OBSERVATIONS ON THE MOVEMENTS AND REPRODUCTION OF THE CASCADE FORM OF CUTTHROAT TROUT

by

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INTRODUCTION

This thesis presents the results of studies primarily concerned with the life history of the cutthroat trout, Salmo clarkii Richardson, which were conducted from June, 1956, through September, 1957, in Lookout Creek and its tributaries which are located in an experimentally logged area of the Willamette National Forest.

The increased cutting of our virgin forest in the high Cascade region of Oregon has created a need for biological knowledge concerning the cutthroat trout, which is one of the region's native game fishes. Proper management of this fish must be based on a knowledge of its life history and the factors limiting its populations. Such information may make it possible to adjust logging procedures to cause the least possible danger to populations of cutthroat trout.

The major objectives of the study were: (1) to determine the distribution of all species of fish in the Lookout Creek and Blue River drainages; (2) to learn more about the life cycle of cutthroat trout, particularly with regard to age, migration and reproduction; (3) to determine trout movements between Lookout Creek and its tributaries; (4) to determine by stock and recruitment studies whether the tributaries play a large role as brood streams

for Lookout Creek; (5) to maintain observations on the influence of controlled logging on stream conditions.

This investigation was initiated in 1951 by the Oregon Cooperative Wildlife Research Unit[1] in conjunction with the Willamette Research Center of the U.S. Forest Service. In 1951 and 1952, Mr. Donald Wustenberg (11, p. 1 - 51) completed a preliminary survey of the influences of controlled logging on the cutthroat trout of Lookout Creek. Other investigations being carried on by the Forest Service include a study of the influence of logging on annual stream runoff.

[1]United States Fish and Wildlife Service, Oregon State Game Commission, Wildlife Management Institute, Agricultural Research Foundation, cooperating

DESCRIPTION OF LOOKOUT CREEK, ITS TRIBUTARIES, AND THE SURROUNDING AREA

Lookout Creek and Surrounding Area

The H. J. Andrews Experimental Forest, Figure 1, lies on the west slope of the Cascade Mountain Range in Lane County, Oregon, within the boundaries of the Willamette National Forest, and comprises 14,000 acres of 300-year-old Douglas-fir, Pseudotsuga menziesii (Menzies), timber and 1,265 acres of experimentally logged land.

Lookout Creek and its major tributaries, Mack Creek and McRae Creek, Figure 2, have about 17.5 miles of stream bed and drain the entire experimental forest. Lookout Creek enters Blue River, a large tributary of the McKenzie River. Angling was not permitted on Lookout Creek above Tributary 0 from 1952 to 1959. Observations on trout distribution were also made in the South Fork McKenzie River, which drains an area south of the experimental forest, as well as in Deer Creek, a stream having a portion of its source on the eastern slope of Carpenter Mountain. Carpenter Mountain and Lookout Mountain border the eastern edge of the experimental forest and have elevations over 5,000 feet. Lookout Creek elevations range from 1500 feet at its confluence with Blue River to 3,000 feet in Upper Lookout Creek.

Figure 1. Aerial Photo of H. J. Andrews Experimental Forest, Courtesy of U.S. Forest Service

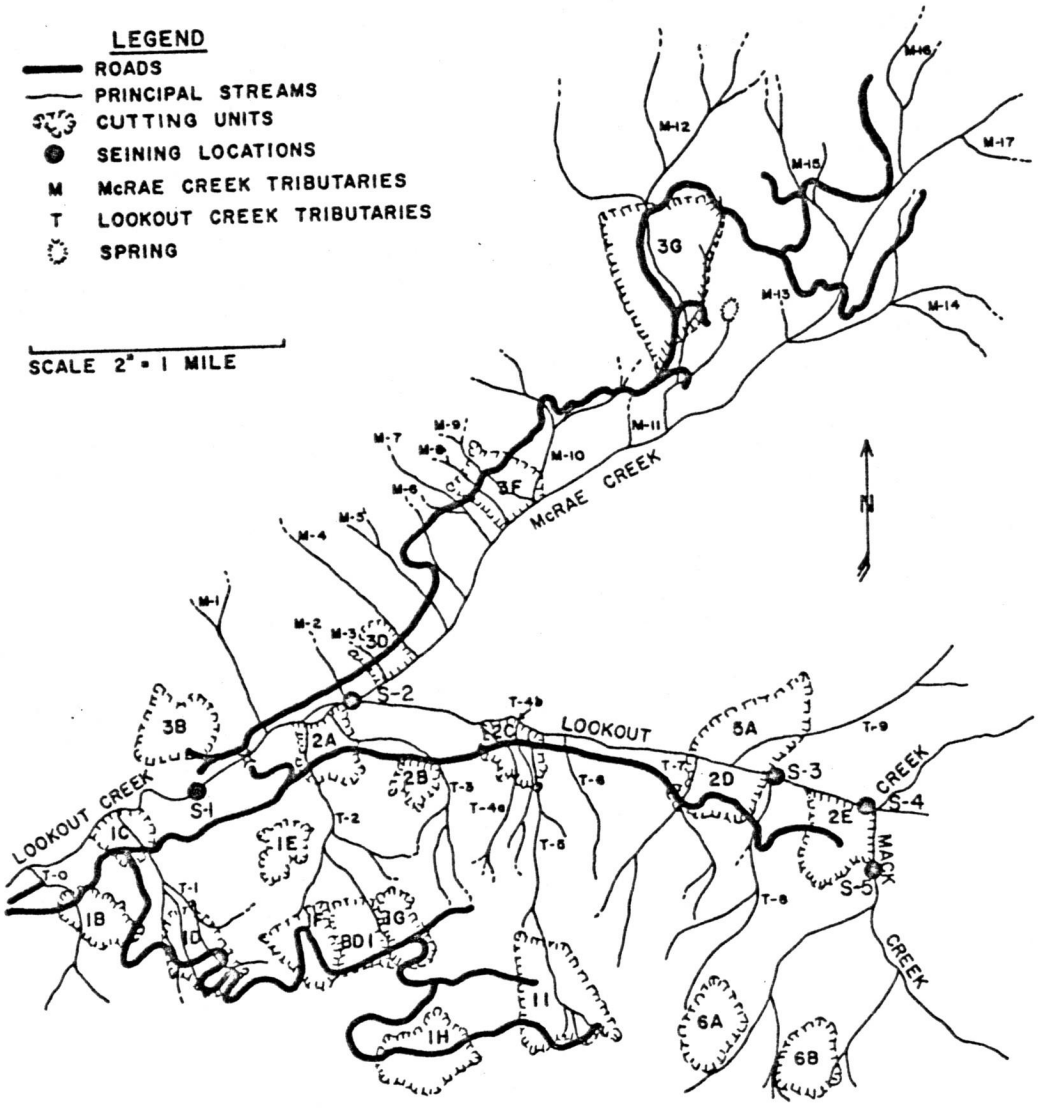

FIGURE 2. H. J. ANDREWS EXPERIMENTAL FOREST LOOKOUT CREEK AND PRINCIPAL TRIBUTARIES.

The staggered-setting system of logging, Figure 1, which involves removal of forest cover from scattered blocks or "units" of timber, is employed on the H. J. Andrews Experimental Forest. These units range in size from 15 to 70 acres, with 38 acres being about average. Slash is burned on each unit following logging. Blocks of timber are sold to private operators by the U.S. Forest Service. The method of logging and road building are specified in contracts drawn up in conformity with the experimental logging plan. Under this system of logging, damage to the streams may be kept at a minimum. The numerical prefixes in the names of cutting units refer to the block of timber sold to a certain operator under a specific contract. For example, Unit 2A, Figure 2, signifies that this was the A unit of the second block of timber sold.

Dominant stream bottom types present in this area are boulders, rubble, and bedrock. According to U.S. Forest Service records taken at the Lookout Creek gauging station, the water flows of that stream from June, 1956, to September, 1957, ranged from 2409 cubic feet per second to 7.5 cubic feet per second. Extreme high water occurred when a snow pack was melted by warm winter rains. Water temperatures from a U.S. Forest Service thermograph ranged from 33°F. to 64°F. during this same period.

Lookout Creek Tributaries

Lookout Creek tributaries, Figure 2, were given designations of 0 through 9. South-slope McRae Creek tributaries were given designations of 1 through 14 and were distinguished by the prefix "M". All tributaries given numerical designations throughout the text are reported as being "small tributaries". Portions of all of the study streams were located in logged-off regions. Water flow estimates were taken in all tributaries during the spring spawning movement and again in July, after fry had emerged from the gravel; estimates were obtained through the use of Embody's formula (8, p. 252). On May 14, Mack and McRae Creeks were flowing 15 and 9 cubic feet per second, respectively. During the same period, small tributary flows measured in cubic feet per second were 0.5 in Tributary 0, 1.5 in Tributary 2, and 1.7 in Tributary 8. Summer minimum flows measured in cubic feet per second were 0.1 in Tributary 0, 0.2 in Tributary 2, and 0.3 in Tributary 8. Mack and McRae Creek summer flow estimates were 2.4 and 1.2 cubic feet per second, respectively, Table 1.

