THE POPULATION AND MOVEMENT OF FISH IN PRICKLEY PEAR CREEK, MONTANA

by

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Table of Contents

Abstract

A two year study was made on the populations and movements of fish in Prickley Pear Creek, Montana. Populations were determined for six sample sections of the stream four times in 1949 and three times in 1950. Practically all fish over 3.5 inches were captured, marked and released. The most numerous species present were brown trout, rainbow trout and longnose suckers, except for freshwater sculpins. Only a small number of eastern brook trout, mountain whitefish, American burbot, carp and western white suckers were present. Only one cutthroat trout was found.

The number of brown trout in relation to all trout was approximately 60 per cent in 1949 and 54 per cent in 1950. Their numbers increased in both years from June through September. Their weight decreased slightly from June through September in both years, and their weight in relation to that of all trout was 74 per cent in 1949 and 73 per cent in 1950. The number of rainbow trout comprised approximately 35 per cent of the trout population in 1949 and about 41 per cent in 1950. They increased in numbers from June through September in both years. Their weight remained relatively constant in 1949 and increased progressively in 1950, but their weight in relation to all other trout was about 24 per cent for both years. The number of trout in relation to all fish except freshwater sculpins was about 80 per cent in 1949 and 78 per cent in 1950, and their weight 58 per cent in 1949 and 47 per cent in 1950. Planted rainbow trout are included in these figures but did not exceed 8.9 per cent of the total weight of all trout at any time. There was a variation of 43.78 to 67.91 pounds per acre of trout during the two year period. The weight of trout decreased from an average of 63.99 pounds per acre in 1949 to 45.13 pounds in 1950. Weights remained relatively constant for the sampling periods each year but showed a significant difference between years. Suckers made up about 13 per cent of the number and 33 per cent of the weight in 1949 and 22 per cent of the number and 49 per cent of the weight in 1950. The total weight of all fish varied from 58.87 to 241.10 pounds per acre at the different sampling periods.

A large number of trout were recaptured in the same areas where tagged. Eleven were recovered six times in the same area. No discernable pattern was obtained from the movement of trout.

Introduction

An investigation of the populations and movements of fish in Prickley Pear Creek, Montana, was first studied in the summer of 1949, and is continuing. Data secured during 1949 and 1950 are reported here. This project was sponsored and financed by the Montana State Fish and Game Department and represents the first effort of its kind within the state. A similar study was made by Shuck (1945) in Crystal Creek, New York. Smith et al (1949) investigated the populations of some trout streams in Minnesota. Needham and Cramer (1943) observed the movements of trout in Convict Creek, California.

Description of the area

Prickley Pear Creek was selected because of its suitable size, accessibility and popularity as a fishing stream. It runs in a northeasterly direction over most of its 23 mile course and enters the Missouri River about 6 miles upstream from Craig, Montana. The upper 11 miles traverses a narrow valley, while the lower 12 miles flows largely through a rocky canyon. The creek drains an area of approximately 394 square miles, mostly of grassland with open stands of ponderosa pine. The elevation at the head of Prickley Pear Creek is 4,250 feet above mean sea level and at its mouth is 3,300 feet. The gradient is approximately 41 feet per mile. Most of the land in this drainage is privately owned and is used chiefly for stock grazing, there being very little cultivated land in the valley. Since the entire stream could not be studied intensively because of time and facilities, the lower 13 miles were selected. Five small tributaries

enter this part of the creek. In the study area, stream width varied from 15 to 60 feet and maximum depths from about 6 inches to 8 feet. There was an average distance of approximately 260 feet between pools with a depth of 3 feet or greater. Riffle areas were mostly shallow, covered with gravel and rubble.

