A trout population study on a small creek in Gallatin County, Montana
by George D Holton

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
Montana State University
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Abstract:

A study during two summers and the intervening winter was made of a rainbow, brook and brown trout population in four sample sections of a small spring-fed creek in the Gallatin Valley, Montana. A direct current shocker was used for sampling the population. Fish taken were fin clipped and released. Information was obtained on distribution of species in the creek, population changes through the year, movement and population stability, standing crops, age composition, survival, growth and reproduction. Of 1,016 4-inch brook trout planted in August 1950, an estimated 5 per cent were left in the 2 1/2 mile study area during the following calendar year.

Brook trout predominated in the upper part of the study area; rainbow trout, in the lower part. Rainbow trout older than age group 0 had their maximum number in the first inventory of the year due to recruitment of young fish and gradually declined in number to the last inventory of the year. The loss in total trout weight due to the reduction in number through the year was largely offset by the gain in weight of individual fish. Brook trout (upper study section) and brown trout older than young of the year showed a decided numerical increase during their spawning season. A population turnover greater than expected from normal mortality and recruitment was indicated by low recoveries of marked fish theoretically available and by the paucity of brook and rainbow trout over two years old. There was evidence of limited movement. The standing crop per acre in the combined four study sections in August 1951 was estimated to be 4,586 trout or 106 pounds. At this time 80 and 85 per cent respectively of the brook and rainbow trout numbers were in age group 0, 18 and 13 per cent were in age group I and 2 per cent of each were in age group II.

Some individual brook and rainbow trout attained legal length (7 inches) in their second summer, however, the majority did not reach this size until their second fall or the following spring. There were an estimated 5,867 young of the year per mile the first fall and 5,468 per mile the second summer. A collection of brook trout during their spawning season showed that some young of the year males were ripe and that at least 72 per cent of the fish over 6 inches long were males.

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partial fulfillment of the requirements

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at

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Head, Major Department

Chairman, Examining Committee

Dean, Graduate Division

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The Brook

I come from haunts of coot and hern,
I make a sudden sally,
And sparkle out among the fern,
To bicker down a valley.
.....

I wind about, and in and out,
With here a blossom sailing,
And here and there a lusty trout,
And here and there a grayling,
.....

And out again I curve and flow
To join the brimming river,
For men may come and men may go,
But I go on forever.

- Tennyson

MADE IN U.S.A.

11/22/74 Gift - Mother

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ABSTRACT

A study during two summers and the intervening winter was made of a rainbow, brook and brown trout population in four sample sections of a small spring-fed creek in the Gallatin Valley, Montana. A direct current shocker was used for sampling the population. Fish taken were fin clipped and released. Information was obtained on distribution of species in the creek, population changes through the year, movement and population stability, standing crops, age composition, survival, growth and reproduction. Of 1,016 4-inch brook trout planted in August 1950, an estimated 5 per cent were left in the $2\frac{1}{2}$ mile study area during the following calendar year.

Brook trout predominated in the upper part of the study area; rainbow trout, in the lower part. Rainbow trout older than age group 0 had their maximum number in the first inventory of the year due to recruitment of young fish and gradually declined in number to the last inventory of the year. The loss in total trout weight due to the reduction in number through the year was largely offset by the gain in weight of individual fish. Brook trout (upper study section) and brown trout older than young of the year showed a decided numerical increase during their spawning season. A population turnover greater than expected from normal mortality and recruitment was indicated by low recoveries of marked fish theoretically available and by the paucity of brook and rainbow trout over two years old. There was evidence of limited movement. The standing crop per acre in the combined four study sections in August 1951 was estimated to be 4,586 trout or 106 pounds. At this time 80 and 85 per cent respectively of the brook and rainbow trout numbers were in age group 0, 18 and 13 per cent were in age group I and 2 per cent of each were in age group II. Some individual brook and rainbow trout attained legal length (7 inches) in their second summer, however, the majority did not reach this size until their second fall or the following spring. There were an estimated 5,867 young of the year per mile the first fall and 5,468 per mile the second summer. A collection of brook trout during their spawning season showed that some young of the year males were ripe and that at least 72 per cent of the fish over 6 inches long were males.

INTRODUCTION

An investigation of the population and ecology of trout in Trout Creek, Gallatin Valley, Montana was made during the summers of 1950 and 1951 and the intervening winter. This stream is one of numerous small spring-fed creeks which occur in the area.

Somewhat similar studies on trout stream populations have been made by Stefanich (1952) on Prickley Pear Creek, Montana; Schuck (1945) on Crystal Creek, New York; Needham, Moffett, and Slater (1945) on Convict Creek, California and Shetter and Leonard (1943) on Hunt Creek, Michigan.

The writer wishes to acknowledge the assistance of Dr. C.J.D. Brown who directed the study and helped prepare the manuscript. Invaluable aid in setting up electric shocking equipment was given by Dr. A. R. Jordan and Mr. H.G. Helterline; identifications of aquatic plants were verified by Dr. W.E. Booth; free access to the portion of the creek studied as well as other cooperation was given by Messrs. Hugh Spain, Radford McGuire, Wilbur Spring and Ralph Herdina. Several students at Montana State College also assisted, especially Marvin Boussu and William Clothier who helped collect field data and Jack Bailey who assisted in aging the fish. The Montana Fish and Game Department allowed use of certain equipment, assisted in preparation of the scale mounts, and provided use of the state shocking crew on one occasion. The Montana State College Agricultural Experiment Station gave financial assistance.

DESCRIPTION OF CREEK

Trout Creek is $3\frac{1}{2}$ miles northeast of Belgrade, Montana at an altitude of approximately 4,450 feet. It originates in springs which are scattered

along its entire length and meanders through a fertile agricultural area for a distance of 4 miles to where it enters the East Gallatin River.

The drainage is about seven square miles.

Study Area and Sections

Observations were confined to the upper $2\frac{1}{2}$ miles of the creek. Four representative 300-foot sections were established without bias as to pools, riffles and cover. Starting with the uppermost, these study sections were designated 1, 2, 3 and 4 (Fig. 1).

Pertinent physical measurements were made in each section (Table 1). Widths and depths were determined when water levels were intermediate between March low water and September high water levels. Average widths were based on measurements made every 5 feet along the creek and in general increased progressively going downstream. Riffles within sections had an average mid-stream depth of 6.3 inches, and pools, a maximum depth of 31 inches. The bottom in riffle areas was usually composed of small gravel. In calm areas sand and silt prevailed.

