# ABUNDANCE AND MOVEMENT OF YOUNG TROUT IN A PORTION OF THE MADISON RIVER, MONTANA

by

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A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE

in

Fish and Wildlife Management

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Bozeman, Montana

June, 1968

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# ACKNOWLEDGEMENTS

I wish to thank Dr. C. J. D. Brown for directing this study and for help in preparing the manuscript. Thanks are due the Montana Fish and Game Department for the use of equipment and for the preparation of scales, and to the Bozeman Fish Cultural Development Center for supplying fish used in perfecting marking techniques. I wish to express appreciation to my wife, Mary Elizabeth for help and encouragement. I am grateful to fellow students who assisted with the field work.

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# ABSTRACT

The species, number, and size of young trout which occupy two areas of the Madison River; the changes in species composition over the study period; the extent of movement; and the specific habitat of young trout were studied during the summer of 1966 and the summer and fall of 1967. Brown trout and rainbow trout were found in the study areas, with brown trout being the most abundant. The ratio of rainbow trout to brown trout increased from 5.6:100 to 28.6:100 as the sampling period progressed in 1967. Young trout were generally found in water greater than 15 cm in depth where velocities were between 0.09 and 0.51 m/sec., and in or under dense overhanging shore vegetation. Most brown trout and rainbow trout were found in the upstream area, where greater amounts of aquatic vegetation and overhanging bushes existed. A total of 349 brown trout and 25 rainbow trout were marked and released during this study. A total of 132 brown trout and 10 rainbow trout were recaptured at least once. The maximum number of times that a brown trout was recaptured was 5, and that a rainbow trout was recaptured was 3. The trout in the study areas generally remained in the section or sub-section of original capture. The average straight-line distance outside of the section or sub-section in which originally captured was 11.4 m for brown trout and 6.4 m for rainbow trout.

# INTRODUCTION

Studies concerning fish population biology have generally dealt with adults. Only a relatively few have been done on fish less than one year of age. Some of the more important investigations on young salmonids are: survival of young brook trout in Michigan (Shetter, 1961; Latta, 1962); growth and survival of fingerling hatchery brown trout in New York (Shuck and Kingsbury, 1945); aggressive behavior of juvenile Coho salmon as a cause for emigration in Oregon (Chapman, 1962); migration behavior of juvenile rainbow trout in outlet and inlet streams of lakes in British Columbia (Northcote, 1962); behavior of juvenile Pacific salmon (Hoar, 1954), aggressive behavior of under-yearling Kamloops trout (Stringer and Hoar, 1955) and stream aquarium behavior of juvenile brown trout (Hartman, 1963). These last three were done in British Columbia.

The objectives of my study were to determine: (1) the species, number and size of young trout which occupy two small areas of the Madison River; (2) the change in species composition over a period of time; (3) the extent of movement; and (4) the specific habitat of the young trout.

The study areas were located about 40 km upstream from the mouth of the Madison River. One area was situated 0.5 km below the mouth of Cherry Creek on the east bank and the other was 2.0 km above the mouth of Cherry Creek on the west bank. The downstream area was located on the main river, while the upstream area was located on a side channel, which was approximately 25 m wide. The study extended from 3 August to 7 October 1966 and from 12 April to 4 December 1967. Quantitative information was

collected between 6 August and 16 September 1966 in the upstream area, and between 29 August and 4 December 1967 in the upstream and downstream areas.

## METHODS

Most fish were taken with the aid of a D. C. shocker and dipnet, however, some were collected with a seine or a dipnet alone. Each study area was divided into sections and sub-sections as illustrated in Figure 1. All sections were sampled at intervals of two weeks. Posts were placed at the corners of section 1A at the upstream area and at sections 2 and 3 at both areas. When water levels permitted, each of these sections was enclosed with a common sense seine (6.3 mm mesh) before collections were made. This procedure was followed to prevent young trout from escaping. In 1966, only the upstream area was sampled (sections 1A, 2, and 3). In 1967, sampling included sections 1, 2, 3, and 4 in both areas. Sections 2 and 3 were enclosed with a 3.2 mm mesh seine early in the season when fish were generally less than 90 mm and with a 6.3 mm mesh net later in the season when fish were somewhat larger. Two sampling passes were made along the shore, followed by two passes offshore at sections 1 and 4. The offshore portion included, as nearly as possible, a strip two meters wide beginning one meter from shore.