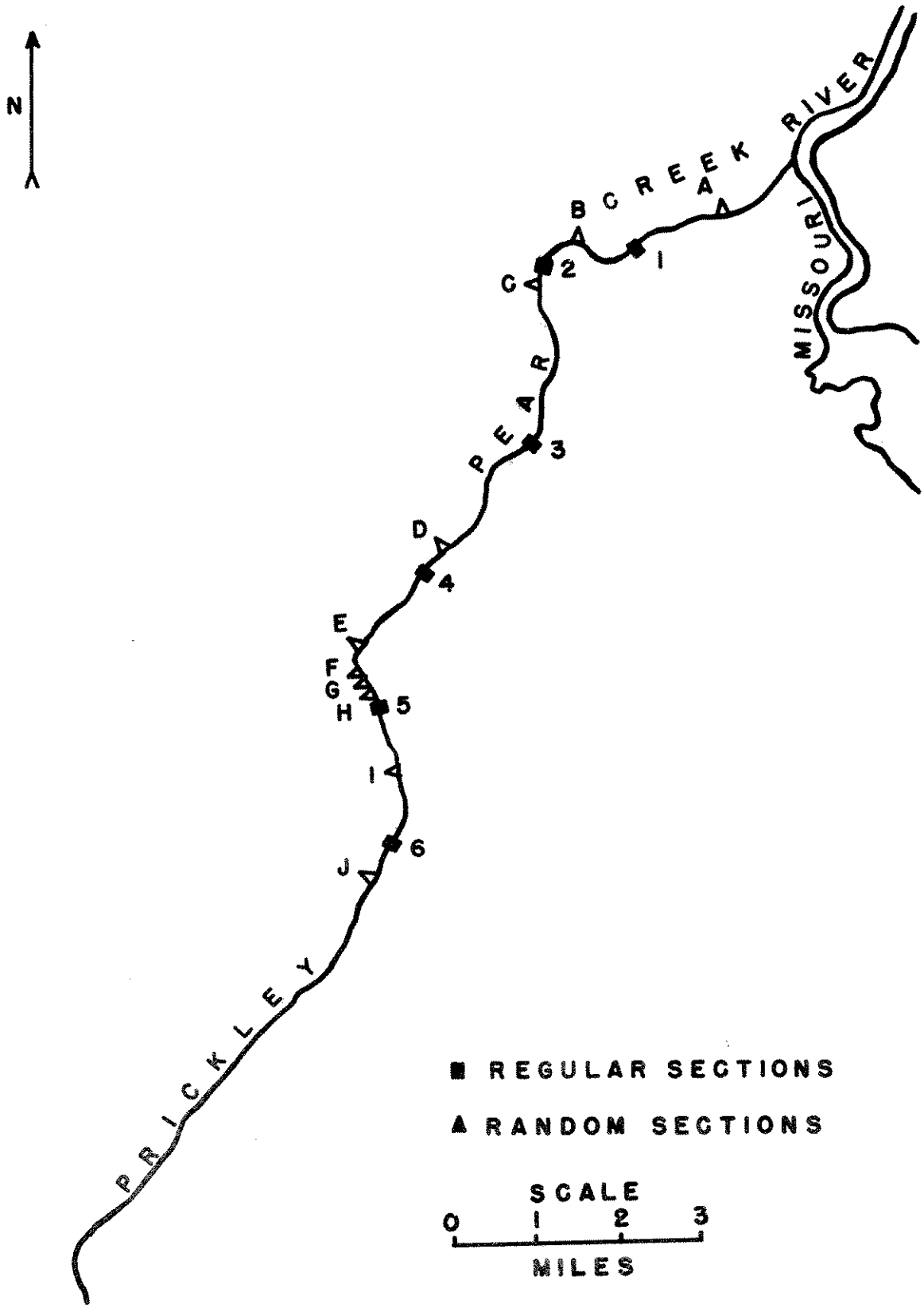
Size and location of sections

Inasmuch as it was impractical to cover the entire 13 miles of stream under consideration, six representative sections at more or less equal intervals were established. (Fig. 1). Section 2 was arbitrarily chosen at approximately 3.6 road miles from the mouth of the creek. Sections 3, 4, 5, and 6 were established at successive intervals of 2.3 road miles upstream from section 2, and section 1 was located at a point 1.4 road miles downstream from section 2. Thick brush, swamp and absence of a road prevented the establishment of this section at an interval equal to the others. Each section was 600 feet long and its lower boundary was marked by means of a concrete post for later reference. A plane table map was prepared for each section showing stream outline, bank cover and contour.

Water temperatures

The water level in Prickley Pear Creek exhibited the usual pattern of streams for this region, with a high run-off in late spring and early summer followed by a sharp decrease in flow in late summer and a small but relatively steady decrease through fall and winter.

In 1949, daily morning and evening water temperatures were taken with a Taylor pocket thermometer from June 18 through September 23. During this period the minimum water temperature was 44 degrees F., and the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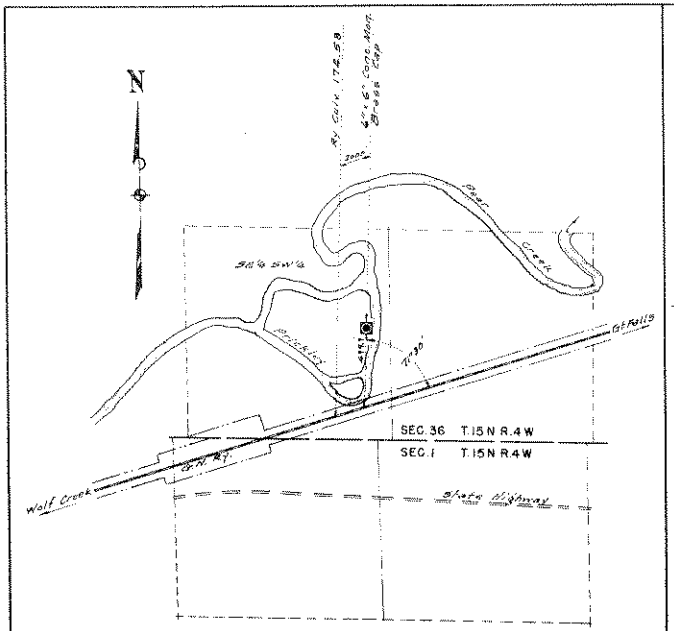