Monthly mean temperatures for June, July, and August, 1956, in Tributary 2 were 57.5°F., 61.1°F., and 60.5°F., respectively. In contrast, temperatures on Tributary 8 were seven or eight Fahrenheit degrees lower during this

same period. The high of 69°F. was recorded for Tributary 2 on July 24, 1956. Mean temperatures, Table 1, in the main stream for June, July, August, and September were 48.3°F., 57.7°F., 58.4°F., and 55.7°F., respectively. The minimum temperature of 32°F. was recorded for the small tributaries, while the lowest recorded temperature for Lookout Creek was 33°F. For a more detailed description of stream temperature and how it is influenced by logging, the reader is referred to Wustenberg (11, p. 34-41).

METHODS AND MATERIALS

Trapping

Inclined-screen traps, Figure 4, were used to capture downstream migrating fish; each trap consisted of a live box and inclined screen attached to a rectangular water weir which blocked the entire stream. All of the downstream migrants were probably captured except during extreme high water. Fish migrating upstream were taken in "V - type" traps, Figure 5. Wings to guide fish into the traps were constructed by placing sections of 1-inch-mesh chicken wire against a rock barrier built at angles downstream from the trap, thus blocking the entire stream.

The first trap frames were made of 2" x 4" lumber and the bottoms were covered with 1" x 6" shiplap.

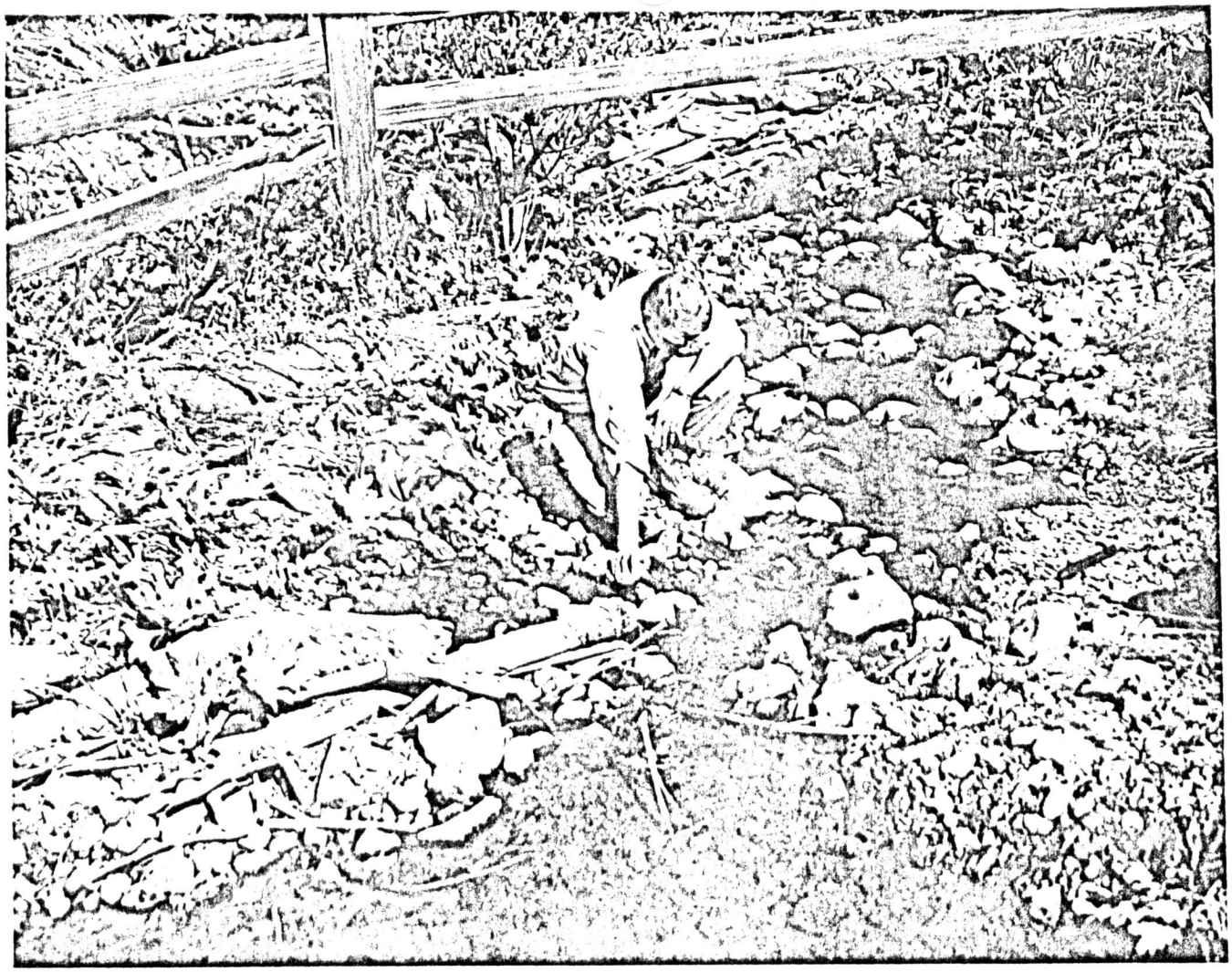

Figure 3. Typical Small Tributary

Table 1

General Information on Logging Activity, Water Flow, Water Temperature, Cutthroat Trout Habitat and Insect Abundance, in 1956 and 1957, for Lookout Creek and Eight Tributaries

Tributary	T-0	T-2	T-7	T-8	T-9	M-12	McRae Creek	Mack Creek	Lookout Creek
Date Logged	1951	1951	1952	1957	1954	1953	1953	1952	-
Maximum 1956 Temperature	-	69°F.	-	61°F.	-	70°F.	-	56°F.	64°F.
Mean Temp.									
June, 1956	-	57.5°F.	-	-	-	-	-	-	48.3°F.
July, 1956	-	61.1°F.	-	54.3°F.	-	60.2°F.	-	54.9°F.	57.7°F.
Aug., 1956	-	60.5°F.	-	52.1°F.	-	-	-	53.8°F.	58.4°F.
Maximum Flow 1956-57, cfs.	40	53	38	50	68	85	268	317	2409
Minimum Flow 1956-57, cfs.	0.1	0.2	0.2	0.3	0.3	0.4	1.2	2.4	7.5
Stream Damage	Large slide	Channel change	Heavy silt-	Large slide	Major slide	-	-	Log barriers	Slides, etc.
Insect Abundance	Mod-erate	Mod-erate	Mod-erate	Mod-erate	Little	Great	Great	Great	Great
Approx. Yds. of Stream Containing Fish	300	600	75	300	600	1500	-	-	-

Downstream fry traps were covered with 1/8"-mesh hardware cloth, while upstream traps were covered with 1/4"-mesh wire. In periods of high water in the early part of the study, it became evident that wooden-framed traps used in the two large tributaries of Lookout Creek were extremely bouyant and susceptible to frequent washouts. Four newly-designed traps, Figure 5, with frames of 1/2" galvanized pipe and equipped with heavy hardware-cloth bottoms, were used during the spring runoff period. When adequately anchored, these traps were highly resistant to washouts. The pipe-framed traps were also light and easy to install.

From November 1, 1956, until June 15, 1957, upstream V-type traps were maintained at the confluences of three of the tributaries with Lookout Creek, (Mack Creek and Tributaries 2 and 8), to gain information concerning upstream adult movement. During the spring, additional traps were placed at the confluences of McRae Creek and Tributary 0. A trap located within 15 yards of the confluence of a tributary with Lookout Creek is referred to as a "confluence trap". Additional traps were maintained at varying intervals above the confluence traps in Tributaries 0, 2, and 8 to determine the distances trout moved to reach Lookout Creek. During the summer and fall of 1956, and in the summer of 1957, downstream inclined-screen traps were maintained at the confluences and at varying intervals above the confluences of Mack Creek,

Figure 4. Inclined Screen Trap

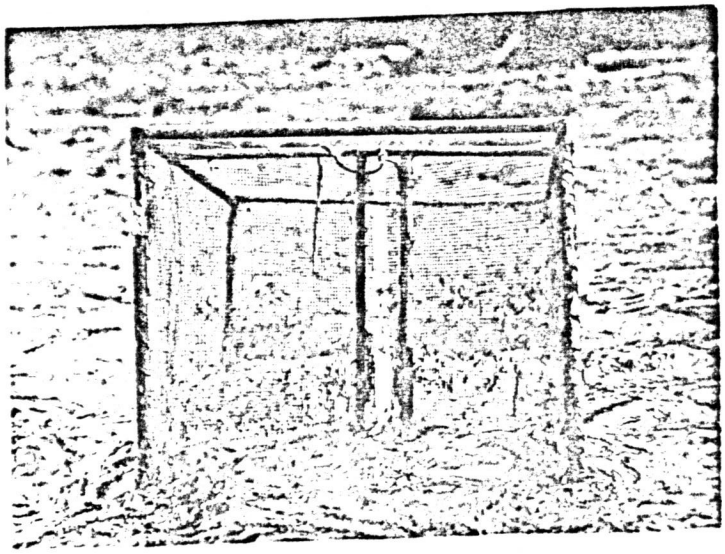

Figure 5. V-type Trap

and Tributaries 2, 8, and M-12 to study downstream juvenile movement. In 1957, additional traps were maintained on Tributaries 0, 7, and 9. Downstream traps were located above the confluences of the tributaries to gain information concerning the origin of migrant juveniles.

Marking and Sampling

Various combinations of fin marks were used to identify adult migrants which were moving into and fry which were moving out of the small tributaries. Because of their small size, fry less than two months old were anesthetized with chloretone before marking. When the number of possible fin marks was exhausted, sub-cutaneous injections of rubber latex (3, p. 95-96) were used to distinguish fish from the various marking stations in Lookout Creek.

