison of trout population estimates from section in the Ruby River, Long Creek, and Blacktail Creek drainages

Section	Number per acre	Pounds per acre	Number per 1000 feet	Pounds per 1000 feet
Middle Fork Ruby River	49 ± 16*	11.8	27 + 9	6.4
West Fork Ruby River	72 ± 39	24.4	20 ± 11	6.6
East Fork Ruby River	117 ± 27	12.8	45 ± 11	5.0
Long Creek	36 ± 24	19.5	11 ± 7	6.2
East Fork Blacktail Creek	215 ± 59**	64.2	114 ± 31	34.1

*Total ± 2 standard deviations. This equals 95% confidence interval.
**Trout under 6 inches not included

Table 2. Turbidity sampling stations*

Station	Location
1.	East Fork of Blacktail (section 34)
2.	Unnamed creek (entering East Fork of Blacktail (section 34)
3.	Bridge located upstream from Anderson Ranch
4.	Blacktail Creek 1/4 mile below junction of East Fork
5.	Blacktail Creek 100 yards below mouth of Middle Fork
6.	Bridge on West Fork of Blacktail upstream from Middle Fork
7.	Bridge across West Fork of Blacktail (section 20)
8.	Culvert on West Fork of Blacktail (section 4)
9.	Bridge on West Fork of Blacktail at Anton Station turnoff
10.	Clover Creek at culvert on County Road
11.	East Fork of Clover Creek 200 yards above junction with Clover Creek
12.	Long Creek at bridge above junction with Red Rock River
13.	Long Creek at bridge downstream from Piute Creek
14.	Piute Creek
15.	Crow Creek
16.	Long Creek bridge near Fish Creek Road
17.	Jones Creek near road bridge
18.	Divide Creek
19.	Corral Creek
20.	Ruby Creek at bridge below Corral Creek
21.	Swamp Creek
22.	Coal Creek
23.	Basin Creek
24.	Poison Creek
25.	East Fork of Ruby
26.	Middle Fork of Ruby - 100 yards upstream from mouth
27.	West Fork of Ruby
28.	Elk Creek
29.	Main Ruby upstream from Burnt Creek
30.	Burnt Creek
31.	Cottonwood Creek
32.	Short Creek
33.	Lazyman Creek
34.	Lewis Creek
35.	Ruby River by Canyon Creek Campground
36.	Ruby River by bridge towards Ledford Creek
37.	Ruby River by bridge above Ruby Reservoir
38.	Idaho Creek
39.	Ruby River below Ruby Reservoir

*See figures 1 - 4

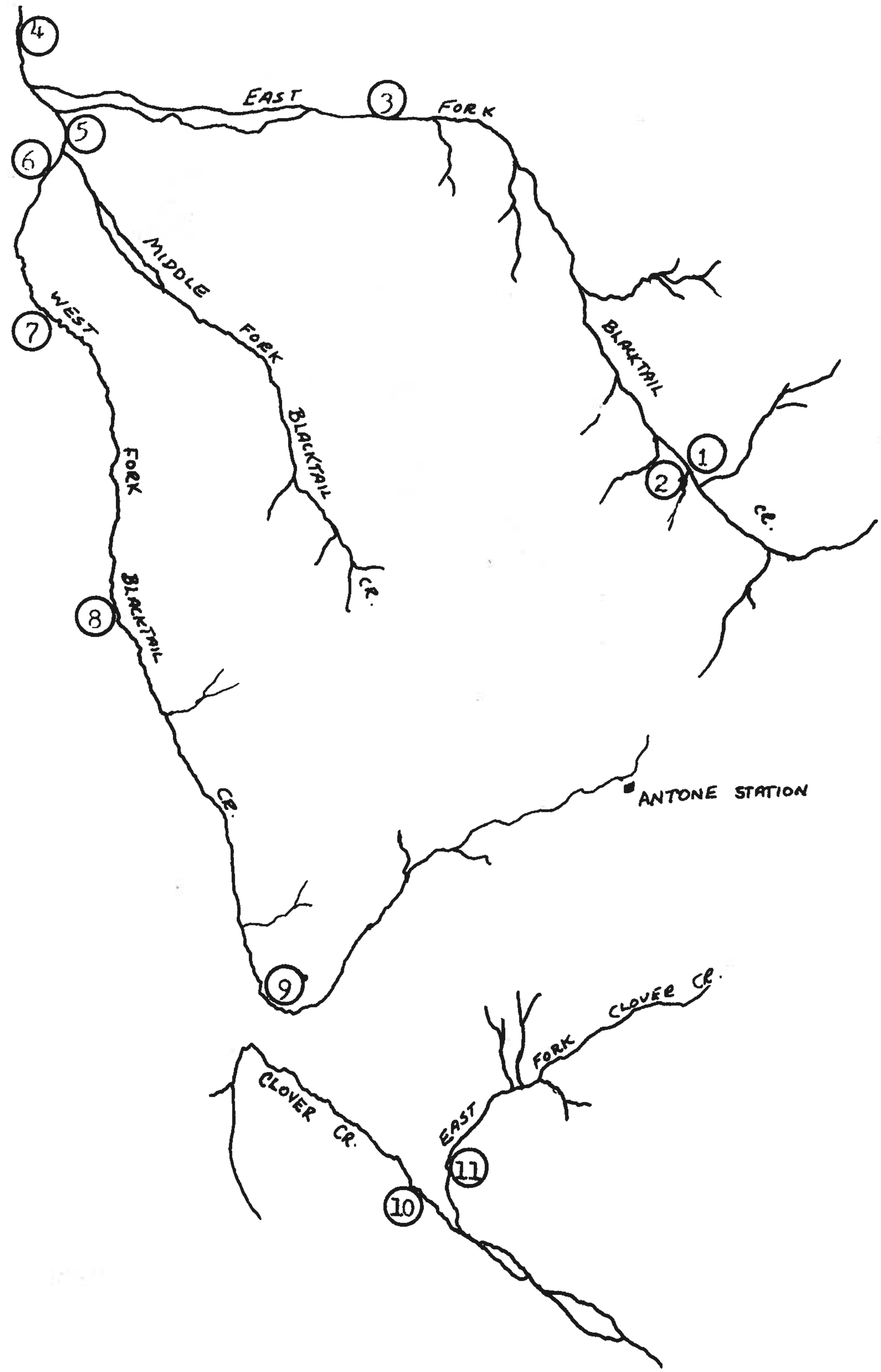


Figure 1. Map of Blacktail Creek and Clover Creek drainages showing sampling stations 1 to 11.

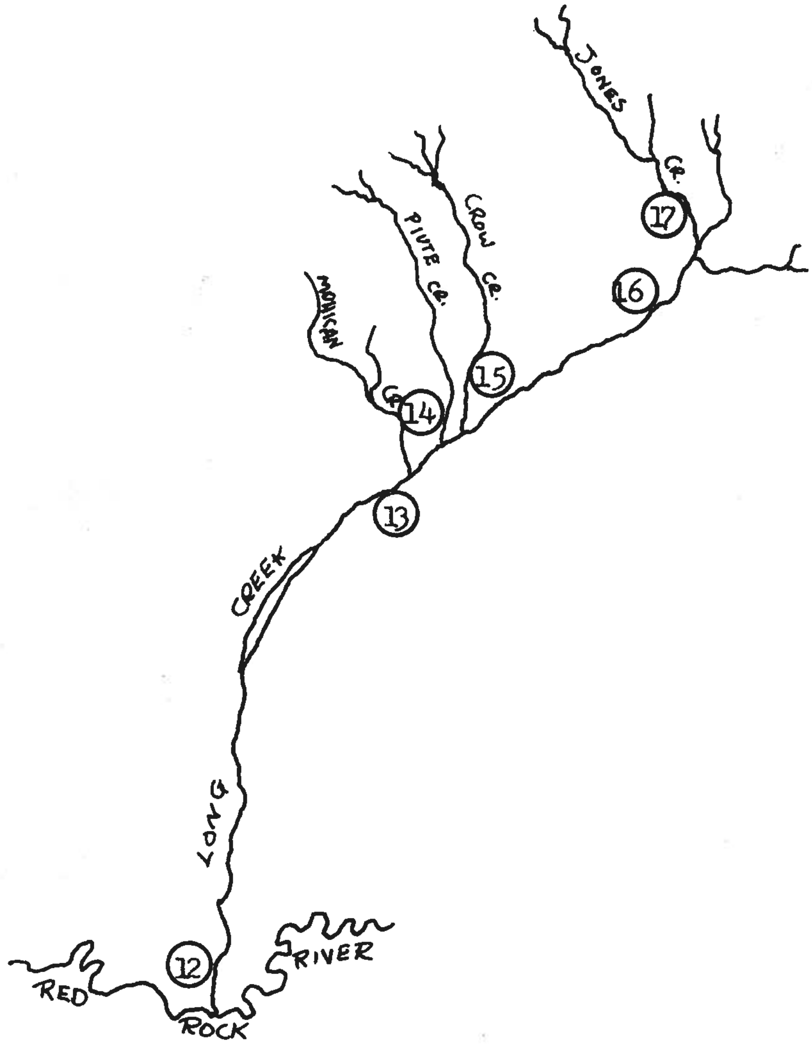


Figure 2. Map of the Long Creek drainage showing sampling stations 12 to 17.