Velocity and volume of flow measurements were made in fall when high water levels were being approached. Velocities were measured with a current meter half way between the surface and bottom at 12-15 equal intervals across the creek. Both velocity and volume of flow increased from the upper to the lower part of the study area. During the investigation two flash floods were caused by melting snow. One on February 9 and 10, 1951 and the other on March 26. The volume during these floods was estimated roughly to be seven times greater than in the fall. Floods of this nature were reported to be an annual occurrence. They caused

Table I - Comparison of physical characteristics of study sections.

	Section			
	1	2	3	4
Length (feet)	300	300	306	300
Average width (feet)	5.5	10.4	15.5	15.5
Area (acres)	0.038	0.072	0.109	0.107
Riffles - per cent of section length	22	50	33	40
Pools ^{1/} per cent of section length	13	44	49	39
Volume of flow (cu. ft. per sec.)	2.36	9.07	12.21	14.72
Average velocity (ft. per. sec.)	0.75 (8.2) ^{2/}	1.75 (7.7)	1.82 (5.9)	2.00 (5.5)

^{1/}At least 12 inches deep.

^{2/}Average depth (inches) of stream at place where velocity was measured.

washing of the stream banks and scouring of the bottom. The flow in section 4 was reduced approximately 20 per cent for 2-3 weeks during the summer due to an irrigation diversion.

In the upper two-fifths of the study area, (section 1 included) Trout Creek flowed through a small ravine in which willows (Salix sp.) were frequent. Section 1 had little shade from willows but was narrow enough so that overhanging sedges (Carex rostrata and C. nebraskensis) and other herbs covered a considerable portion of the creek surface (Fig. 2). The lower three-fifths of the study area (sections 2, 3 and 4 included) was more open. Much of it was bordered by low banks with occasional clumps of willows and other shrubs (Figs. 3 and 4). Sections 2 and 3 had several well shaded pools. Section 4 was completely open. There was less undercut bank in section 3 than in the others.

Aquatic plants were present in the study area from early summer until mid-winter. They were most dense in section 1 and least dense in section 4. In section 1 (Fig. 2) water cress (Nasturtium officinale) predominated. It choked the edges along most of the section and occurred as mid-stream patches which in places extended from bank to bank. There were also occasional patches of a narrow-leaved pondweed (Potamogeton sp.) with foliage three to six inches long, and a small amount of brook grass (Catabrosa aquatica). In the lower three sections water cress was common along the edges while separate patches of water speedwell (Veronica connata), brook grass and pondweed were found in mid-stream. In section 2 brook grass and water speedwell predominated and in sections 3 and 4 water speedwell was most abundant (Fig. 3). Filamentous

Fig. 2. Upper part of study area (section 1).

Fig. 3. Middle part of study area (section 3).

Fig. 4. Lower part of study area (section 4).

algae were prevalent in the creek in summer and fall.

Temperatures

Year around temperatures were secured at the upper, middle and lower portion of the study area (Fig. 1). These were taken with Taylor "Sixes" maximum-minimum thermometers and were usually recorded three or four times a month from August 1950 to October 1951. The maximum and minimum readings for each station were plotted on a graph opposite the date taken (Fig. 5).

The maximum water temperature in the hottest part of summer was 63 degrees F. and the minimum winter temperature was 32 degrees F.. This minimum occurred only for short periods, the usual December to March minimum being about 38 degrees F. The highest and the lowest temperatures recorded were at station 3 (Fig. 1) where spring water had the least moderating effect. The maximum summer temperatures at station 1 were greater than those at station 2 due to warmer water from a small tributary which entered the uppermost part of the study area.

Chemical Analyses

Limited chemical analyses using standard limnological methods were made at various points along the study area on March 1 and July 27, 1951. Chemical conditions in and below section 1 were found to be comparable on both dates and conditions at all points were well within the range tolerated by trout with the possible exception of low dissolved oxygen (24 per cent saturated) and high free CO₂ (30.0 p.p.m.) at the source on March 1. Dissolved oxygen and pH increased going downstream while free CO₂ decreased. In the study sections pH ranged from 7.5 to 8.1

Fig. 5. Maximum-minimum temperatures in Trout Creek

and free CO₂, from 3.0 to 13.0 p.p.m. On both dates water in section 1 was 77 per cent saturated with oxygen and in section 4 approximately 100 per cent.

In general the dissolved salt content decreased going downstream. On March 1 total hardness in the lower and upper study sections varied from 222 to 232 p.p.m. (as CaCO₃), and total alkalinity (methyl orange) from 204 to 223 p.p.m. Conductance ranged from 450 to 500 X 10⁶ mho per centimeter at 25 degrees C.

Species of Fish Present

Trout were by far the most numerous fish. Rainbow trout (Salmo gairdnerii) and eastern brook trout (Salvelinus fontinalis) predominated. Brown trout (Salmo trutta) were less numerous. Hybrid rainbow x cutthroat trout were probably present, but no attempt was made to separate them from the rainbow trout. Freshwater sculpins (Cottus sp.) were present in considerable numbers. Other fish collected included six young mountain whitefish (Prosopium williamsoni), three large suckers (Catostomus sp.) and one longnose dace (Rhinichthys cataractae).

METHODS

Population Inventories

Fish were collected by the direct electrical current method (Rayner, 1949). Power was supplied by a small 250-watt D. C. generator which was protected by a fuse but operated without a rheostat or meters. Two triangular-shaped electrodes formed by wrapping 16 gage copper wire horizontally on a wooden frame were employed (Shetter, 1948). A small pair each with 14-inch base, 15-inch height and $\frac{1}{4}$ -inch interval between

wire windings was used in section 1, and a large pair each with 24-inch base, 18-inch height and 3/8-inch windings was used downstream. The electrodes were mounted on wooden handles and were connected to the generator by 100 feet of rubber insulated cable. The shocker could be operated with a minimum of two men.

A unit of stream up to 150 feet long was blocked at each end with 1/2-inch square mesh seines. The energized electrodes were worked up- and downstream within the area until no fish with a total length greater than 3-3 1/2 inches was taken. Fish were retrieved with a dip net of 1/4-inch square mesh and held in live boxes covered with ordinary window screen.

A 0.5 per cent urethane solution was employed to anesthetize captured fish (Gerking, 1949). Total lengths were taken to the nearest 0.1 inch and weights, to the nearest 0.01 pound. Fish were marked by cutting off one or more fins flush with the body surface. A different fin was clipped for each section (section 1, right pectoral; 2, left pectoral; 3, right pelvic and 4, left pelvic) and a distinctive combination of two clipped fins was used for each location outside the study sections. The amount of error caused by regenerated fins was not determined. It was considered unimportant, however, since the lapse from the first to the final inventory was only one year and fins that had started to regenerate were again clipped from recaptured fish in each collection. Fish smaller than 3 1/2 inches in length were so numerous in some collections that the majority were counted but not measured. After fish were processed they were held in a live box until fully recovered and then released into the portion of the creek from which they were captured.

