



Changes in the trout population of a small Montana stream
by Alfred Henry Wipperman

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

An investigation of the rainbow, brown, and brook trout population was conducted on Trout Creek,, Gallatin County, Montana from July 1962 to March 1963. The objectives were similar to those of Holton (1953) who made the initial study of the trout population in this same creek in 1950 and 1951. The results from the studies are compared. Four study sections were established at nearly the same locations as in the initial study.

The distribution of the trout species in the creek was about the same in both studies. A comparison of physical, chemical, and certain biological factors within sections showed little change between the two study periods. During the August and October-November inventories, the species composition in the study sections was 76, 16, and 8 percent respectively rainbow, brown, and brook trout compared to 78, 3, and 19 percent for the same species in the initial study. The weight composition was 70, 20, and 10 percent respectively for brown, rainbow, and brook trout compared to 31, 39, and 30 percent for the same species in the initial study. The total number of all trout was 22 percent less in the present study, but total weight was 49 percent greater. The following changes occurred for each trout species from the initial to the present study: brown trout increased 307 percent in number and 238 percent in weight; brook trout decreased 65 percent in number and 50 percent in weight; rainbow trout decreased 23 percent in number and 26 percent in weight. The estimated standing crop in August was 210 pounds per acre compared to 106 pounds per acre in the initial study. There were 343 trout 7 inches or over in total length compared to 197 in the initial study. Most of the trout attained a length of 7 inches or over by their second fall. The average total length in the August inventory was 11.95, 9.55, and 9.30 inches respectively for brown, brook, and rainbow trout. The average total length for rainbow trout and brook trout was slightly greater than in the initial study.

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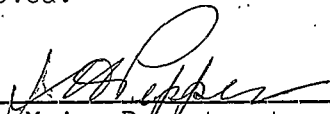
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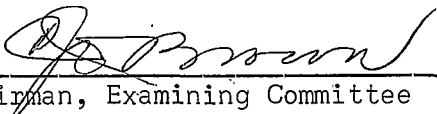
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Abstract

An investigation of the rainbow, brown, and brook trout population was conducted on Trout Creek, Gallatin County, Montana from July 1962 to March 1963. The objectives were similar to those of Holton (1953) who made the initial study of the trout population in this same creek in 1950 and 1951. The results from the studies are compared. Four study sections were established at nearly the same locations as in the initial study. The distribution of the trout species in the creek was about the same in both studies. A comparison of physical, chemical, and certain biological factors within sections showed little change between the two study periods. During the August and October-November inventories, the species composition in the study sections was 76, 16, and 8 percent respectively rainbow, brown, and brook trout compared to 78, 3, and 19 percent for the same species in the initial study. The weight composition was 70, 20, and 10 percent respectively for brown, rainbow, and brook trout compared to 31, 39, and 30 percent for the same species in the initial study. The total number of all trout was 22 percent less in the present study, but total weight was 49 percent greater. The following changes occurred for each trout species from the initial to the present study: brown trout increased 307 percent in number and 238 percent in weight; brook trout decreased 65 percent in number and 50 percent in weight; rainbow trout decreased 23 percent in number and 26 percent in weight. The estimated standing crop in August was 210 pounds per acre compared to 106 pounds per acre in the initial study. There were 343 trout 7 inches or over in total length compared to 197 in the initial study. Most of the trout attained a length of 7 inches or over by their second fall. The average total length in the August inventory was 11.95, 9.55, and 9.30 inches respectively for brown, brook, and rainbow trout. The average total length for rainbow trout and brook trout was slightly greater than in the initial study.

INTRODUCTION

Holton (1953) made the initial investigation on the population and ecology of rainbow, brook, and brown trout in Trout Creek during the summers and intervening winter of 1950 and 1951. He obtained information on species distribution, movement and population stability, standing crop, age and growth, survival, and reproduction. Eleven years later, the present investigation was conducted from July 1962 through March 1963, and had similar objectives.

I wish to express appreciation to Dr. C. J. D. Brown who directed the study and assisted in preparation of the manuscript. Thanks are due to Mr. George Holton who suggested the problem and assisted in locating the study sections in the field. I am indebted to my wife, Evelyn, for her assistance and encouragement. I am grateful to several students at Montana State College for help in collecting fish. The Montana Fish and Game Department allowed use of shocking equipment and prepared the scale mounts. The Montana State College Agricultural Experiment Station furnished some equipment and helped analyze water samples.

Description of Study Area

Trout Creek is located about 4 miles northeast of Belgrade, Montana. Its length is approximately 4 miles, and it runs through flat cultivated and pasture land before emptying into the East Gallatin River. Its water supply comes chiefly from springs. Runoff, precipitation, and irrigation also add to the water supply. The drainage area is about 5 square miles. This creek flows through a narrow ravine which has high steep banks (5-10

feet) leaving very little flood plain. A dense growth of shrubs and herbs line the banks except in the middle portion where shrubs are limited to scattered clumps.