All trout less than 160 mm in total length were measured to the nearest millimeter. Trout larger than this were not measured, but their relative abundance was noted. Most small trout were marked (fin clip

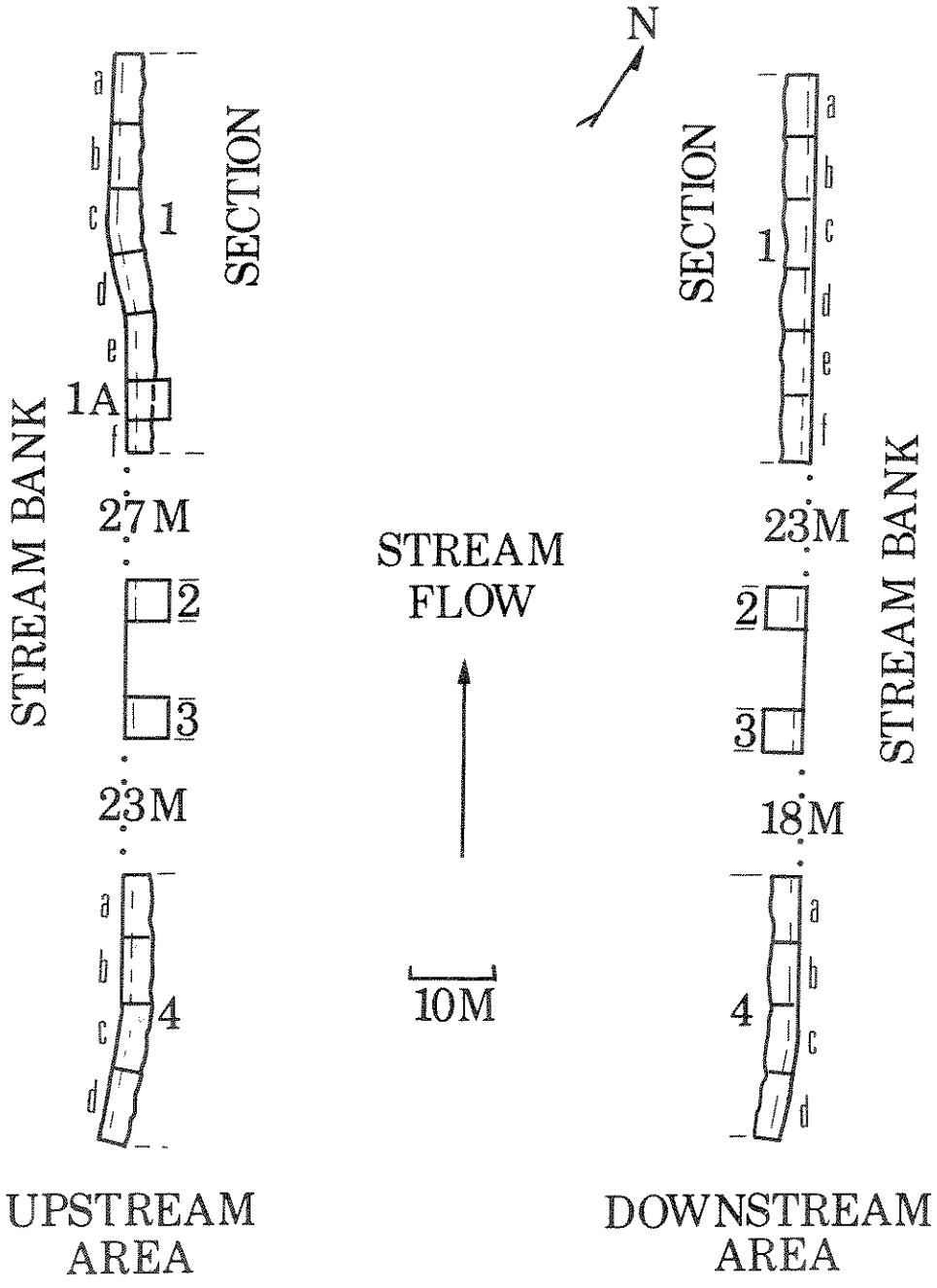


Figure 1. Map of the Study Areas on the Madison River, Montana.

