



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  
MASTER OF SCIENCE in Fish and Wildlife Management  
Montana State University  
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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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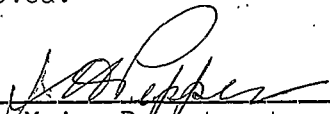
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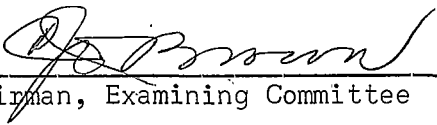
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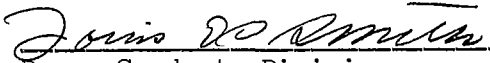
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## Abstract

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,



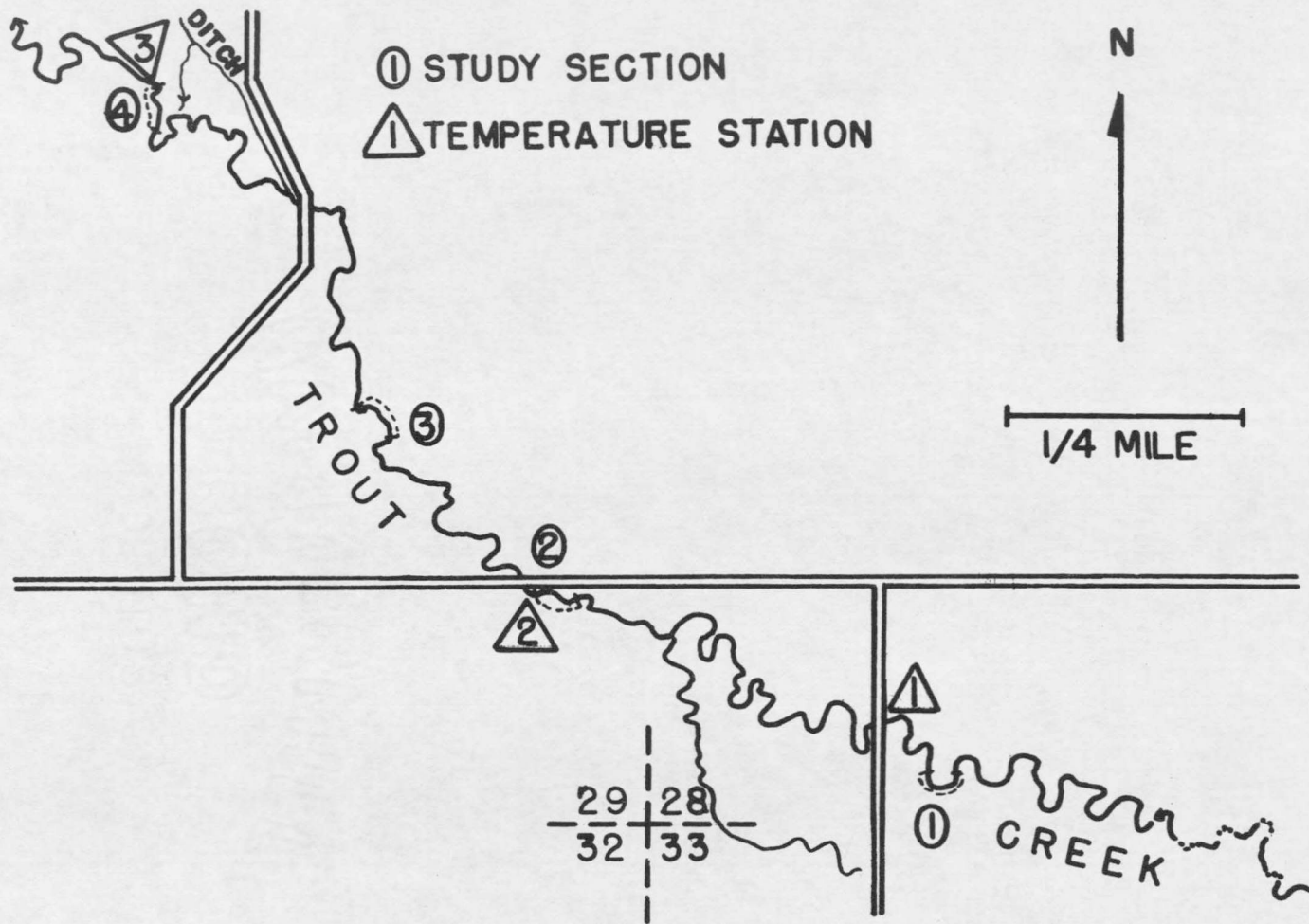


Fig. 1. Trout Creek study area (T. 1N., R. 5E.).

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 <sup>1/</sup>	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 <sup>1/</sup>	63	65	26	6	8	18	19	21
Gravel	39	-	30	-	14	-	64	-
Sand & silt	61	-	70	-	84	-	33	-
Hardpan	-	-	-	-	2	-	3	-
Pools <sup>1/</sup>	5	13	40	44	27	49	35	39
Gravel	27	-	20	-	22	-	12	-
Sand & silt	64	-	57	-	75	-	59	-
Hardpan	9	-	23	-	3	-	29	-

<sup>1/</sup> 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 <sub>3</sub> )	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 Holton 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) <sup>1/</sup>	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

<sup>1/</sup> 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.
<b>Rainbow</b>						
0	221	1.47	176 (4) <sup>1/</sup>	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
<b>Brown</b>						
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
<b>Brook</b>						
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

<sup>1/</sup> 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) <sup>1/</sup>	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

<sup>1/</sup> 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) <sup>1/</sup>	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

<sup>1/</sup> 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



