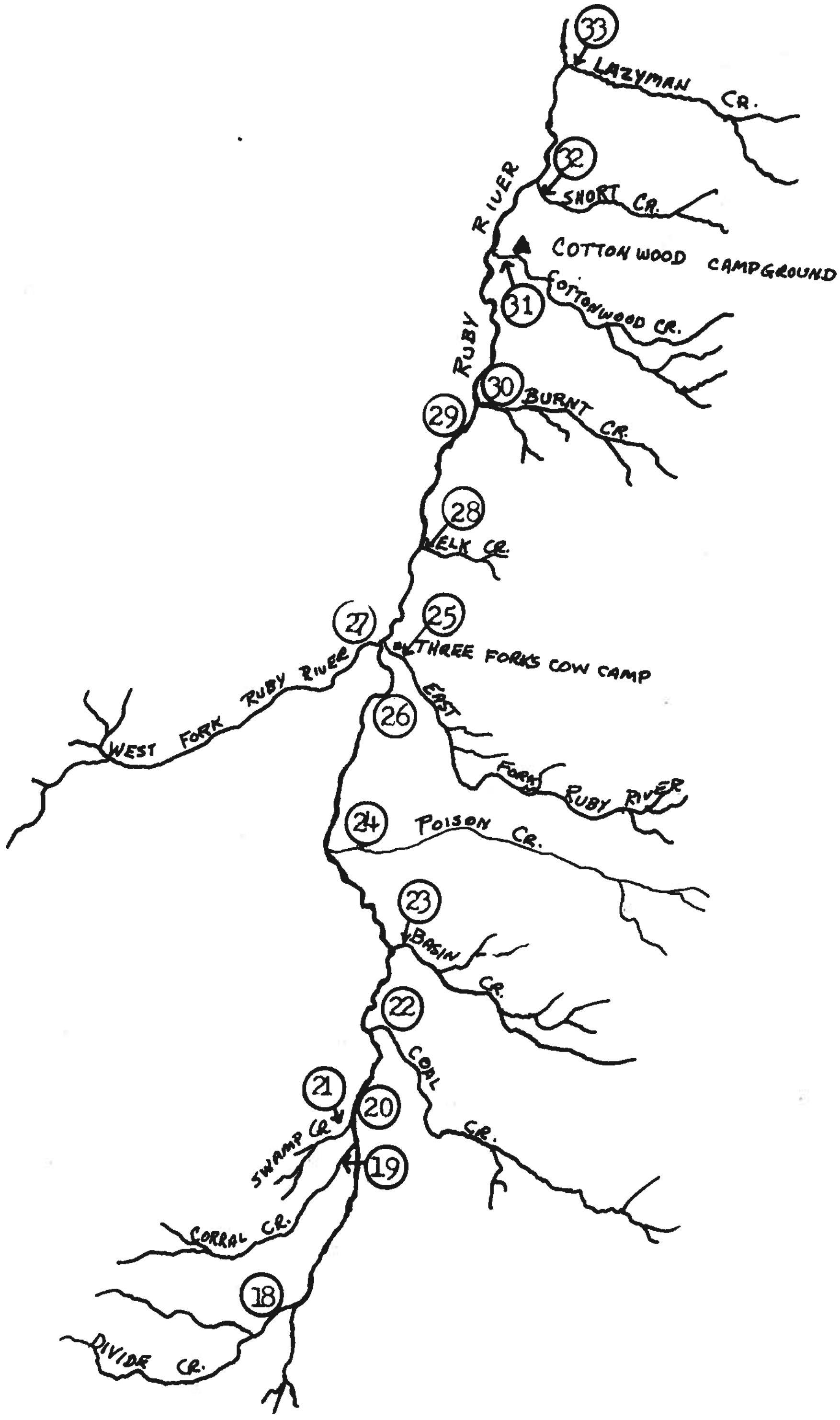


Figure 3. Map of the Ruby River drainage showing sampling stations 18 to 33.

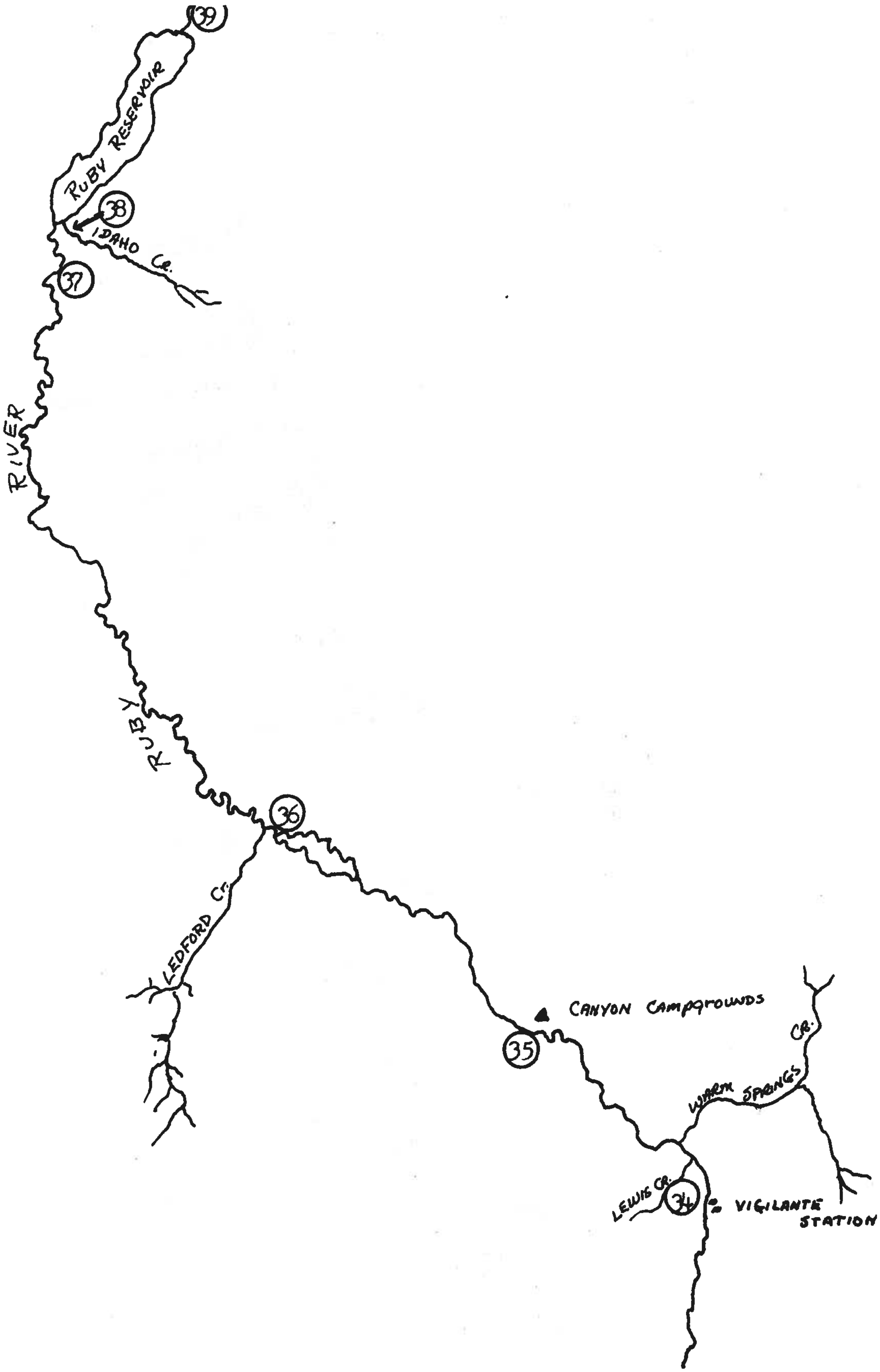
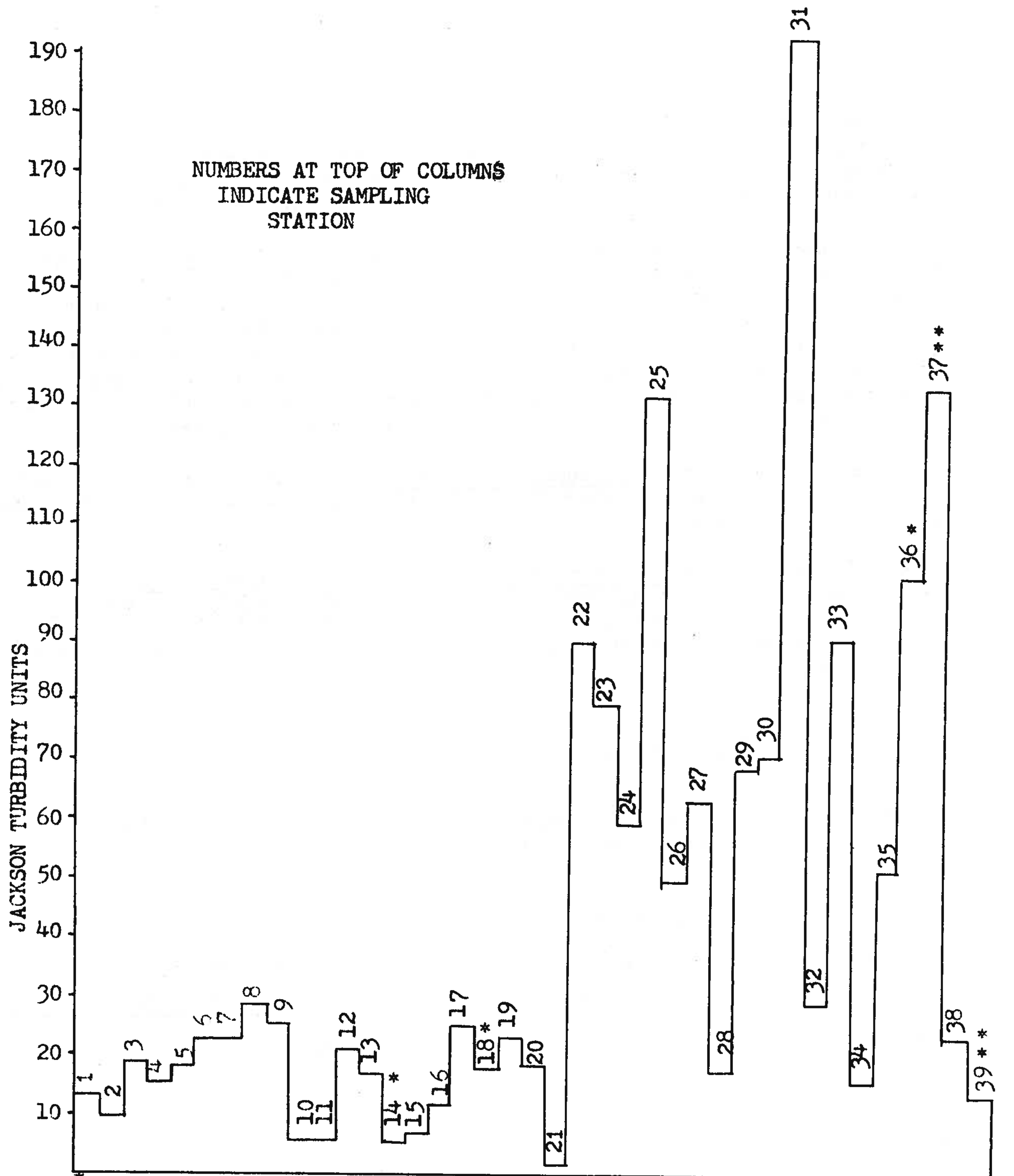


Figure 4. Map of the Ruby River drainage showing sampling stations 34 to 39.