and/or dye injection) in order to identify recaptures and place of release. Scales were taken from approximately 60 fish for age determination. Following these procedures, fish were allowed to recuperate before being distributed at random throughout the area from which they were captured. Some sampling was done outside and within approximately 100 m of regular sections in an attempt to capture marked fish.

Numerical analyses were restricted to the young trout. The number and density of trout are given for each section.

Water levels were determined from a reference marker during each sampling period. Velocities were obtained with a current meter at irregular intervals in 18 places within the sampling areas. These measurements were taken at 30 cm intervals, extending out from the shore. The boundaries of the sections and sub-sections were generally used for the measurements. Air and water temperatures and weather conditions were recorded for each sampling period. Sampling areas were mapped and the vegetation identified. Percentages of bottom material were determined using a modification of the Daubenmire method (Daubenmire, 1959). Five categories were recognized: silt - less than 0.02 mm in diameter; sand - from 0.02 to 2.0 mm; gravel - 2.0 to 25 mm; small rubble - 25.0 to 150.0 mm; large rubble - greater than 150.0 mm. Sampling plots, in linear series, were measured at each study area. These were approximately 2 m apart and at varying distances from shore (0.3 to 3.0 m).

## RESULTS

Determinations of depths, volumes, levels, bottom materials, angle of stream banks, temperatures, and vegetation were made to see if these influenced the number and distribution of young trout. The mean depth for the downstream area was 36.9 cm, with a range of 15.2 to 64.0 cm (118 measurements), while that for the upstream area was 33.2 cm, with a range of 12.2 to 79.3 cm (103 measurements). The mean volume for the downstream area was 0.57 cu.m/sec., with a range of 0.26 to 1.04 cu.m/sec. (10 measurements), while that for the upstream area was 0.51 cu.m/sec., with a range of 0.14 to 0.94 cu.m/sec. (8 measurements). Large variations in depths and volumes existed, depending upon when and where measurements were made.

Water levels were low during the first part of May, and increased to the maximum during June, 1967, due to runoff (Figure 2). A general decline followed and continued through mid-August. Water levels increased between mid-August and mid-October due to water manipulation at the dam upstream. A rapid decline began in mid-November and continued to the end of the sampling period. The bottom materials, in the order of decreasing abundance for the downstream area, were: small rubble, large rubble, gravel, silt, and sand (Table 1). In the upstream area, they were: small rubble, gravel, sand, large rubble, and silt. Stream banks were approximately vertical to the water surface at both study areas. Water temperatures generally decreased, from 20.5 C on 6 August to 11.0 C on 7 October 1966 and from 19.0 C on 29 August to 2.5 C on 6 November 1967. After this date, temperatures were fairly constant through 4 December, except for a temporary