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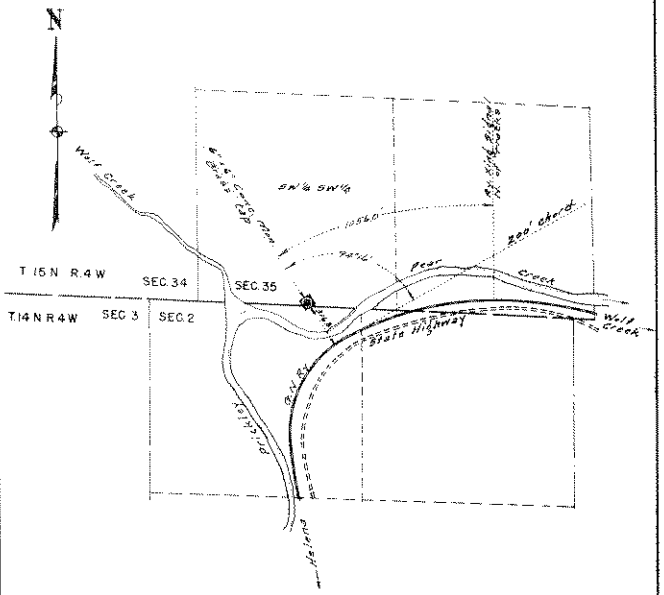

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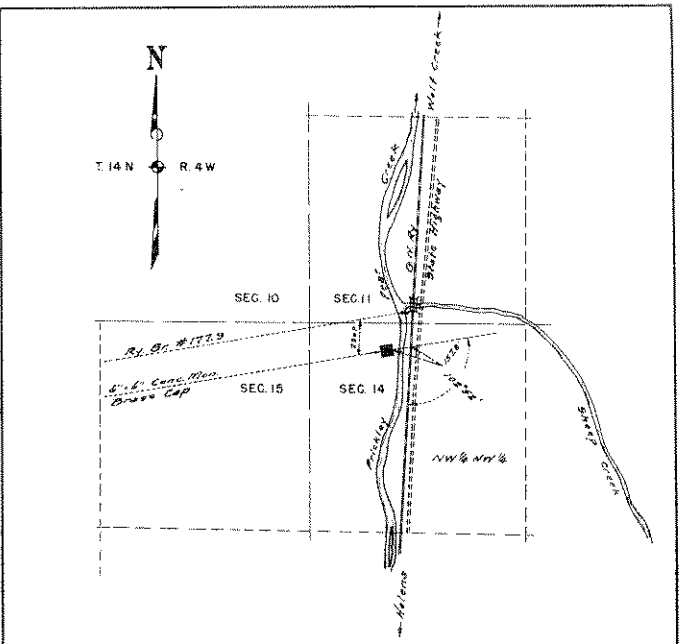

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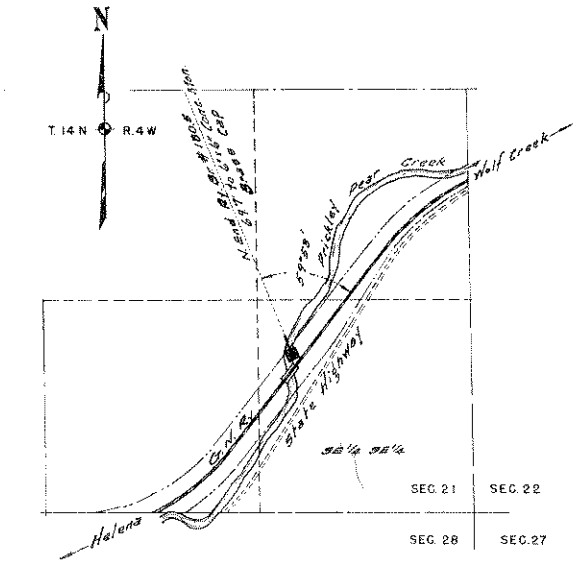

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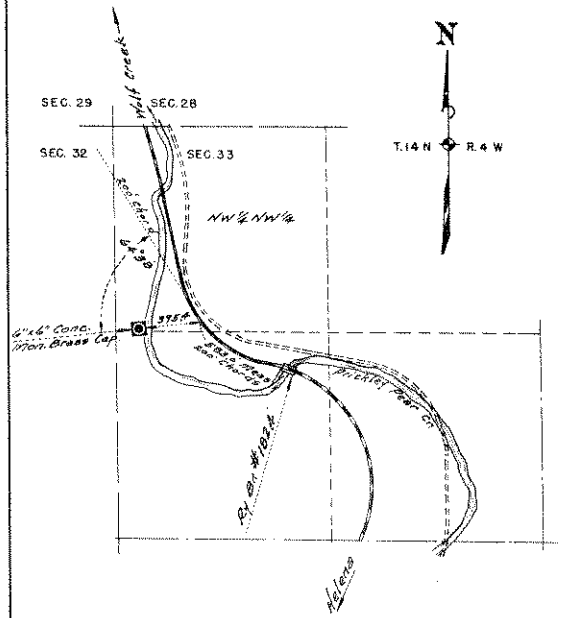