*Average from six weekly readings only

**Average from five weekly readings only

Figure 5. Average turbidity readings from weekly sampling, May 25 to July 9, 1970.

The greatest trout population was found in the East Fork of Blacktail Creek with an estimate of over 64 pounds per acre. The West Fork of the Ruby River had the second highest trout biomass present (24 pounds per acre) and had double the biomass found in sections of the Middle and East Fork of the Ruby River.

The East Fork of the Ruby River section had a higher number of trout per acre than the West Fork section. Of the 106 trout captured while sampling, 67 percent were found to be under 5.0 inches in the East Fork and Ruby River section. There were no trout captured under 5.0 inches in the Long Creek or West Fork of the River section and only 4.4 percent of the trout captured in the Middle Fork were less than 5.0 inches. Scale analyses showed all trout captured under 5.0 inches were young-of-the year. It appears that reproduction was limited or non-existent in 1970 in those sections with few or no trout under 5.0 inches.

Mountain whitefish (Prosopium williamsoni) were found only in the West Fork of the Ruby River section where the estimated number and pounds per acre was 10 and 8.5, respectively.

Rainbow trout (Salmo gairdneri), cutthroat trout (Salmo clarki) or their hybrids were present in all sections. Brook trout (Salvelinus fontinalis) predominated in the sampling on the East Fork of Blacktail Creek and comprised nearly 50 percent of the catch on Long Creek, but were not present in the Ruby River sections.

Results - Section Morphology and Cover

A comparison of the physical characteristics of the study sections is shown in Table 3. Section lengths ranged from 2650 feet on the East Fork of Blacktail Creek to 1650 feet on the Middle Fork of the Ruby River.

Table 3. Physical characteristics of study sections.

	East Fork Blacktail Creek	West Fork Ruby River	East Fork Ruby River	Middle Fork Ruby River	Long Creek
Length (feet)	2650	1900	2000	1650	1750
Average width (feet)	23.1	11.8	16.8	23.7	13.8
Area (acres)	1.41	.51	.77	.90	.56
Total exposed streambank (feet)	----	72 (75.7)*	134(134)	328(397.6)	22.5(25.7)
Total undercut bank (square feet)	----	139.9(147.2)	67.4(67.4)	72.5(87.9)	82.5(94.3)
Average depth (feet)	----	.92	.52	.83	1.02

*Weighted for a comparison on a 2000 foot basis - weighted figure is in parentheses.

The Middle Fork of the Ruby River had the greatest average stream width and total exposed streambank. The Middle Fork has a scoured appearance which occurred below the confluences of Coal and Basin Creeks. This section had the most unconfined channel, while Long Creek and the West Fork of the Ruby River had the least exposed streambank. Average depths were lowest in the East Fork of the Ruby River due primarily to lower summer flows. The area of undercut bank was highest on the West Fork of the Ruby River.

Table 4. Cover area (square feet) for each classification of cover in study sections. (Cover area weighted for comparison on a 2000-foot basis)

Overhanging cover above surface	Section			
	Middle Fork Ruby River	West Fork Ruby River	East Fork Ruby River	Long Creek
0-2 feet	551.2	448.0	676.8	737.1
2-5 feet	218.5	106.4	240.2	261.1
5-10 feet	13.3	21.1	0.0	49.7
Total cover	783.0	575.5	917.0	1047.9

Cover measurements were obtained on all sections with the exception of the East Fork of Blacktail Creek where cover appeared comparable to that found in the Long Creek section. Total cover comparisons (Table 4) show the greatest amount of cover in Long Creek and the least amount of over-hanging cover in the West Fork of the Ruby River drainage. When comparing the total cover area with the total surface area of the sections, the Middle Fork of the Ruby River had the least percentage of cover and Long Creek the highest. (Table 5).

Table 5. Percentage of overhanging cover from 0-10 feet compared to total water surface area within study sections. (Comparisons weighted on a 2000-foot basis)

Section			
Middle Fork Ruby River	West Fork Ruby River	East Fork Ruby River	Long Creek
1.65	2.44	2.73	3.79

Willows (Salix spp) comprised over 60 percent of the cover from 0 to 2 feet above the surface on all sections and nearly 100 percent of the cover from 2 to 5 feet. Water birch (Betula spp) was the other primary overhanging species.

Recommendations:

Problems observed at the time of sampling included a lack of stream bank and ground vegetation (caused by extensive use by cattle in certain locations), erosion along streambanks and high spring flows.

An evaluation of the watershed and grazing practices should be made in the Ruby River drainage to determine causes and areas of soil loss. Primary emphasis should be placed on Basin Creek, Coal Creek and Poison Creek in the Middle Fork of the Ruby River drainage, the complete East Fork of the Ruby drainage and Cottonwood Creek and Lazyman Creek, tributaries of the Ruby River. A comprehensive plan should be established to control sediment losses. The burden of sediment sampling and control measures should fall under the responsibility of the U. S. Forest Service who manages this area. Measures should be undertaken to maintain and enhance brush cover along the stream.

A study should be designed to measure intragravel permeability and oxygen in potential spawning areas on Long Creek and the Ruby River and its main tributaries. Vibert boxes could be placed in several areas to determine survivability of trout eggs. The amount of sediment transported by various tributaries and the main streams would have to be monitored at the same time to establish any relationship it may have in contributing to the low standing crop of trout.

Additional fish population information should be obtained on the Ruby River and its tributaries and also on Long Creek. Water temperature information would also be desirable as many of the tributaries do not have overhanging bank vegetation.

Big Hole River Fish Population Study

Trout population estimates were obtained on a 22,500 foot section of the Big Hole River in April and September, 1970 (Table 6), and compared to September, 1969 estimates. Multiple mark and recapture runs were necessary. Estimates were made for yearling and older trout during September sampling and two year and older trout during spring sampling.

Wild Trout Populations

Electrofishing was more efficient during the spring sampling. A total of 318 and 341 brown trout were marked during September, 1969 and 1970 sampling, respectively. During April, 1971 a total of 526 were marked. The number of sampling trips remained constant (4) although crews varied. Wild rainbow trout were taken in greater numbers in April when over 200 were marked. The highest number in both fall sampling periods was 119. It was believed that cooler water temperatures and the location of trout had more effect on the catch rate than crew differences.

The percentage of rainbow to brown trout remained relatively constant ranging from 27 to 33 percent. In comparing the number and pounds per 1000 feet (Table 7), the combined biomass of rainbow and brown trout was the same for all estimates. There was a slight decrease in the total number of trout from September to April. An 8.7 percent decrease occurred in the brown trout population during the winter months, while rainbow trout increased 10.8 percent.

Table 6. Trout population estimates and condition factors for wild rainbow and brown trout for the Melrose section (22,500 feet) of the Big Hole River

Date	Species	Size interval estimated	Number in section	Pounds in section	Condition factor
September - 1969	Brown trout	6.0- 9.9	237	57	36.22
		10.0-13.9	638	430	36.26
		14.0-17.9	648	992	36.76
		18.0+	421	1207	36.20
		Total	1944 ± 638*	2686	
	Rainbow trout	7.0+	788 ± 614	654	
		Total	788 ± 614	654	
April - 1970	Brown trout	6.0- 9.9	184	50	34.31
		10.0-13.9	439	312	35.93
		14.0-17.9	889	1281	35.25
		18.0+	262	743	33.90
		Total	1774 ± 334	2386	
	Rainbow trout	7.0-12.9	336	176	37.69
		13.0-15.9	417	493	38.16
		16.0+	120	270	38.34
		Total	873 ± 285	939	
September - 1970	Brown trout	6.0- 9.9	555	146	37.93
		10.0-13.9	390	291	38.37
		14.0-17.9	929	1503	38.36
		18.0+	294	811	36.29
		Total	2168 ± 629	2751	
	Rainbow trout	7.0-12.9	541	210	40.62
		13.0-15.9	196	233	39.28
		16.0-19.9	78	151	40.05
		Total	815 ± 372	594	

*Total ± 2 standard deviations. This equals 95 percent confidence interval.

It appears that a much stronger brown trout year class occurred in 1969 than in 1968 as shown by the number of trout in the 6.0-9.9 size interval in September, 1970 compared to September, 1969 (Table 6). The number of brown trout over 18.0 inches decreased by over 25 percent although the total brown trout population increased due to the influx of the yearlings.

Table 7. Trout population estimates on the Melrose section (22,500 feet) of the Big Hole River showing number and biomass per 1000 feet of stream

Date	Trout species	Number ± 2 standard deviations*	Biomass (pounds)
September - 1969	Brown	86 ± 28	119
	Rainbow	35 ± 27	29
	Grand total	121 ± 55	148
April - 1970	Brown	79 ± 15	106
	Rainbow	39 ± 13	42
	Grand total	118 ± 28	148
September - 1970	Brown	96 ± 28	122
	Rainbow	36 ± 17	26
	Grand total	132 ± 45	148

*This equals 95 percent confidence interval.

A general decrease in condition factor (C) occurred on all brown trout size groups from September to April (Table 6). Rainbow trout had higher condition factors than brown trout during both spring and fall sampling periods.

Several hundred trout, ten inches and larger, were tagged with Floy anchor tags in September, 1969 and April, 1970 (Table 8). Tag return signs were placed in conspicuous areas and news releases regarding the tags were given to local newspapers. The data presented assumes a majority of the tagged fish harvested had the tag numbers reported.

Tag return rates ranged from 9.3-14.0 percent for both species (Table 8) with a higher percentage of brown trout tags returned from each tagging period, 11.4 and 14.0 compared to 10.2 and 9.3 rainbow returns, respectively.

Table 8. Return of anchor tagged wild rainbow and brown trout from the Big Hole River in 1969 and 1970.

