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REPORT ON 1958 FISHERY STUDIES BY THE
BUREAU OF SPORT FISHERIES AND WILDLIFE ON
ROCKY MOUNTAIN NATIONAL PARK

by

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INTRODUCTION

Fishery biologists of the Rocky Mountain Sport Fishery Investigations began a study in 1957 to determine the status and distribution of the green-back trout, Salmo clarki stomias, in Rocky Mountain National Park (Bulkley, 1957). The objectives of the 1957 work were threefold:

1. To secure specimens of fish so that positive identification could be made;
2. To secure live specimens to serve as brood stock for cultural and study purposes;
3. To appraise stream and lake habitat with a view toward establishment of sanctuaries in Rocky Mountain Park.

The investigation was expanded in 1958 to obtain more detailed information on the fishery through a creel census on the east side of the park, and to obtain data on the life history of the Forest Canyon cutthroat, which is presumably the green-back trout.

The stream and lake survey was continued with emphasis also on the east side of the Continental Divide. A fish trap was installed in upper Big Thompson River in Forest Canyon, and the biology of the cutthroat in that stream was studied. Plans for eradicating fish in the Fay Lake drainage to provide an area for planting green-back trout were carried out. The results of the 1958 work are included in this report.

ACKNOWLEDGMENTS

Personnel from several Government agencies and private organizations assisted during the course of the 1958 work. Special appreciation is expressed to Superintendent James V. Lloyd of Rocky Mountain National Park, and his staff, for invaluable help, both in actual assistance and encouragement. Steve Mindock, Park Ranger, assisted in collecting creel census data, and the following National Park Service personnel assisted in the eradication project: Richard H. Boyer, G. Earl Steele, Foster Freeman, and Robert Weldon.

Mr. Wayne Seaman, Dr. Howard Tanner, and Mr. James T. Morgan of the Colorado Department of Game and Fish provided much assistance and the use of their facilities and equipment.

The help of Messrs. Frank McGraw, Bill Robinson, and Kermit Pierce made the semivolunteer creel census possible. Assistance by Mr. Thomas French, Superintendent of the U. S. Fish-Cultural Station, Leadville, Colorado, is also greatly appreciated.

Dr. Oliver B. Cope, Chief, Rocky Mountain Sport Fishery Investigations, supervised the project and provided much technical advice and assistance.

CREEL CENSUS

In 1958 two types of creel census were conducted. An intensive census was carried out on the Fall River and Big Thompson drainages within Rocky Mountain National Park, and a semivolunteer creel census was conducted in the North Fork of the Big Thompson River, Lawn Lake, and Wild Basin areas.

The intensive census was similar to the one conducted on the Madison River in Yellowstone Park (Benson, et al., 1958). During each two-week period there were eight fisherman count days and six fisherman interview days. Census days were picked at random during each period, with the restriction that one weekend day in each week was always included. The clerk worked on Saturday one weekend and Sunday the next, the first weekend day in the season being picked at random. As fishing pressure was highest on weekends, weekends and holidays were treated separately from weekdays in deriving estimates of harvest and fishing intensity.

The fisherman count was carried out by driving slowly from the Fall River entrance to Endovalley Campground, to Moraine Park, to the Fern Lake parking lot, to the Thompson Entrance, and then to Bear Lake. Hence, Fall River, Big Thompson River, Mill Creek, Glacier Creek, and Bear Lake were sampled (figure 1). The clerk stopped as often as necessary to obtain a count of fishermen on each stream and on Bear Lake. Speed was gauged so that one trip took two hours; four trips comprised the census day. Direction of travel was alternated to remove possible bias from starting at the same point each time.

For the fisherman interviews the clerk drove over the census route, interviewing as many fishermen as possible each census day. Fishermen were questioned regarding length of fishing time, catch, and number in the fishing party. Daily starting time varied for both the fisherman counts and interviews so that all hours in the fishing day were adequately covered during each two-week period.

For the semivolunteer census, wranglers at the McGraw Ranch, Fall River Lodge, and the Triangle U Livery recorded data on all fishing parties they transported into Rocky Mountain National Park. The Park Ranger at Wild Basin recorded all fishing data he obtained as he checked fishing licenses and creel limits. Further data were obtained by the stream survey crew as they encountered fishermen in the various areas. An estimate of the mean catch per hour and species composition of the catch in these areas was thus obtained. As each recorder knew approximately what percent of the total fishing pressure he was sampling, rough estimates of harvest were also possible. The harvest estimates are only indicative, however, because of the crude nature of this census.

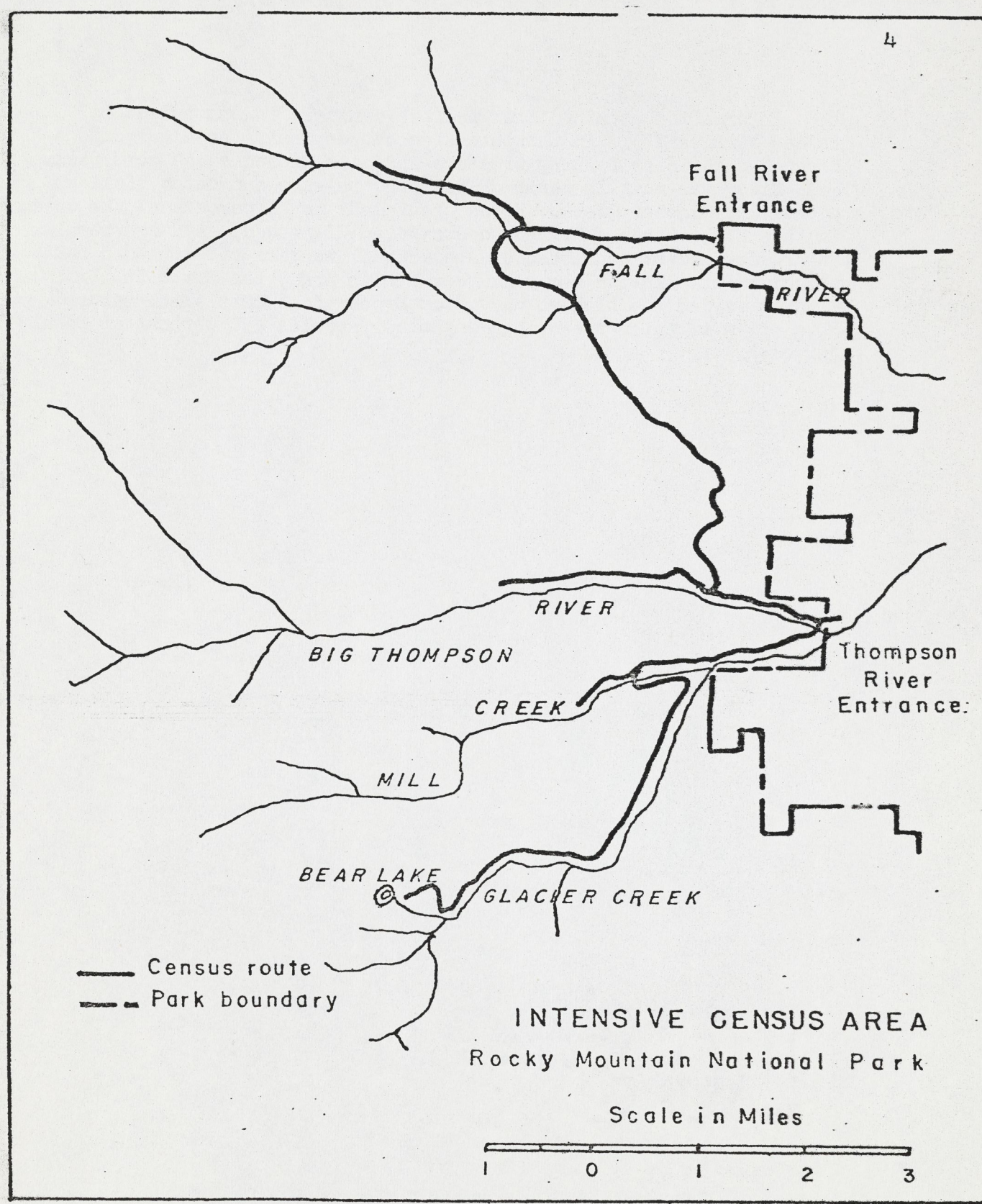


Figure 1. Location of intensive creel census conducted in Rocky Mountain Park, 1958.

Information obtained from the two censuses is summarized in tables 1, 2, and 3. In the intensive census area, the Big Thompson River had the most fishing pressure and also produced the most fish. Fall River was next in terms of fishing pressure and catch, followed closely by Glacier Creek. Brook trout made up 71 percent of the catch in this census area. Rainbow contributed 22 percent, and the remaining seven percent consisted of about equal numbers of brown and cutthroat trout. In the semivolunteer census area, the North St. Vrain River provided the biggest harvest. Brook trout were also captured more often in this stream than any other species (50 percent of total harvest).

Table 1. Estimated fishing pressure and harvest from intensive creel census area, 1958.

Area	Total fisherman hours	Mean catch per hour	Harvest				Total
			Rainbow	Brook	Brown	Cutthroat	
Big Thompson River	8,924	0.6650	952	4,567	287	129	5,935
Fall River	8,453	0.6274	1,152	3,926	200	26	5,304
Glacier Creek	8,039	0.5382	1,341	2,525	66	395	4,327
Bear Lake	3,728	0.1585	114	477	--	--	591
Mill Creek	322	0.1646	0	53	0	0	53
Totals	29,466		3,559	11,548	553	550	16,210

Table 2. Mean lengths and age frequencies of catch in intensive creel census area, 1958.

Area and species	Mean total length in inches	Number of fish in each age group				
		I	II	III	IV	V
Big Thompson River						
Rainbow	8.01	27	0	1		
Brown	9.45	0	5	13		
Cutthroat	6.66	0	0	11	1	
Brook	7.04	2	52	10		
Fall River						
Rainbow	6.74	54	0	0		
Brown	7.78	0	16	0		
Cutthroat	6.00	3	0	3		
Brook	6.98	2	57	16	2	1
Glacier Creek						
Rainbow	7.58	43	0	0		
Brown	8.50	0	1	0		
Cutthroat	10.20	0	0	0	1	
Brook	6.63	0	26	5		
Bear Lake						
Rainbow	9.20	0	0	10		
Brook	8.99	0	2	12		

Table 3. Creel census estimates obtained from the 1958 semivolunteer creel census.

Area	Mean catch per hour, all species	Estimates harvest				
		Rainbow	Brown	Brook	Cutthroat	Total
North St. Vrain River	1.03	460	480	1,315	395	2,650
Sandbeach Lake	1.19	940	0	0	10	950
Hunter Creek	1.14	5	0	5	465	475
Ouzel Lake	2.00	0	0	475	0	475
Box Lake	2.13					
Pear Lake	0.44	31	0	0	219	250
Thunder Lake	1.40	35	0	23	180	238
Eagle Lake	1.54	0	0	25	63	93
Gourd Lake	0.556					
Upper West Creek	3.71	0	0	122	60	182
Husted Lake	3.77	0	0	294	0	294
Cow Creek	9.42	2	2	845	0	849
Lawn Lake	1.15	104	0	1,378	104	1,586
Crystal Lake	0.13					
Ypsilon Lake	0.06					
Fern Lake	0.85					
Haiyaha Lake	0.03					
Roaring River	2.50					

FISH POPULATIONS

Population estimates

To supplement the creel census data, a shocking crew operated on Fall River and Big Thompson River during late August and early September to obtain an estimate of the trout population remaining in the two streams. Most of the fishing pressure occurred prior to Labor Day (September 1), so the estimates obtained should approximate the number of fish left at the end of the fishing season.

Population estimates were obtained by shocking the same stream area on two different days. On the first day all fish captured were measured, marked by clipping the dorsal fin, and then released. On the second day the number and lengths of marked and unmarked fish were recorded. Only a relatively small number of fish were recovered, so it was necessary to base some of the final estimates on the assumption that about ten percent of the population was sampled. The ten-percent figure was estimated from observation of the large number of fish seen escaping from the electrodes into the deep holes.

On Fall River two areas (2,000 feet total length) were sampled; the total number of fish captured was 370 brook trout, 25 rainbow, 11 brown, and 122 suckers. On Big Thompson River one sample area (500 feet) produced 81 brook trout, 6 rainbows, and 46 suckers. No cut-throat were taken from either stream by the shocking crew.

The mean total lengths of all fish above two inches taken from Fall River were: brook, 4.94 inches; rainbow, 6.26 inches; brown, 8.05 inches; suckers, 7.34 inches. For the Big Thompson River mean total lengths were: brook, 5.24 inches; rainbow, 7.17 inches; and sucker, 7.30 inches.

Numerous young-of-the-year brook trout approximately two inches in length were recovered. No young of either rainbow or brown trout were observed, which would indicate that reproduction by these two species was limited during 1958. The size range of both the rainbows and browns was narrow.