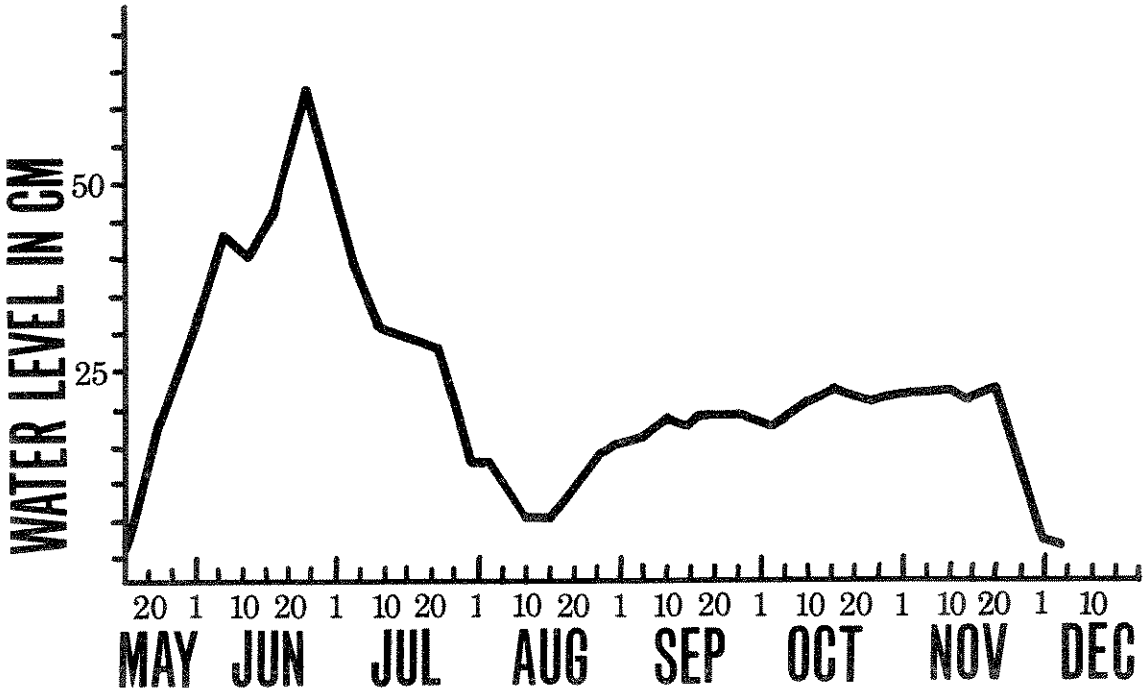


Figure 2. Water Level During the 1967 Sampling Period.

Table I. Percentage of bottom material in the study areas as determined by the Daubenmire method.

| Area | Bottom Materials | | | | |
|---|---|---|---|---|---|
| | Silt | Sand | Gravel | Small Rubble | Large Rubble |
| Downstream | | | | | |
| Number of samples | 200 | 200 | 200 | 200 | 200 |
| Sum of mid-point percentages | 792.5 | 242.5 | 1,970.0 | 10,687.5 | 5,132.5 |
| Mean percentage | 3.96 | 1.21 | 9.85 | 53.44 | 25.66 |
| Upstream | | | | | |
| Number of samples | 200 | 200 | 200 | 200 | 200 |
| Sum of mid-point percentages | 1,502.5 | 2,417.5 | 2,937.5 | 9,422.5 | 2,332.5 |
| Mean percentage | 7.51 | 12.09 | 14.69 | 47.11 | 11.66 |

increase of 6.0 C in mid-November. Shelf ice was present along the shore of the upstream area during the last sampling period.

Terrestrial vegetation adjacent to the shoreline was about 98% grass (Gramineae) and sedge (Carex) and 1% rose (Rosa) in the downstream area, while it was about 33% rose, 29% snowberry (Symphoricarpos albus), and 21% grass and sedge in the upstream area. The aquatic vegetation included filamentous algae (Cladophora), which occupied about 3% of the upstream area and 0.5% of the downstream area, and water milfoil (Myriophyllum

exalbescens), which covered about 9% of the upstream area and 7% of the downstream area. Other species of submerged aquatic vegetation were rare.

Brown trout (Salmo trutta) and rainbow trout (Salmo gairdneri) were common in the study areas; the former were the most abundant. The earliest seasonal collection of a young-of-the-year brown trout (23 mm in total length) occurred 30 April 1967. Young rainbow trout (25 mm and 31 mm) were first obtained on 5 May. Other species of fish taken were: mountain whitefish, Prosopium williamsoni; longnose dace, Rhinichthys cataractae; carp, Cyprinus carpio; Utah chub, Gila atraria; longnose sucker, Catostomus catostomus; mountain sucker, Catostomus platyrhnchus; white sucker, Catostomus commersonii; stonecat, Noturus flavus; bluegill, Lepomis macrochirus; and mottled sculpin, Cottus bairdii. The longnose dace, suckers and sculpin were by far the most abundant.