In order to study the general movement of trout in Lookout Creek, five seining stations (S-1, 2, 3, 4, and 5) were established approximately one-half mile apart, from Mack Creek to the lower edge of Unit 3-B, Figure 2. From 1955 through 1957, trout were captured, marked, and returned to the water at these seining stations. Information on the movements of trout taken the previous year could thus be obtained during subsequent seining operations. From October, 1956, to June, 1957, marking was intensified at and between seining locations S-3 and S-4.

Mark and recapture areas between the seining locations are referred to as seining sub-stations. For convenience of reporting, data from the sub-stations are lumped with the results for the nearest seining station. Recoveries of marked fish were made in August and September, 1957, with the aid of cresol and electrofishing equipment. In addition to sampling, sightings of marked fish were made during underwater surveys.

The number of fry contained in Tributary 0 and the lower part of Tributary 2 were counted by diverting the stream and removing the dead or dying fish. The upper portion of Tributary 2, along with Tributary 8, had to be treated with rotenone and the fish scooped out of the water with a dip net. Dead or dying fish were placed in buckets filled with water and taken back to the laboratory to be weighed, measured, and sexed. Fork length measurements are used throughout this paper. Efficiencies of the two methods of capture were tested by marking a number of fish in a section of stream and comparing the percentage recoveries during the inventory, Table 12.

Skin diving with the aid of a rubber face mask, snorkel, and rubber suit was effective in determining the species and numbers of fish present in portions of the Blue River Drainage, Figure 6. In making underwater censuses, the diver drifted downstream identifying and counting the fish observed. Records of new species, fin

Figure 6. Method of Underwater Survey

marks, numbers of fish seen, and other phenomena along the way were tabulated by a second individual on the bank. Dorsal, anal, and caudal fin marks were easily identified, while pelvic and adipose marks were more difficult to see. Species determination of adult fish was possible in most cases. The person on the bank also aided in measuring the stream length surveyed and the size of pools.

In Lookout Creek seining stations, population estimates were made by the mark-recovery method, by counting stunned fish during cresol application and by underwater counts. The cresol sample probably resulted in an underestimate of the population. At S-4, 73 fish were taken by this method while only a week previously from 83 to 87 fish were counted by the underwater method. The mark-recovery method may have resulted in an overestimate of the actual population, since the previous year, a population estimate of 155 fish was obtained at this same station.

Age Analysis

Collections for age analysis were taken from Lookout Creek, Mack Creek, and Tributary 8. Nearly all of the fish present in the lower section of Mack Creek and Tributary 8 were collected with applications of rotenone and cresol. In Lookout Creek electrofishing was employed and only a sample of the trout was obtained. From this original

sample of 400 trout, 270 fish were selected on the basis of size for age analysis. When possible, twenty trout were selected from each three-centimeter length class to insure that adequate numbers from each age group would be present in the sample. Scale samples were taken from each fish from the left side just below the dorsal fin. In the scale analysis, it was found that regenerated scales were extremely abundant on some fish, and 51 samples had to be re-collected from the preserved specimens. Even though repeated sampling was tried, 19 fish had to be discarded from the sample. Scales were read with a microprojector which had magnifications of 112 and 224 diameters. The high power was employed as a check when doubtful readings were obtained under low magnification. Because of the limited time available, accuracy of the age determinations was not checked by tagging trout. Decreases in growth rate due possibly to aging and environmental limitations caused the annuli in some trout to form at increasingly closer intervals near the margins of the scales. It is therefore believed that some cutthroat may be a year older than is indicated by scale readings.

OBSERVATIONS ON THE LIFE HISTORY OF THE CUTTHROAT TROUT

Distribution of Fish in the Blue River Drainage

Rainbow trout were apparently dominant in streams with summer flows in excess of five cubic feet per second. Cutthroat trout seemed to prefer the upper portions of streams where the flow was less than five cubic feet per second. Dominant cutthroat trout populations were also found in small tributaries (with summer flows between one and five cubic feet per second) flowing into larger streams dominated by rainbows. Although other regions were not inspected, it may be that this general cutthroat-rainbow relationship exists throughout the Cascade Mountains of central Oregon. The Oregon whitefish, coarse-scaled sucker, and chinook salmon were confined by a falls to the lower portion of Blue River.

The following species of fish were observed in the Blue River drainage:

Salmo gairdnerii (Richardson). . . . . rainbow trout
Salmo clarkii (Richardson) . . . . . cutthroat trout
Oncorhynchus tshawytscha (Walbaum) . . . chinook salmon
Prosopium oregonium (Jordan and Snyder) .Oregon whitefish
Catostomus macrocheilus (Girard) . . coarse-scaled sucker
Rhinichthys cataractae (Girard) . . . . . longnosed dace

Rhinichthys nubilus (Girard) . . . . . black-sided dace
Cottus beldingii (Eigenman and Eigenman). smooth bullhead
Cottus rhotheus (Rosa Smith). . . . . torrent sculpin

Rainbow trout were dominant in lower Blue River, while in the headwaters, cutthroat predominated. During marking operations over 500 fish were handled in Lookout Creek from the section extending from two miles to four miles above its confluence with Blue River. Less than 2 per cent (10 fish) were rainbows. Wustenberg (11, p. 6) found that 50 per cent (33 fish) of the trout caught in the lower portion of Lookout Creek were rainbow trout. This distribution of cutthroat and rainbow trout in relation to stream size was also found to occur on the Upper South Fork McKenzie River and on Deer Creek, which is a tributary of the McKenzie River.

Dominant cutthroat populations were observed in a small tributary flowing into the lower one-half mile of the South Fork McKenzie River, and in Luckyboy Creek which drains into lower Blue River. Both the South Fork McKenzie River and Blue River contained dominant rainbow populations. All tributaries studied (Tributaries 0, 2, 7, 8, 9, and M-12) contained relatively unmixed populations of cutthroat trout. Only two rainbows were found migrating into Tributary 2 during the spring, while no rainbows were found in this tributary during the summer fry inventory.

Tributaries 0, 2, 7, 8, 9, and M-12 altogether contained approximately 4.5 miles of stream, but only 1.3 miles of this water was inhabited by cutthroat trout. Existence of stream barriers was probably the main reason for the absence of fish from most of this water.

As suggested by Greenberg (6, p. 269-299), some species of stream fish appear to have a "peck" order and to occupy specific niches within a pool. Most of the cutthroat trout in the pools of Lookout Creek were concentrated in, or adjacent to, the surge of water at the head of each pool. Larger fish appeared to prefer and defend territories just below the surface surge. Smaller and less aggressive fish seemed to be pushed into possibly less desirable places to either side of the main surge and, to a lesser degree, to lower portions of the pool. Still others took positions in dark areas under overhanging rocks, usually near the head of the pool; these fish were darker in color than the other trout.

Migrant salmonids from the McKenzie River and the lower part of Blue River are usually blocked by a falls, Figure 7, located two miles below the confluence of Lookout Creek with Blue River. Although salmon are known to utilize the lower part of Blue River, only on one occasion have they been observed above this falls. In September, 1957, a gravid female chinook salmon was collected from the Luckyboy Pool which is one-half mile above