Known casualties were light. Of 2,440 fish handled from May through September 1951 (recaptures considered as new fish) only 20 (0.8 per cent) were immediate casualties. All were less than 4 inches long and 5 were less than 2 inches long. Of the 20, 9 were believed to have died from handling rather than from the effects of electricity. An additional 2-3 per cent of the fish were caught by their gills in the wire of the positive electrode. Fish 4-5 inches in length were mostly affected. Undoubtedly some of these fish were injured, though no mortality was observed. Approximately 2 per cent of the fish had body burns caused by contact with an electrode.

The equipment was very satisfactory for making population inventories on Trout Creek where undercut banks and areas of dense aquatic vegetation prevailed. The fish were attracted to the positive electrode where they were easily captured. Few were stunned.

About 10 feet was the maximum distance the electrodes could be apart and have the shocker effective. In one field test a voltmeter was used and the generator output was found to be 138 volts with the large electrodes completely submerged at this interval. In this instance the theoretical drop in potential between the electrodes was 13.8 volt per foot. Inasmuch as fish would sometimes escape if midway between electrodes held 10 feet apart but would be captured if near the positive electrode, it is felt that 13.8 volts per foot approaches the minimum voltage drop that would satisfactorily collect fish under the conditions existing in Trout Creek. The interval between the electrodes was normally six to eight feet. Each bank had to be worked separately with both

electrodes to draw fish from the undercut. Efficiency was low in pools more than 3-4 feet deep.

Several efficiency tests patterned after those of Haskell and Zilliox (1941) were made during the summer of 1951. Blocking nets were installed and an initial run made through the enclosed area with the shocker. Fish taken were marked with a distinctive notch on the anal or dorsal fin and returned within a minute or two to the place where captured. The estimated lengths of the fish were recorded. This procedure was followed until from 10 to 30 fish of all sizes were marked and then starting over again the population was completely inventoried using the method described previously. The percentage of recaptured marked fish was used as an indication of efficiency.

Two tests were made using the large electrodes. The first upstream from section 1 in a 49 foot length of stream averaging $3 \frac{3}{4}$ feet wide. There was a total of 16 fish involved in the final collection. All of the marked fish (5) from 4.2 to 6.9 inches long were recovered and 4 of 5 marked fish less than $3 \frac{1}{2}$ inches in length were recovered. The second test was in a 120 foot portion of section 3. Here, nearly three hundred fish were involved in the final collection. Of 14 marked fish from 4.4 to 9.4 inches long, 13 were recaptured; and of 15 fish less than $3 \frac{1}{2}$ inches, 10 were recovered.

A third test was made using the small electrodes in a 150 foot portion of section 1. In this experiment an hour interval was allowed between marking the fish and starting the final shocking. There were 84 fish in the final collection. All of the marked fish (13) from 5.0 to

8.1 inches long were recovered and of 9 marked fish less than $3\frac{1}{2}$ inches in length, 8 were recovered.

Combining the results of these tests, in the $3\frac{1}{2}$ inch and larger size group 31 of 32 marked fish were recovered giving an efficiency of 97 per cent. In the smaller size group 22 of 29 marked fish were recovered giving an efficiency of 76 per cent. Although these tests were not as extensive as would be desirable and have other shortcomings as pointed out by Schuck (1948), they did indicate the efficiency of population inventory methods used in this study. The percentages derived were the basis for correcting population figures used in determining age composition, survival of wild trout and standing populations.

Ageing

Approximately 1,600 scale samples were taken as a basis for determining the age composition of trout populations. Of this number 836 were studied. Of these, 685 were from fish collected in the regular inventories and 151 were from other collections. A subsample of 10 individuals was used for each $\frac{1}{2}$ -inch size group in which there were sufficient scale samples. All available scale samples were studied for size groups in which the class frequency was below this level (Ketchen, 1950). This was done for each species in each season, the two summers being treated separately.

Subsampling was used mainly to verify the assumption that fish in a well represented model size group in the length-frequency distribution were all of the same age. Fish in poorly represented size groups, where overlap was possible, were aged by reading scales from the exact fish

concerned. However, scale samples were available for only about 50 per cent of these specimens. In several instances recaptured fish that could be definitely identified were aged by using scales taken in earlier collections. About 15 whose ages were questionable were assigned to age groups on the basis of size.

Annuli were determined with the aid of a scale projection machine. Studies showed that the annulus formed in the spring and all fish were credited with having a new annulus after January 1 even though it was not completed (Hile, 1948). There was reasonably close agreement between the ages determined by the scale method and those shown by length-frequency distributions. A detailed study of annulus formation will appear in a later paper.

Weight Assignment (Unweighed Fish)

Average weights for each trout species were determined for 0.1 inch length intervals, the average for any one length being based on all fish of that size weighed. These averages were used to assign weights to individual rainbow and brown trout not weighted in the first shocking of sections 2 and 4 and to a few fish from other inventories which escaped before being weighed.

The length-weight relationships for small brook, rainbow and brown trout cited by Carlander (1950) were used as the basis for the weights of fish less than 3 inches in length since weights were not taken on fish of this size. Weights for each 0.1 inch length-interval were obtained from curves constructed on the basis of these data. Weights of larger fish taken from the curves agreed reasonably well with actual weights obtained

in the field.

Where fingerlings less than $3\frac{1}{2}$ inches long were counted rather than weighed and measured, weights were assigned in proportion to the calculated weight of fingerlings actually measured in the same collection or in collections made a short time previously.

HATCHERY FISH

A total of 1,016 (4-inch) brook trout from the U.S. Fish and Wildlife Service Hatchery at Bozeman, Montana was planted in the two middle study sections on August 14, 1950. An effort was made to minimize the effect of handling. The fish were marked by removal of the adipose fin, treated with a brine solution and then held at the hatchery for 10 days prior to being planted. There were no fatalities during this period. Marked fish were transported to the creek in aerated water which was never more than 10 Fahrenheit degrees above that at the hatchery (49°F.). Before removal of the fish from the hatchery truck, the water in the tank was tempered to within 4 Fahrenheit degrees of the temperature of the creek water (51°F.). Approximately one-half of the 1,016 fish were distributed throughout each of sections 2 and 3.

On September 14, one month after planting, sections 2 and 3 were inventoried by shocking. Thirty-eight hatchery fish were found in section 2 and 24 in section 3. In the November inventory, 8 were found in section 2 and 23 in section 3. In the spring shocking period (May-June 1951), none was found in section 2 and only 2 in section 3. During the final shocking period (August 1951) no hatchery fish were found in either section.