Estimates of the total population of adult fish, six inches in length and larger, were made from the collected data (table 4). The estimates indicate that for the areas sampled a substantial number of adult fish remained in the streams at the end of the fishing season. Further and more intensive shocking should be carried out in 1959 to obtain estimates which are statistically sound.

Scales of fish collected from the creel census and by shocking were used to determine growth rates of each species present (table 5). Back calculations of growth were made by direct proportion. As many of the rainbow and brown trout^{1/} were assumed to be hatchery fish, any growth comparisons between species is difficult. However, some

^{1/} The introduction of brown trout is not recorded in planting records, but the species exists in the three streams. Age frequency of this species in the catch and the failure to find young-of-the-year brown trout in the stream indicates that they may have been planted in recent years.

Table 4. Estimated population of trout six inches in length and larger remaining in three areas on September 2, 1958.

Area	Species	Estimated population per 100 yards of stream
Fall River, 1/4 mile above Roaring River junction	Brook	38
	Rainbow	3
	Brown	<u>1</u>
		42
Fall River, 1/4 mile below bridge	Brook	45
	Rainbow	8
	Brown	<u>19</u>
		72
Big Thompson, 1/4 mile below Fern Lake parking lot	Brook	48
	Rainbow	18
	Brown	<u>0</u>
		66

Table 5. Calculated total lengths and growth increments, in inches,
of trout from Rocky Mountain National Park.

Area and species	Number of fish	Calculated lengths					Increments of growth				
		I	II	III	IV	V	I	II	III	IV	V
Fall River											
Rainbow ^{1/}	54	5.10					5.10				
Brown	17	2.90	7.45	10.75			2.90	4.55	5.07		
Cutthroat ^{2/}	3	--	3.38	4.93			--	3.38	1.55		
Brook	52	3.02	5.58	7.79	9.32	10.83	3.02	1.81	1.97	1.37	1.41
Big Thompson River											
Rainbow ^{1/}	30	6.53	7.74	11.03			6.53	2.81	3.29		
Brown	18	3.42	6.26	9.01			3.42	2.84	2.83		
Cutthroat ^{2/}	12	--	3.38	6.23	7.43		--	3.38	2.85	2.18	
Brook	44	3.06	5.71	7.91			3.06	2.66	2.17		
Glacier Creek											
Rainbow ^{1/}	43	6.98					6.98				
Brown	1	4.68	7.65				4.68	2.97			
Cutthroat ^{2/}	1	--	2.98	5.95	8.93		--	2.98	2.97	2.98	
Brook	31	3.14	5.53	7.95			3.14	2.39	1.76		
Bear Lake											
Rainbow ^{1/}	10	2.72	5.26	8.29			2.72	2.54	3.03		
Brook	14	3.72	6.35	8.26			3.72	2.63	2.02		

^{1/} Comparison of scales with scales from hatchery fish indicated that most of these were hatchery fish.

^{2/} Cutthroat were aged on the assumption that first year annulus was missing from all scales as found in Forest Canyon cutthroat. Hence, some error may exist in these readings.

differences were quite evident. Rainbow trout appeared to grow faster in Glacier Creek and Big Thompson River than in the other areas. Brook trout grew at about the same rate in the three streams, but slightly faster in Bear Lake. In general, the rainbow and brown trout were growing as fast or faster in the streams than the other two species. Hence, if they were planted fish, they were competing satisfactorily with the wild stock.

Return of stocked fish

Scales from all rainbow in the catch were compared with scales of trout from the Denver Hatchery, source of fish planted in 1957 in Rocky Mountain National Park. Scales of the hatchery fish had evenly spaced, distinctive circuli near the focus. This growth pattern was found on most of the rainbow scales from the three streams. A growth check near the center of the scales was assumed to be a planting check. Length of the fish when this check was formed was calculated as 3.12 inches. The fish were two and one-half to four inches in length when planted, so this assumption is probably correct. Failure of the shocking crew to find any young-of-the-year rainbow in Fall River and Big Thompson River supported the conclusion that most of the stream rainbows were hatchery fish. Scales of rainbow trout from Bear Lake had the characteristic hatchery center, but had three growth checks. Hence, they were obviously from the 1955 planting, as no rainbow reproduction occurs in Bear Lake. Assuming that all rainbow trout from Bear Lake and all Age Class I rainbows from the three streams were planted fish, 1958 returns were calculated (table 6).

Table 6. Recovery in 1958 of rainbow trout stocked in four waters at Rocky Mountain National Park.

Area	Date of plantings	Size of plantings ^{1/}	Harvest of planted fish in 1958	Percent of plant	Percent of 1958 harvest in each area
Fall River	1957	40,000 ^{2/}	1,152	2.88	21.72
Big Thompson River	1957	5,500	920	16.73	15.50
Glacier Creek	1957	7,700	1,341	17.41	16.68
Bear Lake	1955	2,700	114	4.22	18.60

^{1/} All fish were 2½ to 4 inches in length when planted.

^{2/} Only fish planted in creel census area are included; 20,000 fingerlings planted above Chasm Falls are not included.

The population estimates obtained from shocking indicated that a number of rainbow trout remained in the streams at the end of the season. Also, the rainbow in Fall River were not large enough to enter the fishery until late in the season. Hence, any conclusions about the success of fingerling plantings in these areas should await the 1959 creel census returns. Effort should be made also in 1959 to determine if rainbow are reproducing in the streams, or if the present population is mostly planted fish, as indicated by the scales.

STREAM AND LAKE SURVEY

The general survey of park waters commenced in 1957 was continued. A total of 17 lakes and six streams, mostly east of the Continental Divide, were examined in 1958. General information obtained by the survey party is summarized in tables 7 and 8, and maps showing bottom contours of the lakes are presented in the appendix. Comments on the lakes are given below:

Crystal Lake

Cutthroat trout taken from Crystal Lake during 1958 averaged 13.0 inches in total length; rainbow trout, probably part of the 1955 planting, averaged 9.9 inches in length. Great numbers of copepods of the genus Diaptomus were observed in the lake, but were not found in fish stomachs examined. The last recorded planting of cutthroat trout was in 1944. All of the cutthroat collected belonged to Age Class IV, so a later planting may not have been recorded.

Little Crystal Lake

A large population of rainbow trout and a few mature cutthroat were present in Little Crystal Lake. Eight captured rainbows averaged 9.0 inches in length; these were probably part of the 1955 planting.

Lawn Lake

Brook trout reproduction still appears adequate in Lawn Lake. Mean length of brook trout examined was 9.0 inches; a single cutthroat measured 9.6 inches. The partial draining of the reservoir each year undoubtedly affects spawning in the lake, but apparently survival is sufficient to maintain a sizeable population.

Emerald Lake

No trout were captured by the survey party in Emerald Lake, although a few large brook trout undoubtedly exist there. One brook trout examined by the creel census clerk measured 14.5 inches. Past history of good fishing in this lake suggests that a plant of cutthroat might improve fishing.

Haiyaha Lake

Cutthroat trout of various sizes were observed in the lake, although most of the fish were caught in pools below the outlet. These fish averaged 11.0 inches in length. Fishing, in general, was only fair.

Dream Lake

No fish appear to exist in Dream Lake at present. Either the 1955 plant of 2,000 cutthroat did not survive, they moved down into the lake outlet, or they were all captured prior to 1958. As large

Table 7. Summary of lake survey data collected in Rocky Mountain National Park, 1958.

Lake	Location of lake	Approximate surface area (acres) ^{1/}	Elevation (feet above sea level)	Maximum depth (feet)	Surface temperature (° F.)	pH.	Methyl orange alkalinity ppm.	Spawning facilities and success	Species present ^{2/}	Date of survey
Crystal	T.6N., R.74W., S.23	34.7	11,450	Over 125'	50°	6.0	4.5	None	C, R	7-30-58
Little Crystal	T.6N., R.74W., S.23	4.9	11,450	20	53°	6.0	5.0	None	R, C	7-31-58
Lawn	T.6N., R.74W., S.25	27.0	10,700	34	54°	6.2	6.0	Poor - brook trout	B, R, C	8- 1-58
Emerald	T.4N., R.74W., S.15	7.0	10,200	56	50°	6.0	4.0	None	B	8- 9-58
Haiyaha	T.4N., R.74W., S.15	12.3	10,200	29	45°	6.0	7.0	Poor	C, B	8- 8-58
Dream	T.4N., R.75W., S.15	10.7	9,900	14	58°	6.0	6.0	None	--	8- 8-58
Tourmaline	T.4N., R.74W., S. 9	1.0	10,300	12	56°	6.4	8.0	None	--	8- 6-58
Odessa	T.4N., R.74W., S. 9	8.4	10,000	22	56°	6.0	9.0	Some	C	8- 6-58
Fern	T.4N., R.74W., S. 3	20.0	9,500	31	58°	5.5	13.0	Adequate	B, C	8- 6-58
Sandbeach	T.3N., R.73W., S.18	13.3	10,350	40	60°	6.2	8.0	None	R, C	8-22-58
Husted	T.6N., R.73W., S. 8	12.4	11,200	21	50°	6.5	6.0	Adequate - brook trout in lake	B	7- 8-58
Lost	T.6N., R.73W., S. 8	9.0	10,830	21	54°	6.2	6.5	Some	B, C	7- 8-58
North Fork No. 1, unnamed	T.6N., R.73W., S.18	2.8	11,700	27	41°	6.2	3.0	None	--	7- 9-58
North Fork No. 2, unnamed	T.6N., R.73W., S.18	3.3	11,620	10	52°	6.6	5.0	None	--	7- 9-58
North Fork No. 3, unnamed	T.6N., R.73W., S. 7	11.5	11,500	21	50°	6.4	5.0	None	--	7- 9-58
North Fork No. 4, unnamed	T.6N., R.73W., S. 7	8.6	11,350	18	48°	6.8	10.0	None	--	7- 9-58
Unnamed, at head of Black Canyon	T.6N., R.73W., S.30	1.0	10,200	3	47°	6.2	8.5	None	--	8- 1-58

^{1/} Area measured from aerial photographs.^{2/} Listed in order of relative abundance, C = cutthroat, B = brook, R = rainbow.

Table 8. Summary of stream survey data collected in Rocky Mountain National Park, 1958.

Stream	Flow (cfs)	Velocity (fs)	Average width (feet)	Average depth (inches)	Water temperature (°F.)	Aquatic fish food	Fish present ^{1/}	Pools ^{2/} size, type, frequency			Spawning facilities	Date of survey	Location of survey
Forest Canyon Creek	4.3	1.0	9.3	6.5		Poor	C*	1	2	2	Adequate	8-15-58	Below rock cut, 10,000 ft. elev.
Hunter Creek	8.6	1.95	13.2	5.0	46°	Poor	C*	2	2	2	Adequate	8-22-58	At top of steep slope--9,500 ft.
Roaring River	8.5	3.0	7.3	5.2		Poor	B*, C	2	2	2	Adequate	8- 1-58	1/2 mi. below Lawn Lake, 10,650 ft.
Roaring River	18.0	1.92	13.4	11.5		Poor	B*, C	1	2	1	Adequate	8- 1-58	1/4 mi. below Ypsilon Junction, 9,200 ft.
Fern Creek	5.4	1.67	10.5	4.1	44°	Poor	B*, C	3	3	3	Adequate	8- 6-58	20 yards above Odessa Lake.
Tonahutu Creek	21.2	2.1	11.3	12.0	52°	Average	B*, C	2	2	2	Adequate	7-23-58	7-1/2 mi. from Grand Lake in upper Big Meadow, 9,550 elev.
North Fork of Big Thompson	26.1	2.4	12.5	7.5	50°	Poor	B, C	2	2	3	Adequate	7- 9-58	1/2 mi. below Lost Lake, 10,600 ft.
North Fork of Big Thompson	60.0	5.0	12.0	15.6	52°	--	B*	2	1	1	Poor	7- 9-58	At Park boundary, 8,900 ft.

^{1/} In order of relative abundance: C = cutthroat; B = brook; asterisk indicates that species is abundant.

^{2/} Pools were classified in following manner:

- Size - 1. Averaging wider or longer than stream width.
- 2. As wide as or as long as stream width.
- 3. Averaging narrower or shorter than stream width.
- Type - 1. Deep--2 feet or more with abundant shelter and plants.
- 2. Intermediate in depth, shelter, and plant abundance
- 3. Shallow, exposed pools without shelter and without plants and having a shifting bottom.
- Frequency - 1. More or less continuous--75% pools to 25% riffles.
- 2. Rather close succession--50% pools to 50% riffles.
- 3. Shallow, infrequent pools--about 25% of length of stream section.

cutthroat have been taken from Dream Lake in earlier times, the latter is probably true. If the lake is planted in 1959, a follow-up should be made to determine what is happening to the fish.

Tourmaline Lake

This tiny, shallow lake appears unsuited for trout production, although it has been stocked several times in the past. It is so shallow that the fish would undoubtedly winterkill.