Location of trout. Young trout were generally found in water greater than 15 cm in depth, where velocities were between 0.09 and 0.51 m/sec., and in or under dense overhanging shore vegetation. Their locations were recorded for both the inshore and the offshore portions of the study sections in 1967. A total of 84.7% (233 of 275) of the trout were found in the inshore portions, which constituted approximately 32% of the study areas. A total of 85.7% (215 of 251) of the brown trout and 75.0% (18 of 24) of the rainbow trout were found in the inshore portions. In addition to the usual cover found in the inshore portions, uprooted aquatic vegetation clinging to overhanging shore plants, and flooded terrestrial plants

(especially the grasses) in late July also provided cover for the trout. Boussu (1954) reported that uprooted aquatic vegetation supplied cover for young trout.

Number and density of trout. The number and density of trout captured were determined in both 1966 and 1967 for each section (Table II). The upstream area had a greater number than the downstream area. A total of 94 brown trout and one rainbow trout were taken in the upstream area in 1966. Of these, 39 brown trout and the rainbow trout were taken in section 2. Four additional brown trout were collected outside of, but near to, the regular sections. A total of 251 brown trout and 24 rainbow trout were taken in 1967; of these 217 brown trout and 23 rainbow trout were from the upstream area. A total of 138 brown trout from this area was taken in section 1, while 16 of the rainbow trout were found in section 4. Section 1 of the downstream area had the most brown trout (21) prior to 9 October, and section 4 had the most (10) after this time. One rainbow trout was taken in section 1. An additional 309 brown trout and 46 rainbow trout were captured outside of regular sections.

The overall ratio of rainbow trout to brown trout increased as the sampling period progressed in 1967. For the periods designated, these ratios were: 29 August to 25 September — 5.6:100 (215 trout); 26 September to 23 October — 9.0:100 (167); 24 October to 20 November — 14.6:100 (206); 21 November to 4 December — 28.6:100 (42).

Table II. Number/section and density of brown trout and rainbow trout in the areas for the sampling intervals.

| Sampling interval | | Number and density (fish/$m^2$ surface)[1] | | | |
|---|---|---|---|---|---|
| | | Section | | | |
| 1966 | Species | 1A | 2 | 3 | |
| | | Upstream area | | | |
| 6-19 Aug | B** | 11 (0.5) | 16 (0.7) | 13 (0.6) | |
| 20 Aug-2 Sep | B | 9 (0.4) | 13 (0.6) | 10 (0.4) | |
| 3-16 Sep | B | 5 (0.2) | 9 (0.4) | 8 (0.3) | |
| | R** | | 1 | | |
| 1967 | | 1 | 2 | 3 | 4 |
| | | Downstream area | | | |
| 29 Aug-11 Sep | B | 6* | | | |
| 12-25 Sep | B | 5 | | | |
| 26 Sep-9 Oct | B | 4 | | | 1 |
| 10-23 Oct | B | 1 | | | 2 |
| 24 Oct-6 Nov | B | | | 1 | 3 |
| 7-20 Nov | B | | | | 3 |
| | R | | | | 1 |
| 21 Nov-4 Dec | B | | | | 2 |
| | | Upstream area | | | |
| 29 Aug-11 Sep | B | 22*(0.2) | 1* | 1* | 20*(0.2) |
| | R | 0.5* | | 0.5* | 1* |
| 12-25 Sep | B | 23*(0.2) | 1* | 1 | 9 (0.1) |
| | R | 0.5* | | | 5 |
| 26 Sep-9 Oct | B | 14 (0.1) | 2 (0.1) | 1 | 4 |
| | R | | | 1 | |
| 10-23 Oct | B | 11 (0.1) | 3 (0.1) | 1 | 5 |
| | R | 1 | | 1 | 4 |
| 24 Oct-6 Nov | B | 13 (0.1) | | 1 | 5 |
| | R | | | | 2 |
| 7-20 Nov | B | 10 (0.1) | | | |
| | R | | | | 2 |
| 21 Nov-4 Dec | B | | 1 | | |
| | R | | | 1 | 1 |

*Average of two samples taken during the interval.
** B — brown trout; R — rainbow trout.
[1]Density is less than 0.1 fish/$m^2$ surface when not given.