Total trout tagged over 10 inches	Total returned 1969	Total returned 1970	Percent return	Combined percent return
September 1969				
Rainbow - 59	0	6	10.2	11.2
Brown - 333	5	33	11.4	
April 1970				
Rainbow- 205	-	19	9.3	12.6
Brown - 487	-	67	14.0	

Nearly 75 percent of the brown tag returns and 61 percent of the rainbow trout tag returns were within the first two months of the season, with the greatest harvest coinciding with the locally-called salmon fly hatch (Table 9). There was a general decline of tag returns throughout the summer with few trout being harvested after September. An increase in the rainbow harvest occurred in mid-August but a sharp decrease followed.

Table 9. Wild trout tag return percentages for two week periods through the 1970 fishing season.

Date	Brown trout		Rainbow trout	
	Number	Percent	Number	Percent
May 17 - 30	5	5	3	11
May 31 - June 13	13	12	4	15
June 14 - 27	35	34	7	27
June 28 - July 11	14	13	3	12
July 12 - 25	9	8	1	4
July 26 - August 8	6	6	1	4
August 9 - 22	7	7	5	19
August 23 - September 5	6	6	0	0
September 6 - 19	4	4	0	0
September 20 - October 3	4	4	1	4
October 4 - 17	0	0	0	0
October 18 - 31	0	0	0	0
November 1 - 14	0	0	0	0
November 14 - Closing	1	1	1	4
Total	104	100	26	100

Of tag returns with home addresses given, 39 (31.2%) of 125 were from non-resident fishermen.

Of tags returned where location of fish capture was recorded, it was found that brown trout tagged in September exhibited nearly twice as much movement as those tagged in April (Table 10). Movement was defined as those fish caught more than one mile above or below the section.

Table 10. Number of tagged trout exhibiting movement out of the section from reported returns on the Big Hole River.

	Tagged September, 1969				Tagged April, 1970		
	Remained in section	Exhibited movement	Percent movement		Remained in section	Exhibited movement	Percent movement
Rainbow	4	0	0	Rainbow	10	4	29
Brown	16	15	48	Brown	35	12	26

From recorded locations of captured tagged rainbow trout it was found that 29% of those tagged in April moved, while no movement was recorded from September tagging. This information suggest that rainbow and brown trout movement may be considerable in the Big Hole River although a detailed census designed to obtain tag returns and catch locations would be necessary to substantiate or disprove the above information. Low summer flows due to irrigation dams drying up side channels and greatly changed flow patterns in the summer may cause some of the movement and affect the trout populations involved.

Hatchery Rainbow Trout Populations

Thirty-six hundred hatchery rainbow trout planted in the middle of the section were injected in the left jaw tith National Fast Blue 8GXM dye following the procedure outlined by Kelly (1967). The objective was to determine upstream-downstream movement and mortality rate. Another 449 were tagged with numbered Floy anchor tags to determine the fishermen harvest rate.

The hatchery trout were planted at three intervals during July and August. Four thousand hatchery trout were marked with dye under the right jaw and planted 1.5 miles downstream from the end of the section. All marked and tagged trout were held a minimum of two weeks in the hatchery and only 3 mortalities were recorded. None of the anchor tagged trout had succumbed.

An estimated total of 1045 left-dyed hatchery trout (Table 11) were in the section during September for a decrease of 71 percent. The majority of the trout remained at the planting site with a slightly higher number found in the first 0.5 mile upstream. More hatchery trout were found in the upstream 0.5-2.0 miles above the planting site than below.

Only one of the 4000 right-jaw dyed trout planted 1.5 miles below the section was captured.

A total of 49 anchor tagged hatchery rainbow were reported harvested by fishermen in 1970 for a 10.9 percent return rate. A total estimate of tagged trout showed 67 ± 46 of the 449 planted remained in the section. This shows an 85.1 percent decrease for the two months following planting. Several of the tagged rainbow were reported caught and released and these fish were not considered in this discussion.

Table 11. Estimated number of dye-marked hatchery rainbow trout found at various distances from a planting site on Big Hole River

Distance from planting site		Estimated number* of hatchery rainbow
0.0 - 0.5 miles upstream		522 ± 178*
0.0 - 0.5 miles downstream		462 ± 257
0.5 - 2.0 miles upstream		42 ± 20
0.5 - 2.0 miles downstream		19 ± 15
	Total	1045 ± 470

*Total ± 2 standard deviations - This equals 95% confidence interval.

Narrows Creek Spawning Improvement Study

Background and Methods

Elk Lake is located in the northeast corner of the Centennial Valley in Southwestern Montana. It lies at an elevation of 6,800 feet and has an area of 283 surface acres and a maximum depth of 50 feet. The lake provides sport fishermen with Arctic grayling (*Thymallus arcticus*), cutthroat trout (*Salmo clarki*) and lake trout (*Salvelinus namaycush*).

Fingerling cutthroat trout were planted in Elk Lake each year from 1954 to 1963, but fishing was reported good only following the 1957 plant when catchable-sized trout were also planted (Wipperman, 1965). Subcatchable cutthroat trout were planted in 1965 and fishermen have reported a good cutthroat fishery following annual planting with subcatchables. To plant cutthroat of this size, it has been necessary to hold trout overwinter in the hatchery, adding considerably to the planting expense.

Narrows Creek, an intermittent tributary of Elk Lake, appears to be the primary spawning stream for grayling and cutthroat trout. The stream has been reported to go dry in late summer and some years freezes to the bottom in the winter. These factors plus the small size of the stream (1/2-2 cfs) limit the potential of the stream to provide adequate recruitment (particularly cutthroat trout) to the Elk Lake fishery.

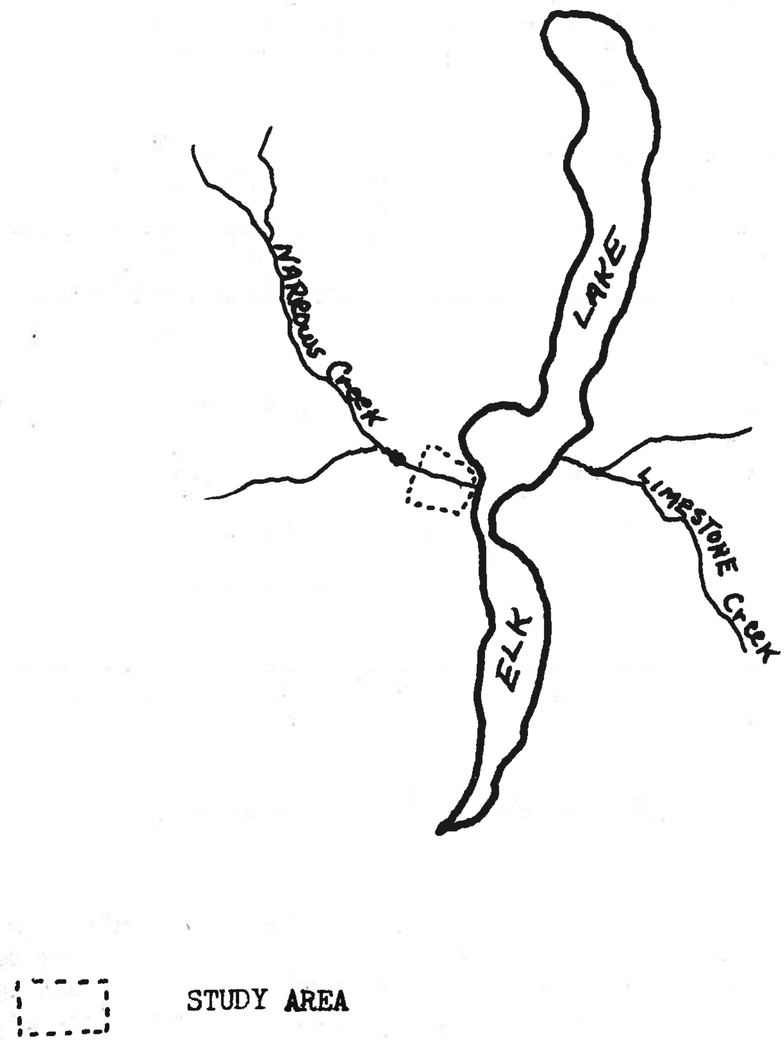


Figure 6. Map showing location of Narrows Creek spawning area.

Narrows Creek is ideally located to attempt development of more spawning area. Flows could be regulated by construction of an upstream dam or by pumping water from Elk Lake to maintain constant flows during dry periods and throughout the winter. The long-term objective of this development would be to provide a wild cutthroat fishery in Elk Lake and to sustain or improve the current grayling fishery.

The objective of this study was to determine the number of fry that returned to Elk Lake following emergence in Narrows Creek (Figure 6) and to determine at what period migration occurred. Water temperatures on Narrows Creek were to be monitored to determine the temperature ranges during the period of fry migration.

A modified box-type fry trap was placed 40 feet upstream from the mouth of Narrows Creek. The trap consisted of 14 x 14 x 12 inch box placed in the stream bottom. Wings (3 feet x 8 inches) were placed upstream as a guide to the trap. Bobbinetting was placed on the wings and 8 inches in height around the rear and sides of the box. The wings were anchored into the bank on each side of the stream, thus allowing no area where fry might escape going into the trap.

The trap was monitored on a twice-day (morning and evening) basis until October 27, 1970. Trapped fry were removed with a dip net, counted and placed downstream.

Temperature readings from Narrows Creek were obtained daily using a maximum-minimum thermometer placed downstream from the trap.

Results

Both cutthroat trout and grayling were observed spawning in Narrows Creek on June 11. Local residents had observed fish in the stream the previous week. The gry trap was placed in the stream on June 30 and monitored daily until October 27.

A total of 3,567 fry were passed through the trap while it was in operation. Fry were moving downstream on July 1, at which time the yolk sac had not been completely absorbed by some of the fry. The peak period of fry migration occurred during the month of July, with the greatest migration occurring between July 16 and 25 when 2,937 fry were passed (Figure 7). Severe thunderstorms on July 14 and 15 washed out the trap and a substantial number of fry were probably washed downstream on those days.

Fry movement was greatest during night hours as revealed by considerably more fry being present in the morning sampling. For the period July 16-20, 1,278 fry were passed in the morning sampling versus 232 in the evening.