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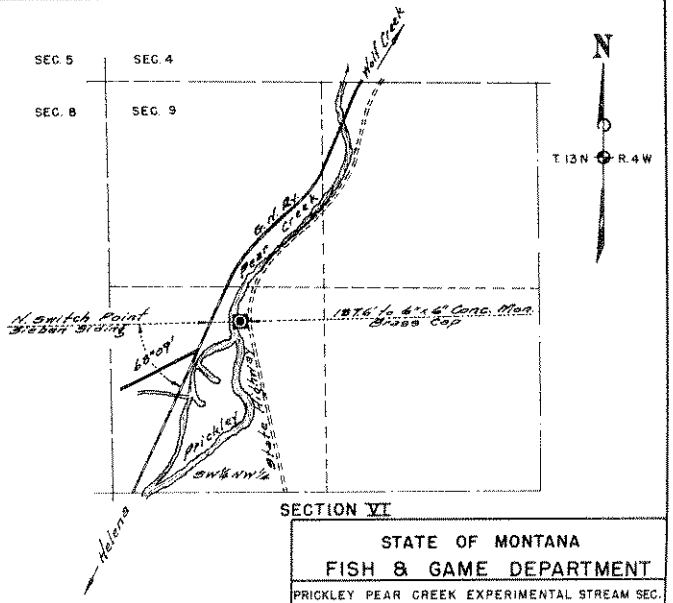


SECTION VI

STATE OF MONTANA
FISH & GAME DEPARTMENT

PRICKLEY PEAR CREEK EXPERIMENTAL STREAM SEC.

Surveyed by C.N.C.	Sheet 1 of 1 Sheets	MAPS OF DEFINITE LOCATION
Drawn by C.C.B.		
Traced by C.V.D.		
Date 10/27/60		Scale 1" = 400'

maximum 66 degrees F. The average daily water temperature was 54.6 degrees F. Considerable daily variation was observed. On three occasions, as much as 12 degrees difference was recorded between 7:30 a.m. and 7:30 p.m.

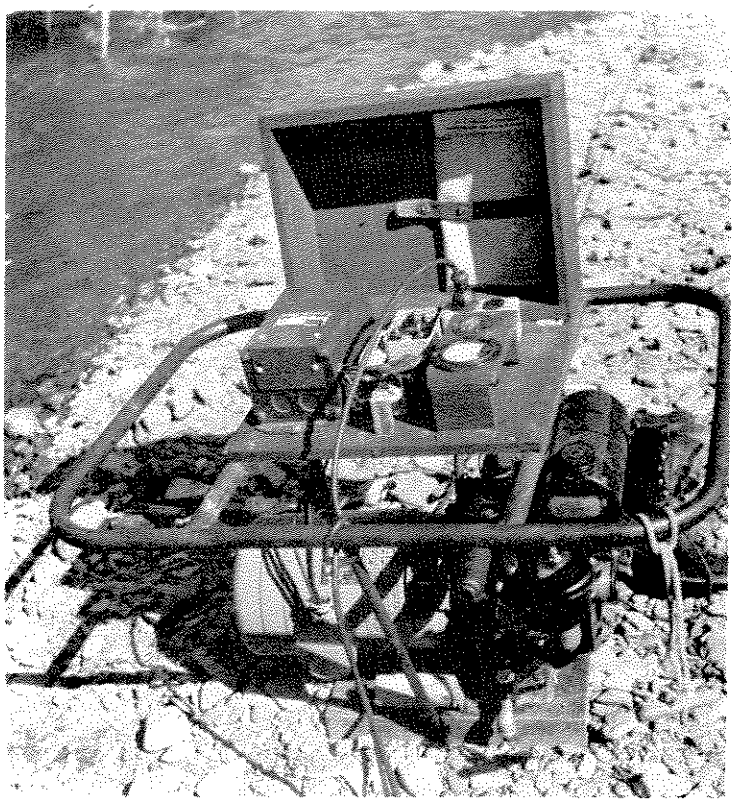
In 1950, daily water temperatures were taken with a maximum-minimum thermometer from June 18 through September 26. The minimum for this period was 45 degrees F. and the maximum was 67 degrees F. The average daily water temperature was 54.6 degrees F. The greatest daily variation occurred on August 1, when there was a difference of 16 degrees F. between maximum and minimum temperatures.

The pH of Prickley Pear Creek was 8.2 as determined by one sample taken each year.