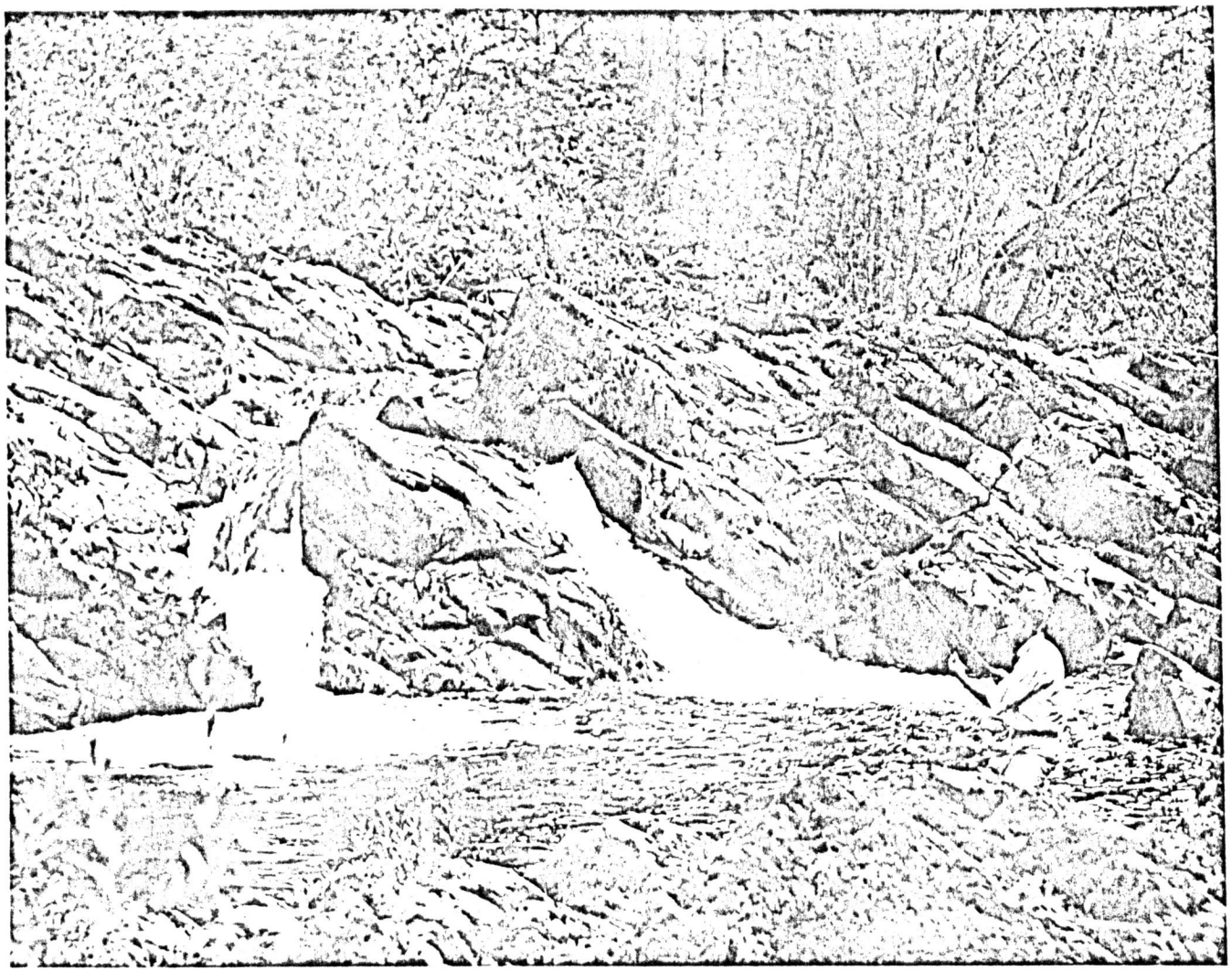

Figure 7. Blue River Falls

the falls.

This falls also marks the upper limit of the distributions of the Oregon whitefish and the coarse-scaled sucker in Blue River. Both the black-sided dace and long-nosed dace have been taken from Lookout Creek as far upstream as a mile from its confluence with Blue River. The torrent sculpin was found in Blue River but was not numerous. The smooth bullhead was collected from Tributaries 1 and 2 and from Lookout Creek; this species is believed to be present throughout Lookout Creek, but it is not numerous.

Underwater survey observations indicated that portions of Blue River and South Fork McKenzie River are heavily populated with coarse-scaled suckers. On August 20, 1957, 60 coarse-scaled suckers over ten inches in length were counted in a single pool 150 feet long and 50 feet wide at a point one-half mile below the Blue River Falls. Other pools surveyed below the falls on Blue River contained from one to ten coarse-scaled suckers, from one to eight whitefish, and numerous trout. Over 100 coarse-scaled suckers were observed in the lower mile of the South Fork McKenzie. Fewer than 30 trout, ten inches long or over, and five adult chinook salmon were also observed in this same area. Fish-of-the-year and yearling salmonids were extremely abundant.

Analyses of stomach contents of two coarse-scaled suckers taken on May 7, 1957, and one in August revealed only a few caddis fly larvae.

According to Carl and Clemens (1, p. 69-70), suckers compete to some extent with game fish for food, and they feed upon fish eggs. Even though young suckers are eaten by game species, these fish may be undesirable. Underwater observations of large rough-fish concentrations and the apparent scarcity of game fish in lower Blue River and the South Fork McKenzie suggest the possibility of competition between the rough and game fish species. Coarse-scaled suckers will undoubtedly increase rapidly and spread to all parts of the Blue River system when the proposed U.S. Army Corps of Engineers dam is constructed below the Blue River Falls.

Age and Size at Maturity of Cutthroat Trout

Cutthroat trout in the Lookout Creek area were generally found to be short-lived, Figure 8. Since scale samples were taken from all of the larger fish collected, presumably scales from some of the oldest fish were examined. Scale analysis indicated that 95.3 per cent of the cutthroat trout collected were from three months to three and one-fourth years old, Table 2. Four and three-tenths per cent of the fish were four years old, and only one fish was five years old. This is not surprising, since

Fleener (5, p. 243) working with cutthroat trout from the Logan River, Utah, found that only a small percentage of fish lived to be three years old.

Table 2

Mean Fork Length in Centimeters of 251 Cutthroat Trout of All Age Groups Collected From Lookout Creek and Mack Creek on September 16, 1957, and from Tributary 8 on August 2, 1957

	T-8		Mack Creek		Lookout Creek	
Age Group	No. in Sample	Mean Length	No. in Sample	Mean Length	No. in Sample	Mean Length
0	20	4.05	16	5.57	19	5.19
I	35	7.20	24	9.05	10	9.40
II	18	10.40	20	11.95	16	12.71
III	8	12.30	22	14.15	28	15.60
IV	4	13.60	4	15.05	6	19.60
V	0	0	0	0	1	23.90
Total	85		86		80	

The size of three-year-old cutthroat trout varied between Lookout Creek and its tributaries, Table 2. Samples of fish in their third year from Lookout Creek had a mean fork length of 15.60 centimeters (6.1 inches). The mean fork length for similar samples from Mack Creek and Tributary 8 were 14.15 centimeters (5.5 inches) and 12.30 centimeters (4.8 inches), respectively. The length of

the largest fish collected was 27.0 centimeters (10.6 inches). The legal limit of cutthroat trout is 15.24 centimeters (6 inches). The legal fork length obtained from a conversion factor of .48 centimeters was 14.76 centimeters (5.8 inches). The presence of small cutthroat is by no means an unusual situation in the McKenzie region. During angling trips and creel checks in the South Fork McKenzie area, only a few cutthroat trout in excess of 28.10 centimeters (11 inches) were observed.

A sample of 94 trout taken from a side channel of Lookout Creek just below S-2, contained six gravid males and four ripe females in the size group from 9.1 to 12.0 centimeters (3.58 to 4.72 inches). From Figure 8, it can be seen that trout in this size group would fall into age group I or II. During the spawning movement on Tributaries 2 and 8, 179 trout were checked for degree of sexual development. The above size group contained only five gravid trout. All fish examined in excess of 13.0 centimeters were found to be mature. Because of the small number of mature fish taken in the size group from 9.1 to 12.0 centimeters, it can be surmised that most of the trout at Lookout Creek do not mature until the end of the second year of life.

Scale formation in young fish began mainly during July in Tributary 0. Of 21 fish taken on July 23, 1957,

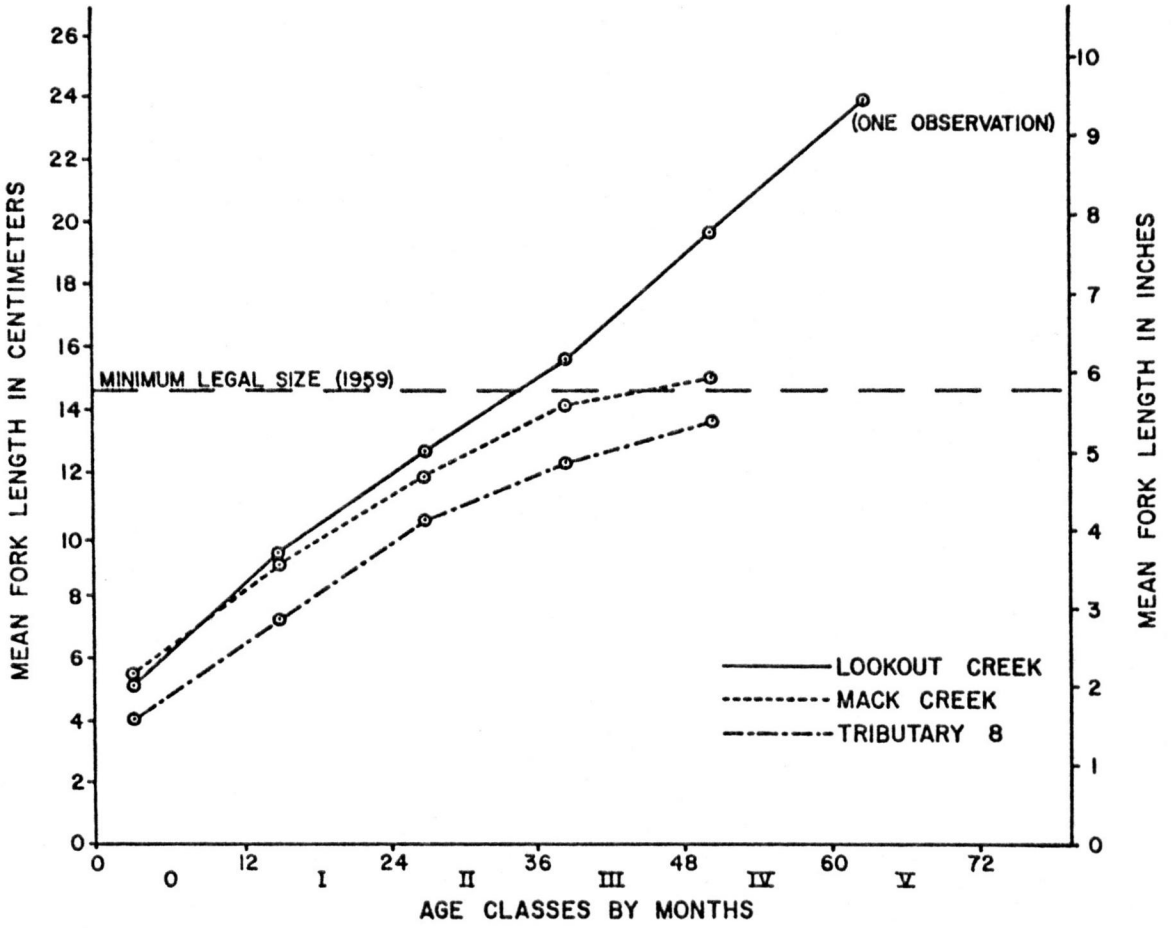

FIGURE 8. MEAN FORK LENGTHS OF 251 CUTTHROAT TROUT COLLECTED FROM TRIBUTARY 8, AUGUST 2, 1957, AND FROM MACK CREEK AND LOOKOUT CREEK, SEPTEMBER 16, 1957.

all had formed some scales in the dorsal fin area. Annulus formation may occur between October and February. No newly formed annuli were evident in a sample taken on September 16, 1957.