The study area was confined to the upper $2\frac{1}{2}$ miles of the creek where four 300-foot sections were established. These were nearly the same as those of the initial study (Holton 1953), and were designated 1, 2, 3, and 4, beginning upstream (Fig. 1). Certain physical measurements (Table 1) were made at minimum water levels in each section during late July and early August. Average widths were based on 60 measurements and average depths on several hundred per section. The percentage of riffles, flat water (Boussu 1954), pools, and bottom types was taken when depth readings were made.

Riffle areas. Riffles were characterized by high velocity and surface turbulence. They made up about 44 percent of the area within the sections and their average depth was 5.4 inches. The bottom was about 74 percent fine gravel, 24 percent sand and silt, and 2 percent hardpan.

Flat water areas. Flat water was characterized by depths less than 12 inches and lacked surface turbulence. These constituted approximately 29 percent of the area. The bottom consisted of about 62 percent sand and silt, 37 percent fine gravel, and 1 percent hardpan (absent in Sections 1 and 2).

Pool areas. Pools were characterized by maximum depths over 12 inches and little or no surface turbulence. They made up approximately 27 percent of the area within sections and their average maximum depth was 23.8 inches. The bottom was about 64 percent sand and silt, 20 percent gravel,

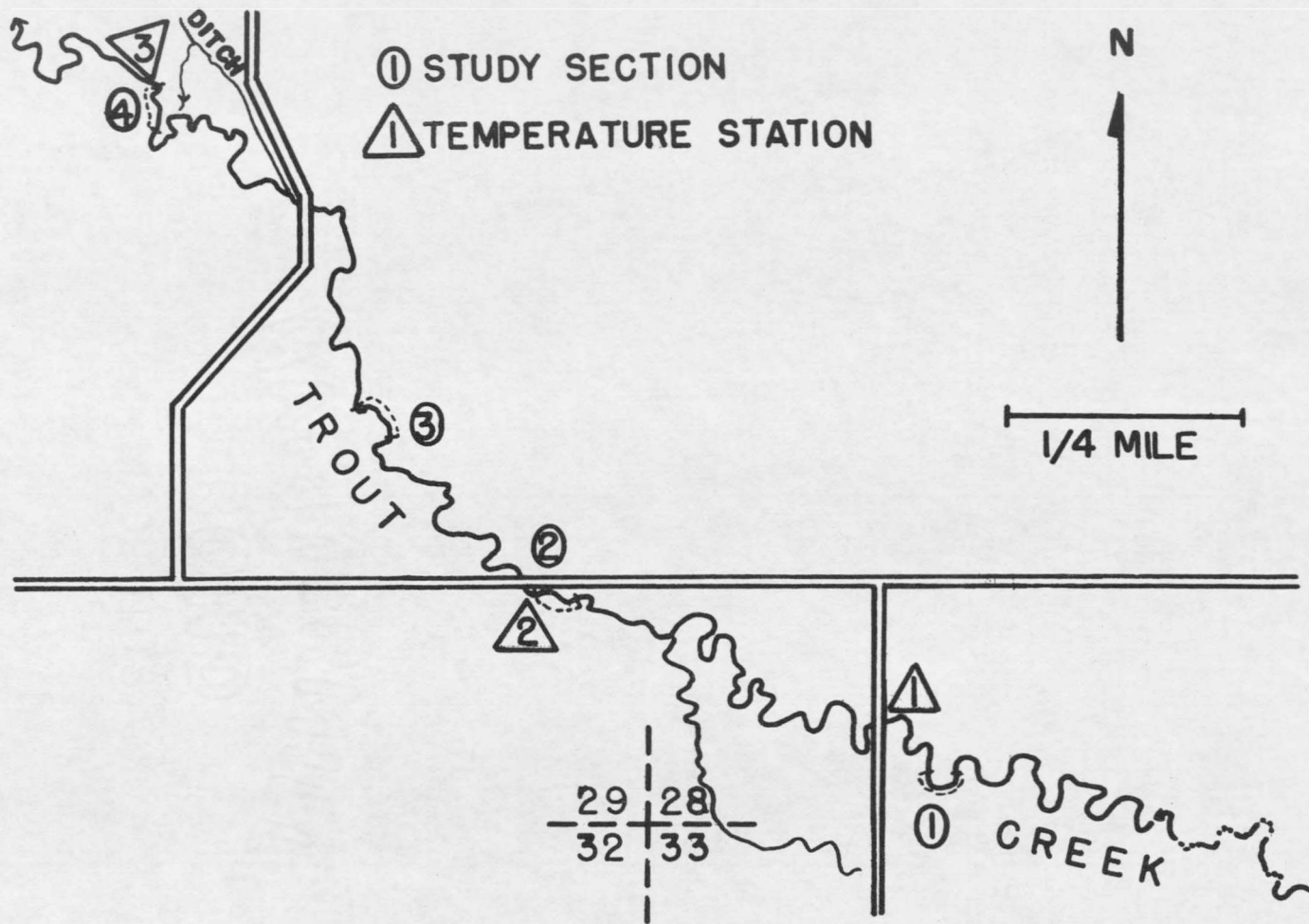


Fig. 1. Trout Creek study area (T. 1N., R. 5E.).