Equipment and Material

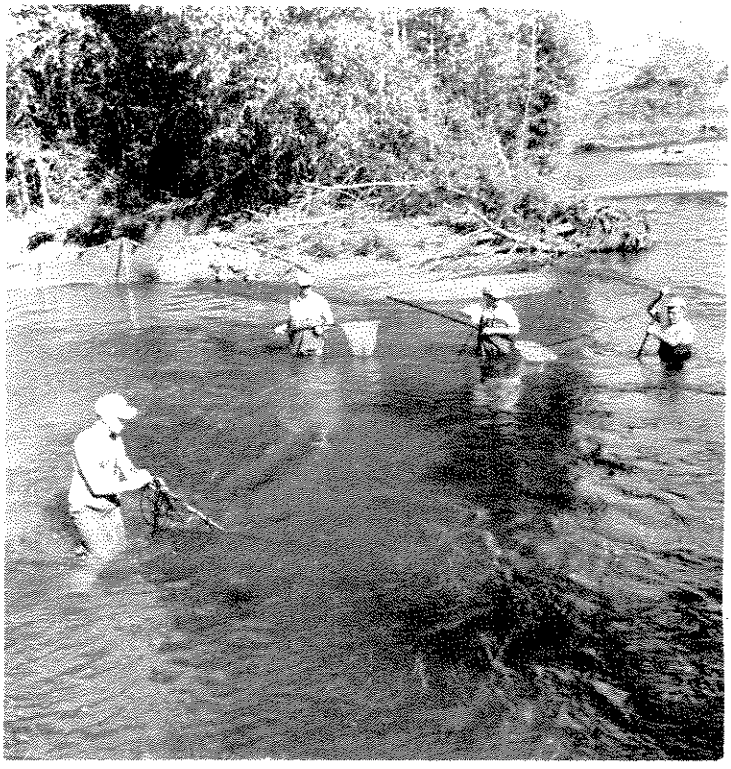
The electric shock method was used in collecting fish. This has been employed by a number of workers, notably Haskell (1940) and Shetter (1948). A portable 500-watt alternating current generator provided the electrical energy (Fig. 2). A rheostat and transformer made it possible to secure voltages ranging up to 240. Each electrode consisted of a brass tubing grid 16 inches square which was welded to a 6 foot handle made of 3/8 inch pipe covered with garden hose. A phone jack receptacle was fastened in the end of each handle and these were connected to the grid by an insulated wire running through the center of the pipe. An extension cord 125 feet long and fitted with phone jacks connected the electrodes to the generator.

Pens for holding live fish consisted of wooden frames covered with 1/4 inch mesh hardware cloth. Corners were reinforced with metal plates. The tops were removable and hinged at the center. This made it possible

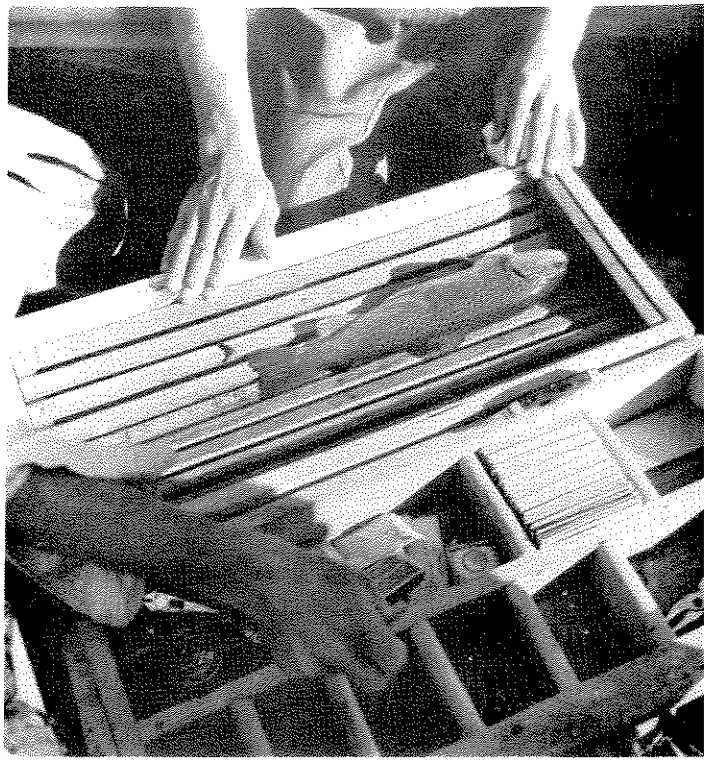


The Electric Shocker

Electrode



Crew Equipment in Operation



Taking data

to have either the entire top open or either half, at the convenience of the operator. At times it was necessary to have part of the top closed in order to prevent fish from escaping.

Dip nets were of the usual design. They were equipped with cotton netting either 1/4 or 1/2 inch bar measure. Nets used for blocking stream sections were made of 1/2 inch bar measure seine material. A measuring board calibrated in 0.1 of an inch was used for determining lengths and a platform scale graduated in 0.02 of a pound was employed for taking weights.