Adult Movement

Movement in Lookout Creek

According to Dimick and Merryfield (4, p. 29-31), two biological phases of cutthroat apparently exist in the Willamette River system. The first, referred to as the "migratory phase", lives in the main river during the spring and summer and moves into the tributaries to spawn during the late fall and winter. The second type, referred to as the "non-migratory phase", lives in the upper stretches of the tributary streams.

Cutthroat in Lookout Creek are believed to be of the non-migratory phase. A mark and recapture program was carried on at seining locations S-1, 2, 3, 4, and 5 located approximately one-half mile apart on Lookout Creek, Figure 2. Mark and recapture sub-stations were maintained above and below each seining location; for convenience of reporting, returns from sub-stations and tributaries are lumped in with the returns for the nearest seining station. During the study period, 1112 trout were fin clipped or injected with rubber latex at the various stations, Table 3.

Table 3

The Number of Cutthroat Trout Marked at Lookout Creek From June, 1955, to September, 1957

	S-1	S-2	S-3	S-4	S-5	Total Marks
No. Marked While Seining, 1955	75	112	0	39	0	226
No. Marked While Seining, 1956	0	95	0	93	0	188
No. Marked at Seining Sub-stations, 1956-57	0	31	83	214	70	398
No. Marked at Traps, 1956-57	0	101	114		85	300
Total Marks	75	339	197	346	155	1112

Table 4

The Number of Mark Returns at Five Seining Locations on Lookout Creek From July, 1956, to September, 1957

	S-1	S-2	S-3	S-4	S-5	Totals
No. Fish Remaining In the Same Pool	0	16	0	34	0	50 (32.2)*
No. Fish Moving Less Than 200 Yds.	2	32	22	20	24	100 (64.6)
No. Fish Moving More Than 200 Yds.	1	1	1	0	2	5 (3.2)
Total No. of Mark Returns	3	59	23	54	26	

*Per cent of total mark returns

Of 155 mark recoveries made, Table 4, 32.2 per cent (50 trout) remained in the pool where they were first marked, 64.6 per cent (100 trout) moved less than 200 yards, and only 3.2 per cent (5 trout) moved more than 200 yards. Of 698 trout marked in S-3, 4, and 5, none were taken in a sample of 484 trout from the S-1 and 2 areas, indicating probably no major downstream migration of cutthroat occurred during the study period. The large percentage of trout remaining in the pool where they were first marked, 32.2 per cent, suggests that cutthroat in the Lookout Creek area may have a fairly restricted home range. This seems reasonable since Miller (9, p. 687-691) found that the average length of the home range of cutthroat trout from Gorge Creek, Alberta, Canada, was approximately 20 yards.

Spawning Movement into Small Tributaries

Little is known concerning spawning movements of the cutthroat trout. Although Dimick and Merryfield (4, p. 29-31) reported that the non-migratory phase of cutthroat trout spawns in May, June, and July, no reference was made to spawning movements into small tributaries. From late September, 1956, to early June, 1957, a trapping program was carried on to determine the extent and time of this movement.

From November 1 to January 6, cutthroat trout made

scattered visits into the tributaries. Forty adult trout, Table 5, entered Tributaries 2, 8, and Mack Creek. Since none of the migrant trout were observed to have ripe gonads, it is not likely that trout movement during the fall and early winter is related to reproduction. Maximum movement occurred between December 16 and 30. Records

Table 5

Adult Migrant Cutthroat Trout Entering Three Tributaries of Lookout Creek During November, December, 1956, and January, 1957

Date	T-2	T-8	Mack Creek	Total
Nov. 1-15	0	5	0	5
Nov. 16-30	1	3	1	5
Dec. 1-15	5	0	0	5
Dec. 16-31	10	12	0	22
Jan. 1-16	0	0	3	3
Totals	16	20	4	40

concerning the remaining tributaries were incomplete because of trap washouts. Movement up to the traps ceased when water temperatures dropped to 38°F. on January 6, 1957.

During late March, April, May, and early June, a spring spawning movement of cutthroat trout occurred in the Lookout Creek tributaries. During this three and

one-half month period, 351 cutthroat trout entered five tributaries of Lookout Creek, Table 6. Three per cent of

Table 6

The Total Number of Adult Cutthroat Trout Entering Five Tributaries of Lookout Creek During the Spring of 1957

Date	T-1	T-2	T-8	McRae Creek	Mack Creek	Totals
Feb. 10-20	0	0	0	0	0	0
Feb. 21-28	0	0	0	0	0	0
Mar. 1-10	0	0	0	0	0	0
Mar. 11-20	0	0	0	0	0	0
Mar. 21-31	0	11	5	4	0	20
Apr. 1-10	0	30	15	17	1	63
Apr. 11-20	0	16	15	26	8	65
Apr. 21-30	10	17	34	17	22	100
May 1-10	0	10	18	9	23	60
May 11-20	0	1	3	5	8	17
May 21-31	0	0	3	6	11	20
June 1-10	0	0	1	3	2	6
Totals	10	85	94	87	75	351

the migrants (10 fish) moved into Tributary 1, which was flowing approximately 0.5 cubic feet per second. Fifty-one per cent of the migrants (179 fish) entered Tributaries 2 and 8, which were flowing approximately 1.0 and

1.2 cubic feet per second, respectively. The remaining forty-six per cent of the migrants (162 fish) entered Mack and McRae Creeks, which were flowing approximately 14 and 10 cubic feet per second, respectively. Movement began during the last week in March and ended on June 8. The peak movement occurred during the last ten days in April, Table 6.

It can be seen from Figure 9 that the amount of trout movement was influenced by water temperature. No upstream or downstream movement of trout was observed in January, 1957, when water temperatures were below 38°F. Movement did not begin again until temperatures increased to 41°F. in March, 1957.

The period of spawning was generally thought to coincide with the period of spawning movement, beginning in the last week of March and ending the first week of June. Fry emergence was believed to occur mainly in June.

Information concerning the number of migrants that actually spawned in the tributaries is scant. During the migration, in April and May, 27 trout were taken in Tributary 2 as they moved out of the stream. Eighteen of these fish were spent, indicating that some spawning had occurred within the tributary. Observations of spent fish on this tributary the following year further substantiated this belief.

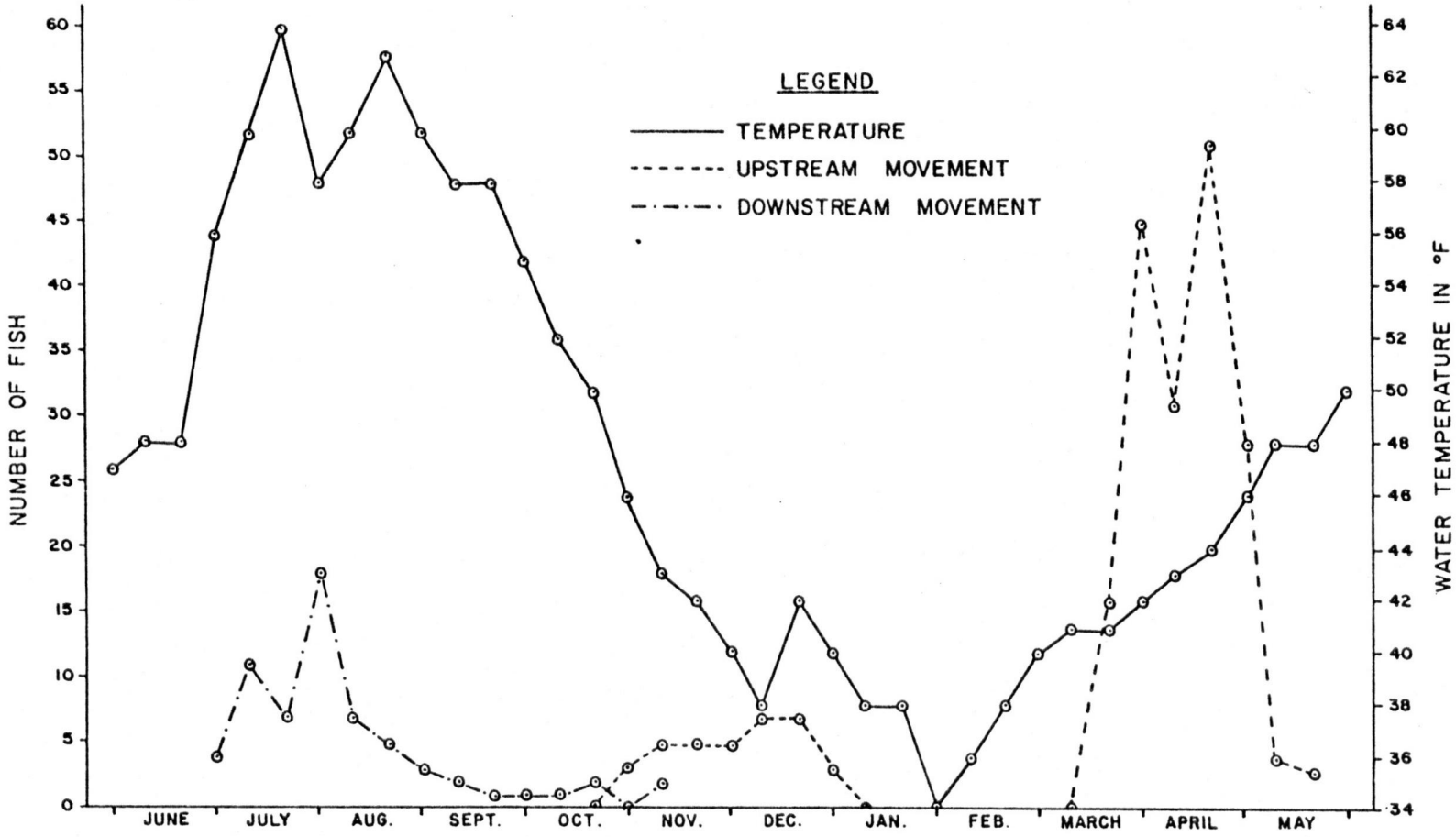

FIGURE 9. WATER TEMPERATURE AND MOVEMENT TRENDS ON TRIBUTARY 2 AND 8, 1956 AND 1957.