Table 1. Physical characteristics of study sections for the two study periods.

Study period	Section							
	1		2		3		4	
	Present	Initial	Present	Initial	Present	Initial	Present	Initial
Length - feet	300	300	300	300	300	306	300	300
Average width - feet	6.2	5.5	10.6	10.4	15.3	15.5	15.1	15.5
Area - acres	0.042	0.038	0.073	0.072	0.105	0.109	0.104	0.107
Average depth - inches	5.1	-	7.9	-	7.7	-	8.3	-
Average velocity - f./s.	0.55	0.75	1.06	1.75	1.98	1.82	1.91	2.00
Volume - c.f.s.	1.90	2.36	7.08	9.07	13.40	12.21	13.82	14.72
Riffles ^{1/}	32	22	34	50	65	33	46	40
Gravel	84	-	68	-	72	-	72	-
Sand & silt	13	-	27	-	27	-	27	-
Hardpan	3	-	5	-	1	-	1	-
Flat water ^{1/}	63	65	26	6	8	18	19	21
Gravel	39	-	30	-	14	-	64	-
Sand & silt	61	-	70	-	84	-	33	-
Hardpan	-	-	-	-	2	-	3	-
Pools ^{1/}	5	13	40	44	27	49	35	39
Gravel	27	-	20	-	22	-	12	-
Sand & silt	64	-	57	-	75	-	59	-
Hardpan	9	-	23	-	3	-	29	-

^{1/} Figures in percentages.

and 16 percent hardpan.

The following differences were found between the present and initial studies: riffle area increased about 32, 10, and 6 percent in Sections 3, 1, and 4 respectively, and decreased approximately 16 percent in Section 2; flat water increased about 20 percent in Section 2 and decreased 10 percent in Section 3 with little change in Sections 1 and 4; pool area decreased approximately 22 percent in Section 3, 8 percent in Section 1, and 4 percent in both Sections 2 and 4. There was about 22 percent more riffle area in all sections in the present study, and about 26 percent less pool area than in the initial study. Flat water area remained about the same in both studies. The bottom types in the present study were generally fine gravel predominating in riffle areas, and sand and silt in calm areas. About the same composition was estimated in the initial study.

Velocity and volume. Measurements were made in September (Table 1) and were comparable to those of the initial study except in Section 2 where the velocity was about 40 percent less. Maximum levels occurred in November when the volume in Section 1 was about double the September flow. A small flood caused by melting snow occurred during the first week of February 1963. This was about triple the September volume. Water (1 to 2 c.f.s.) was diverted into an irrigation ditch above Section 4 during the entire study period. Most diverted water returned to the creek immediately above Section 4.

Temperatures. Water temperatures were obtained with corrected maximum-minimum thermometers. Three temperature stations (Fig. 1) were

established at about the same locations used in the initial study. The average temperatures for the present (45.2 F.) and initial study (45.6 F.) were nearly the same. In both studies, the maximum temperature was 62 F. (August) and the minimum approached 32 F. (February). Weekly maxima were usually 4-15 degrees higher than minima. Numerous springs along Trout Creek prevented ice formation even during several weeks of sub-zero temperatures in January and February.

Chemical analyses. These were made September 9, 1962 (Table 2). In

Table 2. Chemical analyses (ranges) for the two study periods.

Study periods	Dissolved oxygen (per cent saturated)	pH	Total hardness (CaCO ₃)	Total alkalinity (methyl orange)	Conductivity in reciprocal megohms (25° C.)
Present	88-100	7.9-8.2	180-198	168-224	316-375
Initial	77-100	7.5-8.1	222-232	204-223	450-500

general the dissolved salt content, pH, dissolved oxygen, and conductivity increased progressively from Stations 1 to 4. The dissolved salt content and conductivity were about 15-25 percent lower than reported in the initial study. Dissolved oxygen and pH were about the same in both studies.

Cover. Cover and shade were provided by dense growths of sedge (Carex rostrata) and clumps of willow (Salix sp.) except in Section 4 where willows were absent. Undercut banks added considerable cover, especially in Section 4. Aquatic plants were abundant throughout the study period until late January. Most of the midstream vegetation occurred in

riffle areas. Watercress (Nasturtium officinale) was common along the edges of the stream in all sections. It also occurred in the middle as small patches except in Section 1 where it choked the stream from bank to bank. Brook grass (Catabrosa aquatica) was sparse in Sections 1 and 4 and common in Sections 2 and 3 while horned poolmat (Zannichella palustris) and water speedwell (Veronica connata) were sparse in Sections 1 and 2, abundant in Section 3, and common in Section 4. Filamentous algae was abundant in late summer and fall, and with other vegetation formed large floating rafts along the edges of pools and flat areas.

Wildlife. The kingfisher and the blue heron were the only animals observed known to prey on fish. Muskrats and mallard ducks altered the habitat by destroying most of the aquatic vegetation during extreme cold periods in the winter. Muskrats were common throughout the study area and mallard ducks were numerous in the fall and winter.