In general, higher densities were found in 1966 than in 1967. The maximum density for brown trout (0.7 fish/$m^2$ surface) for both areas occurred in section 2 of the upstream area in 1966. A progressive decrease occurred throughout the sampling periods in 1966 and 1967 for both study areas. The maximum density for rainbow trout (0.1 fish/$m^2$ surface) occurred in section 4 of the upstream area in 1967. The density did not change substantially throughout the sampling period.

Length frequency distribution. A total of 659 brown trout (1966, 1967), and 69 rainbow trout (1967) were measured. Length frequencies are given for each two week interval for brown trout and 4 week interval for rainbow trout. Fish taken during each collection period were grouped in 10 mm length intervals (Figure 3). A total of 59.2% of the brown trout were in the two length intervals between 81 and 100 mm in total length in 1966, while 59.3% were in the three length intervals between 81 and 110 mm in 1967. A total of 63.8% of the rainbow trout were in the three length intervals between 81 and 110 mm. The smallest brown trout was 58 mm in total length and the largest 160 mm, while the smallest rainbow trout was 64 mm and the largest 152 mm (Table III). Trout larger than 160 mm in total length were rarely found in the study areas. In general, the average size and the range in total length increased from the first collection period to the last in both 1966 and 1967.

Age. The ages of the larger fish including 52 brown trout and 13 rainbow trout taken during 1967 were determined by scale analyses. Only four brown trout and two rainbow trout had one annulus; the remainder had