Some cutthroat trout were observed to return to Tributary 2 during two successive years. Trapping records from this tributary during 1958 revealed that 12 per cent of the trout (10 fish) marked the preceding year returned to the same stream the next year. This figure is presumably low because of fish taken in Tributary 2 by sampling and because of trapping mortality that may have occurred the previous year.

To measure the distance trout moved into the tributaries, traps were maintained at intervals of 15 yards (station 1), 25 yards (station 2), and 150 yards (station 3), above the confluence of Tributary 8. Traps were placed 15 yards (station 1), and 45 yards (station 2), above the confluence of Tributary 2.

From Table 7 it can be seen that 40 per cent (38 trout) of the fish entering Tributary 8 passed through station 2 (25 yards), while only one fish reached station 3, located 150 yards above the confluence. Although the data concerning Tributaries 0 and 2 were incomplete because of trapping difficulties, it was believed that a similar condition existed. From April 21 to June 30, only 14 per cent (12 trout) of the run was recorded at a point 45 yards above the confluence of Tributary 2, and no trout were observed to go as far as the 140 yard trap on Tributary 0. No migrants from McRae Creek were taken

in a trap located three-fourths of a mile above the confluence of Tributary M-12. Even though trapping may have influenced upstream movement, it appears likely that only the lower portions of the small tributaries are utilized by migrant spawners.

Table 7

Distances Gained in Linear Yards By 227 Migrating Adult Cutthroat Trout On Tributaries 2 and 8

	Tributary 2		Tributary 8		
Date	15 Yds. (Sta.1)	45 Yds. (Sta.2)	15 Yds. (Sta.1)	25 Yds. (Sta.2)	150 Yds. (Sta.3)
Mar. 21-31	11	no data	5	0	0
Apr. 1-10	30	no data	15	7	0
Apr. 11-20	16	no data	15	4	0
Apr. 21-30	17	0	34	7	1
May 1-10	10	10	18	11	0
May 11-20	1	1	3	4	0
May 21-31	0	1	3	5	0

From available published and unpublished information, it is evident that cutthroat trout movement is variable. Some trout were observed to move in and out of a tributary in the same day, while a few spent at least part of the summer in the tributaries. Trout were also observed to enter a tributary, move back down to the main stream, and

to return to the same stream another day.

To determine the length of time spent in tributaries by migrant spawners, trout were trapped as they moved in and out of Tributary 2 during April and May. Of 14 marked trout captured during this period, 12 spent less than two weeks in the stream, the other two fish spending more than a month. One migrant in Tributary 2 and five migrants in Tributary 8 were captured while sampling more than a month after the spawning migration had ended.

Migrants were also observed to return to Lookout Creek and to re-enter the tributary a second time. Nineteen trout, or 22 per cent of the run, entered Tributary 2 for a second time; 32 fish, or 34 per cent of the run, re-entered Tributary 8. Since it is believed that some of these migrants passed back through the trapping area due to slight injuries incurred in trapping or marking, these figures may be higher than would be expected under normal conditions of undisturbed migration.

Since no fish were ever observed entering the tributaries during daylight hours, it seemed possible that migration occurred mainly at night. To check this, traps were inspected just before sunset and again at sunrise on Tributaries 2 and 8. In a period of six days, 25 trout entered the two tributaries during the day and 18 trout entered during the night, Table 8. Cutthroat in

this area apparently do not exhibit diurnal differences in the amount of movement.

Table 8

Diurnal Fluctuations in Migration of Cutthroat Trout on Tributary 2 and Tributary 8, From April 3 to May 4, 1957

	Tributary 2		Tributary 8	
Date	Day catch	Night catch	Day catch	Night catch
Apr. 3	5	5	1	2
Apr. 4	3	0	2	1
Apr. 8	3	0	0	0
Apr. 24	1	1	0	1
Apr. 29	3	1	5	3
May 4	1	4	1	0
Totals	16	11	9	7

Cramer (2, p. 338) reported a 1.1:1 (males to females) sex ratio for 257 coastal cutthroat trout from the Alsea River. In 1955, Hansen (7) reported a sex ratio of 1.3:1 for 70 trout moving into a small tributary from the Willamette River. In Lookout Creek, males dominated the catch throughout the migration. A sex ratio of 4.7:1 was obtained for 69 cutthroat trout moving into four tributaries during the first three weeks of the migration. During the peak of the run in late March, the arrival of additional females had decreased the ratio to

1.4:1. The sex ratio throughout the entire run for 318 trout was 1.3:1. A sample of 154 fish taken in September, 1957, from Lookout Creek and Mack Creek resulted in a 1.2:1 sex ratio.

It would seem that male fish slightly dominated the spawning run and possibly the cutthroat population of Lookout Creek. The dominance of males in the run might be expected because they mature at an earlier age than do the females.

During the spring, as the spawning migration progressed, the size of migrant spawners decreased from a mean of 17.2 centimeters in April to 15.1 centimeters in May. No significant difference was observed between the size of male or female fish during the run.

Juvenile Downstream Movement Out of Small Tributaries

Little is known concerning the downstream movement of resident or non-migratory juvenile and adult cutthroat trout in Oregon streams. At Lookout Creek, a small number of fry moved out of the tributaries during June, July, and August, soon after emergence from the gravel. Some of the fish, however, spent the first summer and winter in tributary streams, and moved out as yearlings (nine-month-old trout between 6 and 9 centimeters in length are considered to be yearlings) during March, April, May and June. A few

fish spent two or more winters in the tributaries before moving into the mainstream in the spring. Although little movement occurred during mid-winter, some cutthroat trout drifted out of the tributaries during nearly all months of the year.

Small numbers of cutthroat trout fry drifted out of the small tributaries after emergence from the gravel. From June through November in 1956, 51 fry, 7 yearlings, and 6 adults moved out of Tributary 2 and Tributary 8, Table 9. In 1957, traps were operated on three additional tributaries (Tributaries 0, 7, and 9) until the fry inventory in August and September. During late June, July, and early August, 70 fry, 5 yearlings, and 7 adults moved out of these tributaries, Table 10. Although migration occurred throughout the summer and fall, most of the summer downstream movement occurred in July of 1956 and 1957. Minimum water flows in the late summer and early fall are believed to be the major cause of a decrease in the movement as the summer progressed.

At Mack Creek, one of the large tributaries of Lookout Creek, the number of downstream fry migrants captured was comparable to the number of fry moving out of the small tributaries. During the summer of 1957, 20 fry moved out of Mack Creek compared to a run of 31 fry in Tributary 8 in 1956, Table 9.

Table 9

Downstream Movement of Fry and Adult Cutthroat Trout In Two Tributaries of Lookout Creek From June 15 to December, 1956

Date	T-2			T-8			Total
	Fry	Yearling	Adult	Fry	Yearling	Adult	
June	1	2	0	0	1	0	4
July	13	3	0	20	0	0	36
Aug.	4	0	0	7	1	2	14
Sept.	0	0	0	3	0	1	4
Oct.	0	0	0	1	0	3	4
Nov.	2	0	0	0	0	0	2
Total	20	5	0	31	2	6	64

In the summer of 1956, one trap was placed approximately 100 yards above the confluence trap on Tributary 2 to determine if fry moved from the headwaters of the small tributaries to reach the main stream. In the summer of 1957, traps were installed approximately 100 yards above the confluence traps in Tributaries 0, 2, and 8. The 30 fish passing through these traps were marked and returned to the stream. None of these trout were subsequently taken in the confluence traps, indicating that few fish from the upper portions of small tributaries reach the main stream during the summer. In other words, most of the trout moving out of the tributaries during

Table 10

Downstream Movement of Fry, Yearling, and Adult Cutthroat Trout In Five Tributaries of Lookout Creek From June 15 to September 16, 1957

Date	T-0		T-2		T-7		T-8		T-9		Total
	Fry	Yearling and Adult	Fry	Yearling and Adult	Fry	Yearling and Adult	Fry	Yearling and Adult	Fry	Yearling and Adult	
June 15-30	3	0	5	2	3	0	2	4	1	1	21
July 1-15	4	0	3	0	10	0	6	1	2	0	26
July 16-31	3	0	5	0	2	0	4	0	4	0	18
Aug. 1-15	1	0	0	0	5	0	3	2	0	0	11
Aug. 16-31	0	0	0	0	2	0	2	2	0	0	6
Total	11	0	13	2	22	0	17	9	7	1	82

this period were believed to come from the lower portion of these small streams.