Species of fish. Rainbow trout (Salmo gairdneri) comprised about 75 percent of the salmonid population with brown trout (Salmo trutta) and brook trout (Salvelinus fontinalis) accounting for approximately 15 and 10 percent respectively. The mottled sculpin (Cottus bairdi) was common and a few small mountain whitefish (Prosopium williamsoni) were collected in Section 4.

Methods

Population inventories. Fish were collected by electrofishing using a portable D.C. generator with a maximum output of 900 watts (300 volts and 3 amperes). The study sections were divided into 150-foot units,

blocked with nets, and shocked until no more fish were caught. Captured fish were anesthetized with a 1:12,000 solution of Tricaine Methanesulfonate (MS-222). Total lengths were taken to the nearest 0.1 inch and weights to the nearest 0.01 pound. In collections where trout under 3 inches in length were numerous, a representative portion was measured and the remaining were counted. Weights were assigned to trout less than 3.6 inches in length since fish this small could not be weighed individually. These assigned weights were based on a sample of 225 rainbow trout (2.0-3.5 inches) segregated into one-tenth inch groups which were collected outside the study area. Trout were marked differently for each section by clipping the adipose fin and combinations of the pelvic fins. After the trout were processed, they were allowed to recover in live boxes and then released into the portion of the stream where captured.

Known mortality from shocking and handling accounted for 107 (3.7 percent) of 2894 trout captured during regular inventories. All casualties but one were under 4 inches in length. Most of these (77 percent) were caused by electric shock.

Efficiency tests similar to those of Haskell and Zilliox (1941) were made to determine the completeness of the collections. Two tests involving 150 feet of stream in both Sections 3 and 4 were conducted during regular inventories. The sites chosen contained the deepest pools (39 inches) and about average aquatic vegetation. Ten trout of various sizes over 4 inches were captured, marked, and returned to Section 4. Over 150 trout were taken in the final collection and all 10 marked fish were recaptured. A test in Section 3 involved 12 trout over and 13 under 4:

inches. All but one marked trout under 4 inches were recaptured in the final collection.

Combined results of the two tests showed 100 percent recapture for trout over 4 inches and 92 percent of those under 4 inches. These data were the basis for adjusting the population under 4 inches for all sections.

Age. A total of 765 scale samples was taken. Samples were taken from all trout over 4 inches in length and from a representative sample of smaller trout. Annuli and scale measurements were determined with the aid of a scale projection machine. Trout were credited with having formed the current year's annuli at the time of capture (Brown and Holtón 1953) except for collections made in January and February 1963. Brown trout older than age group III could not be aged accurately because erosion or resorption obliterated scale characters. These were grouped as age-IV or older.

TROUT POPULATIONS

There was no stocking and relatively little fishing pressure on Trout Creek for several years before and during the study period. Any changes in the trout population are probably due to other factors. The trout populations were inventoried three times in each of the four study sections as follows: August 18-25, 1962; October 6-November 2, 1962; December 19, 1962-February 9, 1963. The minimum time between shocking periods for any section was 7 weeks and the maximum 15 weeks.

Species Distribution

The abundance of each trout species was determined by averaging the numbers taken during all inventories in each section. Rainbow trout were abundant throughout the study area comprising 44, 77, 83, and 78 percent of all trout in Sections 1 to 4 respectively (Tables 3-6). Brown trout

Table 3. Trout numbers and weights for each inventory in Section 1.

Species and age group	Date of inventory					
	<u>Aug. 18, 1962</u>		<u>Nov. 2, 1962</u>		<u>Dec. 20, 1962</u>	
	No.	Wt.	No.	Wt.	No.	Wt.
Rainbow						
0	13	0.04	64	0.97	84 (33)	1.29
I	-	-	-	-	-	-
II	1	0.23	1 (1) ^{1/}	0.25	-	-
III or older	-	-	-	-	-	-
Total	14	0.27	65 (1)	1.22	84 (33)	1.29
Brown						
0-III	-	-	-	-	-	-
IV or older	-	-	-	-	1	1.94
Total	-	-	-	-	1	1.94
Brook						
0	41	0.57	35(10)	0.78	50 (14)	1.14
I	14	1.46	25 (7)	3.91	26 (12)	3.34
II	2	0.51	5 (2)	1.80	5 (3)	1.39
III or older	-	-	-	-	-	-
Total	57	2.54	65(19)	6.49	81 (29)	5.87
Grand total	71	2.81	130(20)	7.71	166 (62)	9.10
Lbs./acre		67		184		217

^{1/} Recaptured fish marked previously in this section.

were found in all sections but were never the most abundant species. They constituted 0.3, 16, 13, and 21 percent of all trout in Sections 1 to 4 respectively. Brook trout were most abundant in the upper study section but progressively decreased downstream. They comprised 56, 7, 4, and 1

Table 4. Trout numbers and weights for each inventory in Section 2.