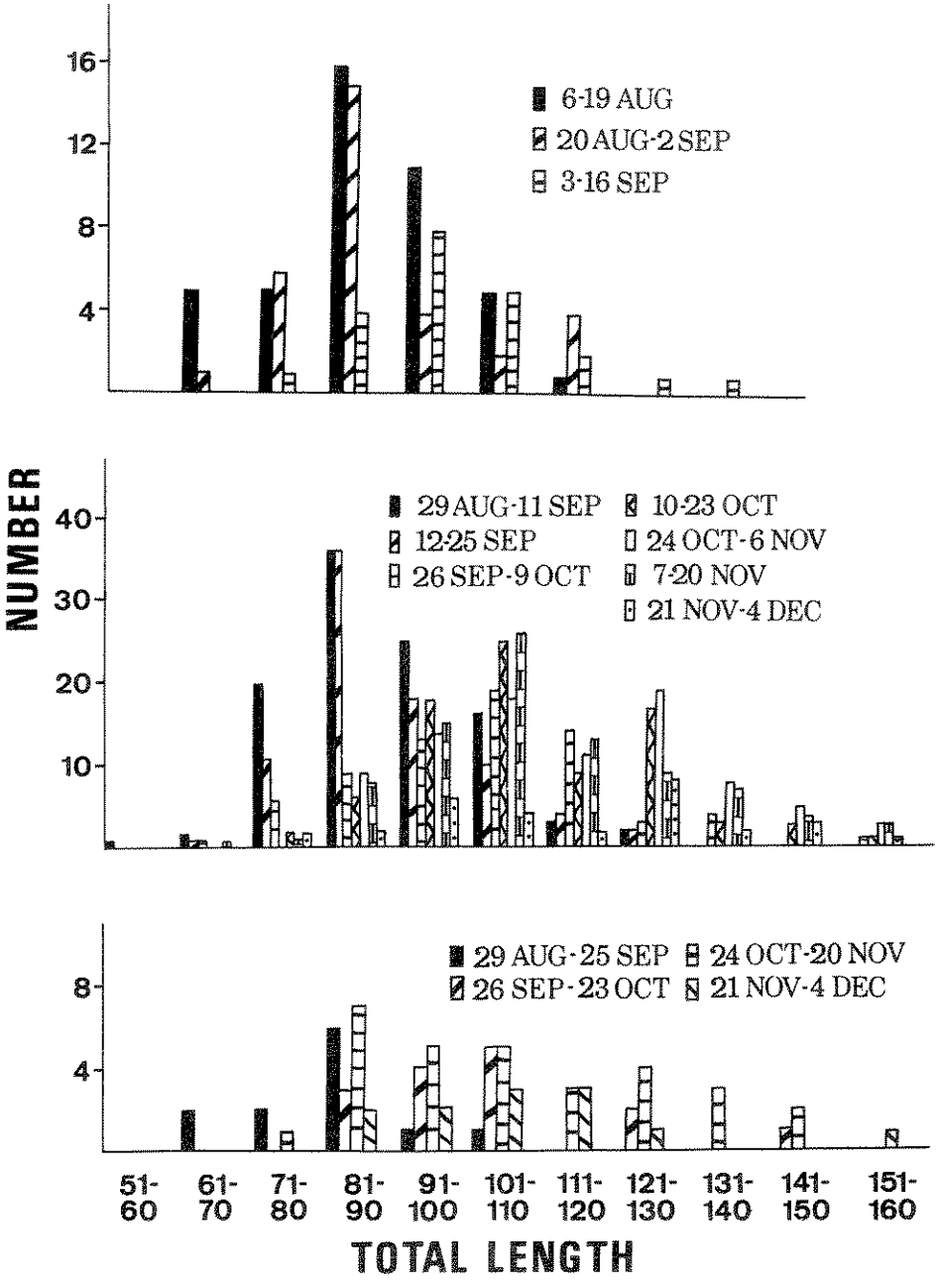


Figure 3. Length Frequency Distributions of Brown Trout and Rainbow Trout.

Table III. Maximum and minimum total lengths of brown trout and rainbow trout for the sampling intervals.

| Sampling Interval | Brown Trout Total Length (mm) Minimum | Maximum | Sampling Interval | Rainbow Trout Total Length (mm) Minimum | Maximum |
|---|---|---|---|---|---|
| 1966 | | | 1967 | | |
| 6 to 19 August | 66 | 114 | 29 August to 25 September | 64 | 109 |
| 20 August to 2 September | 69 | 117 | 26 September to 23 October | 84 | 147 |
| 3 September to 16 September | 79 | 135 | 24 October to 20 November | 76 | 147 |
| 1967 | | | 21 November to | | |
| 29 August to 11 September | 58 | 124 | 4 December | 86 | 152 |
| 12 to 25 September | 64 | 140 | | | |
| 26 September to 9 October | 69 | 155 | | | |
| 10 to 23 October | 81 | 157 | | | |
| 24 October to 6 November | 79 | 157 | | | |
| 7 to 20 November | 64 | 157 | | | |
| 21 November to 4 December | 79 | 160 | | | |

none. From this it was assumed that trout under 160 mm in total length were usually young-of-the-year. This agrees with other reports on young-of-the-year trout in Montana (Purkett, 1950; Bishop, 1955).

Movement. A total of 349 brown trout and 25 rainbow trout were marked and released in the section or sub-section in which they were captured in 1966 and 1967 (Table IV). The number of times fish were recaptured in each instance given below represents the least number. A total of 132 (37.8%) of the brown trout were recaptured once, 29 (8.3%) twice, 11 (3.2%) 3 times, three (0.9%) 4 times and one (0.3%) 5 times. One hundred-and-twelve of the fish recaptured once, 27 twice, 10 3 times, three 4 times and one 5 times were found in the section or sub-section of original capture or within approximately 10 m from it. The least number of times recaptured and the elapsed time from original release to last recapture are as follows: once - 14 days (2 to 48 days), twice - 26 days (13 to 52 days), 3 times - 34 days (27 to 58 days), 4 times - 49 days (36 to 56 days), 5 times - 62 days. Six brown trout were recaptured in the offshore portion of a sub-section after being released in the inshore portion, and four showed the opposite movement. A total of 32.3% of the fish were found adjacent to or outside the section or sub-section of original capture. The average straight-line distance that fish were found away from the section or sub-section in which released was 11.4 m (3.5 to 70 m). The maximum straight-line distance downstream was 30 m and upstream was 70 m.