Downstream movement of cutthroat fry was almost non-existent in Tributaries 2 and 8 during November, December, January, and February in 1956. Although trap washouts hampered movement studies in the fall, only three cutthroats were captured in confluence traps of the two tributaries. Presumably because of low water temperatures, no movement occurred in Tributaries 2 and 8 during January and February.

In March, April, May, and early June, a spring movement of yearling and adult trout occurred in Tributary 2, and presumably in other small streams. Trout moving through the trap into the lower 100-yard section of Tributary 2 were considered to have moved into Lookout Creek. Since migrant spawners were unable to reach the area above the trap because of a log barrier, trapped migrants can be considered resident fish moving out of the area for the first time. In the spring of 1957, 24 yearling and 12 adult cutthroat trout moved from Tributary 2 into Lookout Creek, Table 11. It is interesting to note that only 11 adults moved out of the tributary during the remainder of the year, indicating that older fish preferred to move downstream in the spring. A similar yearling migration was thought to occur on Tributary 8, but due to

trap washouts, only two yearling cutthroat were taken.

To substantiate the fact that a spring migration occurs, and to better define its limits and magnitude, a trapping study was carried on in a small tributary referred to as Luckyboy Creek, draining into the north side of Blue River approximately 300 yards downstream from the Old Scout Camp.

In 1958, from March 15 until June 15, 59 yearlings and 12 adult cutthroat were trapped as they moved out of this stream into Blue River, Table 11. Peak movement

Table 11

Spring Downstream Movements of Juvenile and Adult Cutthroat and Rainbow Trout on Tributary 2 of Lookout Creek in 1956, and Luckyboy Creek, Tributary to Blue River, in 1957

	Tributary 2		Luckyboy Creek			
	Cutthroat		Cutthroat		Rainbow	
Date	Yearling	Adult	Yearling	Adult	Yearling	Adult
Mar. 1-15	1	1	-	-	-	-
Mar. 15-31	2	2	10	5	1	1
Apr. 1-15	4	3	11	1	1	2
Apr. 15-30	4	3	9	1	0	1
May 1-15	3	1	20	5	4	2
May 15-31	6	0	5	0	0	0
June 1-15	2	1	4	0	0	0
Totals	22	11	59	12	6	6

occurred during May in Luckyboy Creek as it had in Tributary 2 the preceding year.

Twelve rainbow trout were captured moving out of Luckyboy Creek, indicating that this species may also contribute trout to Blue River.

Stock and Recruitment

Mature cutthroat trout stock in Lookout Creek tributaries consisted of gravid spring migrants and resident spawners. Observations of spawning and downstream catches of spawned-out migrants indicate that at least some of the migrants utilized these areas for spawning. Because of the lack of quantitative information concerning spawning use, the relative importance of these two stocks remains obscure. In the Lookout Creek tributaries, the presence of large numbers of gravid migrants in some of the tributaries did not result in substantial increases in the numbers of fry produced. Failure of gravid migrants to spawn, poor reproductive conditions, or high mortality of embryos or fry may be possible reasons for this condition.

Information regarding stock was obtained during spring upstream trapping activities. Recruitment estimates were obtained approximately one month after the fry had emerged from the gravel. Two methods were used to enumerate the number of fry contained in the

lower 210-foot section of each tributary. On Tributaries 0 and 2, fry were counted after the water was diverted from these small streams. In the upper portions of Tributary 2 and Tributary 8, this was not feasible, and the streams had to be sampled with the aid of rotenone. Downstream traps were placed at the confluence of each tributary to make certain that none of the fry in the production areas went uncounted. The major sources of error in juvenile counts occurred in the areas treated with rotenone where fish were observed to lodge themselves under rocks in attempting to evade the irritation of the toxic chemical. Some of these fish undoubtedly went uncounted. To test this belief and to get at least an estimate of the number of fry present, juveniles were marked before sampling and a population estimate obtained by the mark and recovery method. In Tributaries 0 and 2, where water was diverted out of the stream, mark recoveries of 92.8 per cent and 85.7 per cent were obtained. Comparatively lower percentage recoveries were made in the areas treated with rotenone. Forty per cent of the originally marked fish were recovered in Tributary 8, and a 33 per cent recovery was obtained in upper Tributary 2.

From Table 12, it can be seen that fry production in Tributary 0 and in Tributary 2 was nearly the same (68 fry were produced in Tributary 0, and 74 fry in Tributary 2). However, 75 more gravid migrants were observed in

Table 12

The Estimated Population of Fry from the Lower 210 Foot Sections of Three Tributaries of Lookout Creek. The Sampling Method Used and Percentage Recovery Are Included.

Tributary	T-0	Lower T-2	T-8	Upper T-2
Sampling Method	Diversion	Diversion	Rotenone	Rotenone
No. Fry Caught	63	64	10	9
No. Fry Marks Recovered	13	12	4	3
Per cent Recovery	92.8%	85.7%	40.0%	33.3%
Estimated Fry Population	68	74	25	27
Available Gravid Migrants	10	85	94	0

Tributary 2 than in Tributary 0. A similar comparison can be made between Tributary 0 and Tributary 8. In Tributary 8, 25 fry were produced compared to 68 fry in Tributary 0. Ninety-four gravid migrants moved into Tributary 8, compared to only ten moving into Tributary 0. In upper Tributary 2, where migrant spawners were not present, 27 fry were produced. These observations indicate that little or no relationship exists between the size of the spawning run and the corresponding number of juveniles produced.

Development of logging policy concerning small tributaries must be based on a knowledge of the ecological

relationship between these tributaries and Lookout Creek. To understand this relationship, factors such as water chemistry, flow, and temperature, along with stock and recruitment, must be considered. This investigation deals mainly with stock and recruitment.

The role that small tributaries play as brood streams for Lookout Creek will remain obscure until the factors limiting trout numbers in the main stream are determined. With the information available, it may be possible to state that small tributaries are probably insignificant as brood streams. The observations which follow are the basis for this belief: (1) Stream surveys showed that only 1.3 miles of the 4.5 miles of small tributaries in the drainage contained trout populations. (2) The lower 100-yard sections of Tributary 0 and Tributary 2 were observed to dry up in the late summer, thus taking probably the most important sections of these streams out of production. (3) The number of fish moving out of the small tributaries was small compared to existing trout populations in Lookout Creek. Only 262 trout of all ages were captured moving out of the tributaries during all periods of trapping. In comparison, 310 cutthroat were observed in a 300-yard section of Lookout Creek during underwater survey counts in 1957. In 1952, Wustenberg (12, p. 8) estimated that 1000 trout were present in the S-1 seining location approximately 120 feet long and 30 feet wide. (4) The

number of potential fry migrants contained in the small tributaries was not great. One month after emergence from the gravel, an estimated population of 194 fry was obtained from four 210-foot sections of stream in Tributaries 0, 2, and 8.

SOME OBSERVATIONS ON THE INFLUENCES OF LOGGING ON STREAM CONDITIONS

Siltation

Siltation, stream bed scouring, and changes in stream channel were more evident on the logged tributaries than on streams which were not logged. High silt concentrations during maximum water flows were apparently caused by dirt and mud slides resulting from logging operations. Slides changed the channels in Tributaries 0 and 9 during the winter of 1958. A sudden release of water, which had been backed up by a slide in Unit 5-A, deposited large amounts of silt in Tributary 9 and in Lookout Creek. The same storm brought a similar occurrence in Tributary 0. During high water in 1957, lower Tributary 2 would have changed course had a log jam not been removed. No major stream changes of this nature were observed in virgin areas.

Determinations of suspended particles (silt) were made during the winter of 1956-57. Samples were analyzed by the Gooch crucible method generally used by the U.S. Geological Survey (10, p. 5). Sampling stations were maintained just above the confluences of Lookout Creek, Mack Creek, Tributary 2, Tributary 8, and on Blue River above the confluence of Lookout Creek. Samples were collected only during high water when silt concentrations could be presumed to be at a maximum. During flooding on

December 11, 1956, high silt concentrations of 187.0 parts per million in Tributary 2 and 83.0 parts per million in Tributary 8 were obtained, Table 13. During two subsequent high water periods, on February 14 and 22, all silt concentrations recorded at the five stations were less than 44.5 parts per million. On December 21, 1957, Lookout Creek had a silt concentration of 820.0 parts per million, the highest recorded. Three large slides

Table 13

Suspended Particles of Silt in P.P.M. at Five Stations on the Blue River and Lookout Creek Drainages

Date	Lookout Creek	Blue River above the Lookout Creek confluence	T-2	T-8	Mack Creek
Dec. 11 1956	5.4	18.0	187.0	83.0	10.0
Feb. 14 1957	44.5	8.1	8.0	4.4	.7
Feb. 22 1957	24.0	8.8	37.0	26.4	9.4
Feb. 25 1957	24.7	26.0	-	-	-
Dec. 20 1957	820.0	119.0	-	-	-

occurring at approximately the same time were believed to be the major cause of such a high silt concentration. During this same storm, a concentration of only 119.0 parts

per million was observed on Blue River above its confluence with Lookout Creek. It is evident that dirt or mud slides into streams due to road building or other logging operations can be major sources of siltation in streams.