Species and age group	Date of inventory					
	<u>Aug. 25, 1962</u>		<u>Oct. 6, 1962</u>		<u>Jan. 3, 1963</u>	
	No.	Wt.	No.	Wt.	No.	Wt.
Rainbow						
0	221	1.47	176 (4) ^{1/}	1.22	152(54)	1.35
I	1	0.18	2 (1)	0.34	2 (1)	0.40
II	1	0.42	-	-	1 (1)	0.50
III or older	2	2.02	1 (1)	1.18	1 (1)	0.76
Total	225	4.09	179 (6)	2.74	156(57)	3.01
Brown						
0	43	0.53	23(12)	0.36	16 (9)	0.29
I	3	0.42	1 (1)	0.20	3 (1)	0.81
II	1	0.70	-	-	3 (1)	2.02
III	4	5.68	4 (4)	5.81	2 (2)	2.26
IV or older	4	12.61	6 (4)	19.62	4 (3)	11.04
Total	55	19.94	34(21)	25.99	28(16)	16.42
Brook						
0	21	0.36	7 (3)	0.11	15 (1)	0.32
I	4	0.41	1 (1)	0.05	1	0.15
II	-	-	-	-	2	0.50
III or older	-	-	-	-	-	-
Total	25	0.77	8 (4)	0.16	18 (1)	0.97
Grand total	305	24.80	221(31)	28.89	202(74)	20.40
Lbs./acre		340		396		279

^{1/} Recaptured fish marked previously in this section.

percent of all trout in Sections 1 to 4 respectively. The general distribution of trout in the study sections is similar to that reported in the initial study (Holton 1953).

Population Changes

The number and weight of each age group were determined to show changes between each species at each inventory (Tables 3-6). There was a general numerical decrease from the first inventory (August) to the last (December-February) in age groups 0 and I. Brown trout (age-0) decreased

Table 5. Trout numbers and weights for each inventory in Section 3.

Species and age group	Date of inventory					
	<u>Aug. 25, 1962</u>		<u>Oct. 13, 1962</u>		<u>Dec. 19, 1962</u>	
	No.	Wt.	No.	Wt.	No.	Wt.
Rainbow						
0	394	2.54	216(14) ^{1/}	1.86	203(78)	1.99
I	8	1.14	5 (2)	0.75	6 (4)	0.98
II	4	1.30	1 (1)	0.31	3	0.75
III or older	1	0.66	-	-	-	-
Total	407	5.64	222(17)	2.92	212(82)	3.72
Brown						
0	41	0.49	13 (4)	0.23	14 (6)	0.25
I	8	1.21	4 (3)	0.84	8 (5)	1.99
II	6	3.39	7 (6)	4.49	9 (5)	5.78
III	3	3.74	4 (2)	4.81	1	1.63
IV or older	3	6.84	2 (2)	3.70	3 (1)	4.71
Total	61	15.67	30(17)	14.07	35(17)	14.36
Brook						
0	18	0.31	10 (3)	0.23	5	0.12
I	3	0.34	-	-	-	-
II	2	0.97	2 (2)	1.03	-	-
III or older	-	-	-	-	-	-
Total	23	1.62	12 (5)	1.26	5	0.12
Grand total	491	22.93	264(39)	18.25	252(99)	18.20
Lbs./acre		218		174		173

^{1/} Recaptured fish marked previously in this section.

from 195 to 37, rainbow trout from 902 to 464, and brook trout from 84 to 70. Rainbow trout (age-I) decreased from 22 to 9, brown trout from 17 to 12, while brook trout increased from 21 to 27. Age groups II or older fluctuated between inventories (August to December-February) for all species without distinct patterns. Brown trout in age groups I or older were reported to increase during the spawning season of the initial study.

The total weight of trout remained about the same throughout the study period, but did show some variations between inventories. Total

Table 6. Trout numbers and weights for each inventory in Section 4.

Species and age group	Date of inventory					
	Aug. 18, 1962		Oct. 27, 1962		Feb. 9, 1963	
	No.	Wt.	No.	Wt.	No.	Wt.
Rainbow						
0	274	1.93	439 (9) ^{1/}	3.61	25 (2)	0.18
I	13	2.00	6 (5)	0.93	1	0.36
II	-	-	-	-	4	1.52
III or older	1	0.97	1 (1)	0.90	3	2.89
Total	288	4.90	446(15)	5.44	33 (2)	4.95
Brown						
0	111	1.45	57(16)	1.14	7	0.15
I	6	1.34	4 (2)	1.08	1	0.30
II	6	3.95	4 (2)	3.37	4 (2)	2.80
III	2	1.82	2	2.22	4 (2)	4.54
IV or older	1	3.92	1	1.88	3 (2)	7.38
Total	126	12.48	68(20)	9.69	19 (6)	15.17
Brook						
0	4	0.07	1	0.03	-	-
I	-	-	-	-	1	0.20
II	-	-	2	0.99	-	-
III or older	-	-	-	-	-	-
Total	4	0.07	3	1.02	1	0.20
Grand total	418	17.45	517(35)	16.15	53 (8)	20.32
Lbs./acre		168		155		195

^{1/} Recaptured fish marked previously in this section.

rainbow trout weight was about 15 percent less in the October-November and December-February inventories than in August. An influx of spawning brook trout in Section 1 caused an overall gain in weight of about 61 percent for this species. This was also observed in the initial study.