Odessa Lake

The fish population in Odessa Lake is very small at present; only a single large cutthroat was observed by the survey party. An 11.6-inch cutthroat was captured there by a fisherman on August 29. The lake should be planted in 1959.

Fern Lake

A well-balanced population of brook trout exists in Fern Lake; reproduction appears adequate and no stocking is needed. Fly fishing was excellent in 1958 with fish averaging 8.0 inches in length.

Sandbeach Lake

Many fishermen found excellent fishing for rainbow in Sandbeach. Survival of the 1955 rainbow plant appeared to be good. Fish averaged 10.0 inches in total length.

Husted Lake

Husted Lake is another area where the brook trout are spawning successfully in the lake. The population is well balanced with fish of all sizes up to ten inches observed. Mean length of 11 captured fish was 8.6 inches.

Lost Lake

No fish were reported taken from Lost Lake during the year, although the survey party observed several "rises" on the lake. Fishing was very poor, from all reports. Lack of suitable spawning gravel coupled with a lack of fish planting since 1948 may account for the poor success on this lake.

Unnamed North Fork Lakes

Five lakes above Lost Lake on the North Fork of Big Thompson River were checked by the survey crew. All five lakes appeared barren. The lakes were planted once in 1934. As little fishing pressure is exerted in this remote area, any fish planted in the lakes would probably not be utilized.

Age, length, and diet of fish

Scale and stomach samples were taken from all fish collected. Calculated lengths and age composition of each sample collected from the lakes and streams are given in table 9. As all of the fish were captured by angling, the age composition is probably similar to the age composition of the fishermen's catch. Most of the fish from each area belonged to a single age class.

For all waters, including those in the creel census areas, brook trout were largest for their age in Bear Lake and Tonahutu Creek. A single brook trout taken from Emerald Lake was very large for its age, but the accuracy of the scale reading was questionable. Rainbow put on better growth in the large streams than in the lakes. The largest cutthroat were produced in Crystal Lake.

The size of stomach samples was limited to less than a dozen fish from each area, but the sample did give an indication of the fish diet during the summer in the different waters. Analysis of the stomach samples is found in tables 10 and 11. The stomach samples were collected on the same date as the other survey data.

The diet of trout from most areas was predominantly terrestrial organisms. Brook trout from Fern Creek were the only notable exception; of the five brook trout stomachs examined from this stream, less than 30 percent of the contents was of terrestrial origin. Approximately half of the stomach contents of cutthroat from Crystal Lake and Hunter Creek was terrestrial insects. Stomachs of trout from the other waters contained only small volumes of aquatic invertebrates, but their frequency of occurrence was high. There were often large numbers of aquatic organisms in the stomachs, but their small size in comparison to terrestrial insects made them of less importance.

Table 9. Calculated lengths by direct proportion of trout from waters of Rocky Mountain National Park. Number of fish in each age class is given in parentheses.

Location and species	Number of fish	Calculated length, in inches, to each annulus				
		I	II	III	IV	V
Crystal Lake						
Rainbow ^{1/}	1	1.85	5.54	7.76 (1)	--	--
Cutthroat	9	--	4.03	8.22	11.66 (9)	--
Little Crystal						
Rainbow ^{1/}	8	2.17	5.69	8.29 (8)	--	--
Lawn Lake						
Brook	4	3.16	6.16 (1)	7.90 (3)	--	--
Cutthroat	1	--	2.84	5.33	8.53 (1)	--
Emerald Lake						
Brook	1 ¹	4.14 ^{2/}	8.28	10.77	12.40	14.00 (1)
Haiyaha Lake						
Cutthroat	5	--	3.03	5.23	8.03 (5)	--
Odessa Lake						
Cutthroat	1	--	4.70	7.84	10.30 (1)	--
Fern Lake						
Brook	7	3.51	6.41 (7)	--	--	--
Sandbeach Lake						
Rainbow ^{1/}	9	3.07	6.88	9.06 (9)	--	--
Husted Lake						
Brook	9	2.80	5.82	8.14 (9)	--	--
Fern Creek						
Brook	4	3.02	5.79 (4)	--	--	--
North Fork						
Brook	6	3.21	5.54 (5)	7.55 (1)	--	--
Hunter Creek						
Cutthroat	15	--	3.74	6.67 (15)	--	--
Brook	1	2.84	5.67 (1)	--	--	--
Rainbow	1	2.35	5.87	8.21 (1)	--	--
Tonahutu Creek						
Cutthroat	11	--	3.37	5.86 (8)	8.74 (3)	--
Brook	21	2.77	5.54 (15)	8.22 (6)	--	--
Roaring River						
Brook	23	2.70	5.34 (23)	--	--	--
North Fork						
Brook	5	2.81	5.42 (1)	8.15 (4)	--	--

^{1/} Probably part of 1955 planting of rainbow fry.

^{2/} Annuli indistinct--age may be incorrect.

Table 10. Stomach analyses of trout from lakes in Rocky Mountain National Park in percent of total volume and percent of frequency of occurrence; number of stomachs examined in parentheses.

Food item	Crystal Lake cutthroat (8)		Little Crystal rainbow (7)		Lawn Lake brook (4)		Haiyaha Lake cutthroat (4)		Fern Lake brook (5)		Husted Lake brook (5)		Sandbeach rainbow (2)	
	Volume	Frequency	Volume	Frequency	Volume	Frequency	Volume	Frequency	Volume	Frequency	Volume	Frequency	Volume	Frequency
Terrestrial organisms	45.94	75	75.91	85	86.66	100	88.62	100	96.50	100	95.37	80	100.00	100
Diptera	0.42	13	20.58	43	8.33	25	4.08	50	32.46	80	0.73	20	0	0
Hymenoptera	4.26	38	6.87	14	0	0	28.57	100	10.82	60	0	0	96.82	100
Ephemeroptera	0	0	0	0	0	0	0	0	6.49	20	0	0	0	0
Hemiptera	0.58	38	13.99	57	19.16	50	12.44	100	30.51	100	79.73	80	0	0
Coleoptera	0.21	25	6.17	43	4.17	25	23.80	100	12.98	60	0	0	3.18	50
Lepidoptera	34.30	63	9.10	28	55.00	25	0	0	0	0	12.95	20	0	0
Orthoptera	0	0	9.60	28	0	0	19.73	75	3.24	40	0	0	0	0
Trichoptera	6.17	38	9.60	14	0	0	0	0	0	0	1.96	20	0	0
Aquatic organisms	54.06	100	24.09	71	13.34	75	11.38	50	3.50	60	4.63	100	0	0
Tendipedidae	2.08	38	6.99	43	9.17	75	0.50	50	1.32	40	4.51	100	0	0
Trichoptera	50.30	100	0	0	0	0	10.88	25	0	0	0	0	0	0
Nematoda	1.66	25	0	0	0	0	0	0	2.16	20	0	0	0	0
Hydracarina	0	0	0	0	0	0	0	0	0.02	20	0.12	20	0	0
Copepoda	0.02	25	0	0	0	0	0	0	0	0	0	0	0	0
Cladocera	0	0	17.10	28	2.50	25	0	0	0	0	0	0	0	0
Pelecypoda	0	0	0	0	1.67	25	0	0	0	0	0	0	0	0

Table 11. Stomach analyses of trout from Rocky Mountain National Park streams, in percent of total volume and percent of frequency of occurrence; number of stomachs examined in parentheses.

Food item	Hunter Creek cutthroat (5)		Roaring River brook (10)		Fern Creek brook (5)		North Fork brook (6)	
	Volume	Frequency	Volume	Frequency	Volume	Frequency	Volume	Frequency
Terrestrial organisms	52.55	80	78.08	90	29.43	80	76.41	100
Diptera	2.58	20	23.92	80	22.65	60	14.15	83
Hymenoptera	34.00	80	14.34	70	--	--	14.15	83
Plecoptera	--	--	19.72	50	--	--	22.24	67
Ephemeroptera	--	--	10.16	30	--	--	1.01	17
Hemiptera	10.95	40	5.76	80	3.23	20	4.24	67
Coleoptera	3.14	40	2.39	40	3.23	20	8.59	83
Lepidoptera	--	--	--	--	--	--	10.01	34
Arachnida	1.88	40	--	--	--	--	--	--
Orthoptera	--	--	--	--	0.32	20	--	--
Trichoptera	--	--	1.79	10	--	--	2.02	17
Aquatic organisms	47.45	100	21.92	100	70.57	100	23.59	100
Tendipedidae	1.51	60	11.53	80	12.29	60	0.25	17
Simuliidae	0.62	40	1.79	70	2.59	60	--	--
Tipulidae	--	--	--	--	0.65	20	--	--
Plecoptera	5.03	40	--	--	6.46	20	2.02	17
Trichoptera	15.11	80	1.79	30	38.89	60	9.10	50
Ephemeroptera	25.18	80	4.18	30	3.23	20	11.12	67
Colcoptera	--	--	2.39	30	6.46	40	0.50	17
Nematoda	--	--	0.24	10	--	--	0.60	34

PLANTING RECOMMENDATIONS

Many of the lakes within Rocky Mountain National Park lie in bowl-shaped glacial cirques at high altitude. The typical lake has little shoal area, so productivity is often low. Only a minimum of cover, usually in the form of boulders, is available. Most lakes do not have inlets or outlets which are open for fish movement, and adequate spawning gravel is scarce. Natural reproduction is difficult or impossible under these conditions, especially when cutthroat trout are stocked.

The present stocking policy for Rocky Mountain National Park is, where stocking of lakes is considered necessary, that native cutthroat under four inches are to be stocked. Where natural reproduction does not take place, restocking is necessary every few years or the lakes become barren. Such planting would be on a population-sustaining basis rather than a put-and-take basis.

Several lakes covered by the survey in 1958 were found in need of stocking. Assuming that the policy of planting three- to four-inch cutthroat will be continued, the following planting suggestions for 1959 are made: Emerald Lake, 1,500 fish; Dream Lake, 2,500 fish; Odessa Lake, 2,000 fish; Lost Lake, 1,600 fish. The other lakes surveyed still had sizeable populations of fish or were judged unsuitable for stocking (i.e. Tourmaline Lake). Size of plantings given above were determined from lake stocking tables by Davis, as quoted by Rounsefell and Everhart (1953). Numbers were based on amount of fishing pressure, spawning facilities, and surface area of the lakes.

In relation to the mean number of fingerlings planted in these lakes in the past (Emerald, 19,000; Dream, 7,900; Odessa, 8,900; Lost, 9,500), the above recommendations appear small. Reimers (1958) pointed out that oftentimes too many fish are planted in Alpine Lakes for the available food supply. The suggested plantings are in keeping with lake size and with available food.

Some adjustment in size and species of fish planted in Rocky Mountain National Park lakes may be desirable if future investigation reveals that there are other lakes similar to Bear Lake in the Park. Pennak^{1/} found that Bear Lake suffers a period of oxygen depletion in the summer. The lack of sufficient oxygen in the lower depths restricts the amount of lake available to the fish for foraging. Hence, a smaller number of fish should be stocked than indicated by the surface area. Cooper, as quoted by Rounsefell and Everhart, made adjustments in planting numbers to compensate for the reduced amount of lake bottom available to the fish. Pennak also stated that summer oxygen depletion is uncommon in high Colorado Lakes, but that where it does occur, rainbow trout are more suitable for planting than

^{1/} Letter from Robert W. Pennak, University of Colorado, to Superintendent, Rocky Mountain National Park, dated May 12, 1946.

cutthroat. Cutthroat trout have a higher oxygen threshold than other trout species. Hence, rainbow or brook trout may be more suitable than cutthroat in some park lakes. }

The factor of predation should be considered if three-inch fingerlings are planted in park lakes. In lakes such as Emerald Lake, where a few large fish still remain, some predation on the planted fingerlings must be expected. Weberg (1954) studied two Colorado lakes, Fishhook Lake, Routt County, and Lost Lake, Jackson County, to determine what size of fingerling was best suited for stocking high mountain lakes. Three sizes of fish were planted: one-inch fry and three and five-inch fingerlings. Best returns over a three-year period were made by the three-inch plant of rainbow trout (34.56 percent). Only 0.66 percent of the one-inch rainbows, 2.73 percent of the one-inch cutthroat, and 25.33 percent of the five-inch rainbows were recovered. Weberg found that predation on the stocked fish was not a problem even though mature rainbow and brook trout were in the lakes when fry were stocked. However, the study was conducted during the summer months only, when insect food was abundant. It was not possible to check the winter and spring diet of the fish at a time when insect numbers would be lower. An estimated 10.3 percent of all rainbow and cutthroat planted during the study in Fishhook and Lost Lakes were returned to the creel. Many of the remaining 89.7 percent may have been lost by predation during the winter or spring months.

Fish from the two lakes fed chiefly on aquatic organisms, indicating that the aquatic forms were relatively abundant. Fish from lakes examined in Rocky Mountain National Park fed mostly on terrestrial insects during the summer, suggesting that aquatic insects were relatively scarce. Hence, fish from those lakes may turn to cannibalism more readily than fish in the Weberg study when their usual diet of terrestrial organisms is unavailable.