In 1951 (February-September) approximately one-fifth of the study area was shocked not including portions repeated. During this period 10 hatchery fish were found and none of these was over 6.8 inches. If there were no recaptures (fish captured more than once) in the area covered, there would be an estimated 50 hatchery fish, or 5 per cent of the original plant, present in the entire study area during the calendar year following planting. This result is nearly equivalent to an estimated survival of 6.3 per cent (from one September to the next) reported by Schuck (1948) as the highest for several plantings of brown trout fingerlings in Crystal Creek, New York. His figure was based on inventories made by the electric shock method.

A total of 135 hatchery fish including recaptures was caught during the entire investigation on Trout Creek. Hatchery fish were found throughout the entire study area. There was no discernable pattern of movement away from the original planting sites.

WILD TROUT POPULATIONS

Except for the marked hatchery fish planted during the study, the fish in Trout Creek were considered to be wild fish. There were no records of recent plantings by the local hatchery and the majority of fish captured were less than three years old.

Dates of Inventories

The fish populations in the four study sections were inventoried at five main shocking periods as follows: July 25-August 24, 1950; September 14, 1950 (sections 2 and 3 only); October 28-November 19, 1950; May 17-June 3, 1951 and August 4-12, 1951. Other portions of the study area were

shocked at irregular intervals throughout the period of investigation.

Species Distribution

The different species of trout showed a definite pattern of distribution in the study area. Brook trout predominated at the upper end. In section 1 their numbers comprised 83-96 per cent of all trout in the regular inventories (Table II). Rainbow trout predominated in the lower three sections where they constituted 70-92 per cent (Tables III, IV, and V). The first inventories of sections 2 and 4 show a lower percentage of rainbow trout because insufficient effort was made to capture young of the year. The progressive change from predominately brook trout in the upper part of the study area to predominately rainbow trout in the lower part is demonstrated by comparing the yearling classes in each section during the main inventories. (Tables II, III, IV and V). As a general rule the number of brook trout yearlings progressively decreased going downstream while the number of rainbow trout yearlings increased. For example in the August 1951 inventory the number of brook trout yearlings was 36, 20, 9 and 1 in sections 1 to 4 respectively while in the same sections the number of rainbow trout yearlings was 4, 37, 45 and 56.

Brown trout were found throughout the lower three-fifths of the study area but were nowhere the predominant species. Only two were found, one on each of two occasions, in the upper two-fifths of the study area. They were never found in section 1.

There were noticeably fewer sculpins in section 1 than in the others. This area was judged to be inferior habitat for the species.

Population Changes Between Inventories

The numbers and weights comprising the age groups of each trout species at each shocking are presented to show population changes between shocking periods (Tables II, III, IV and V). These data indicate a numerical increase in young of the year fish, especially rainbow trout, from spring (time of hatch) through late fall. This is probably not the case since there should be a maximum at hatching followed by a progressive decrease through the year. The apparent increase is most likely due to collecting methods and also to insufficient efforts being made in the early collections to capture young of the year fish.

To determine the pattern of numerical changes for rainbow trout older than young of the year, all inventories were treated as if they were from the same year thus giving a sequence from spring through summer and fall. On this basis rainbow trout older than age group 0 showed maximum numbers in the first inventory of the year and then a more or less progressive decline to the last inventory of the year. This is best shown by section 3 where there were 133 in June 1951, 51 in August 1951 (53 in August 1950), 31 in September 1950 and 21 in November 1950. Rainbow trout of this age category in sections 2 and 4 showed a similar decrease in numbers. This pattern was expected since at the first of each year the yearling class is recruited from the numerically strong young of the year class of the previous year. Section 1 was an exception to the above pattern presumably because brook trout was the predominant species. No information was secured during the rainbow trout spawning season to show whether or not they increased at that time.

Table II - Section 1. Trout numbers and weights (pounds) in each inventory.

Species and age group	Date of shocking							
	<u>Aug. 24, 1950</u>		<u>Nov. 18, 1950</u>		<u>May 20, 1951</u>		<u>Aug. 12, 1951</u>	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Brook (hatchery)			2	0.06	1	0.02	1	0.05
Brook (wild)								
0	51	0.63	53(22) ^{1/}	1.33	3	0	101	0.77
I	45	3.57	77(25)	9.67	48(14)	1.70	36(18)	2.83
II	1	0.19	2	0.74	20(13)	2.50	0	0
III & older	0	0	0	0	0	0	0	0
Total	97	4.39	134(47)	11.80	72(27)	4.22	138(18)	3.65
Rainbow								
0	1	0	13 (1)	0.18	0	0	0	0
I	10	0.45	13 (4)	0.58	9 (1)	0.22	4 (1)	0.18
II	1	0.24	1 (1)	0.25	1 (1)	0.07	1	0.12
III & older	0	0	0	0	0	0	0	0
Total	12	0.69	27 (6)	1.01	10 (2)	0.29	5 (1)	0.30
Grand total	109	5.08	161(53)	12.81	82(29)	4.51	143(19)	3.95
Lbs./acre		134		337		119		104

^{1/}Figures in parentheses = numbers of recovered fish marked previously in this section.

Table III - Section 2. Trout numbers and weights (pounds) in each inventory.

Species and age group	Date of shocking									
	July 25, 1950 ^{1/}		Sept. 14, 1950		Nov. 19, 1950		May 30, 1951 ^{2/}		Aug. 4, 1951	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Brook (hatchery)			38	1.07	8	0.23	0	0	0	0
Brook (wild)										
0	7	0.07	25 (5) ^{3/}	0.37	12 (2)	0.23	0	0	72 (2)	0.60
I	22	2.17	27 (10)	3.32	12 (5)	1.91	12 (4)	0.51	20 (4)	1.90
II	1	0.19	1	0.32	0	0	7 (3)	0.86	4 (4)	0.92
III & over	0	0	0	0	0	0	0	0	0	0
Total	30	2.43	91 (15)	5.08	32 (7)	2.37	19 (7)	1.37	96 (10)	3.42
Rainbow										
0	7	0.03	209 (6)	1.13	314 (82)	2.39	1	0	204	0.52
I	24	1.22	23 (10)	1.51	12 (7)	0.88	58 (14)	1.36	37 (20)	2.15
II	2	0.63	3 (2)	0.84	0	0	13 (8)	1.92	8 (4)	2.51 ²⁴
III & over	1	0.41	1 (1)	0.73	0	0	1	0.94	0	0
Total	34	2.29	236 (19)	4.21	326 (89)	3.27	73 (22)	4.22	249 (24)	5.18
Brown										
0	0	0	1	0.02	0	0	0	0	3	0.02
I	3	0.25	4 (2)	0.46	4 (2)	0.71	0	0	0	0
II	0	0	0	0	1	0.58	5 (4)	1.30	4 (3)	1.47
III & over	0	0	0	0	1	1.69	1	2.99	1	3.90
Total	3	0.25	5 (2)	0.48	6 (2)	2.98	6 (4)	4.29	8 (3)	5.39
Grand total	67	4.97	332 (36)	9.77	364 (98)	8.62	98 (33)	9.88	353 (37)	13.99
Lbs./ acre		69		136		120		137		194

^{1/}This section was 482 feet long on this date. Before the next shocking it was reduced to 300 feet. Numbers and weights have been corrected in proportion to the reduction in section length.