From late August to October 27, generally less than four fry per day were passed through the trap. During a short period in late August, the stream flowed underground for about 20 feet above the mouth, making it impossible for fry to reach the lake. On October 27, the stream was found to be frozen to the bottom in several areas and it was presumed that fry remaining in the stream would not survive the winter. Several hundred fry were observed in the stream prior to its freezing. Sampling in various portions of the stream showed these to be cutthroat trout. The potential of Narrows Creek to produce substantial numbers of cutthroat

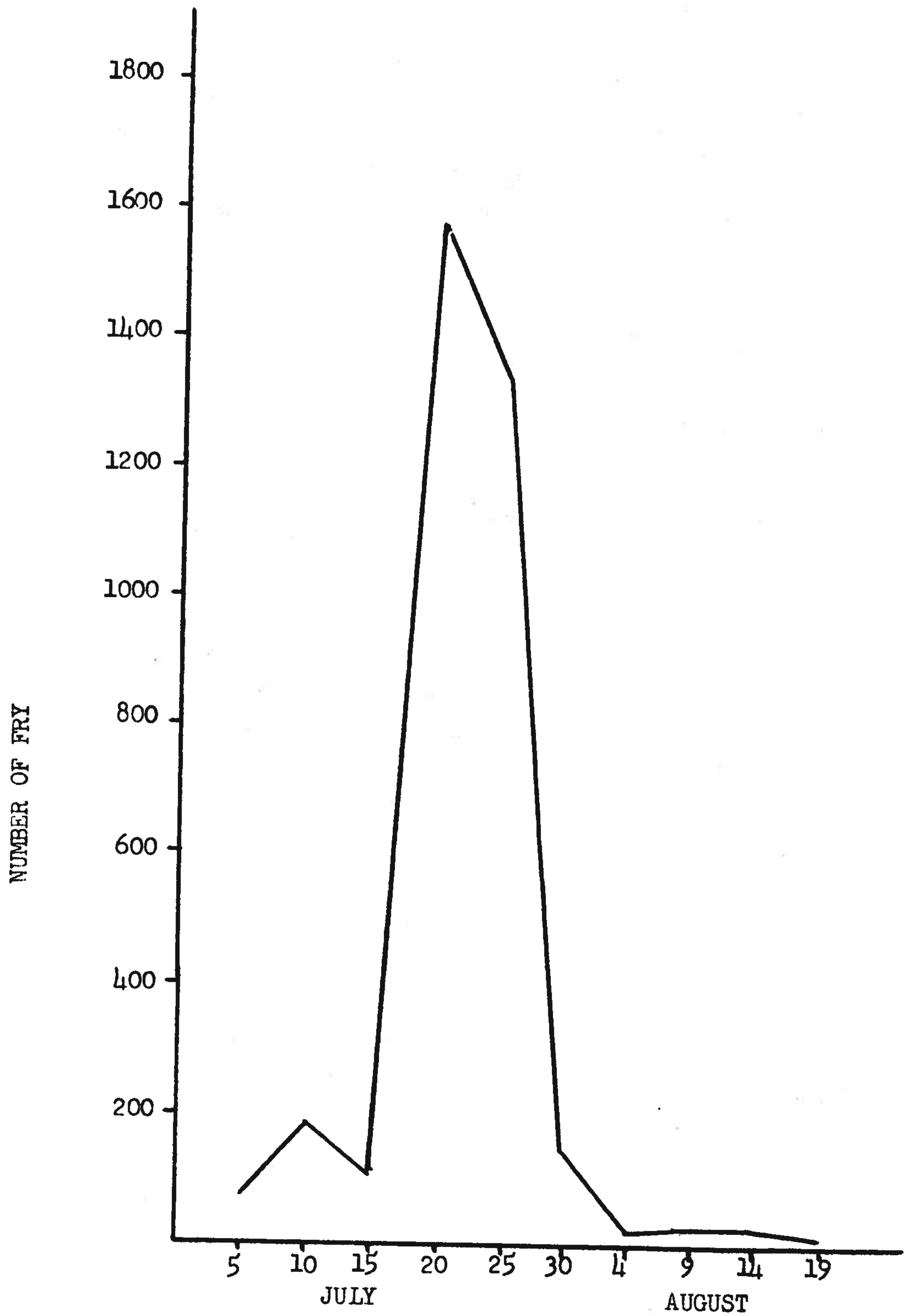


Figure 7. Five-day totals showing the numbers of fry which were passed through the downstream trap on Narrows Creek in 1970.

trout for natural stocking of Elk Lake was not realized, as the majority of young cutthroat did not reach the lake.

Although both grayling and cutthroat trout were known to have spawned in Narrows Creek, there was no attempt to distinguish between species when passing fry through the trap. Samples of fry were obtained on August 4 and 17 and September 2. On August 4, 2 of 6 fry were grayling (Table 12), as determined by the number of dorsal fin rays exceeding 15; the grayling ranged from 1.0-1.3 inches in total length. Cutthroat trout comprised the remainder of the fry and ranged from 0.9-1.5 inches. Five fry were obtained on August 17 and all were cutthroat trout (range 1.2-1.8 inches). The sample obtained from various sections of the stream in September was composed of 8 fry, all cutthroat trout, ranging from 1.3 to 2.1 inches. Although these were small samples, there is an indication that the grayling fry migrated to the lake prior to August 15. Nelson (1954) observed that grayling fry increased downstream migrations from Red Rock Creek and Antelope Creek spawning areas to Upper Red Rock Lake around early July in 1952.

The maximum temperature on July 1 was 54° F. and the minimum temperature, 42° F. Maximum temperatures from July 16 to July 30 ranged from 51° F. on July 23 to 70° F. on July 18, 22 and 28. Maximums were generally between 65° and 70° for this period which coincided with maximum fry migration (Figure 8). Minimum readings remained between 50° and 55° F. for the same period.

A reading of 82° F. occurred on August 5, but this may have been due to thermometer disturbance by children playing near the creek. Maximum readings of 76° F. occurred on August 10 and 11, but generally remained under 70° F. during the study period.

Table 12. Length of fry taken from Narrows Creek in 1970.

Date	Species	Number	Range (inches)
August 4, 1970	Grayling	2	1.0-1.3 (2.6-3.2 mm)
	Cutthroat	4	0.9-1.5 (2.3-3.6 mm)
August 17, 1970	Cutthroat	5	1.2-1.8 (3.3-4.5 mm)
September 2, 1970	Cutthroat	8	1.3-2.1 (3.4-5.4 mm)

Recommendations

Current information shows that few of the fry that emerge in Narrows Creek enter Elk Lake. Narrows Creek frequently dries up in late summer and has flowed underground near its mouth. The creek also freezes solid in winter months.

Either a dam or a pump installation will be necessary to maintain ample flows in Narrows Creek particularly in the latter part of the summer. It must be confirmed that monies are available for this type development before preliminary investigations begin.

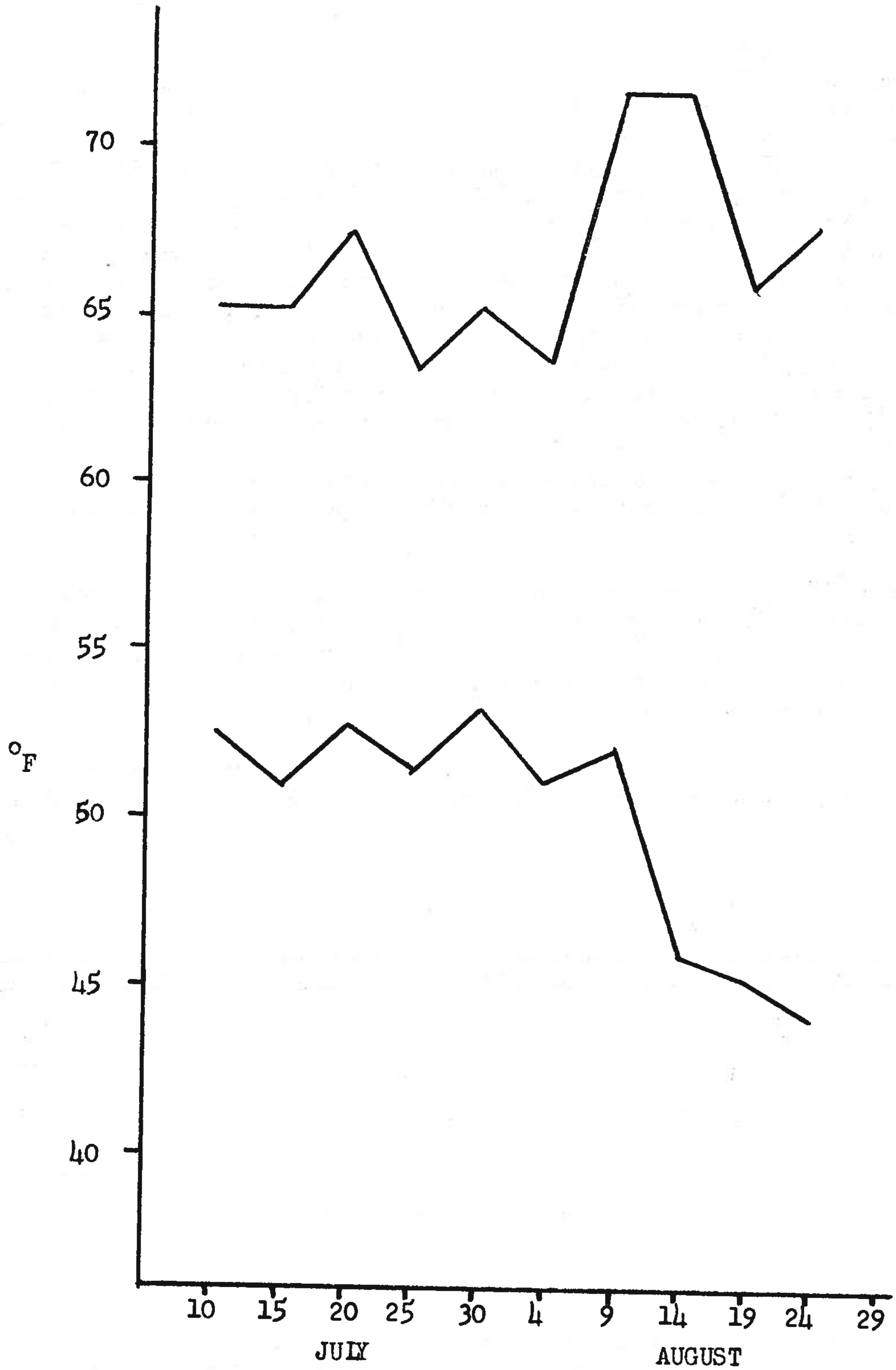


Figure 8. Five-day average maximum-minimum temperatures for Narrows Creek, 1970.