An alternative to planting three-inch fingerlings, which would be susceptible to predation, is to plant larger fish. If six-inch fingerlings were planted, the planting figures for three-inch fish should be multiplied by 0.55, as fewer fish would be needed. Planting of larger (or smaller) fish than three inches would be more expensive. Weberg calculated relative costs of rearing and planting three sizes of fish in relation to numbers returned to the creel. He found that three-inch fish were the most economical size to plant in Fishhook and Lost Lakes. His findings would hold for any park lakes which must be stocked by packhorse. Thus, if cost is a factor, the present planting of three-inch fingerlings in lakes may still be most suitable, even if some predation exists. ?

The only other alternative in lakes where spawning does not take place is to wait until all old fish have died before planting, or to chemically remove the few remaining fish with toxicants, and then restock the lakes. The latter practice is becoming popular in several states.

None of the streams covered by the survey and the creel census need stocking in 1959. Under the present stocking policy of population sustenance in contrast to put-and-take fishing, it is questionable whether these streams should be included in the stocking program unless the size of stocked fish can be increased.

One of the problems concerning anglers who fish on Fall River, Big Thompson River, and Glacier Creek has been the small size of fish. Addition of hatchery fish to these streams to remain for several years prior to harvesting increases competition, and thus amplifies the problem of undersized fish. Good populations of brook trout are present in many of the streams. Brook trout reproduction is high, so the present wild populations are probably producing numbers which represent the streams' total fish capacity. Rounsefell and Everhart in discussing this subject state, "Introduction of hatchery fish to such water merely serve to handicap the naturally reared population and increase the burden on the productivity of the habitat." (P. 380).

The situation within the park differs from that found on other fishing waters. When catchable-size fish are planted "in front of the angler," the fish remain in the streams only a relatively short time. Thus, a stream can support large numbers of big fish during the summer months when food production is high. Most of these fish are removed prior to the time when competition becomes keen. When small fish are planted in the stream to grow large before entering the creel, they usually compete directly with the wild fish and both populations suffer. Hence, if catchable-size fish cannot be planted, it seems advisable to discontinue planting in these streams under present conditions.

As brook trout in the census streams make up well over half of the catch (table 1), there may be some merit in encouraging this species by reducing the stocking of other trout. Brook trout are easily captured, reproduce rapidly, and can adapt to submarginal habitats. They appear to be well suited for the majority of the anglers found along these streams who often lack extensive experience in trout fishing.

GREEN-BACK TROUT

Forest Canyon study

Introduction

To obtain information on the biology of the Forest Canyon cutthroat trout, purported to be the green-back trout, studies were conducted during the summer of 1958 in upper Forest Canyon.

The headwaters of the Big Thompson River originate near the Continental Divide at an elevation of approximately 11,500 feet. The main channel is located in Forest Canyon and is often referred to as Forest Canyon Creek. There is no road along the seven and one-half miles of stream from its origin to the mouth of the canyon at the pool on the Big Thompson River. The canyon walls are steep, with heavy timber on the slopes. The stream flows through a series of long alpine meadows which alternate with strips of dense conifer forest. It finally cascades down a series of waterfalls near the canyon mouth. Stream velocities vary from approximately one foot per second in the meadow areas to over four feet per second in the cascades. Velocity near the canyon mouth is even higher.

The study area, a meadow near the head of the stream, was three-fourths mile in length and extended from an elevation of 10,450 feet up to 10,570 feet. The area was delimited on the upper end by a series of cascades which marked the upper boundary of the fish population in the stream, and on the lower end by a weir and fish trap. Data were collected from fish on the entire stream down to the pool, with the exception of data on reproduction success which were collected in the study area only.

An upstream-downstream trap was installed to obtain information on spawning habits of the fish. The trap was constructed of three-foot-square sections of hardware cloth. Other fish were collected with fly rods, cresol, and with dip nets.

Length, growth, and age

The cutthroat in Forest Canyon Creek rarely exceed nine inches in total length. Collections were made over the entire stream, and the largest fish captured measured 236 mm. (9.3 inches). The average length of adult fish was slightly less than eight inches. The green-back trout as discussed by Jordan (1891) was also a relatively small fish. It was reported as seldom exceeding three-fourths of a pound in weight.

To determine the length frequency of the stream population, a 100-yard section of stream located one-half mile below the fish trap was treated with cresol on August 26. All fish in the area were collected

and measured, and scale samples taken. No fish under 85 mm. were observed in the section. The largest specimen was 212 millimeters. Length frequency of the 43 fish was determined (table 12).

Table 12. Length frequency of 43 Forest Canyon cutthroat taken from 100 yards of stream.

Size class (mm.)	Number of fish
80- 89	1
90- 99	4
100-109	3
110-119	4
120-129	2
130-139	6
140-149	3
150-159	7
160-169	3
170-179	3
180-189	2
190-199	0
200-209	4
210-219	1

Age frequency of the above fish, determined from scale analysis, indicated that two and three-year old fish were the predominant age classes in the population. Age composition of the sample was: Age Class I, 19 percent; Age Class II, 33 percent; Age Class III, 41 percent; Age Class IV, 7 percent.

No young-of-the-year were found in the above sample, but fry were observed upstream near the fish trap on the same day (August 26). Four of these fry measured from 19 to 20 millimeters in total length.

As the main growing season approached its end, it was concluded that Forest Canyon fry are less than 45 millimeters in length by the end of their first summer.

Cutthroat trout usually form scales when approximately 45 millimeters in length. Laakso and Cope (1956) found that cutthroat in Yellowstone Lake formed scales when 41 to 44 millimeters long. Cutthroat from the Wind River Range, Wyoming, first had detectable scales at 46 millimeters total length (Robertson, 1947). Hence, Forest Canyon fish would probably not be long enough to form scales during their first winter. In turn, the growth check for the first year of life would be missing when scales were formed. The first growth check on the scales was assumed to be the annulus for the second winter of life. Under this assumption, the fish were aged and growth rates calculated.

The body-scale relationship, determined from 85 fish from 85 to 222 millimeters, was adequately expressed by the formula:

$$L = 30.207 + 7.976 \text{ SR}$$

where L equals total length in millimeters and SR equals the scale radius in tenth inches times a scale magnification of 115. Plotted data supported the conclusion that the relationship was linear.

For back calculations of growth the calculated Y intercept (30.207) was used. Table 13 presents calculated lengths at each year of life and annual growth increments.

Table 13. Calculated length, in millimeters, of 86 Forest Canyon cutthroat trout.

Year Class	Number of fish	Mean total length	Calculated lengths			
			I	II	III	IV
I	8	93.12				
II	15	130.13	--	100.01		
III	48	173.59	--	93.53	149.24	
IV	15	205.40	--	91.15	148.52	191.17
Weighted mean				94.32	149.07	191.17
Growth increments				94.32	57.11	42.10

The eight fish in Age Class I were all captured on August 26. Comparison of their length with the calculated length of Age Class II fish indicates that most of the annual growth is completed by this date and that very little growth occurs during the winter. It was not possible to calculate lengths for Age Class I fish because of the missing first annulus. However, they were undoubtedly less than 45 millimeters long at the end of their first year or scales would have been formed and the annulus recorded.

The length-weight relationship was determined from 84 fish of various sizes taken throughout the summer. This relationship is expressed by the formula:

$$\text{Log weight (grams)} = -4.98638 + 2.96716 \log \text{total length (mm)}.$$

Hence, a 100-millimeter fish weighed approximately nine grams; a 200-millimeter fish weighed 69 grams.

Food habits

Information on the amount of fish food available in the stream was obtained from analysis of bottom samples taken at four different locations during the summer. The lowest station was at 9,000 feet and the upper station at 10,450 feet, approximately 40 yards above the fish trap. The predominant invertebrates at all stations, in order of relative abundance, were immature forms of Ephemeroptera, Plecoptera, Tendipedidae, and Tipulidae. All samples indicated low productivity and a relatively poor stream from the standpoint of fish food. The largest number of organisms measured per square foot was 26 invertebrates having a total volume of only 0.2 cc.

Stomach examination of 40 trout of various sizes revealed that the cutthroat turned to sources other than stream organisms for most of their food. Three-fourths of the stomach contents of the 40 fish was terrestrial organisms (figure 2). Stomachs taken in early June showed more aquatic organisms with a preponderance of Tendipedidae larvae than stomachs taken later. The stomach of one eight-inch female contained 812 midge larvae. Apparently, the aquatic invertebrates were readily available to the fish during the period of high water in the spring. The bulk of the diet over the summer by volume and by numbers was composed of adult Hymenoptera and adult Diptera (table 14).

Reproduction

Prior to commencement of the spawning period, a trap was installed in the stream to capture migrating spawners. The trap was put into operation on June 23. At that time fish were abundant both above and below the trap area, but no spawning activity was noticed. The first spawning was observed on July 1, and spawning was completed by July 15. Stream flow at the trap site was approximately 15 cubic feet per second during this period. Stream and air temperatures during the spawning period and through the summer appear in figure 3.

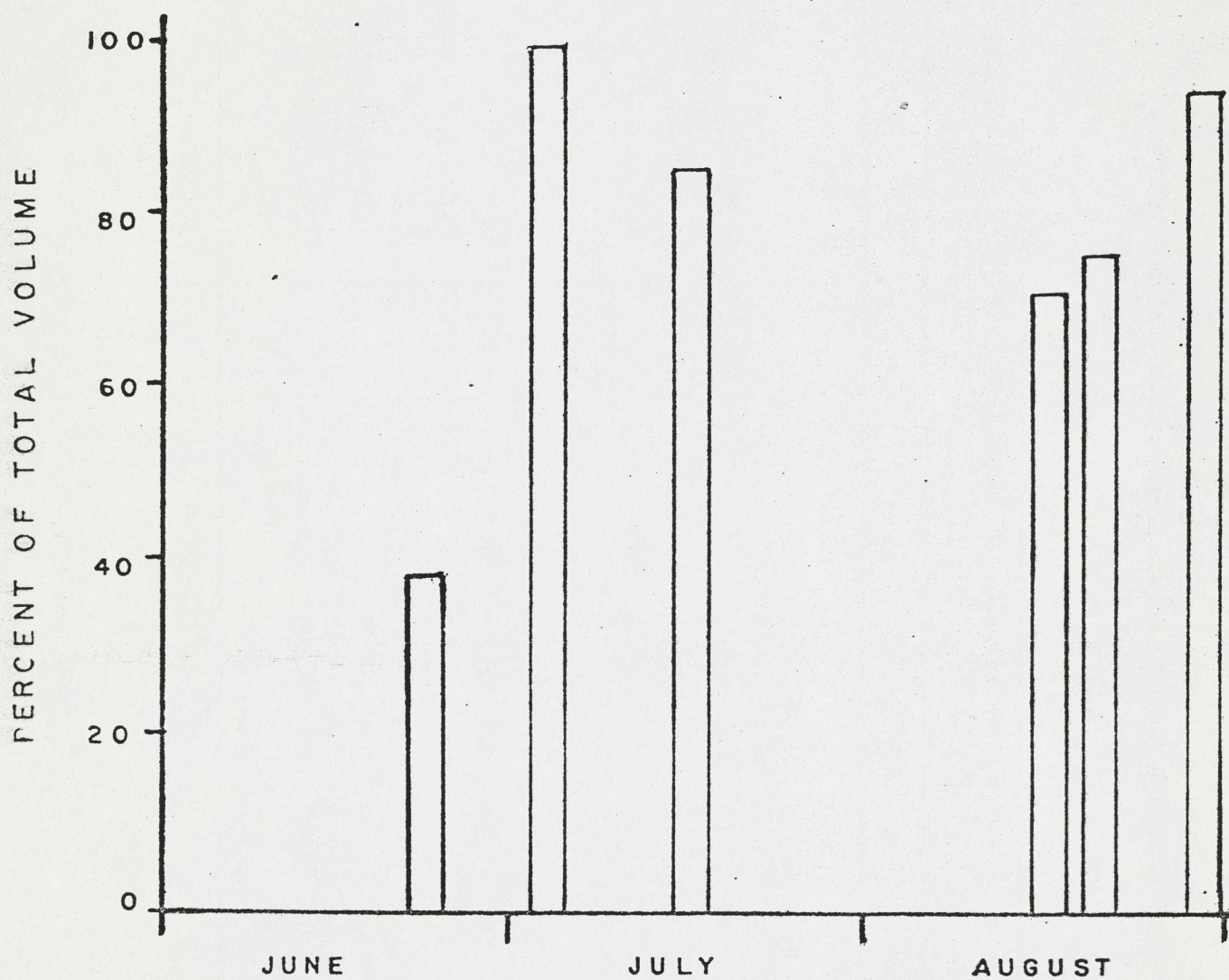


Figure 2. Percent consisting of terrestrial organisms in 40 Forest Canyon cutthroat stomachs, collected in 1958.