^{2/}Four young of the year trout not classified to species are omitted. These were marked and returned to water. ^{3/}Figures in parentheses = numbers of recovered fish marked previously in this section.

Table IV - Section 3. Trout numbers and weights (pounds) in each inventory.

Species and age group	Date of shocking									
	Aug. 9, 1950		Sept. 14, 1950		Nov. 4, 1950		June 3, 1951 ^{1/}		Aug. 11, 1951	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Brook (hatchery)			24	0.72	23	0.95	2	0.13	0	0
Brook (wild)										
0	12	0.13	11 (2) ^{2/}	0.21	9 (2)	0.18	0	0	53 (4)	0.57
I	17	2.01	9 (6)	1.08	15 (6)	2.22	10	0.57	9 (2)	0.83
II	0	0	0	0	0	0	1	0.18	2 (1)	0.69
III & older	0	0	0	0	0	0	1	0.43	0	0
Total	29	2.14	44 (8)	2.01	47 (8)	3.35	14	1.31	64 (7)	2.09
Rainbow										
0	129	0.47	158 (17)	1.02	258 (51)	2.05	0	0	332 (1)	1.04
I	49	2.92	26 (17)	2.01	17 (12)	1.51	114 (13)	3.36	45 (33)	2.91
II	3	0.90	5 (3)	1.86	2 (2)	0.78	18 (5)	2.72	6 (3)	1.59
III & older	1	0.51	0	0	2	1.26	1	0.60	0	0
Total	182	4.80	189 (37)	4.89	279 (65)	5.60	133 (18)	6.68	383 (37)	5.54
Brown										
0	2	0.01	2	0.03	3 (2)	0.05	0	0	12 (1)	0.11
I	3	0.52	2 (2)	0.42	4 (2)	1.24	1	0.06	1 (1)	0.14
II	0	0	0	0	1	0.56	0	0	0	0
III & older	0	0	0	0	4	8.43	0	0	0	0
Total	5	0.53	4 (2)	0.45	12 (4)	10.28	1	0.06	13 (2)	0.25
Grand total	216	7.47	237 (47)	7.35	338 (77)	19.23	148 (18)	8.05	460 (46)	7.88
Lbs./acre		69		67		176		74		72

^{1/}Twelve young of the year trout not classified to species are omitted. These were marked and returned to water.

^{2/}Figures in parentheses = numbers of recovered fish marked previously in this section.

Table V. - Section 4 Trout numbers and weights (pounds) in each inventory.

Species and age group	Date of shocking							
	<u>Aug. 1, 1950^{1/}</u>		<u>Oct. 28, 1950</u>		<u>May 17, 1951</u>		<u>Aug. 5, 1951</u>	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Brook (hatchery)			7	0.30	0	0	0	0
Brook (wild)								
0	12	0.19	2 (1) ^{2/}	0.04	0	0	4	0.07
I	14	1.79	6 (3)	0.98	0	0	1	0.12
II	0	0	0	0	3 (1)	1.08	0	0
III & older	0	0	0	0	0	0	0	0
Total	26	1.98	15 (4)	1.32	3 (1)	1.08	5	0.19
Rainbow								
0	34	0.11	376 (3)	3.16	0	0	154	0.55
I	52	3.46	22(15)	2.56	95(13)	2.19	56(21)	4.84
II	1	0.11	2	0.41	3 (1)	0.72	2 (1)	0.55
III & older	0	0	0	0	0	0	0	0
Total	87	3.68	400(18)	6.13	98(14)	2.91	212(22)	5.94
Brown								
0	12	0.09	13 (2)	0.32	0	0	20	0.24
I	3	0.45	7 (3)	1.84	1	0.02	0	0
II	0	0	0	0	2 (1)	0.99	1	0.44
III & older	0	0	3	7.11	2 (1)	2.86	0	0
Total	15	0.54	23 (5)	9.27	5 (2)	3.87	21	0.68
Grand total	128	6.20	438(27)	16.72	106(17)	7.86	238(22)	6.81
Lbs./acre		58		156		73		64

^{1/}This section was 504 feet long on this date. Before the next shocking it was reduced to 300 feet. Numbers and weights have been corrected in proportion to the reduction in section length.

^{2/}Figures in parentheses = numbers of recovered fish marked previously in this section.

Although in the regular pattern the number of fish in each class decreased through the year, the loss in total weight due to reduction in numbers was offset to a large extent by the gain in weight of individual fish. This was well demonstrated by the August 1951 shocking of section 2 (Table III). Here half the age groups older than young of the year showed a decrease in number but an increase in weight when compared to those in the May 1951 shocking.

While the same pattern of numerical decrease through the year probably existed for the overall population of brook and brown trout, it was not confirmed by data on Trout Creek. The October-November inventory was taken during the spawning season of these species and showed a decided numerical increase of yearlings and older fish. Only section 1 showed a pronounced increase in the number of brook trout. Here the yearling group increased from 45 in August 1950 to 77 in November. The numbers of spawning brook trout did not markedly increase in the other sections which had predominately rainbow trout.

The increase in brown trout older than the 0 age group in the October-November inventory is best demonstrated by sections 3 and 4. Section 3 showed an increase from 2 in the September 1950 shocking to 9 in November and section 4 showed an increase from 3 in August 1950 to 10 in late October. Both sections showed a reduction of brown trout older than young of the year in later inventories.

In the October-November inventory sections 1, 3 and 4 each had a total trout weight double that for the same section in any other inventory. For example, in section 1 the total weight in this inventory was 12.81

pounds. The next highest was the August 1950 inventory with a total weight of 5.08 pounds (Table II). These increases were due largely to the influx of brook or brown trout and to a lesser extent the increased weight of young of the year.

Needham, Moffett and Slater (1945) studied fluctuations of a brown trout population over several years and found there was usually a gain in total pounds per mile over the summer period because of the growth of individual young of the year fish.

Section 2 did not show an increase in total trout weight from the September to the October-November inventory. The presence of two large brown trout accounted for the increase in weight of this species. There was a reduction in both brook and rainbow trout weights.