Influences of Logging on Aquatic Life

Aquatic insect life in Lookout Creek appeared to consist mainly of caddis larvae (Trichoptera), mayfly naiads (Ephemeroptera), stonefly naiads (Plecoptera), and midge larvae (Diptera).

From 1953 to 1956, an insect sampling program was carried on in Lookout Creek and two of its tributaries in an attempt to describe any trends in insect numbers due to logging activity. The methods and general results of this study are contained in a paper prepared for the Fish and Game Department at Oregon State College (12). Results of this study suggested that generally insect numbers in Lookout Creek and its tributaries were not seriously influenced by the method of logging used.

Wustenberg (11, p. 30-31) found that insect numbers in small tributaries were depleted immediately following logging, but that after two years the insect population began to increase again. Observations following Wustenberg's study in 1956, reported on in the previously mentioned paper, suggest that in some instances an increase in insect numbers may occur after logging. In Tributary

M-12, 3.1 times more insects were counted at a station located in the logged-off region than were observed on this same stream in virgin timber. Exposure of the stream to the sun's rays and the resulting algal bloom may account for such an increase.

The type of logging employed in the experimental forest was capable of completely annihilating trout from the logged portions of small tributaries. However, it was found that if depleted areas were accessible to either spawning migrants from the main stream, or to fish from above the logged region, repopulation was likely to occur. According to Wustenberg (11, p. 32-33), in 1951, all of the fish occupying the logged portions of Tributaries 2, 5, and 7 were driven out of the stream or destroyed. Observations four years later on Tributary 2 showed that trout from above the distrubed area and spawning migrants from Lookout Creek had repopulated all sections of the stream. Repopulation occurred only in the lower 30 to 40 yards of Tributaries 5 and 7. On December 21, 1958, a major slide resulted in a large silt load in Tributary 9, and all of the fish were either destroyed or driven out of the lower one-third mile section of the stream. To date, fish have not repopulated this area.

From gross observations, there is no reason to believe that controlled logging seriously affected the

trout populations of the main stream. Observations during underwater surveys showed that an abundant trout population existed in the logged-off portion of Lookout Creek bordered by Unit 2-E. In a 300-yard section of Lookout Creek immediately below and including S-4, 310 cutthroats were counted. Similar population estimates were obtained on other portions of Lookout Creek during this investigation, and earlier by Wustenberg (12, p. 8). However, no definite conclusions can be made concerning the influence of logging until production studies are undertaken.

SUMMARY AND CONCLUSIONS

1. This investigation was initiated in 1956 by the Oregon Cooperative Wildlife Research Unit to gain information concerning the life history of the cutthroat trout in the high Cascade region. The major objectives of the study were: (a) to determine the distribution of all species of fish in the Lookout Creek and Blue River drainages; (b) to learn more about the age, migration, and reproduction of cutthroat trout; (c) to determine trout movements between Lookout Creek and its tributaries; (d) to determine by stock and recruitment studies whether small tributaries play a large role as brood streams for Lookout Creek; and (e) to maintain observations on the influence of controlled logging on stream conditions. Water flows in the main stream ranged from 7.5 to 2400 cubic feet per second during winter storms. Summer minimum flows in the small tributaries ranged from 0.1 to 0.4 cubic feet per second. Minimum flows in the two large tributaries were 1.2 and 2.5 cubic feet per second.

2. Information concerning fish distribution was obtained mainly through underwater surveys with the aid of a snorkel, face mask, and a rubber suit. Cutthroat trout were found to be prevalent in the tributaries and in the headwaters, while rainbow trout were more abundant in the lower portions of the streams studied. This general

distribution was observed on Lookout Creek, Blue River, Deer Creek, and the South Fork McKenzie River. Summer flows greater than five cubic feet per second may be favorable for rainbow trout, smaller streams apparently being more favorable for cutthroat trout. Chinook salmon and the Oregon whitefish were confined by a falls to the lower portion of Blue River. Lookout Creek contained no rough fish; however, large populations of coarse-scaled suckers present below the Blue River Falls could spread to all portions of the drainage when the water is backed up into Lookout Creek by the proposed U.S. Army Corps of Engineers dam.

3. Age determinations of 251 cutthroat trout were obtained by the scale method. Only a few fish at Lookout Creek live to be more than four years old. Adult fish were usually not large enough to be legal for the sport catch until their third year. All trout in excess of 13 centimeters in fork length were mature. Most trout were believed to mature during their second year. Scale formation was thought to occur mainly in July; annuli were apparently formed between October and February.

4. Mark recoveries indicated no general downstream movement of cutthroat trout in Lookout Creek from June, 1956, to September, 1957. A large recovery of fish which had moved less than 200 yards suggests that some trout in

this area have a restricted home range.

5. Two upstream movements of adult trout into the tributaries of Lookout Creek were observed. The first of these occurred in October, November, December, and January and consisted of scattered visits to the tributaries. Since the fish were not reproductively ripe, no reason for this movement could be suggested. The second movement, which was related to reproduction, began the last week in March and lasted until the first week in June. During this period, 343 trout entered five tributaries. Peak movement into the tributaries occurred within the last ten days in April. Movement ceased when water temperatures dropped to 38°F. in January and began again when temperatures increased to 41°F. in March. The period of spawning was generally thought to coincide with the period of spawning movement. Little is known concerning the number of cutthroat trout that spawned in the small tributaries; a few spawners were known to have utilized these small streams. Migrants used only the lower portions of the small tributaries studied. There was considerable variation in the amount of time spent by trout in the small tributaries. Most of the fish may have spent less than two weeks in these streams, while a few remained for at least part of the summer. No diurnal fluctuations in the amount of movement were apparent. Some cutthroat (12.0 per cent of the first year's run)

were observed to return to the same tributary on two successive years. Male cutthroat dominated upstream movements throughout the run. Among mature fish, a predominance of males was thought possibly to occur in Lookout Creek. As the run progressed, the size of migrants decreased.

6. At Lookout Creek, a small number of fry drifted out of the tributaries during June, July, and August. In 1956, 51 fry moved out of two tributaries from June to November. In 1957, 70 fry moved out of four tributaries, from June until August. Peak movement occurred soon after emergence from the gravel in both years. Juveniles drifting out of the tributaries during the summer were believed to come from the lower portions of these small streams. Many of the fish spent their first summer and winter in the tributary streams, and moved out as yearlings during March, April, May, and June. Eighty-one yearlings and 17 adults moved out of two tributaries during this period. Peak Movement occurred in May. A few fish spent two or more winters in the tributaries before moving into the main stream in the spring. Little movement was found to occur during mid-winter.

7. No relationship was found to exist between the number of gravid migrants in a given stream and its corresponding fry production. Stock and recruitment studies indicated that small tributaries may be insignificant as

brood streams for Lookout Creek. However, no definite conclusions can be made until more is learned concerning the factors limiting trout numbers in Lookout Creek.

8. A silt sampling program was initiated to measure some of the gross effects of siltation on stream conditions. From the data, it is evident that dirt slides in the streams due to road building or other logging operations can be a major source of siltation. Cutthroat trout which disappeared from the small tributaries during logging were again evident in one stream and portions of two others. Although conclusive results could not be obtained concerning the main stream, no apparent gross damage resulted to trout or aquatic insect life following controlled logging in the experimental forest.

BIBLIOGRAPHY

1. Carl, G. Clifford, and W. A. Clemens. The freshwater fishes of British Columbia. (Handbook No. 5) Victoria, British Columbia Dept. of Education, Provincial Museum, 1948. 132p.

2. Cramer, Fredrick K. Notes on the natural spawning of cutthroat (Salmo clarkii clarkii) in Oregon. Proceedings, Sixth Pacific Science Congress 3:335-339. 1940.

3. Chapman, Donald W. Use of latex injections to mark juvenile steelhead. Progressive Fish-Culturist 19:95-96. April 1957.

4. Dimick, R. E., and Fred Merryfield. Fishes of the Willamette River system in relation to pollution. Corvallis, 1945. 58 p. (Oregon. Engineering Experiment Station. Bulletin 20)

5. Fleener, Richard B. Life history of the cutthroat trout, Salmo clarki Richardson, in Logan River, Utah. Transactions of the American Fisheries Society 81:235-248. 1952.

6. Greenberg, Bernard. Some relations between territory, social hierarchy and leadership in the green sunfish (Lepomis cyanellus) Physiology and Zoology 20:269-299. 1947.

7. Hansen, Edward. Cutthroat trout. Paper prepared for the Fish and Game Department, Oregon State College. 1955.

8. Lagler, Karl F. Freshwater fishery biology. Dubuque, Iowa, William C. Brown, 1952. 360 p.

9. Miller, Richard B. Permanence and size of home territory in stream-dwelling cutthroat trout. Journal of the Fisheries Board of Canada 14:687-691. Sept. 1957.

10. Theroux, Frank, E. F. Eldridge and W. L. Mallmann. Analysis of water and sewage. 3d ed. New York, McGraw-Hill, 1943. 274 p.

11. Wustenborg, Donald W. A preliminary survey of the influences of controlled logging on a trout stream in the H. J. Andrews Experimental Forest. Master's thesis. Corvallis, Oregon State College, 1954. 51 numb. leaves.

12. Wyatt, Bruce. The relationship of logging to insect abundance. Paper prepared for the Fish and Game Department. Oregon State College, 1957.