Collecting and handling fish

Each section was divided into four 150-foot units. These were blocked off with nets and shocked. On the first trip through a maximum of 160 volts was used to avoid undue injury to large fish. Thereafter a maximum of 190 volts was used until no more fish were observed. Stunned fish were caught with dip nets and placed in holding pens as soon as possible. These pens were always placed in the quietest water available.

Captured fish were anesthetized in a 0.5 per cent solution of urethane before weighing and measuring as outlined by Gerking (1949). Care was taken not to expose fish to urethane longer than 5 minutes. Total lengths to the nearest 0.1 of an inch and weights to the nearest 0.01 of a pound were taken. Nearly all of the fish after being captured were either jaw tagged, tagged with a Peterson disk or fin clipped. Each fish was allowed to recover completely in holding pens before release within the section or in the upper part of the section under study. Errors made in tagging and recording did not exceed 1.7 per cent of the fish taken in any shocking period and was usually much less than this figure. All trout

improperly recorded or identified are classified as "unknown" in population tabulations.

Marking fish

Strap tags similar to those described by Shetter (1936) and Rounsefell and Kask (1945) were used in marking trout. The serially numbered Monel Metal tags used in this study were of two styles (1005 and 18M) and four sizes (1, 3, 4, and 18M) as manufactured by the National Band and Tag Company.

The size tags and the trout on which they were used are as follows (lengths are approximate):

No. 1 on trout 3.5 - 5.5 inches total length

No. 3 on trout 5.6 - 14.0 inches total length

No. 4 on trout 14.1 - 18.0 inches total length

No. 18M on trout 18.1 inches and over total length

A tag was clamped around the dentary bone of each trout, then rounded with pliers in order to prevent unnecessary pressure and chafing.

Species of fish other than trout were either fin clipped or tagged with a Peterson disk held in place with a nickle pin just ventral to the dorsal fin.

Acknowledgements

The writer is indebted to several individuals and agencies who assisted in this study. Dr. C. J. D. Brown gave overall direction to this investigation and helped in the preparation of the manuscript. Mr. Charles K. Phenicie suggested the problem and rendered active assistance in its direction. The following field biologists assisted in the shocking

operations: W. Alvord, J. E. Bailey, W. D. Clothier, V. E. Craig, J. W. Kathrein, and T. J. Ready.

Fish Populations

Fish present

The brown trout (Salmo trutta) was the predominant salmonid species except for one shocking period when it was superceded by rainbow trout (Salmo gairdnerii). Eastern brook trout (Salvelinus fontinalis) were present in small numbers and only one cutthroat (Salmo clarkii) was found. Some hybrid rainbow x cutthroat trout were present but were so difficult to distinguish from the rainbow trout that it was not practical to separate them. They are therefore included with the rainbow trout. The mountain whitefish (Prosopium williamsoni) and the western white sucker (Catostomus commersoni sucklii) were never abundant but were most numerous during the spring. The longnose sucker (Catostomus catostomus) was abundant in the spring and early summer but decreased very markedly in the fall. A few carp (Cyprinus carpio) were present in June, July and August but at no other period of the study. A small number of American burbot (Lota lota maculosa) were present in all but one of the shocking periods. Fresh water sculpins (Cottus bairdii punctulatus) were abundant in all sections at all shocking periods.

Rainbow trout were planted by the Fish and Game Department in experimental sections four and six as follows: 2,955 fingerlings (2 - 5 inches) in September 1949, 904 yearlings (average 6.7 inches) in May 1950, approximately 4,000 fingerlings (average 2-5 inches) in September 1950. Each lot was fin clipped to make subsequent identification possible.

Trout populations

All sections were shocked four times in 1949 and three times in 1950. Each shocking period is designated in consecutive order by a number. These numbers with the actual shocking days which they represent, and the elapsed time between shocking periods are given in Table I. Each shocking period took nine days or less to complete with the exception of the first which took 22 days. Mechanical difficulties with the electric generator prolonged the time necessary to complete the first shocking. Each experimental section required an average of one day to complete.

The writer is confident after careful checking, that practically all fish over 3.5 inches were captured. However, it is certain that at least a few over this size escaped. Fish under this size were extremely difficult to shock, locate and hold in dip nets, although many fish under this size were captured. All of the fish collected in the six sections are

Table I

Designated numbers and inclusive dates of shocking periods with average elapsed days

Shocking period		Total days of shocking period	Average elapsed days since last shocking
Number	Inclusive dates		
1	June 22 to July 13, 1949	22	
2	August 11-17, 1949	7	40
3	September 16-23, 1949	8	36
4	November 24-27, 1949	4	66
5	June 22-30, 1950	9	212
6	August 7-15, 1950	9	44
7	September 18-25, 1950	8	41

included in this study except the fresh water sculpins. These were omitted

because they were almost impossible to collect in the time available. The various species of fish are treated separately with the exception of the longnose and western white suckers which are included together (suckers). However, the proportion of each species was ascertained during the third shocking period. Of the 34 adult suckers captured, 5 were western white suckers and 29 were longnose suckers.