The two summer inventories (July-August 1950 and August 1951) were compared. Section 1 showed a 22 per cent reduction in total trout weight from 1950 to 1951 due mainly to a decrease of 28 per cent in the number of yearlings and older fish. This was the only section that showed a decrease in weight. Section 2 showed a numerical increase in most age groups; the total weight more than doubled. Part of this increase may be attributed to an improvement in collecting methods after the July 1950 shocking of this section. In sections 3 and 4 the total trout weight did not change markedly from summer to summer. Comparison of numbers of each trout species from summer to summer (young of the year excluded) showed a 28 per cent decrease in brook trout and an 11 per cent increase in rainbow trout for the combined four sections.

Movement and Population Stability

About 3,200 wild trout were marked during the investigation and most of these (nearly 2,400) before the May-June 1951 inventory. Altogether about one-quarter of the study area was covered by shocking operations. A total of 57 fish (28 brook, 27 rainbow and 2 brown trout), including repeats, were recaptured more than 500 feet from the stream section in which they were originally taken. Of these, 26 had traveled between $\frac{1}{2}$ and 1 mile, and 5 over a mile. The greatest distance covered was that of a rainbow which traveled about $1 \frac{3}{4}$ miles in a downstream direction. The observations indicated about equal up- and downstream movement, however, the sampling technique was not designed to quantitatively measure the direction of movement.

Limited movement was indicated by observations of fish captured immediately above or below the section in which they had been marked. In one collection 12 fish marked in section 1 were found outside the section but within 220 feet of its upper boundary. On practically every occasion when collections were made adjacent to a study section, marked fish from the nearby study section were found.

The extent to which trout remained in one area was indicated by a comparison of the number marked in any one section to the number recaptured in the same section. This was tabulated for each section in each inventory (Table VI). Although the number available theoretically increased as additional fish were marked in each inventory, the number of recaptures did not increase proportionally. For example, in the September 14, 1950 inventory of section 3 there were 47 recaptures of 183 trout

Table VI - Wild trout marked and recovered in each section.

Section and date shocked	Number marked	Number previously marked	Number recaptured	
Section 1				
Aug. 24, 1950	107	-	-	
Nov. 18, 1950	101	107	53	(32.4) ^{1/2/}
May 20, 1951	47	208	29	(36.7)
Aug. 12, 1951	11	255	19	(46.3)
Section 2				
July 25, 1950	106 ^{3/}	-	-	
Sept. 14, 1950	256	106	36	(42.4)
Nov. 19, 1950	249	362	98	(46.7)
May 30, 1951	64	611	33	(34.0)
Aug. 4, 1951	155	675	37	(47.3)
Section 3				
Aug. 9, 1950	183	-	-	
Sept. 14, 1950	144	183	47	(66.7)
Nov. 4, 1950	225	327	77	(48.9)
June 3, 1951	134	552	18	(12.3)
Aug. 11, 1951	160	686	46	(63.5)
Section 4				
Aug. 1, 1950	191 ^{3/}	-	-	
Oct. 28, 1950	280 ^{4/}	191	27	(52.5)
May 17, 1951	86	471	17	(16.0)
Aug. 5, 1951	131	557	22	(36.7)

^{1/}Numbers in parentheses are the percentages of the population made up by recaptured fish, excluding young of the year.

^{2/}Low due to influx of spawning brook trout.

^{3/}Sections 2 and 4 were 482 and 504 feet long respectively in the first inventory when these fish were marked. Each was reduced to 300 feet before the next shocking.

^{4/}An estimate. About 125 young of the year not marked; this possibly reduced the percentage of the population made up by recaptures in later shockings.

marked on August 9. The number of recaptures in this section fluctuated in the November and June inventories, but in the August 1951 inventory there were still only 46 recaptures of 686 fish marked. Sections 2 and 4 showed similar patterns.

An indication of population stability was also obtained by comparing the percentage of the population (excluding young of the year) which was recaptured fish from inventory to inventory. This was done for each section (Table VI). The percentage was especially constant from inventory to inventory for section 2. As a whole these figures seem to indicate that the percentages of the population made up by recaptures would be fairly consistent were the inventories at equal intervals. The spring inventory (May-June), for all sections except section 1, showed a reduction in the actual number of recaptures as well as a reduction in the percentage of the population (yearlings and older) made up by recaptures. This was expected because of the 6-7 month interval which had elapsed since the October-November inventory. The effect of the two flash floods that occurred during this period is not known. Section 1 showed a progressive decrease in the number of recaptures from the November 1950 to the August 1951 inventory. There was also a progressive reduction of trout numbers in this section.

The greatest percentage recovery of marked fish occurred in section 1 where 107 trout were marked on August 24, 1950; 53 (50 per cent) were recovered 86 days later on November 18.

Discussion of Population Stability

There apparently was a population turnover greater than that which

could be expected from normal mortality and recruitment. As pointed out, additional fish were marked at each inventory yet marked fish did not accumulate from inventory to inventory. Also, at least 45 per cent of the yearlings and older fish were "new" fish in all inventories where marked fish were available. Shetter and Hazzard (1939) found populations of rainbow, brook and brown trout to be relatively unstable in short sections (about 100 feet) of certain Michigan streams. They computed the net percentage loss of marked trout to be 44-94 per cent from month to month. This was based on the number of marked fish returned to the water after any one inventory compared to the number recaptured in the next. For the Trout Creek study sections the net percentage loss of marked trout (computed by the same method) was 81-94 per cent during the 6-7 month interval from October-November 1950 to May-June 1951 and 61-79 per cent during the 2-3 month interval from May-June to August 1951.

The changes in population from inventory to inventory could only have been caused by movement or some mortality factor such as predation, angling, etc. While there was evidence of movement over short distances, the study did not demonstrate emigration from this small creek to the river below. Shocking and handling may have influenced movement.

Mortality from shocking is not considered to be an important factor. Smith and Elson (1950) tested the lethal effects of collecting trout and salmon with a D. C. shocking apparatus. They concluded that delayed mortality was not significant and that fish recovering immediately could be assumed to be uninjured. The writer does not believe urethane was deleterious. Gerking (1949) described it as nontoxic when used in proper

concentrations. Fin clipping, however, may be the cause of mortality, especially when the pectoral fins are removed (Wales, 1947; Shetter, 1951). Pectoral fins were clipped from fish in the upper two study sections of Trout Creek. The effect on the population was not determined.

The paucity of rainbow and brook trout older than age-group II indicated a rapid population turnover. Inasmuch as older fish were scarce at the time of the first as well as later inventories this condition could not be attributed to shocking or marking. The observations made do not disclose the cause of this unexpected loss of older fish. Fishing pressure was considered to be of minor importance since there were few fishermen on the study area after the first 3-4 weeks of the fishing season. Kingfishers, great blue herons and mink were present and four fish with wounds presumed to be beak marks were found. Predation by these animals was not believed to have had a serious effect on the population.