Table 14. Stomach analysis of 40 Forest Canyon cutthroat in percent of frequency of occurrence and percent of stomach volume, summer, 1958. Number of stomachs examined is in parentheses.

Food item	6-23-58 (7)		7-3-58 (2)		7-15-58 (5)		8-15-58 (14)		8-18-58 (18)		8-26-58 (4)		Total (40)	
	F.	V. ^{1/}	F.	V.	F.	V.	F.	V.	F.	V.	F.	V.	F.	V.
Terrestrial organisms														
Diptera	86	30.4	50	0.03	100	83.6	50	28.0	13	4.6	0	0	50	29.76
Hymenoptera	43	5.6	100	98.0	0	0	93	23.6	100	24.1	100	38.8	72.5	32.20
Plecoptera	0	0	50	0.3	20	0.6	7	0.6	50	9.3	75	4.0	25.0	1.30
Ephemeroptera	0	0	100	0.8	0	0	36	3.0	38	9.3	25	1.4	27.5	1.50
Hemiptera	29	1.0	0	0	0	0	57	8.7	25	5.6	100	45.6	40.0	6.30
Coleoptera	29	1.1	0	0	20	0.9	36	4.6	38	21.3	50	4.1	30.0	2.90
Lepidoptera	0	0	0	0	0	0	7	1.6	0	0	0	0	2.5	0.30
Arachnida	0	0	0	0	0	0	21	1.4	13	1.4	0	0	7.5	0.40
Aquatic organisms														
Tendipedidae	100	55.1	100	0.2	100	0.9	57	1.0	38	0.7	50	0.5	67.5	13.50
Simuliidae	0	0	0	0	100	4.4	50	1.7	38	3.2	0	0	25.0	1.40
Tipulidae	14	0.3	0	0	0	0	0	0	0	0	0	0	2.5	0.07
Plecoptera	86	3.6	50	0.3	20	6.7	71	13.0	25	6.5	50	1.4	57.5	5.30
Trichoptera	29	0.8	0	0	20	0.3	0	0	25	2.8	25	1.4	15.0	0.50
Ephemeroptera	43	1.3	100	0.4	40	1.2	50	10.8	25	5.6	25	0.4	42.5	3.17
Coleoptera	29	0.8	0	0	40	1.4	7	0.5	13	2.8	25	1.0	17.5	0.80
Nematoda	0	0	0	0	0	0	36	1.5	25	2.8	25	1.4	20.0	0.60

^{1/} F. = Percent of frequency of occurrence; V. = Percent of total volume of organisms.

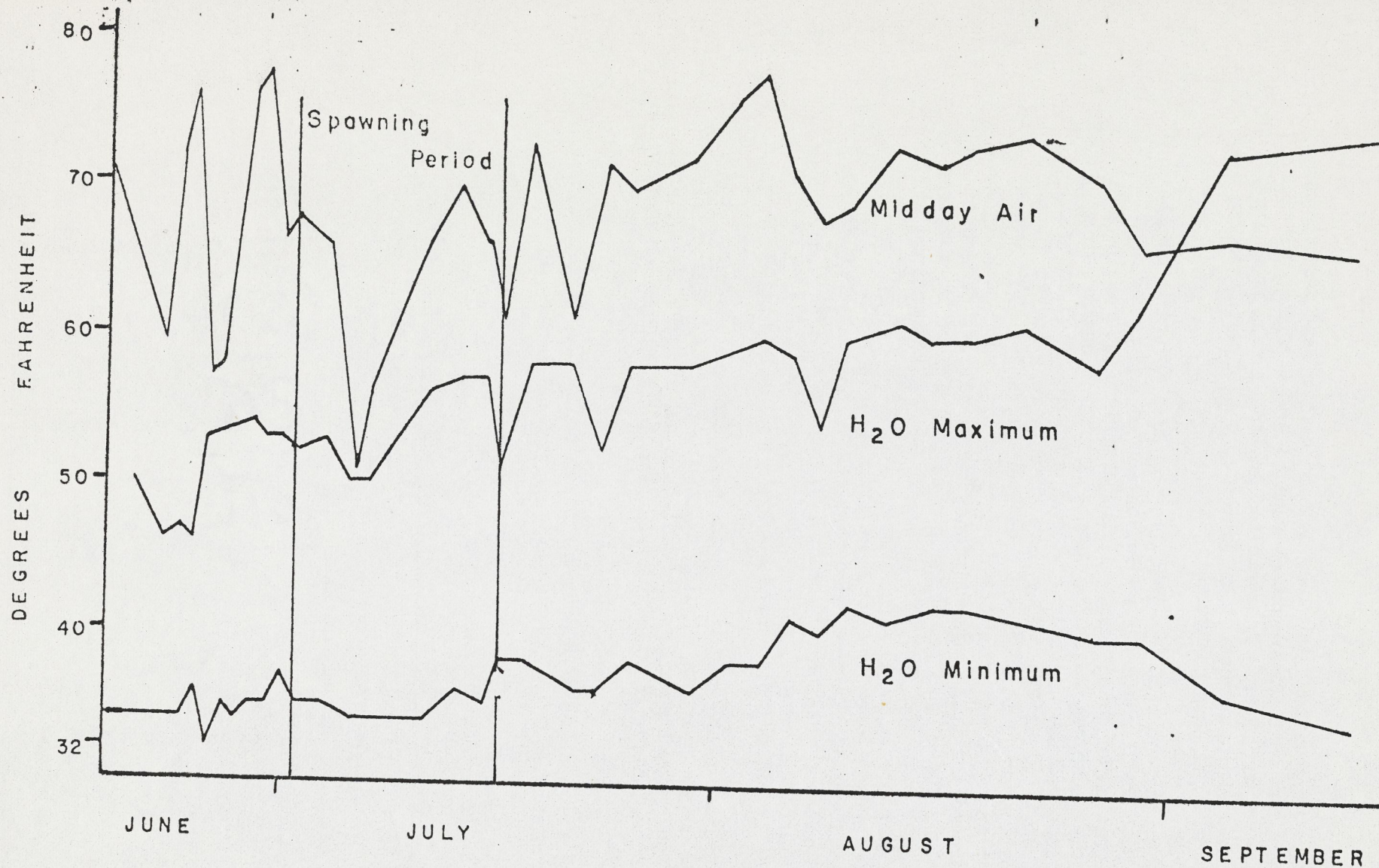


Figure 3. Water and air temperatures recorded at the Forest Canyon trap, June 13 to September 14, 1958.

The large fluctuations in water temperature in late August and September were the indirect result of reduced stream flow. By that time all snow on the watershed had melted and the stream was being fed only from springs. Hence, the smaller volume of water was more affected by external temperature variations.

From the time the trap was installed on June 23 until its removal on October 8, there was no indication of any definite spawning migration in the stream. Although adult fish remained in pools directly above and below the trap through the summer, only one spawner entered the upstream trap and only nine fish entered the downstream trap. As the water level became very low in the late summer (about three cubic feet per second on September 17), it was assumed that the fish entering the downstream trap were seeking the deep pool around the trap rather than trying to migrate downstream. Approximately a dozen fish remained in this pool formed by the trap until October 8 when the trap was removed. Fish also remained at the head of the stream until October. At that time the water level was too low for any extensive movement from pool to pool. From these observations it was concluded that the Forest Canyon cutthroat does not migrate any distance to spawn. As spawning gravel is readily available in most stream sections, apparently there is little need for extensive movement.

Failure to capture spawners in the trap made it necessary to obtain data on the spawning population by other means. Hence, fish were captured by angling with fly rods. The use of small hooks made it possible to collect fish and return them to the stream without serious injury.

Length frequencies of 46 spawning fish collected by all means is given in table 15.

Table 15. Length frequency of 46 spawners from Forest Canyon, captured in 1958.

Length group in millimeters	Number of fish	
	Male	Female
150-159	1	1
160-169	0	3
170-179	5	4
180-189	6	1
190-199	7	2
200-209	1	1
210-219	9	2
220-229	1	2

Mean total lengths of the 46 spawners, by sex, were: males, 193.7 millimeters; females, 185.3 millimeters.

Scale examination revealed that 41 of the fish were either three or four years of age. Scales from five of the 46 fish were all regenerated and could not be read. Age frequency, by sex, is presented in table 16.

Table 16. Age frequency, by sex, of 41 spawners from Forest Canyon, captured in 1958.

Age Group	Frequency		
	Male	Female	Total
III	17	12	29
IV	8	4	12

The majority of the fish obviously spawn at three years of age. It is not known whether the Age Class IV fish were initial spawners or were spawning for the second time.

Comparison of the total number of males captured (30) with the number of females (16) gave a spawner sex ratio of 1.88:1. One to several smaller males were observed near most of the spawning pairs, so an excess of males in the spawning population was evident.

The first emerged fry were observed on August 26. On September 4 a count was made over the study area to determine number of fry surviving to that date. A total of 149 fry was counted. It was estimated that about 25 percent of the fry were observed by the clerk. Hence, approximately 447 fry were missed for a total of 596 fry in the stream section.

A count was made of spawners residing in the study section to obtain an estimate of the total spawners in the area. There were approximately 45 mature females in the section during the spawning season. Two ripe females were examined prior to the spawning period. One four-year-old female (212 mm.) contained 309 eggs by actual count, and a three-year-old fish (202 mm.) had 278 eggs. If most of the 45 adult females in the area spawned, then egg and fry mortality must be very high, as less than 600 fry survived to September 4. The small percentage of fingerlings in the population, determined from length and age frequencies, also indicated a high fry mortality.

Low water levels during August and September forced fry and adult fish into the same general areas. Many of the observed fry appeared to be accessible to the larger fish. On August 26 four adults were taken from pools containing fry, and their stomachs examined for evidence of predation (table 14). There were no fish remains of any kind in their stomachs. If the four fish were representative of the population, much of the high fry mortality must be due to other factors than predation by older fish.

Hatchery culture of green-back trout

In 1957, 26 cutthroat trout were transported from Albion Creek (Boulder Creek drainage) to the U. S. Fishery Station at Leadville, Colorado. It was assumed that spawn could be taken from these fish in 1958. The fish proved to be unadapted to hatchery conditions and only a few survived the full year. None of the survivors came into spawning condition in the spring, although they had put on good growth.

To settle the question of the true taxonomic status of the green-back trout, spawn of the Albion Creek fish or Forest Canyon fish are to be cultured side by side with spawn from the Colorado River cutthroat, Salmo clarki pleuriticus. Any morphological differences in the adults will then be genetic rather than environmental differences.

To supplement the small number of Albion Creek fish remaining in the hatchery, 50 cutthroat were transplanted from Forest Canyon Creek to Leadville in 1958. The fish were captured by angling and then placed in the fish trap for several days before being packed out of the canyon. The fish were carried up to Trail Ridge Road in back-pack fire pumps and then driven down to the Fall River Fish-Cultural Station. When all of the fish had been packed out, they were taken by truck to Leadville.

If these fish survive and spawn in 1959, eggs from a pure strain of Colorado River cutthroat will be obtained and the two strains reared concurrently.

Fay Lake fish eradication project

Introduction

In 1957 plans were made for the restoration of the green-back trout in Rocky Mountain National Park. One phase of the plan was the preparation of an area with a variety of habitat for the introduction and intensive study of this subspecies. Waters in the Fay Lake drainage (2.2 miles in length) are representative of the different types of lakes and streams found in the park, so it was

chosen for the study site. Fay Lake is located in Section 26, Township 6 north, Range 73 west. On September 9, 1958, the three lakes and stream in this drainage were chemically treated to remove the resident fish population. These lakes were Faylene, Fay, and Caddis Lakes.

National Park Service personnel working under the direction of a Fish and Wildlife Service biologist carried out the eradication project.

Methods

The remoteness of the Fay Lake area limited the type and amount of equipment which could be used in the project. Five-man rubber rafts and back-pack fire pumps were considered most suitable, as all equipment had to be packed in.

Thirty gallons of emulsified rotenone (Pro-Noxfish) and 50 pounds of potassium permanganate were used in the operation. Two applications of Pro-Noxfish were made on each lake; a surface application, followed by an application at a depth of 10 to 12 feet. As the maximum depths of Faylene Lake and Fay Lake are 19 feet and 26 feet, respectively, adequate distribution of the toxicant should have resulted. An excess of poison was used to insure sufficient quantities for a complete kill. Bottles with perforated lids containing undiluted rotenone emulsion were placed in all springs, lake inlets, and seepage areas. Spraying commenced at 10:00 a.m. and was completed by 1:00 p.m.

One-fourth mile below Caddis Lake, and just below a 60-foot falls, a neutralizing station was set up on the stream. Potassium permanganate in crystalline form was utilized to oxidize the rotenone. Neutralization was continued for 24 hours after the spraying.