Prior to the dam or pump installation, we should be concerned with evaluating the potential production of Narrows Creek by evaluating fry numbers and speciation. We should also evaluate fry movement in the creek. Adults should be counted during the spawning season to determine numbers presently utilizing the stream. An evaluation of the hatchery cutthroat trout planted in Elk Lake should be made to be sure we have a genetic strain that should migrate to the lake. For example, a Yellowstone cutthroat that goes upstream in inlets to spawn and the fry return to the lake.

Netting combined with a creel-census survey should be carried out on Elk Lake to evaluate fisherman use, fisherman harvest, catch-rate, growth, and species composition. This should be carried out at least two years before dams, pumps and/or a spawning channel is developed for Narrows Creek. This would insure that we could evaluate results of these projects on the Elk Lake fishery.

If it appears Narrows Creek may provide enough fry (hoping that survival in the lake environment is adequate) to benefit the Elk Lake fishery then a dam could be built or a pump obtained to sustain flows and spawning channel development could begin.

Evaluation of the spawning channel development and increased or sustained flows would be by enumerating adult fish use of the spawning grounds. The number of fry in the creek would also be ascertained and the migrant fry would be enumerated using a fry trap and compared to pre-development levels.

The effect on the Elk Lake fishery would be evaluated by using a comparison of the creel census information prior to and following development on Narrows Creek. Extensive netting could also be used as an index. All trout planted in Elk Lake would be marked separately each year throughout the study to distinguish them from wild cutthroat trout.

This should be a cooperative venture with the U.S. Forest Service and Montana Fish and Game Department.

Narrows Creek should be fenced to prevent fish harassment during the spawning period. Fencing would also protect the bank vegetation, which has a direct effect on streambank stability and temperature regimes.

A thorough evaluation of the substrate, where cutthroat trout and grayling spawn, should be made to provide maximum knowledge of what materials should be used in the future spawning channel on Narrows Creek.

Limestone Creek, another tributary of Elk Lake, should be fenced, as a small number of fry were observed in the stream in August. Bank vegetation had been heavily used by cattle which had also severely disturbed the stream in several areas. This stream should be evaluated as to use by spawning fish from Elk Lake.

Other Stream Studies

Cataract Creek Mine Pollution Study

Several drainages were observed to have mines or tailings with acidic effluents during the survey on the Effects of Mining on Trout Streams (Wipperman, 1969, Elser and Marcoux, 1970). A highly acidic drainage was observed at the Crystal Mine which entered Uncle Sam Gulch, a small tributary of Cataract Creek (Figure 9) located near Basin, Montana (Elser and Marcoux, 1970).

Four aquatic insect sampling stations were established in 1970. Three were on Cataract Creek and one on Uncle Sam Gulch (Figure 9). Insects were sampled on June 22, August 3, and September 8, 1970. Six square foot samples using a Surber sampler were obtained at each station on all sampling dates. The pH (determined with a Hach DR-EL chemistry kit) at 8 stations (Figure 9) was determined on the insect sampling days and also on June 18.

The pH determinations were less than 6.0 at the Crystal Mine effluent (Station 5). An increase in the pH occurred on Uncle Sam Gulch (Station 7) prior to its confluence with Cataract Creek. For all sampling periods there was a decrease in the pH between station 4 and station 8 indicating Uncle Sam Gulch had a lowering effect on the pH of Cataract Creek (Table 13). In the September sampling period the reading at station 8 was lower than at station 7.

Table 13. Determinations of pH from stations on Cataract Creek and Uncle Sam Gulch during 1970

Station	Date			
	June 18	June 22	August 3	September 8
1	6.8	7.7	7.0	7.8
2	4.6	7.4	6.6	7.8
3	7.0	6.7	6.7	7.8
4	7.3	7.9	7.6	7.8
5	4.6	4.0*	2.8	3.4
6	4.9	4.3	3.3	4.0
7	6.7	7.2	6.8	7.0
8	6.9	7.4	6.8	6.4

*Below 4.0

Measurements at Station 2 were of an effluent from a tailings pile at the Eva Mae Mine. The pH was measured near the tailings on June 18 and was 4.6. Other determinations at this station were obtained in a swampy area as it entered Cataract Creek. There was a general drop in pH between Station 1 and 3 but it could not be explained by the Eva Mae tailing effluent. Total hardness determinations (Table 14) obtained on June 18 ranged from 20-35 on stations other than 2 and 5 where readings were 230 and 1200+, respectively.

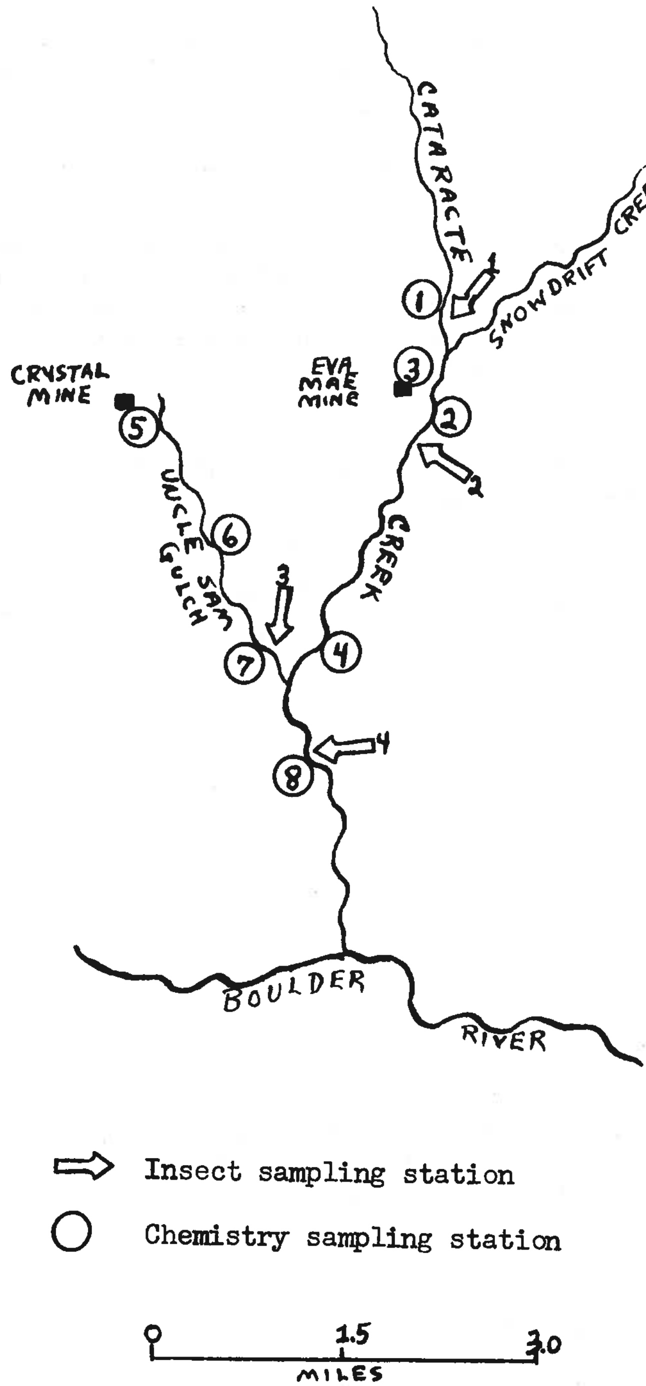


Figure 9. Map of insect and chemistry sampling station on Cataract Creek and Uncle Sam Gulch.

Table 14. Total hardness determinations for station 1-8 on Cataract Creek and Uncle Sam Gulch on June 18, 1970

Station	1	2	3	4	5	6	7	8
Total hardness	20	230	35	20	1200+	35	25	30

Aquatic insect sampling showed a variety of orders present in stations A and B (Table 15). There were no insects taken at stations C and D during the August 3 and September 8 sampling and only 10 Plecoptera were captured in June at Station D. It would appear then, that the effluent from the Crystal Mine was suppressing the aquatic insect population over 2.5 miles.

Table 15. Number of aquatic invertebrates from the Phylum Insecta and Annelida found in six square-foot samples

	Date											
	June 22				August 3				September 8			
Station	A	B	C	D	A	B	C	D	A	B	C	D
Phylum Insecta												
Order												
Plecoptera	20	14	0	10	19	25	0	0	43	8	0	0
Ephemeroptera	31	11	0	0	46	85	0	0	75	75	0	0
Trichopter	2	0	0	0	13	1	0	0	44	7	0	0
Diptera	0	0	0	0	0	0	0	0	8	0	0	0
Coleoptera	0	0	0	0	14	17	0	0	12	45	0	0
Misc.	0	0	0	0	0	0	0	0	4	2	0	0
Phylum Annelida	2	0	0	0	12	0	0	0	71	7	0	0
Total	55	25	0	10	104	128	0	0	257	144	0	0

Because of low conductivities electrofishing gear was not sufficient to obtain fish population estimates. A cutthroat population was observed visually above and below the Eva Mae Mine but no fish were observed in Uncle Sam Gulch or in Cataract Creek below the confluence with Uncle Sam Gulch for at least the first two miles.

Big Sheep Creek Fish Population Study

A 3200-foot section on Big Sheep Creek was electrofished in July, 1970. Brown trout comprised over 96 percent of the trout population with rainbow and rainbow-cutthroat hybrids accounting for the remainder. Only two trout taken were under 7.0

inches in length. Brown trout estimates are presented in two-inch size intervals in Table 16.

Table 16. Population estimate of brown trout from a 3200-foot section of Big Sheep Creek in July, 1970

Size interval (inches)	Population estimate	
	Number	Pounds
7.0 - 8.9	51	10
9.0 -10.9	72	30
11.0 -12.9	77	48
13.0 -14.9	96	96
15.0+	41	54
Total	337 ± 78* (106)**	238 (74)**

* Total ± 2 standard deviations. This equals 95% confidence interval.
** Number and pounds per 1000 feet in parenthesis

Armstrong Spring Creek Evaluation of Fishing Regulations

Armstrong - O'Haire Spring Creek is a small spring-fed tributary to the Yellowstone River, rising approximately 10 miles south of Livingston. The creek, fed by one large spectacular spring and many smaller ones, has a constant flow and temperature, is rich in aquatic vegetation and insect life. Nationally known anglers who delight with the challenge of very small flies and sparkling clear water have long prowled the banks of Spring Creek. When owners of similar waters nearby began leasing hunting and fishing rights to private individuals, it appeared that this water would also be lost to public fishing. However, the Yellowstone River Chapter of Trout Unlimited negotiated for and leased the fishing rights on the stream to preserve public fishing. Fishing has been restricted to flies only, with a two fish limit imposed as an agreement of trespass. Funds for the $6,000 annual cost have been contributed by conservation-minded business concerns and individual fishermen.