Standing Populations

The standing population of trout in the study area was computed on the basis of the August 1951 inventory (Table VII). The numbers and weights were corrected for the efficiency of the shocking method as explained under age composition. Corrected figures showed 1,495 trout to be in the four study sections. These had a total weight of 34.7 pounds. This is equivalent to 4,586 trout or 106 pounds per acre. Rainbow trout comprised 72 per cent by number and 52 per cent by weight; brook trout, 25 per cent by number and 29 per cent by weight; and brown trout 3 per cent by number and 19 per cent by weight.

As already pointed out, in the October-November inventory the total

weights in sections 1, 3 and 4 were at least double those in other inventories. At this time section 1 was computed to have a standing crop of over 300 pounds per acre - by far the largest standing crop for any section. The upper two study sections each carried more pounds per acre during 1951 than either of the lower two sections (Tables II, III, IV and V).

In the corrected August 1951 inventory fish of legal size (7 inches and over) made up approximately 2, 3 and 14 per cent by number and 35, 27 and 93 per cent by weight of the rainbow, brook and brown trout respectively. Legal rainbow trout in this inventory averaged 8.3 inches and 0.25 pounds; brook trout, 8.3 inches and 0.22 pounds; and brown trout, 11.2 inches and 0.85 pounds. There were 197 legal trout per mile of the study area based on corrected figures.

The eight largest fish captured during the study period were brown trout ranging from 18.4 to 25.5 inches. The largest rainbow trout was 17.9 inches and the largest brook trout 12.3 inches.

The standing crop of 106 pounds per acre for the study area as a whole in August 1951 is comparable to the standing crop of 94.40 pounds of brook trout per acre (plus 9.68 pounds of muddlers) found by Shetter and Leonard (1943) in a section of Hunt Creek, Michigan. In their study legal size fish (7 inches and over) comprised 2.3 per cent by number and 19.4 per cent by weight of the brook trout population as compared to 3 per cent by number and 27 per cent by weight in the present study on Trout Creek.

Age Composition

The August 1951 inventory of all four sections was used as the basis

for determining the age composition of the wild trout population in the study area. The total number in each age group from all four sections was compiled for each species of trout. These numbers were corrected on the basis of efficiency tests described above in which 76 per cent of the fish less than $3\frac{1}{2}$ inches in length and 97 per cent of those $3\frac{1}{2}$ inches and over were recovered (Table VII). Weights were corrected by determining the average weight in each age group and multiplying it by the corrected number of fish.

The age compositions of the rainbow and brook trout populations were comparable. In each the young of the year group predominated numerically. It comprised 85 per cent of the rainbow and 80 per cent of the brook trout. This age group was a considerably less important component of population weights making up only 15 and 26 per cent. Yearlings (one annulus) comprised 57 and 58 per cent respectively of the rainbow and brook trout weights but only 13 and 18 per cent of the numbers. Two-year-olds (two annuli) made up 28 and 16 per cent of rainbow and brook trout weights and 2 per cent of the numbers of each species. There were no older rainbow or brook trout taken in this inventory.

The age structure of the brown trout population differed markedly from that of the rainbow and brook trout in August 1951 since the yearling group was of minor importance (one fish) while fish two years old or older comprised 90 per cent of the weight. The age structure of this species had changed considerably since the previous summer. In the July-August 1950 inventory there were nine yearling brown trout and none older.

Table VII - Corrected numbers and weights of trout in August 1951 inventory. Data from all sections combined.

Age group	Brook trout		Rainbow trout		Brown trout	
	No.	Wt. (lbs.)	No.	Wt. (lbs.)	No.	Wt. (lbs.)
0	297	2.60	908	2.78	44	0.47
I	69 ^{1/}	5.90	146	10.37	1	0.14
II	6	1.61	18	5.06	5	1.91
III & older	0	0	0	0	1	3.90
Totals	372	10.11	1,072	18.21	51	6.42

^{1/}One hatchery trout (0.05 pounds) included.

Table VIII - Corrected numbers of wild brook and rainbow trout in inventories used for rate of survival computations.^{1/}

Inventory	Brook trout				Rainbow trout			
	Age group				Age group			
	0	I	II	III & older	0	I	II	III & older
July-Aug. 1950	^{2/}	101	2	0	^{2/}	139	7	2
Oct.-Nov. 1950	81	113 ^{3/}	2	0	1,243	66	5	2
May-June 1951	^{2/}	72	32	1	^{2/}	285	36	2

^{1/}Figures shown are totals for all study sections.

^{2/}Sample inadequate

^{3/}High due to influx of spawning fish.

Survival

Estimated rates of survival for wild eastern brook and rainbow trout were computed from corrected inventory figures for the various age-groups (Tables VII and VIII). Survival was computed by two methods: (1) by comparing numbers in age groups of one inventory with those in an earlier inventory; (2) by comparing age groups in a single inventory with each other. The young of the year sample in the July-August 1950 inventory was not considered representative for either species and was not used to estimate survival of this age group.

The estimated survival of young of the year rainbow trout over the 12 month period (August to August) was 16 per cent when based on the ratio of age group I to age group 0 in the August 1951 inventory. This was comparable to the estimate of 12 per cent survival for nine months (November to August) based on the ratio of age group I in the August 1951 inventory to age group 0 in the October-November 1950 inventory. Estimated survival from age group I to age group II from August to August was about 12.5 per cent by either method.

The survival of young of the year brook trout for nine months (November to August) was estimated to be 84 per cent based on the ratio of age group I in the August 1951 inventory to age group 0 in the October-November inventory. The survival for 12 months if based on the age composition of the August 1951 inventory would be only 23 per cent. This method of computation is not considered valid in this instance. It depends on uniform recruitment from year to year and this apparently was not the case. There were 81 young of the year in the October-November

1950 inventory and 297 in the August 1951 inventory. The writer does not believe the three months difference in season of capture accounts for this variation in numbers. Survival of yearling brook trout over a 12 month period was estimated to be 6 per cent based on the ratio of age group II in the August 1951 inventory to age group I in the July-August 1950 inventory. There were no brook or rainbow trout in age group III in the August 1951 inventory; therefore, there was no apparent survival for age group II and older from August 1950 to August 1951.

Shetter and Leonard (1943) estimated the year to year survival of a brook trout population in a section of Hunt Creek, Michigan to be 65.9 per cent from age group 0 to I. This is somewhat comparable to the estimate of 84 per cent for nine months in the Trout Creek study. Their estimates of 64.3 per cent survival from age group I to II and 13.7 per cent from age group II to III are much higher than estimates for brook trout studied from Trout Creek. Schuck (1948) analyzed Shetter and Hazzard's (1939) data of a summer's seining of three Michigan streams and estimated the survival from fingerlings to yearlings to be 14 per cent for rainbow trout (very similar to estimate for Trout Creek) and 52 per cent for brook trout (lower than estimate for Trout Creek).