Results

No fish were observed in Fay or Faylene Lakes either during the operation or on the following day. This agreed with the 1957 survey results which indicated that the two lakes were either barren or contained very small populations. Spawning facilities in the two lakes are very poor and the area has not been planted since 1950. The stream above and below Caddis Lake and Caddis Lake proper contained a large number of dead cutthroat trout. These appeared to be Yellowstone cutthroat, Salmo clarki lewisi, a fish which has been planted profusely in the area. Scale samples and length measurements were taken from all fish recovered. Size distribution of the fish from Caddis Lake is presented in table 17. Numerous dead fry (1.2 to 1.3 inches) observed in the stream directly above and below Caddis Lake and along the lake shoreline were not included in the count. Age distribution and calculated lengths of the population were determined from 106 fish (table 18). Lengths were calculated by direct proportion.

Table 17. Size distribution of Caddis
Lake cutthroat.

Size group	Number of fish
3.0 - 3.9	10
4.0 - 4.9	24
5.0 - 5.9	27
6.0 - 6.9	13
7.0 - 7.9	4
8.0 - 8.9	11
9.0 - 9.9	10
10.0 - 10.9	9
13.0 - 13.9	1
14.0 - 14.9	1
Total	110
Fish not measured	3
Total kill	113

Table 18. Age distribution and calculated lengths
of Caddis Lake cutthroat population.

Age Class	Number of fish	Length at capture	Calculated length
I	21	4.43	2.05
II	43	5.33	3.58
III	30	8.34	6.76
IV	9	10.16	9.58
V	13	13.76	12.96

Numerous midge larvae (Tendipedidae) were observed in a state of stress moving around on the bottom mud of the lakes. There appeared to be a complete kill of Ephemeroptera nymphs; numerous dead adults were also lying on the surface.

Examination of the stream below the neutralizing station on the day following the spraying revealed 21 dead and 4 dying fish. Probably some of this number had been carried downstream by the current from the sprayed area. No dead fish were observed closer than one-half mile from Roaring River.

It is probable that a 100-percent kill of the fish in the Fay Lake drainage was accomplished. This year's fry had emerged from the gravel and were included in the kill. No dead fish were observed in the two upper lakes, but the large excess of chemical applied should have removed any fish present. A large part of the aquatic insect population was also removed by the treatment. As the kill below the neutralizing station was minimal, it was assumed that the neutralizer was effective in reducing toxicity of the rotenone. Total fish kill in the operation was insignificant and was probably not in excess of ten pounds. The area should be ready for restocking in 1959.

RECOMMENDATIONS FOR FUTURE STUDIES

The following recommendations are submitted for future studies in Rocky Mountain National Park:

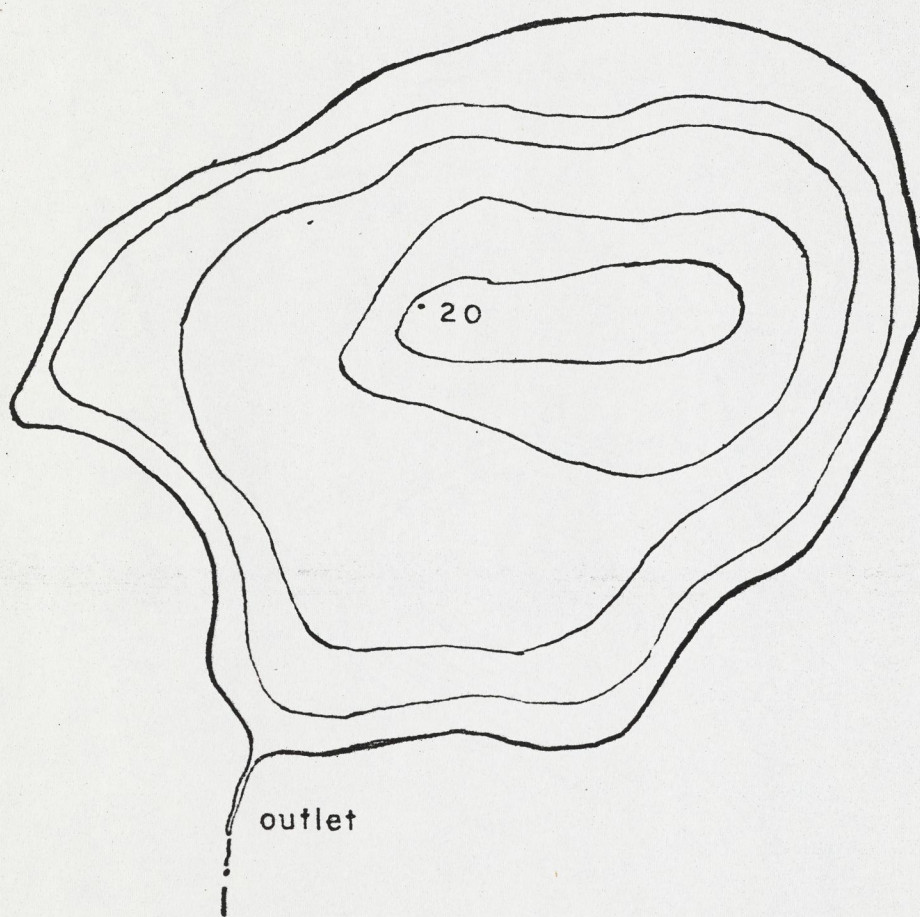
1. Biological studies of the Forest Canyon cutthroat be continued to fill gaps in present information on the biology and life history of this trout.
2. The Fay Lake drainage be planted with green-back trout as soon as positive identification of this subspecies can be made. The trout for stocking this area to be transplanted from Forest Canyon in order to hasten repopulation of the Fay Lakes.
3. Studies be continued on the characteristics of the fishery in the park, including major waters west of the Continental Divide and in Wild Basin.
4. Present survey work on park waters be directed towards a detailed study of a few representative lakes and streams so that general management recommendations can be made on a sounder basis.
5. Efforts to obtain spawn from the Forest Canyon cutthroat be intensified so that the taxonomic status of the green-back trout can be settled as soon as possible.

LITERATURE CITED

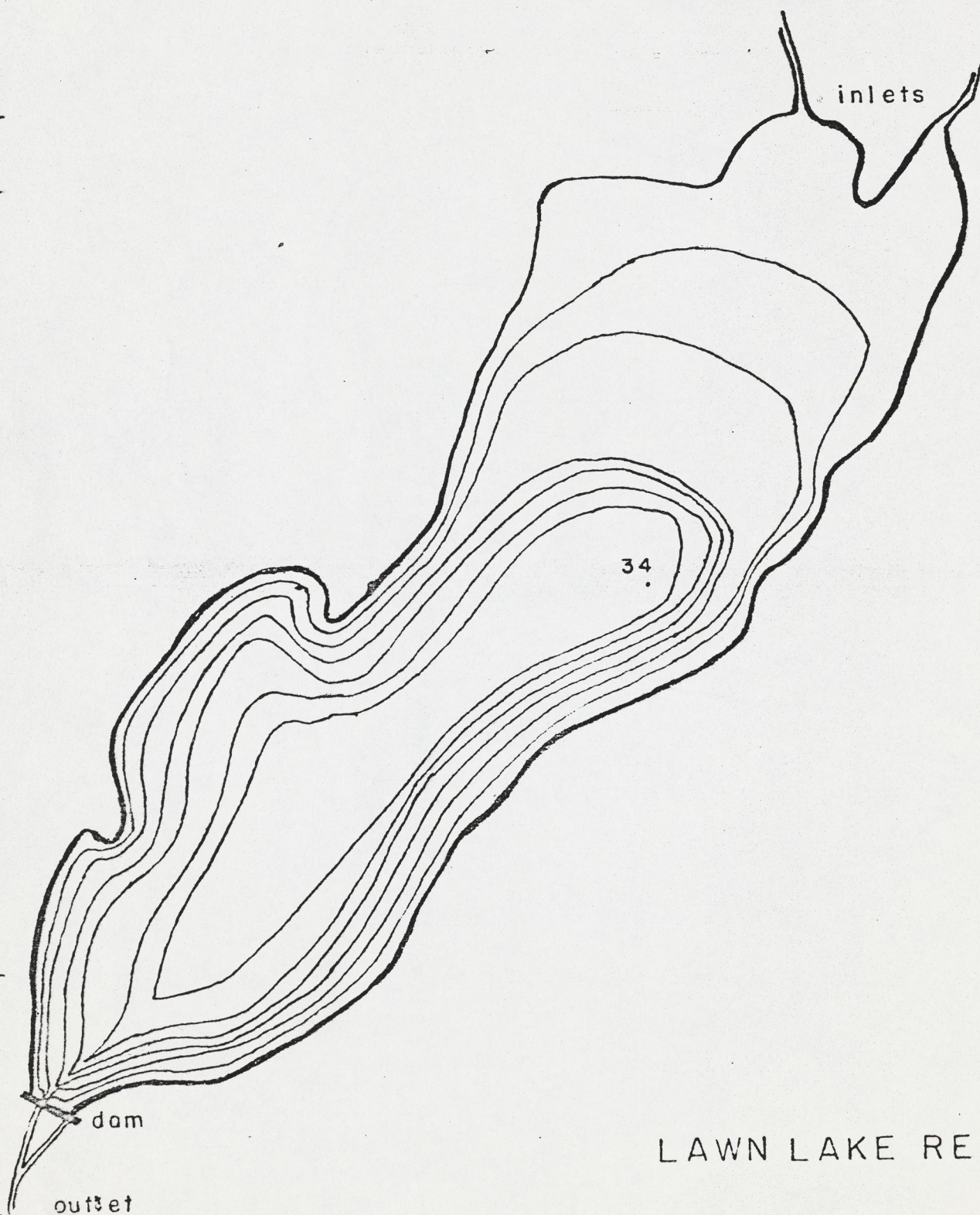
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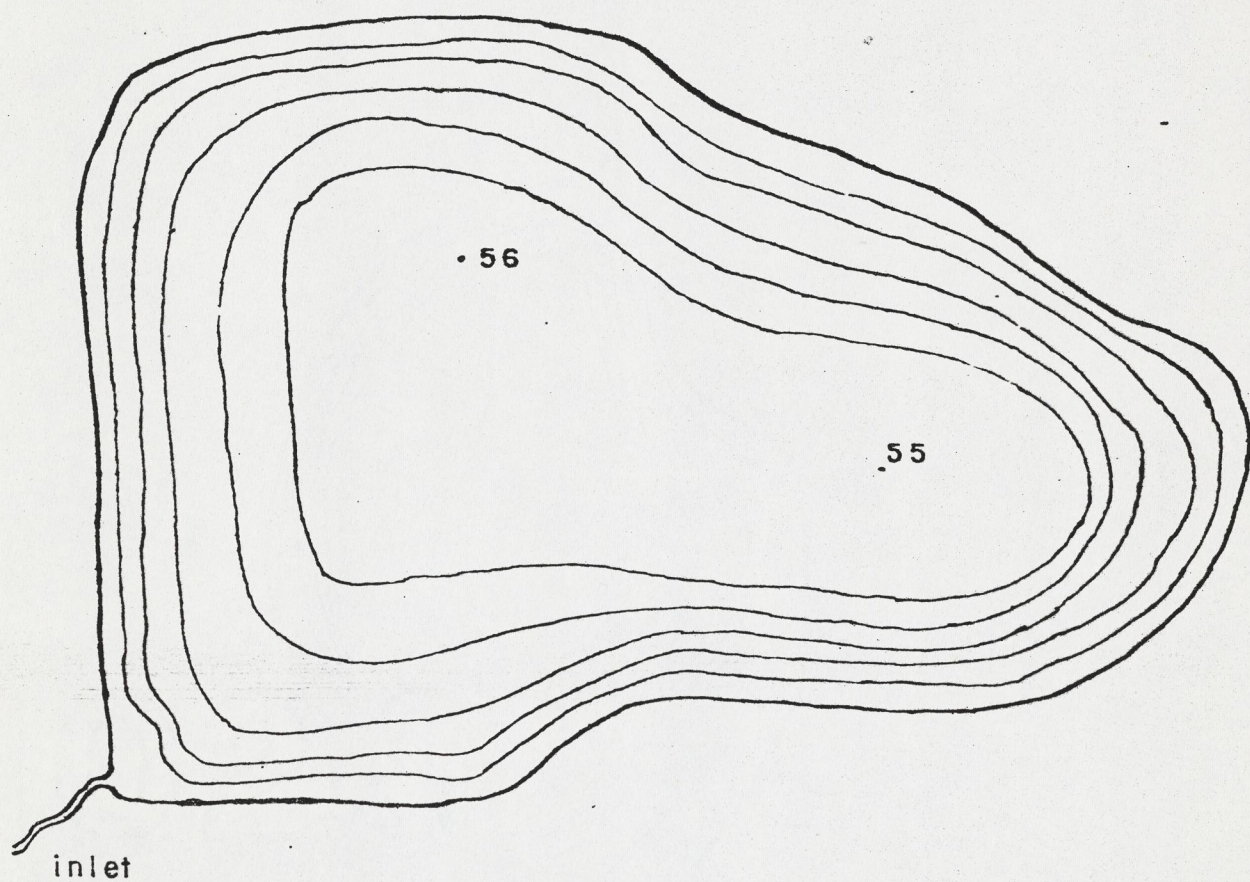
CRYSTAL LAKE