A portion of the stream was sampled as a means of evaluating the restrictions placed on the stream by Trout Unlimited. The section was 2,100 feet in length, and had an average width of 63 feet (delineated from S.C.S. aerial photos taken in 1965, with a scale of 1 inch = 660 feet). The fish population estimates for age class I and older fish are shown in Table 17. Brown trout were predominate, making up 85.4 percent of the total number. Yellowstone cutthroat and mountain whitefish were present in small numbers, but were not included in the population estimate. Age classes I and II contributed 44.2 and 41.7 percent, respectively, of the total brown trout population, indicating good age structure. For rainbow trout, however, age class II predominated, making up 46.4 percent of the total rainbow number. Total standing crop for the section was 1,135 fish and 551 pounds per 1,000 feet of stream and 785 fish and 381 pounds per surface acre.

Sampling, spring and fall, should be continued to evaluate the effects of restrictive regulations on a good trout population. At the time of sampling, the fish appeared to be in a poor condition, which may suggest over-crowding. Along with population estimates, the stream lends itself well to a partial creel census in conjunction with a voluntary type creel census. Information relative to fisherman harvest and pressure would be beneficial in relation to mortality rates.

Table 17. Estimated fish populations from Armstrong Spring Creek, August, 1970, expressed as a number and pounds per 1,000 feet of stream

	Brown trout		Rainbow trout	
Age group	Number	Pounds	Number	Pounds
I	428	87	39	8
II	404	200	77	36
III	114	115	39	44
IV+	23	39	11	22
Totals	969±142*	441	166±42*	110

Total ± 2 standard deviations. This equals 95% confidence interval.

Shields River Fish Population Study

Several sections of the Shields River have been electrofished in the past with resulting population estimates suggesting that recruitment was sub-normal. A section sampled near Wilsall in 1967 revealed a predominately brown trout population (89.5 percent), with age III fish comprising over 50 percent of the total number with yearlings and two-year-olds adding only 11.6 and 5.1 percent, respectively (Wipperman and Elser, 1968). An estimate of mountain whitefish population parameters for the following year indicated a similar trend, with age III whitefish dominating the population (36.2 percent). Yearlings and two-year-olds added 21.6 and 14.8 percent, respectively (Elser, 1969). The Shields River, a tributary to the Yellowstone River, has many problems not uncommon to other trout streams in the area. Channel alterations and eroding banks are common, water demands for irrigation are high, leaving the stream severely dewatered in late summer, and high silt loads are carried in the early spring.

Peters (1965) demonstrated that the amount of sediment passing a given area of stream can adversely affect trout embryo survival, hence eyed Yellowstone cutthroat trout eggs were utilized to evaluate the effects of sedimentation on the salmonoid population of the Shields River.

Six stations were established along the Shields from its confluence with the Yellowstone, to approximately 2 miles upstream from Wilsall (31 river miles). Turbidity was measured at approximately 10 day intervals. Following the period of time necessary for the eggs to complete hatching, as determined from the water temperatures, the artificial redds were dug up, and the number of eggs remaining were counted and mortality rates determined (Table 18).

Table 18. Mortality rates of eyed Yellowstone cutthroat trout eggs planted in the Shields River

Station	Location (River miles above the mouth)	Max. turbidity (J.T.U.)*	Mortality (percent)
1	0.5	340	88.0
2	4.0	300	15.5
3	9.0	270	24.7
4	18.0	235	63.3
5	24.4	250	39.3
6	31.0	80	14.3

*Jackson Turbidity Units

Greatest mortality occurred at the station with the highest turbidity reading (Station 1), while the lowest mortality occurred at the location with least turbidity (Station 6). However, between those two stations, no correlation was evident. This could have been the result of poor techniques in redd construction. The results suggest that the amount of turbidity could be related to hatching success in the Shields River.

A section of the upper Shields River was re-sampled to further establish parameters for a wild Yellowstone cutthroat trout population. The section was located aoproximately 20 miles northwest of Wilsall (T5N, R10E, S.24) and was 1,500 feet in length. The average width of the section was 16 feet, with a pool - riffle periodically of 6.9 times the average width (a pool every 111 feet). Cover, including overhanging brush, undercut banks and debris was measured, revealing a total of 528 square feet of usable trout cover per 1,000 feet of stream.

The section supported a total of 221 wild Yellowstone cutthroat trout per 1,000 feet of stream in 1969, and 219 in 1970 (Table 19). Young-of-the-year and yearling fish made up nearly 80 percent of the total population in 1969 and over 90 percent in 1970. Mortality rates for 1969-1970 are as follows: 0-I, 41.3 percent; I-II, 71.0 percent and II-III+, 86.7 percent, indicating a relatively high turn over rate for the cutthroat trout in this section. Total mortality was 61.5 percent.

Table 19. Estimated numbers of Yellowstone cutthroat trout from 1,500 feet of the Shields River, expressed as numbers and pounds per 1,000 feet of stream

Age group	1969 Number	1969 Weight	1970 Number	1970 Weight
0	104	3	134	5
I	69	5	61	9
II	30	8	20	10
III+	18	17	4	4
Total	221 ± 69*	33	219 ± 82*	28

*Total ± 2 standard deviations. This equals 95 percent confidence interval.

Thermograph stations were established in the Shields River to monitor summer temperatures during the low flow period; station 1 was located at the Convict's Grade Bridge, 0.5 mile above the mouth of the river, and station 2 was in the U. S. G. S. Gage House at Clyde Park, 13.4 miles above the mouth. The five-day average maximum temperatures for the two stations are shown in Figure 10. The highest temperature recorded at both stations was 68.5° in early August.

Yellowstone River Fish Population Study

The upper Yellowstone River, one of Montana's finest "blue ribbon trout streams, is constantly being viewed for possible water development projects. From the Bureau of Reclamation's Allenspur Dam site to the more recent threat of Montana Power's steam generating plant, the resource is in danger. A segment of the Yellowstone, 4.2 miles in length, was sampled in April and October, to evaluate the fish population prior to any development. The section ran from the East River Road Bridge to the 9th Street Island bridge in Livingston. The Allenspur Dam site bisected the section. Multiple mark-and-recapture electrofishing runs were necessary to capture enough fish for a reliable estimate.

Table 20. Estimated fish populations from the Yellowstone River, April and October, 1970, expressed as numbers per 1,000 feet of stream. (Pounds per 1,000 feet are shown in parentheses).

Age group	Rainbow trout Spring	Rainbow trout Fall	Brown trout Spring	Brown trout Fall
I		152 (36)		91 (23)
II	142 (62)	199 (123)	103 (33)	85 (61)
III	63 (67)	107 (111)	41 (37)	53 (71)
IV+	20 (36)	24 (46)	17 (30)	24 (51)
Total	225 (165)	482 (316)	161 (100)	253 (206)
Two std. dev.	± 81*	±255	±65	±73

*This equals 95% confidence interval.

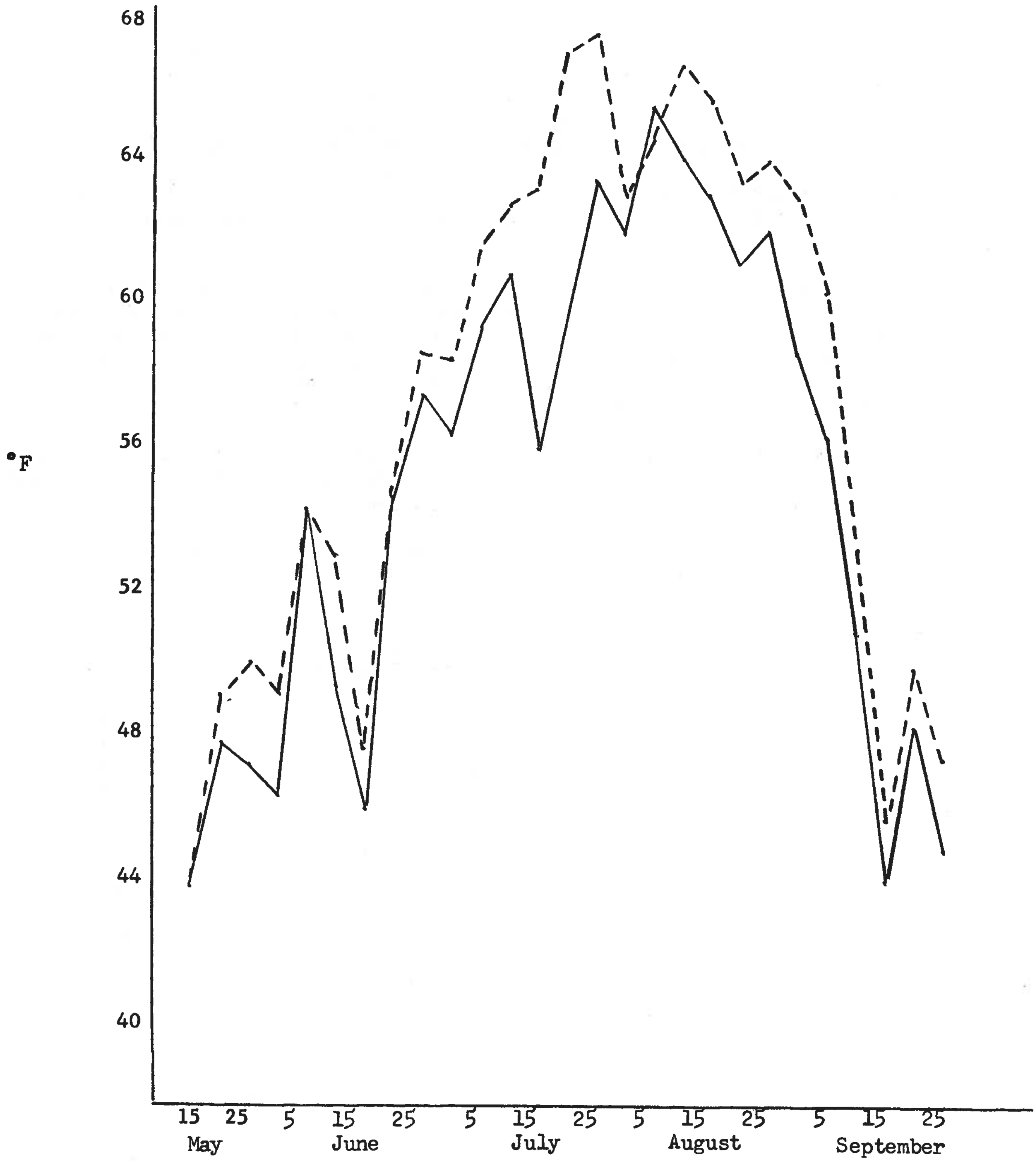


Figure 10. Five - day average maximum water temperatures for the Shields River at Stations 1 (solid line) and 2 (broken line), 1970.