Brown trout

In 1949 the number of brown trout present increased from the first to the third shocking periods and then decreased in the fourth (Table II). On the other hand, the number of brown trout in relation to total wild trout population decreased from 67.0 per cent in the first shocking to 54.9 per cent in the fourth shocking period. When the planted rainbow trout are included, the percentage of brown trout decreased to 42.5 per cent in the third shocking period and then increased to 48.2 per cent in the fourth. The weight of all brown trout in relation to the total weight of all wild trout remained relatively constant at approximately 75 per cent throughout all shocking periods for 1949. The inclusion of the weight of planted rainbow trout because of their small size did not effect the percentages of brown trout to any great extent.

In 1950, the total number of brown trout was decidedly less than in 1949. The number captured increased progressively in consecutive shocking periods. On the other hand their numbers in relation to the total of all wild trout decreased from 62.2 per cent in the fifth shocking period to 40.2 per cent in the seventh. When the planted rainbow trout are included the percentages of brown trout increased from the fifth to the sixth

Table II

The numbers, weights and percentages of each species of trout captured for each shocking period in Prickley Pear Creek

Species	Number	Percentage of total number of wild trout	Percentage of total number of all trout	Total weight	Percentage of total weight of wild trout	Percentage of total weight of all trout
		First shocking, June 22 to July 13, 1949				
Brown	311	67.0		125.28	77.0	
Rainbow	140	30.2		34.74	21.4	
Eastern brook	10	2.2		2.46	1.5	
Unknown	3	0.6		0.17	0.1	
Total	464			162.65		
		Second shocking, August 11-17, 1949				
Brown	376	65.6		108.19	72.3	
Rainbow	175	30.5		38.98	26.0	
Eastern brook	21	3.7		2.29	1.5	
Unknown	1	0.2		0.24	0.2	
Total	573			149.70		
		Third shocking, September 16-23, 1949				
Brown	466	57.1	42.5	111.02	73.4	71.9
Rainbow	327	40.1	29.8	37.42	24.8	24.2
Eastern brook	21	2.6	1.9	2.45	1.6	1.6
Unknown	2	0.2	0.2	0.28	0.2	0.2
Total	816			151.17		
Rainbow planted in 1949	280		25.6	3.28		2.1
Grand total	1096			154.45		
		Fourth shocking, November 24-27, 1949				
Brown	324	54.9	48.2	108.96	75.0	74.5
Rainbow	252	42.7	37.5	34.04	23.5	23.3
Eastern brook	12	2.0	1.8	2.21	1.5	1.5
Unknown	2	0.4	0.3			
Total	590			145.21		
Rainbow planted in 1949	82		12.2	1.04		0.7
Grand total	672			146.25		

Table II (continued)

Species	Number	Percentage of total number of wild trout	Percentage of total number of all trout	Total weight	Percentage of total weight of wild trout	Percentage of total weight of all trout
		Fifth shocking, June 22-30, 1950				
Brown	181	62.2	48.3	77.72	79.4	72.2
Rainbow	84	28.9	22.4	14.61	14.9	13.6
Eastern brook	21	7.2	5.6	4.77	4.9	4.4
Unknown	5	1.7	1.3	0.73	0.8	0.7
Total	291			97.83		
Rainbow planted						
in 1949	6		1.6	0.26		0.2
in May, 1950	78		20.8	9.62		8.9
Grand total	375			107.71		
		Sixth shocking, August7-15, 1950				
Brown	284	58.6	53.4	70.56	72.0	67.3
Rainbow	177	36.5	33.3	25.57	26.1	24.4
Eastern brook	21	4.3	3.9	1.79	1.8	1.7
Unknown	3	0.6	0.5	0.13	0.1	0.1
Total	485			98.05		
Rainbow planted						
in 1949	10		1.9	0.93		0.9
in May, 1950	37		7.0	5.87		5.6
Grand total	532			104.85		
		Seventh shocking, September 18-25, 1950				
Brown	302	40.2	25.0	68.73	67.4	61.6
Rainbow	428	57.0	35.5	30.97	30.4	27.7
Eastern brook	16	2.1	1.3	1.26	1.2	1.1
Cutthroat	1	0.1	0.1	0.55	0.6	0.5
Unknown	4	0.6	0.3	0.42	0.4	0.4
Total	751			101.93		
Rainbow planted						
in 1949	6		0.5	0.90		0.8
in May, 1950	20		1.7	3.81		3.4
in Sept., 1950	430		35.6	5.03		4.5
Grand total	1207			111.67		

shocking periods and then markedly decreased in the seventh. The percentages of total weight gradually decreased in these same periods regardless of whether the planted rainbow trout are included.