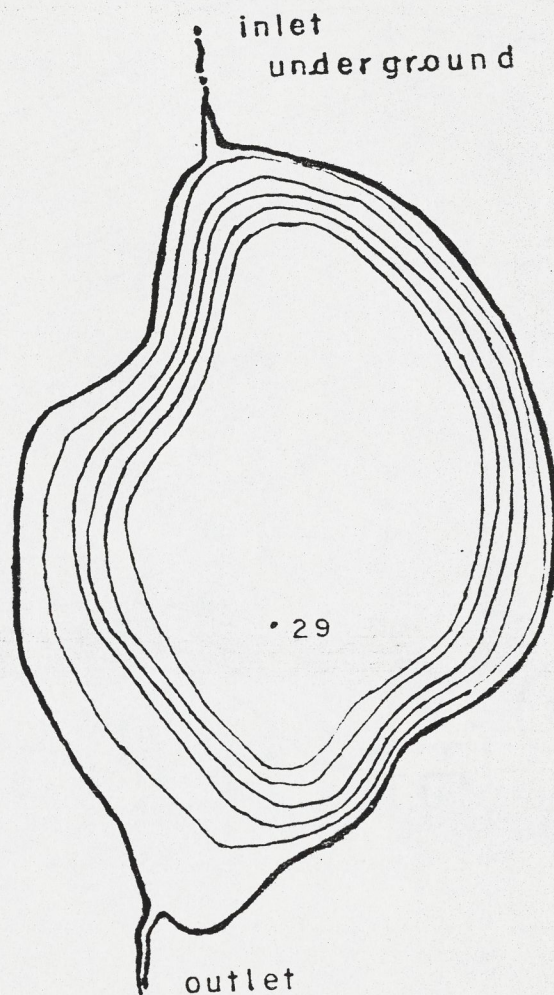
LITTLE CRYSTAL LAKE



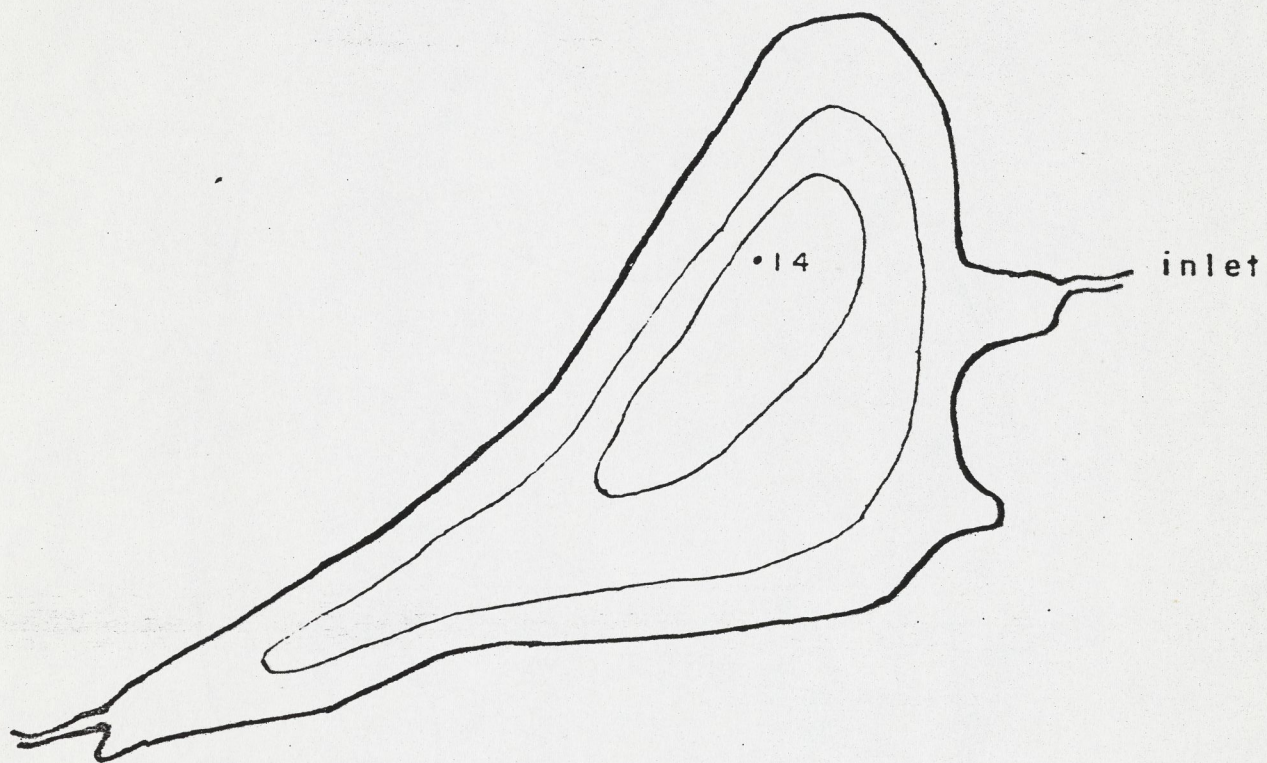
LAWN LAKE RESERVOIR



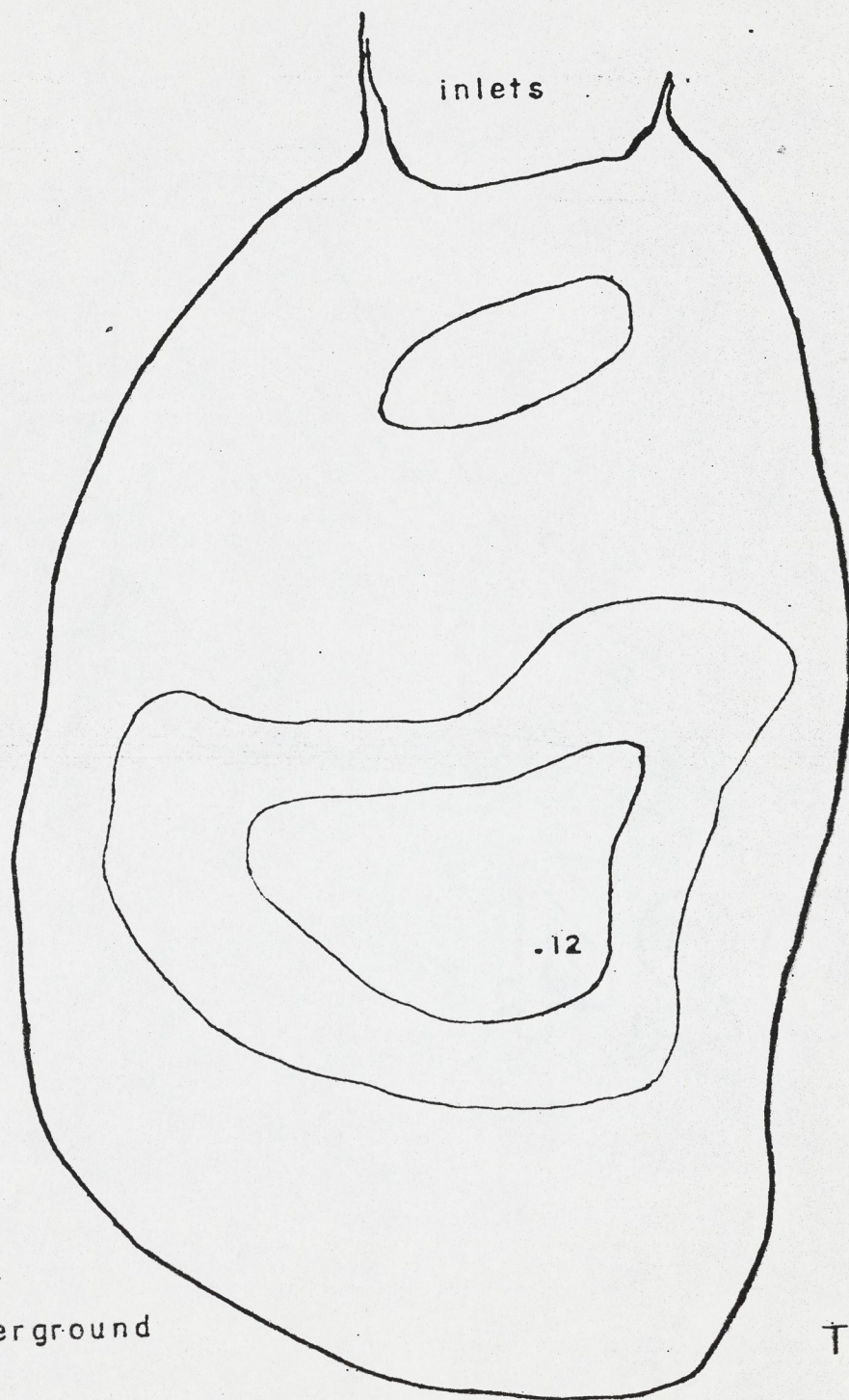
EMERALD LAKE



HAIYAHA LAKE



DREAM LAKE

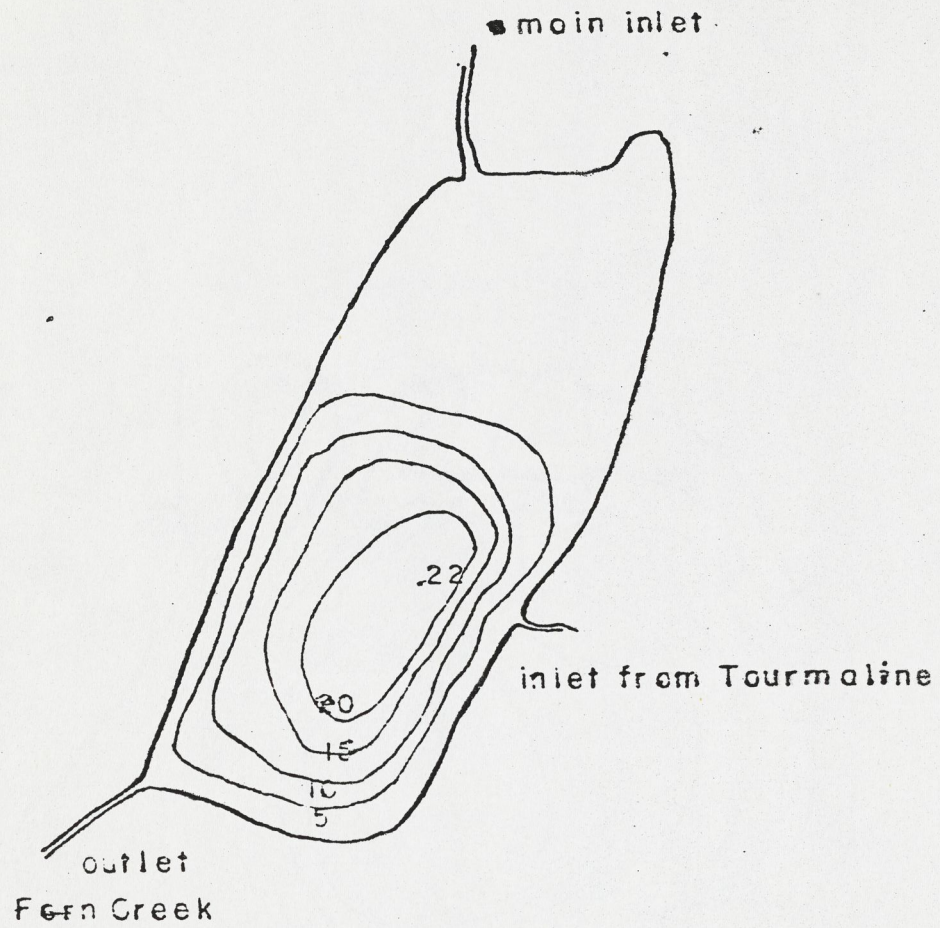


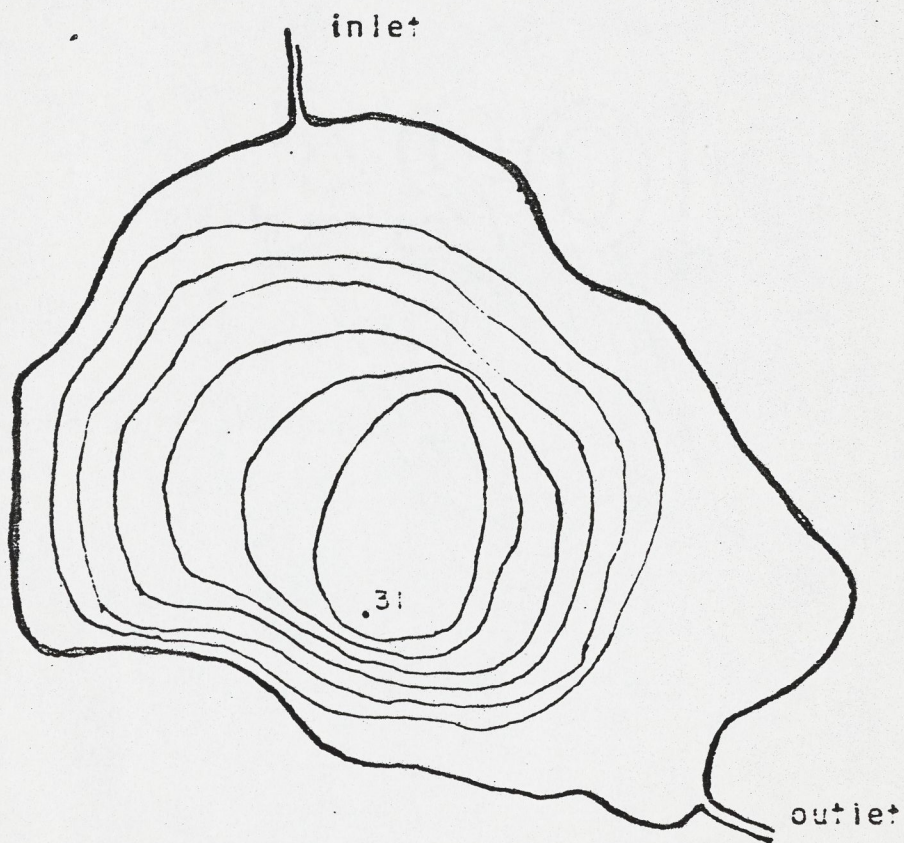
inlets