All recaptured rainbow trout were from the upstream area in 1967. Ten (40.0%) were recaptured once, three (12.0%) twice, and one (4.0%) 3 times. Eight of the fish recaptured once, three twice and one 3 times

Table IV. Number, time and place of recaptures. (Average number days from first release to recapture in parentheses.)

| Year | Species | Number trout | Minimum number times recaptured | Number of recaptures: Inside section of original capture | Adjacent to section of original capture | Outside of section of original capture |
|---|---|---|---|---|---|---|
| 1966 | | | Upstream area | | | |
| | Brown trout | 27 | 1 (22) | 26 | | 1 |
| | | 7 | 2 (31) | 7 | | |
| 1967 | | | Upstream area | | | |
| | Brown trout | 86 | 1 (12) | 49 | 18 | 20 |
| | | 17 | 2 (26) | 6 | 9 | 2 |
| | | 7 | 3 (39) | 1 | 5 | 1 |
| | | 3 | 4 (49) | 1 | 2 | |
| | | 1 | 5 (62) | 1 | | |
| | Rainbow trout | 10 | 1 (19) | 3 | 5 | 2 |
| | | 3 | 2 (36) | 1 | 2 | |
| | | 1 | 3 (39) | | 1 | |
| | | | Downstream area | | | |
| | Brown trout | 19 | 1 (14) | 16 | 3 | |
| | | 5 | 2 (17) | 2 | 3 | |
| | | 4 | 3 (35) | 1 | 3 | |

were found in the section or sub-section of original capture or within approximately 10 m from them. The least number of times recaptured and the elapsed time from original release to last recapture are as follows: once — 19 days (7 to 33 days), twice — 36 days (20 to 61 days), 3 times — 39 days. One rainbow trout was taken in the offshore portion of one

sub-section after being released in the inshore portion, and none showed the opposite movement. A total of 71.4% of the fish were found outside the section or sub-section of original capture. The average straight-line distance that fish were found away from the section or sub-section in which released was 6.4 m. The maximum straight-line distance downstream was 13.5 m and upstream was 3.5 m. Since sampling was limited mostly to the study sections and places adjacent to them, fish which moved beyond these locations would not be taken.

## DISCUSSION

A larger number of trout were found in the upstream than in the downstream area, possibly due to greater amounts of vegetation (cover) in the upstream area. A larger number were found in the inshore portions than the offshore, and again this was probably due to greater amounts of submerged aquatic and overhanging terrestrial vegetation near shore. During the last sampling period in 1967, there was a marked reduction in the number of fish in the upstream area where overhanging vegetation was left high and dry by low water. Boussu (1954) showed that greater numbers of trout were found near overhanging brush and aquatic vegetation. Hartman (1963) reported that fish might be expected to aggregate in stretches of stream with good cover.

The average size of fish increased as the sampling periods progressed and was similar in 1966 and 1967 for comparable periods (29 August to 16 September). In general, the range in total length increased from the beginning to the end of the sampling periods in both years. It may be that larger fish dominate the smaller fish and grow at a faster rate. Chapman (1962) reported this for young Coho salmon. In the present study, there were substantial differences in trout density between the two years of the study. This change may be due at least in part to the sampling inadequacies. McFadden and Cooper (1962) reported that large changes in density may be accompanied by only small changes in size.

Young trout in the study areas generally remained in or near the section or sub-section of original capture. Stefanich (1952) reported that adult brown trout and rainbow trout generally remained in or near the place of release. A strong sense of territorial behavior has been reported in young brown trout and rainbow trout (Kalleberg, 1958; Stringer and Hoar, 1955). In general, the longer the period between release and recapture, the greater the straight-line distance the brown trout traveled.

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