The August and October-November inventories were used to make comparisons between the two study periods because dates of the inventories were similar, and maximum number of fish was collected at these times (Table 7). The two inventories from the initial study (October-November 1950, and

Table 7. Numbers and weights of trout for two inventories of the two study periods. ^{1/}

Species and age group	Present study				Initial study			
	Aug. 1962		Oct.-Nov. 1962		Oct.-Nov. 1950		Aug. 1951	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Rainbow								
0	902	5.98	895	7.66	1243	10.06	908	2.78
I	22	3.32	13	2.02	66	5.70	146	10.37
II or older	10	5.60	4	2.64	7	2.70	18	5.06
Total	934	14.90	912	12.32	1316	18.46	1072	18.22
Brown								
0	195	2.47	93	1.73	16	0.37	44	0.47
I	17	2.97	9	2.12	15	3.79	1	0.14
II or older	30	42.65	30	45.90	10	18.37	6	5.81
Total	242	48.09	132	49.75	41	22.53	51	6.42
Brook								
0	84	1.31	53	1.15	81	1.90	297	2.60
I	21	2.21	26	3.96	113	15.18	69	5.90
II or older	4	1.48	9	3.82	2	0.74	6	1.61
Total	109	5.00	88	8.93	196	17.82	372	10.11
Grand total	1285	67.99	1132	71.00	1553	58.81	1495	34.74
Lbs./acre	210		219		180		106	

^{1/} Data from all sections combined. Numbers and weights adjusted on the basis of efficiency tests in both studies.

August 1951) were treated as if they were from the same year. The species composition of the population in the study sections was 76, 16, and 8 percent respectively rainbow, brown, and brook trout compared to 78, 3, and 19 percent for the same species in the initial study. The number of brown trout in the present study was 307 percent greater than in the initial study. They increased 380, 63, and 275 percent in age groups 0, I, and II or older respectively. Brown trout in age groups II or older constituted 69 percent of all fish in these groups in the present study, and only 33 percent in the initial study. The number of brook trout was 65 percent less than in the initial study. They decreased 64 percent in age group 0,

74 percent in age group I, but increased 63 percent in age groups II or older. The number of rainbow trout was 23 percent less than in the initial study. They decreased 16, 83, and 44 percent in age groups 0, I, and II or older respectively. Even though there were more brown trout in the present study, the total number of all trout was 22 percent less than in the initial study due to a reduction in rainbow trout and brook trout.

The total weight of trout was 49 percent greater in the present study. The weight composition was 70, 20, and 10 percent respectively for brown, rainbow, and brook trout compared to 31, 39, and 30 percent for the same species in the initial study. The weight of brown trout age-I or older comprised 64 percent of the total weight in the present study, and only 30 percent in the initial study. The weight of brown trout was 238 percent greater than in the initial study, while brook trout decreased 50 percent and rainbow trout 26 percent.

The decrease of brook trout and rainbow trout may be due to an increase of brown trout since the physical, chemical, and other biological characteristics changed little between the two studies. The large brown trout may be spawning fish from the East Gallatin River. An increase of large brown trout was found during the spawning season in the initial study. Schuck (1945) reported brown trout replaced brook trout in several New York streams.

Standing Populations

The standing population of all trout was based on the August 1962 inventory (Table 7). The weight of trout varied from 67 pounds per acre

(Section 1) to 340 pounds (Section 2). A total of 1,285 trout weighing 67.99 pounds was collected from all study sections. This is equivalent to 3,966 trout or 210 pounds per acre compared to 4,586 trout or 106 pounds per acre reported in the initial study. The greatest weight of trout found was 396 pounds per acre taken in Section 2 during the October-November inventory. This compares with 337 pounds per acre taken in Section 1 at a comparable inventory in the initial study.

Trout 7 inches or over in total length comprised about 6 percent of the number and 80 percent of the weight of all trout in the present study compared to 3 percent of the number and 43 percent of the weight in the initial study. There were considerably more brown trout in the present study and about equal numbers of rainbow trout and brook trout in both studies (Table 8). Brown trout made up 55 percent of the number and 81 percent of the weight in contrast to 16 percent of the number and 40 per-

Table 8. Numbers and weights from trout 7 inches or over in total length for the August inventories for the two study periods.

Study period	Species of trout					
	Rainbow		Brown		Brook	
	Present	Initial	Present	Initial	Present	Initial
Total number	24	25	43	7	11	12
Av. total length (inches)	9.1	8.3	12.4	11.2	8.1	8.3
Total weight (pounds)	8.13	6.37	45.20	5.97	2.51	2.73
Average weight (pounds)	0.34	0.25	1.05	0.85	0.23	0.22

cent of the weight in the initial study. There were 343 trout (7 inches or over) per mile of stream compared to 197 in the initial study.