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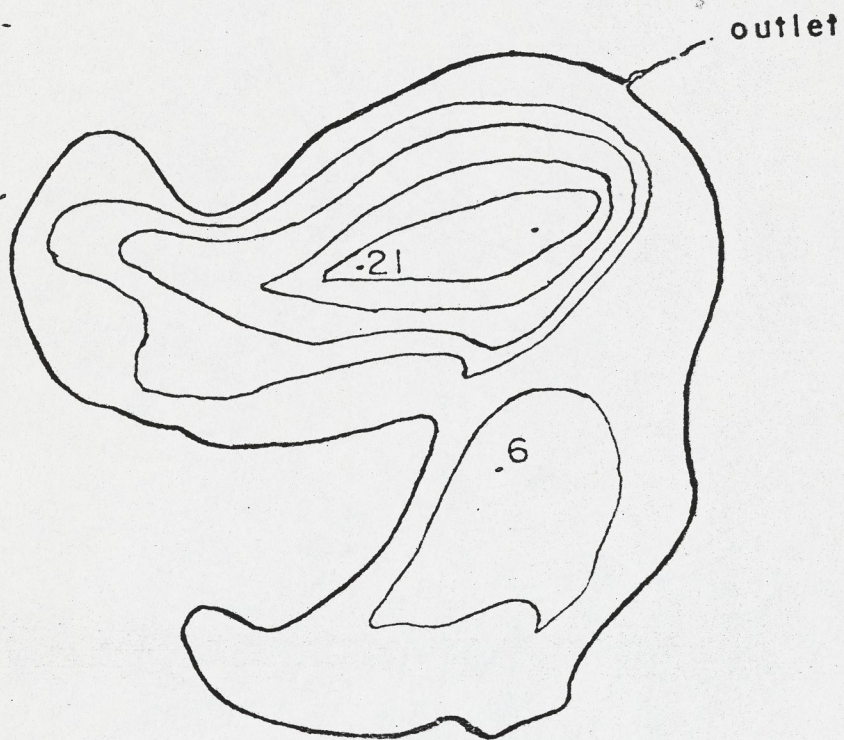
outlet
underground

TOURMALINE

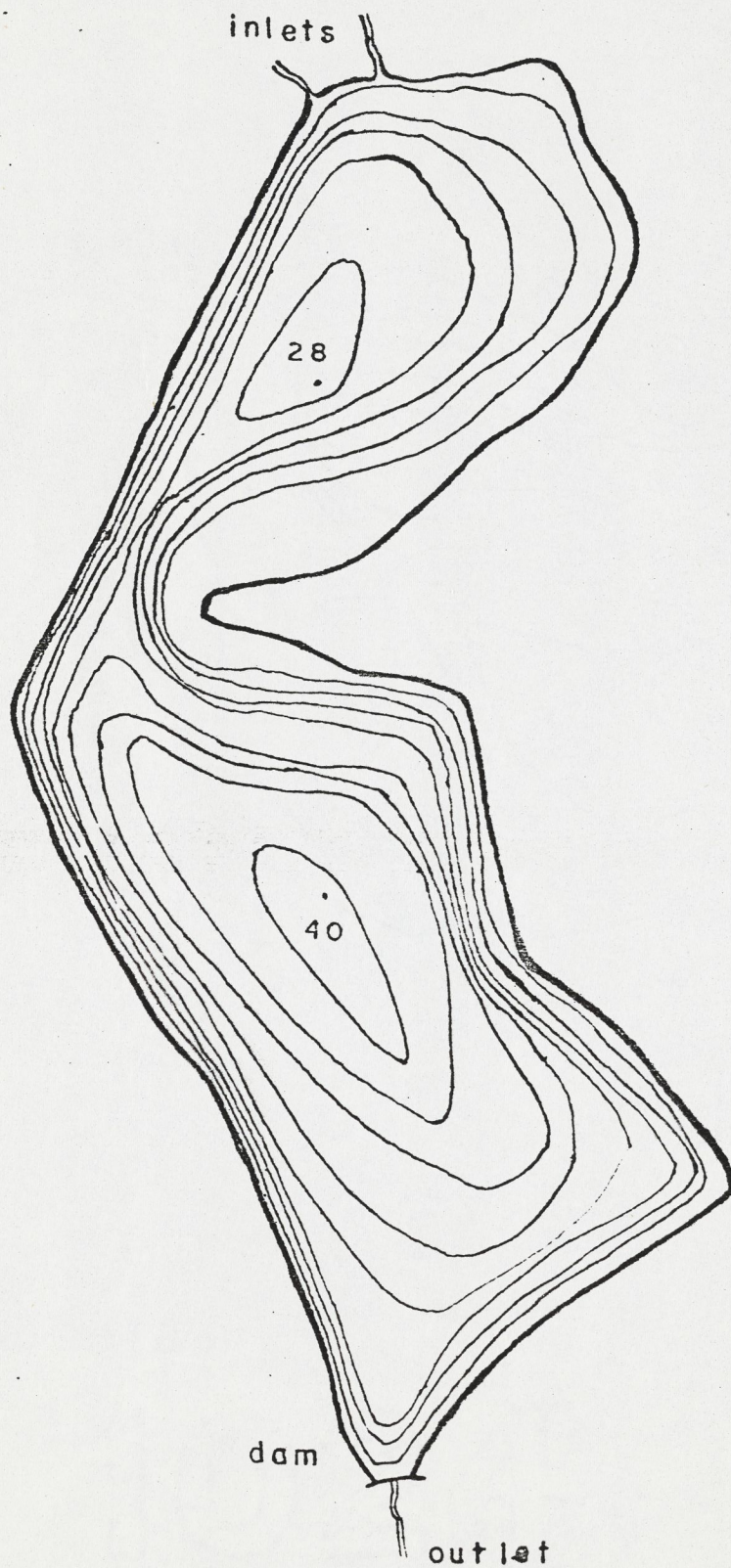




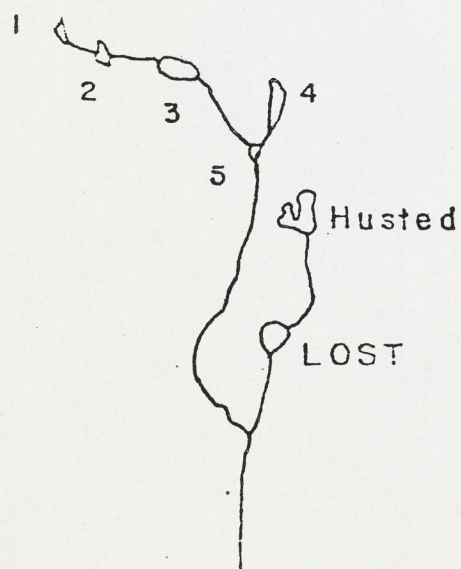
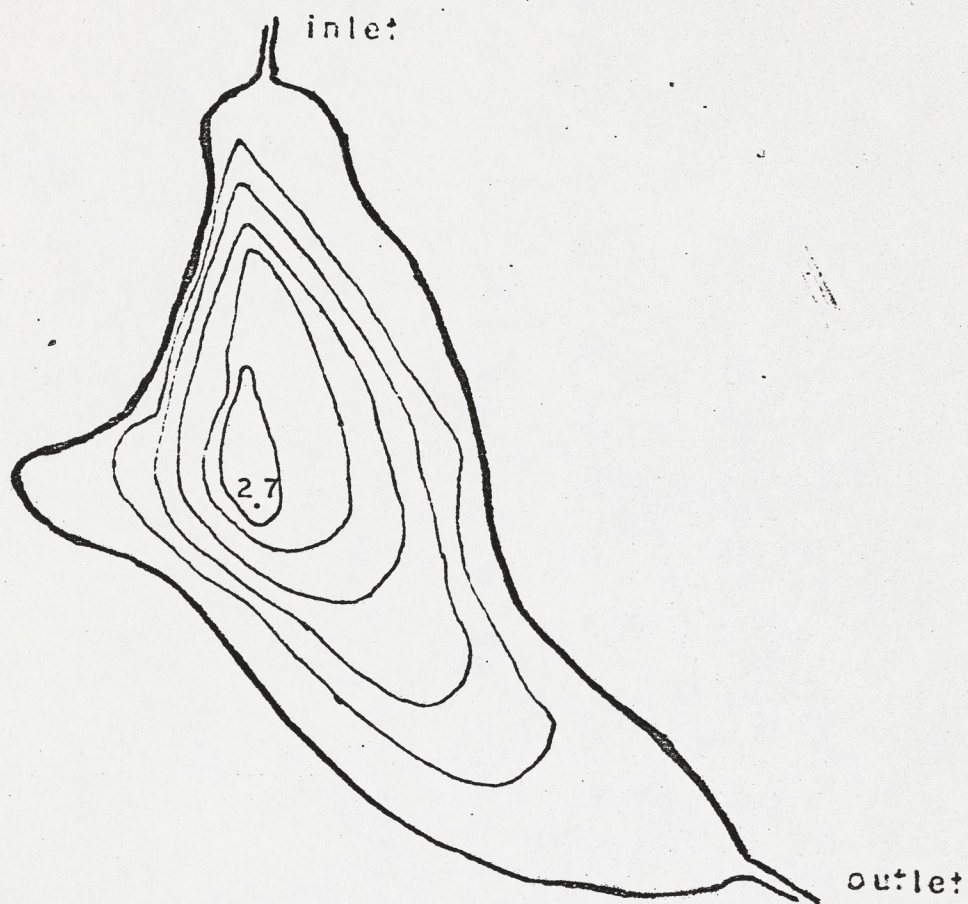
FERN LAKE



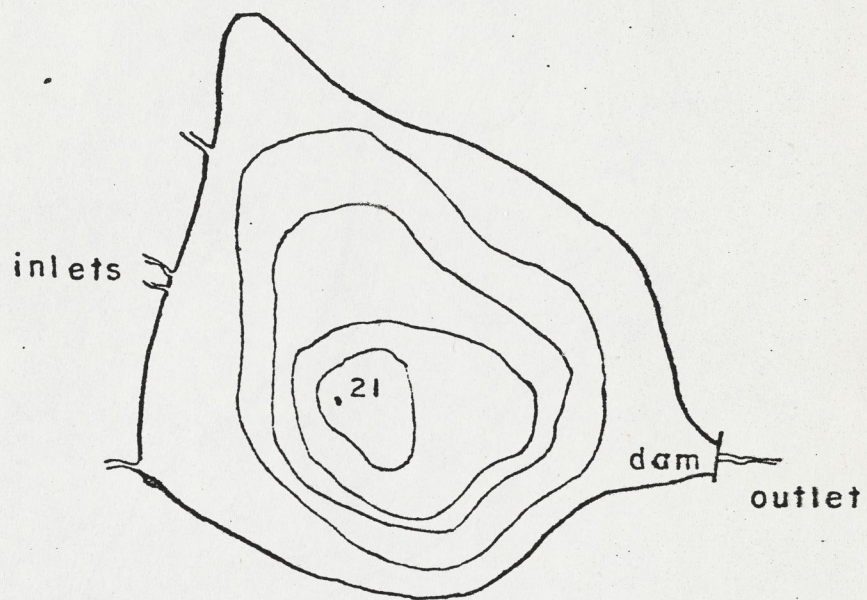
HUSTEDLAKE



SANDBEACH LAKE



NORTH FORK NO. 1



LOST LAKE