Growth

All growth estimates were based on the August 1951 inventory. This was chosen because: (1) the time lapse from beginning to end was comparatively short (8 days); and (2) most collections by other workers have been made during summer, so that a collection in this season made the data more comparable. Growth of rainbow and brook trout was estimated

Table IX - Total lengths of brook and rainbow trout in each age group (August 1951 inventory).

Species and age group	Number of fish	Total lengths at capture (inches)	
		Average	Range
Brook			
0	230	2.90	2.0 - 4.1
I	66	6.08	4.7 - 9.1 ^{1/}
II	6	8.80	8.0 - 9.7
Rainbow			
0	326	2.12	1.0 - 3.3
I	142	5.50	3.7 - 8.3 ^{2/}
II	17	8.63	6.5 - 12.6

^{1/}Standard deviation: 0.8^{2/}Standard deviation: 0.9

from the average total lengths of each age group at time of capture. All measured fish from all sections were included (Table IX).

Young of the year rainbow trout had an average length of 2.1 inches compared with 2.9 inches for brook trout. The difference was probably due to the earlier hatching date of brook trout. Some individuals of each species attained legal length (7 inches) in their second summer, however, the majority did not reach this size until their second fall or the following spring. This growth rate is somewhat better than that reported by Purkett (1951) for the rainbow and brook trout in the Bridger Creek system which is also tributary to the East Gallatin River. Here both rainbow and brook trout averaged 6.6 inches at time of second annulus formation. Phenicie (1950) found that in 12 of the 17 Montana streams sampled rainbow trout did not reach legal length, on the average, until the third year of life.

Comparisons of samples from the various sections of Trout Creek indicated a small but progressive increase in rate of growth from the upper to the lower end of the study area. However, the samples were not large enough to serve as conclusive evidence.

Natural Reproduction

Judging from the large number of fingerling trout, conditions must have been very favorable for natural reproduction in Trout Creek. Corrected inventory figures indicate there were 1,340 young of the year trout in the four study sections (1,206 feet) in October-November 1950 and 1,249 in August 1951. The species composition differed in the two years. In the October-November inventory about 93 per cent were rainbow trout, 6 per

cent brook trout and 1 per cent brown trout. In the August 1951 inventory about 73 per cent were rainbow trout, 24 per cent brook trout and 3 per cent brown trout. Based on these corrected inventory figures there were 5,867 young of the year per mile in late fall (October-November) 1950 and 5,468 per mile in August 1951. Needham, Moffett and Slater (1945) in a study of the wild brown trout population in Convict Creek, California found that natural reproduction contributed an average of over 2,750 fish per mile each year. This was in a portion of stream with an average width not much different from that of the Trout Creek study sections. Their maximum figure was 4,905 per mile which is nearly equivalent to the number found in Trout Creek.

Brook trout collected on November 18, 1950 in section 1 were used for determining age and sex ratio. This collection was selected since brook trout predominated and were spawning at that time. Some males in their first year of life were ripe. Eight of 55 young of the year (including two hatchery fish) taken in this collection exuded milt when light pressure was applied to the belly. These ranged from 4.1 to 4.8 inches in length. The youngest females found to be ripe were yearlings. The smallest of these was 6.3 inches.

Sex was determined only for brook trout which were ripe. This included the majority of those over six inches in length. These were predominately males. A total of 67 included 48 (72 per cent) males, 14 (21 per cent) females and 5 (7 per cent) whose sex was not determined. The unbalanced sex ratio could be caused by males maturing and moving into spawning areas at a younger age than females. However, this

apparently is not the case since recaptured fish, i.e., those marked previously in this section, showed the same predominance of males. Of 17 recaptured fish longer than 6 inches, 12 (70 per cent) were males, 2 (12 per cent) were females and 3 (18 per cent) could not be designated as to sex.

Ripe brown trout in the October-November inventory indicated that their spawning season coincided at least in part with that of the brook trout. The youngest brown trout found to be ripe were yearlings. The sample of this species was too small to give reliable information on sex ratio.

SUMMARY

1. A study of a rainbow, brook and brown trout population in Trout Creek, a small spring-fed creek in the Gallatin Valley, Montana, was made during two summers and the intervening winter. The populations in two study sections were inventoried four times and in two other study sections five times during the investigation. Fish taken were fin-clipped and released. A direct current shocker was used for sampling the population. The minimum drop in potential that would satisfactorily collect fish was estimated to be 13.8 volts per foot.
2. A total of 1,016 marked 4-inch brook trout were planted in August 1950. An estimated 5 per cent remained in the $2\frac{1}{2}$ mile study area during the following calendar year.
3. The different species of trout showed a definite pattern of distribution in the study area. Brook trout comprised 83-96 per cent of the trout numbers in the uppermost study section where the stream was narrow. Rainbow trout comprised 70-92 per cent in the lower three study sections.
4. Rainbow trout older than age group 0 were at their maximum number in the first inventory of the calendar year (May-June) due to recruitment of young fish and then gradually declined in number to the last inventory of the year (October-November). The loss in total trout weight due to the reduction in number through the year was largely offset by the gain in weight of individual fish. Brook trout (upper study section) and brown trout older than young of the year increased markedly during their spawning seasons.

5. A population turnover greater than expected from normal mortality and recruitment was indicated by low recoveries of marked fish theoretically available and by the paucity of brook and rainbow trout over two years old. There was evidence of limited movement.
6. The estimated standing crop per acre in August 1951 in the four study sections combined was 4,586 trout or 106 pounds (197 legal sized trout per mile). Of the brook and rainbow trout numbers, 80 and 85 per cent respectively were in age group 0; 18 and 13 per cent were in age group I and 2 per cent of each were in age group II. There were no older specimens of either species.
7. The estimated survival (August to August) of rainbow trout between age group 0 and I was 16 per cent or less; between age group I and II, about 12.5 per cent. The estimated survival of brook trout between age group 0 and I from fall to summer (nine months) was 84 per cent; between age group I and II from August to August, 6 per cent.
8. The average total lengths (inches) in August 1951 for the various age groups of rainbow and brook trout respectively were: age group 0, 2.1 and 2.9; age group I, 5.5 and 6.1; and age group II, 8.6 and 8.8.
9. On the basis of the four study sections there were an estimated 5,867 young of the year per mile of the study section in late fall (October-November) 1950 and 5,468 per mile in August 1951. A collection of brook trout made during their spawning season showed: (1) some young of the year males were ripe, (2) the youngest ripe females were yearlings, (3) at least 72 per cent of the fish over 6 inches long were males.

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