The standing population of 210 pounds of trout per acre (only species present except for cottids and a few whitefish) found in Trout Creek is

much higher than 56 pounds per acre of trout reported by Stefanich (1952) from a total fish population (including whitefish, suckers, carp, and burbot) of 125 pounds per acre in Prickley Pear Creek, Montana. Nielson, Reimers, and Kennedy (1957) reported a trout population of 120 pounds per acre in Convict Creek, California. McFadden and Cooper (1962) found the trout populations in six Pennsylvania streams varied from 13 to 137 pounds per acre from total fish populations up to 354 pounds per acre.

Movement

A total of 1222 trout was marked during the study period. Only those trout recovered in sections where marked are tallied as recaptures. Marked trout were considered to show no movement when recaptured in the sections where originally marked. The highest percentage (47.6) of marked fish recovered was in Section 1 on November 2, 1962, and the lowest (1.7) in Section 4 on February 9, 1963 (Table 9). Of the trout marked in all sections of the first inventory (August), 29.6 percent were recaptured in the second inventory (October-November) and of those marked in the first two inventories, 19.9 percent were recaptured in the third inventory (December-February). Only 13 trout were recovered in sections other than where marked, and 11 of these moved between Sections 2 and 3. A small rainbow trout moved about one mile downstream (from Section 1 to Section 3) and a small brown trout moved about the same distance downstream (from Section 2 to Section 4). Upstream movement was probably hindered by a small irrigation dam above Section 4 since none of the trout marked below the dam were found in upstream sections.

Table 9. Trout marked and recovered in each section.

Section	Inventory date	Number marked	Number available for recapture	Number recaptured	Yearlings or older recaptured (percent)
1	Aug. 18, 1962	42	-	-	
	Nov. 2, 1962	103	42	20	32.2
	Dec. 20, 1962	-	145	62	48.4
2	Aug. 25, 1962	92	-	-	
	Oct. 6, 1962	168	92	31	80.0
	Jan. 3, 1963	-	259	74	58.8
3	Aug. 25, 1962	130	-	-	
	Oct. 13, 1962	202	130	39	72.0
	Dec. 19, 1962	-	332	99	50.0
4	Aug. 18, 1962	158	-	-	
	Oct. 27, 1962	327	158	35	50.0
	Feb. 9, 1963	-	484	8	28.6

The recovery of marked yearlings and older trout was considerably higher for the second inventory from Sections 2, 3, and 4 than for the third inventory (Table 9). The opposite was true for Section 1 due to an influx of mature brook trout between the first and second inventories.

A greater percentage of yearling and older trout was recaptured than in the initial study. Combining all sections for the October-November inventory, the marked yearling and older trout constituted 56.2 percent of these age groups in the present study compared to 41.8 percent in the initial study.

A higher percentage of marked brown trout was recaptured in the study sections than other trout species. This may indicate less movement by brown trout. Stefanich (1952) found brown trout moved less than rainbow trout in Prickley Pear Creek, Montana. A total of 41.1 percent of 236

marked brown trout was recaptured at least once in the study sections, compared to 38.7 percent of 150 marked brook trout and 25.5 percent of 835 marked rainbow trout.

Reproduction

The smallest sexually mature brook trout collected was 6.3 inches in length. Yearlings made up 84 percent of mature trout. While no sexually mature young-of-year were found, no special study was made on these fish. Holton (1953) found several mature young-of-year males in the initial study. Brasch, McFadden, and Kmiotek (1958) reported 95.5 percent of the male brook trout in a Wisconsin stream were mature at the end of their first summer of life.

The sex of 30 brook trout collected on November 2 in Section 1 was 21 (70 percent) males and 9 (30 percent) females. About the same ratio was found in the initial study. Brown trout and rainbow trout ratios were not made because sex was determined on only a few specimens. The youngest mature brown trout collected was a yearling male.

The spawning season for brown trout and brook trout lasted through most of November and early December. No careful observations were made for the time of fry emergence, however some brook trout fry were collected in spring areas on March 10, 1963. Brown trout fry were probably present at this time, but none were collected.

A total of 1,181 young-of-year trout were present in all sections during the August inventory (Table 7). Rainbow trout constituted 76 percent, brown trout 17 percent, and brook trout 7 percent. There were 5,196

young-of-year per mile of stream compared to 5,468 reported in the initial study.

AGE AND GROWTH

Trout collected in the August inventory were used for age and growth estimates. All sections were combined for each trout species because of the small sample size in older age groups (Tables 7 and 10). Young-of-

Table 10. Total lengths of trout in each age group in the August inventories from the two study periods.