Population estimates for the Yellowstone, spring and fall, are shown in Table 20. The section supported a total of 386 wild rainbow and brown trout (II's and older) per 1,000 feet of stream in the spring and 735 (I's and older) per 1,000 feet in the fall. Weights for the two sampling periods were 265 and 522 pounds per 1,000 feet, respectively. Rainbow trout predominated numerically, making up 66.5 percent in the spring and 65.6 percent in the fall. By weight, rainbows comprised 62.3 percent and 60.5 percent of the total for spring and fall, respectively. Yellowstone cutthroat trout were present in small numbers, but were not included in the estimate.

The Yellowstone River ranks as one of Montana's top wild trout fisheries when compared to our other "Blue Ribbon Streams." Estimates for the Big Hole River near Melrose in the fall indicated a total standing crop of 121 wild trout (I's and older) with a total weight of 153 pounds per 1,000 (Elser and Marcoux, 1970). Vincent (1970), reported the Norris section of the Madison River (spring sample) as having 448 wild trout and 318 pounds per 1,000 feet.

A total of 984 wild trout (496 rainbow, 443 brown, 45 cutthroat) were tagged with numbered Floy T-tags during the spring sampling period. For the period April through October, 53 tags (5.4 percent) were returned by anglers. Percentage returns for rainbow, brown and cutthroat were: 6.6, 3.4, and 11.1 percent, respectively. Even assuming only a small percentage of tags were returned by fishermen, the harvest was not great. Less than 6 percent (3) of the tag returns indicated movement from the section where the fish were tagged.

Sampling and tagging of our important trout fisheries like the Yellowstone should be continued so information will be available when water development projects are proposed.

Lake Studies

Hyalite Reservoir

Hyalite Reservoir is located approximately 15 miles south of Bozeman. This 223 acre lake is located on Hyalite Creek (Middle Creek), and is a portion of the Bozeman City Water supply system. The reservoir is formed by an earthfill dam completed in 1951. The lake supports a wild arctic grayling and cutthroat trout population in addition to an annual plant of 10,000 fingerling Yellowstone cutthroat trout. Because of its close proximity to Bozeman, good access and esthetic values, Hyalite Lake is heavily fished.

Four 125-foot experimental gill nets were fished overnight in June, 1970. All nets were set on the bottom. The total catch is shown in Table 21 and compared with the catch of similar net sets in 1962. The average length and weight of the cutthroat trout catch in 1970 was similar to that in 1962, while the catch of grayling was reduced.

Less than 1.5 percent (2) of the cutthroat trout taken in the nets were obviously of hatchery origin (eroded fins). The annual plant of cutthroat in this reservoir should be fin-clipped to evaluate survivability and return to the creel. Since the majority of the cutthroat taken in the nets were wild fish, this plant might be reduced or dropped.

Table 21. Summary of four gill-net sets in Hyalite Lake, 1970; compared with four similar sets in 1962

Species	Number	Size range (inches)	Average length (in.)	Average weight (lbs)	Percent total
	1970				
Cutthroat trout	100	6.2-19.8	11.3	0.62	66.7
Arctic grayling	43	12.9-16.7	14.3	1.01	28.7
Brook trout	4	9.2- 9.6	9.5	0.35	2.6
Rainbow trout	3	12.6-13.0	12.8	0.69	2.0
Total	150				
	1962				
Cutthroat trout	110	6.4-17.2	10.8	0.61	87.4
Arctic grayling	13	13.8-16.2	15.3	1.32	10.3
Rainbow trout	3	7.1-12.7	10.8	0.53	2.3
Total	126				

Mystic Lake

This lake is located on Sourdough Creek, approximately 12 miles south of Bozeman and is 70 surface acres in size. Mystic Lake is also a portion of the Bozeman City Water supply system. Prior to the 1970 fishing season, the closure was removed and the watershed was opened to non-vehicle travel. Since the lake is close to Bozeman, and is situated in a wilderness type setting, it was anticipated that fishermen use would be moderately heavy.

Three 125 foot experimental gill nets were set overnight in the lake in June, 1970. Although the total catch was small (21 fish), the species composition was surprising. Cutthroat x rainbow hybrids dominated the catch, making up 47.6 percent (10) of the total catch. Lake trout were 33.3 percent (7) of the total catch, with rainbow, cutthroat and brook trout making up the remainder.

No record of lake trout being introduced into the lake was found. The "lakers" ranged in total length from 11.1 to 31.2 inches. Weight of the largest fish was estimated to be in excess of 15 pounds. Examination of scale samples taken from the lake trout indicated ages ranging from 4 to 8 years, thus these fish are apparently successfully reproducing in the lake.

Additional sampling should be conducted in Mystic Lake to evaluate the status of the lake trout in this body of water. A partial creel census should be conducted to monitor fishing pressure and its effect on the lake.

General Lake Surveys

Several lakes were surveyed in 1970 and the results presented in Table 22.

Table 22. Summary of gill net and seine catch data from lake surveys in 1970

Lake (Code number)	Number of net sets	Percent game fish in catch	Species caught (number in parentheses)		Size range (inches)	Average size (inches)
Bond Lake (02-7475)	0 (2)*	100	RbxCt	(1)	7.4	7.4
			Eb	(12)	2.8- 7.8	5.6
Boot Lake (02-7500)	1	15	Ct	(3)	8.2-14.8	11.1
			FSu	(17)	7.4-16.7	13.0
Delmoe Lake (10-8600)	3	7.9	RbxCt	(34)	6.0-16.9	11.1
			Ct	(1)	7.5	7.5
			FSu	(421)	6.9-13.0	10.5
			RSS	(17)	5.5-6.3	6.0
	(3)*	Trace	Ct	(2)	6.4-6.6	6.5
			Eb	(2)	2.2-3.1	2.7
			FSu	(100)	3.7-11.0	7.5
			RSS	(1337)	--	---
Lima Reservoir (01-9040)	3	0	CSu	(287)	9.9-17.4	14.7
Schultz Pond (01-9480)	1	100	Rb	(4)	13.4-24.0	18.0
Mussigbrod Lake (02-8625)	2	10	Gr	(4)	6.8-11.5	9.1
			Eb	(3)	10.3-14.4	12.6
			Ling	(2)	13.4-16.1	14.7
			FSu	(62)	6.3-15.3	11.1
Pear Lake (02-8725)	2	67	Ct	(10)	7.3-17.8	9.8
			FSu	(5)	7.3-13.8	11.2
Twin Lakes (02-9425)	2	79	Ling	(7)	11.9-15.2	13.4
			Lt	(2)	15.6-16.0	15.8
			Eb	(22)	6.2-14.3	9.8
			Rb	(3)	14.6-19.7	17.5

*Number of seine hauls

Bond Lake - This lake becomes virtually dry during summer months due to irrigation demands. An effort should be made to repair the dam and obtain a permanent recreational pool.

Boot Lake - Only one gill net was used to determine the presence of game fish. Cutthroat trout were found.

Delmoe Lake - An unauthorized introduction of the redside shiner was detected in 1966. Many shiners were taken in 1970 with the majority of shiners taken by seining. Because of the large number of suckers and shiners, low percentage of game fish in the lake and close proximity to Butte, this reservoir should be considered for rehabilitation in the near future.

Lima Reservoir - Only largescale suckers were captured in this reservoir. An evaluation of the thermal and oxygen stratification should be made during summer months to evaluate the possibility of planting this reservoir.

Schultz Pond - This lake was surveyed to determine whether or not natural reproduction was occurring. Although only four rainbow were captured, there was a wide range in sizes indicating more than one year class. A wooden structure, possibly a potential barrier, exists near the springs where trout spawn.

Mussigbrod Lake - This lake was surveyed to determine the status of the grayling population. This lake is also used for irrigation and the thermal properties should be evaluated in the summer months.

Pear Lake - The survey showed an excellent cutthroat population.

Twin Lakes - Lake trout are found in Twin Lakes and although they do not provide the major fisheries, lake trout over 10 pounds are reported harvested annually. In 1964, several (6 of 10) lake trout captured were over 22.0 inches while in 1970, only 2 ranging to 16.0 inches were taken. More intensive sampling and a creel census should be initiated to more fully evaluate the status of lake trout in Twin Lakes.

RECOMMENDATIONS

Stream and lake inventories should be continued, with particular emphasis placed on larger trout streams such as the Yellowstone and Big Hole Rivers. Information obtained from the surveys is important for dealing with land and water development projects and is a basis for management of the sport fishery.

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<u>Waters referred to:</u>

Big Hole River Sec. 1	02-0425
Big Sheep Creek	01-6740
Blacktail Creek	01-0720
Long Creek	01-4570
Narrows Creek	01-5210
Ruby River Sec. 2	01-6380
Uncle Sam Gulch	10-7600
Bond Lake	02-7475
Boot Lake	02-7500
Delmoe Lake	10-8600
Lima Reservoir	01-9040
Schultz Pond	01-9480
Mussigbrod Lake	02-8625
Pear Lake	02-8725
Twin Lakes	02-9425
Armstrong Spring Creek	22-0140
Shields River Sec. 1	22-5334
Shields River, Sec. 3	22-5362
Yellowstone River, Sec. 8	22-7070
Hyalite Reservoir	09-8512
Mystic Lake	09-9082