Species and age group	Total lengths (inches) at capture					
	Present study			Initial study		
	No.	Average	Range	No.	Average	Range
Brown						
0	143	3.15	2.4- 4.1	44	-	-
I	17	7.61	6.5- 9.0	1	-	-
II	13	11.95	10.4-13.8	5	-	-
III	9	14.91	13.6-16.7	-	-	-
IV or older	8	20.28	16.6-24.1	1	-	-
Rainbow						
0	340	2.63	1.3- 3.9	326	2.12	1.0- 3.3
I	22	7.20	5.8- 8.9	142	5.50	3.7- 8.3
II	6	9.30	8.0-11.0	17	8.63	6.5-12.6
III	4	13.55	12.5-15.4	-	-	-
Brook						
0	66	3.40	2.7- 4.1	230	2.90	2.0- 4.1
I	21	6.45	4.8- 7.7	66	6.08	4.7- 9.1
II	4	9.55	8.0-10.6	6	8.80	8.0- 9.7

year trout were predominant for each species. They made up 96, 80, and 77 percent respectively of rainbow, brown, and brook trout compared to 85, 86, and 80 percent respectively for the same species in the initial study.

There were considerably fewer rainbow trout in age groups I and II, and

fewer brook trout in age group I than in the initial study. Rainbow trout older than age group III and brook trout older than II were not found. The paucity of older fish was also found in the initial study. Brown trout of all age groups were more numerous than in the initial study. Age groups I or older made up 60, 95, and 74 percent respectively of the total rainbow, brown, and brook trout weights compared to 85, 93, and 74 percent for the initial study.

Young-of-year brook trout and brown trout were longer (total length) than rainbow trout in the August inventory (Table 10). This difference was probably due to the earlier hatching dates of brook trout and brown trout. Brown trout yearlings and two-year-olds grew faster than either rainbow trout or brook trout.

The average total length of all trout for each age group was larger than reported in the initial study (Table 10). Young-of-year rainbow trout were 0.51 inches larger and brook trout were 0.50 inches larger than in the initial study. The older age groups of rainbow trout and brook trout were as much as 1.7 inches larger than in the initial study, but this difference may be due to the small sample of fish in the present study. The minimum size range for rainbow trout is larger for each age group indicating a faster rate of growth. Growth of brown trout could not be compared because data were lacking in the initial study.

Average calculated lengths at time of annulus formation was made on 48 brown trout, 37 rainbow trout, and 46 brook trout. A constant ratio of scale radius to body length was assumed.

The total average calculated lengths for brown trout at annulus formation for years I-III were: 4.2, 9.9, 12.9 inches. A length of 7 inches was reached in the second summer. The size of trout at annulus formation cannot be compared with the initial study since only average total lengths were presented at the time of capture in August. Growth of brown trout in Trout Creek was better than that in Prickley Pear Creek (Bishop 1955) and about the same as that reported by Purkett (1951) for the West Gallatin River, Montana.

The total average calculated lengths for rainbow trout at annulus formation for years I-III were: 3.2, 6.8, 11.4 inches. A length of 7 inches was achieved by most of these at the end of their second fall. Growth of rainbow trout was about the same as that reported for Prickley Pear Creek (Bishop 1955) and slower than those from the West Gallatin River, Montana (Purkett 1951).

The total average calculated lengths for brook trout at annulus formation for year I was 3.8 inches and year II, 7.6 inches. Over half of the brook trout achieved a length of 7 inches at the end of the second fall. The growth of brook trout was slightly greater than that in Prickley Pear Creek (Bishop 1955) and slower than reported for those from the West Gallatin River, Montana (Purkett 1951).

SUMMARY

1. An investigation of the rainbow, brown, and brook trout population in Trout Creek, Gallatin County, Montana was conducted from July 1962 to March 1963. The results were compared with the initial study made by

Holton (1953) on the same stream during the summers and intervening winter of 1950 and 1951.

2. A comparison of physical, chemical, and certain biological factors within the study sections showed little change between the two study periods.

3. Brook trout predominated in the uppermost study section, and rainbow trout in the lower three sections.

4. During the August and October-November inventories, the species composition in the study sections was 76, 16, and 8 percent respectively rainbow, brown, and brook trout compared to 78, 3, and 19 percent respectively for the same species in the initial study. The weight composition was 70, 20, and 10 percent respectively for brown, rainbow, and brook trout compared to 31, 39, and 30 percent respectively for the same species in the initial study.

5. The total number and weight of brown trout increased over the initial study, while rainbow trout and brook trout were less. The total number of all trout was 22 percent less, but total weight was 49 percent greater than in the initial study.

6. The estimated standing crop of trout in August was 210 pounds per acre compared to 106 pounds per acre in the initial study. About equal numbers of rainbow trout and brook trout 7 inches or over in total length were present in both studies, but there were 514 percent more brown trout in the present study.

7. There was evidence of limited movement. Indications were that

brown trout moved less than either rainbow trout or brook trout.

8. An estimated 5,196 young-of-year per mile of stream were present in August compared to 5,468 in the initial study.

9. Brown trout grew faster than either brook trout or rainbow trout. The average total length in the August inventory for age-II fish was 11.95, 9.55, and 9.30 inches respectively for brown, brook, and rainbow trout. The growth of rainbow trout and brook trout was slightly faster than in the initial study.

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