Length frequencies were determined for brown trout for each shocking period. The groups that have the largest number of fish are presumed to be year classes, especially those with lengths under eight inches. However, no scale studies have been made to substantiate this. A complete age growth analysis will be presented in a later paper. In the first shocking period, the greatest number of brown trout were in the 5.1 - 6.0 inch size group or in the 1 plus year class (Fig. 3). In the second shocking period two groups stand out, the 3.1 - 4.0 inch group or the zero year class and the 6.1 - 7.0 inch group or the 1 plus year class. In the third shocking period, prominent length groups are the same as for the second shocking period. In the fourth shocking period, a large number of brown trout are in the 3.1 - 4.0 inch group or the zero year class. Another prominent group is 7.1 - 8.0 inches in length or the 1 plus year class. The sample of brown trout for the fifth shocking period did not exhibit any predominant length groups (Fig.4). However, in the sixth shocking period the 2.1 - 3.0 inch group or the zero year class and the 5.1 - 6.0 inch group or the 1 plus year class are predominant. Two distinct groups appear in the seventh shocking period but in the next higher length groups.

Rainbow trout

In 1949 the number of wild rainbow trout was less than the number of brown trout in each of the four shocking periods. Their numbers increased from the first to the third shocking periods and then decreased in the

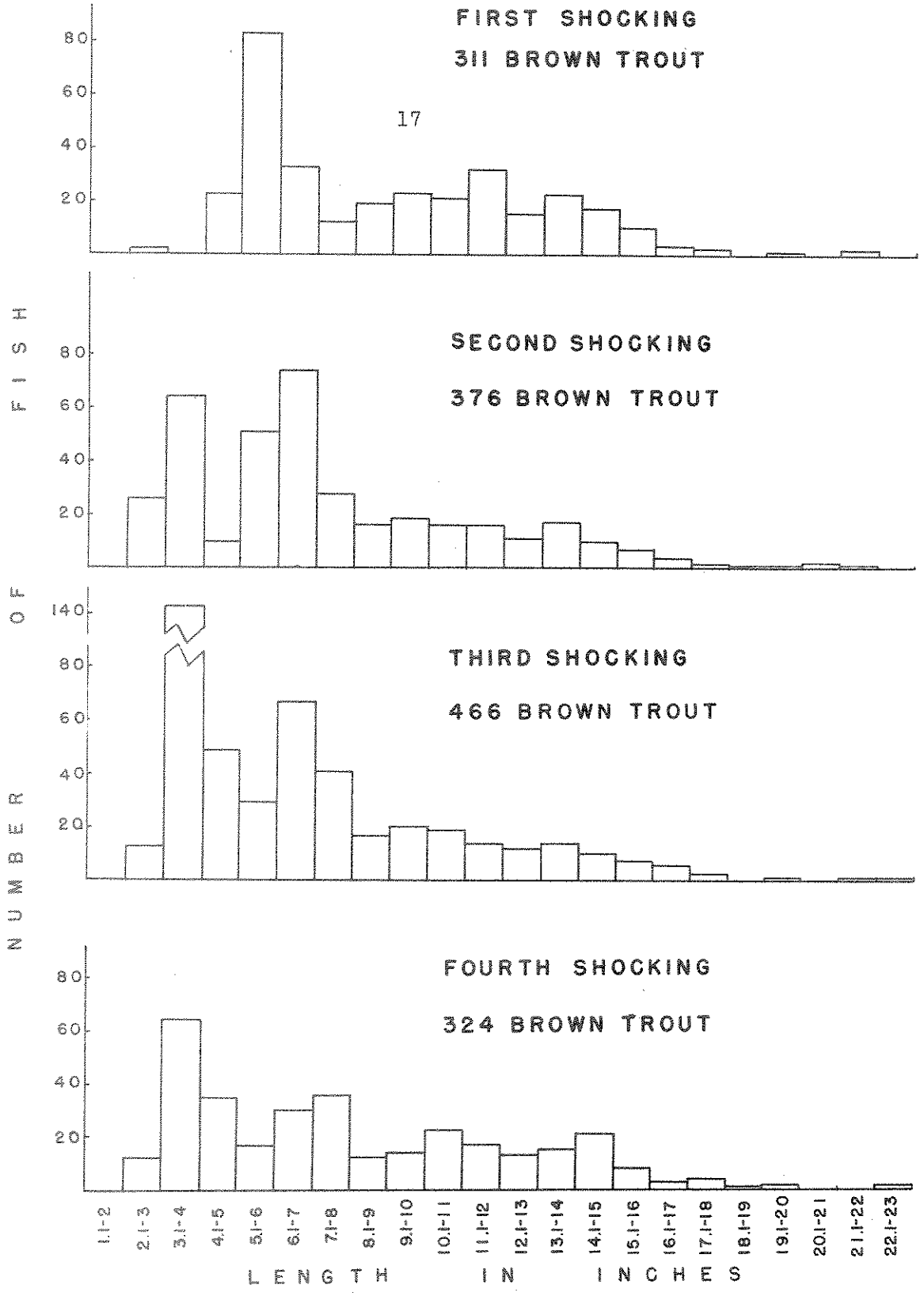


Figure 3. Length frequencies of brown trout for the different shocking periods in 1949.

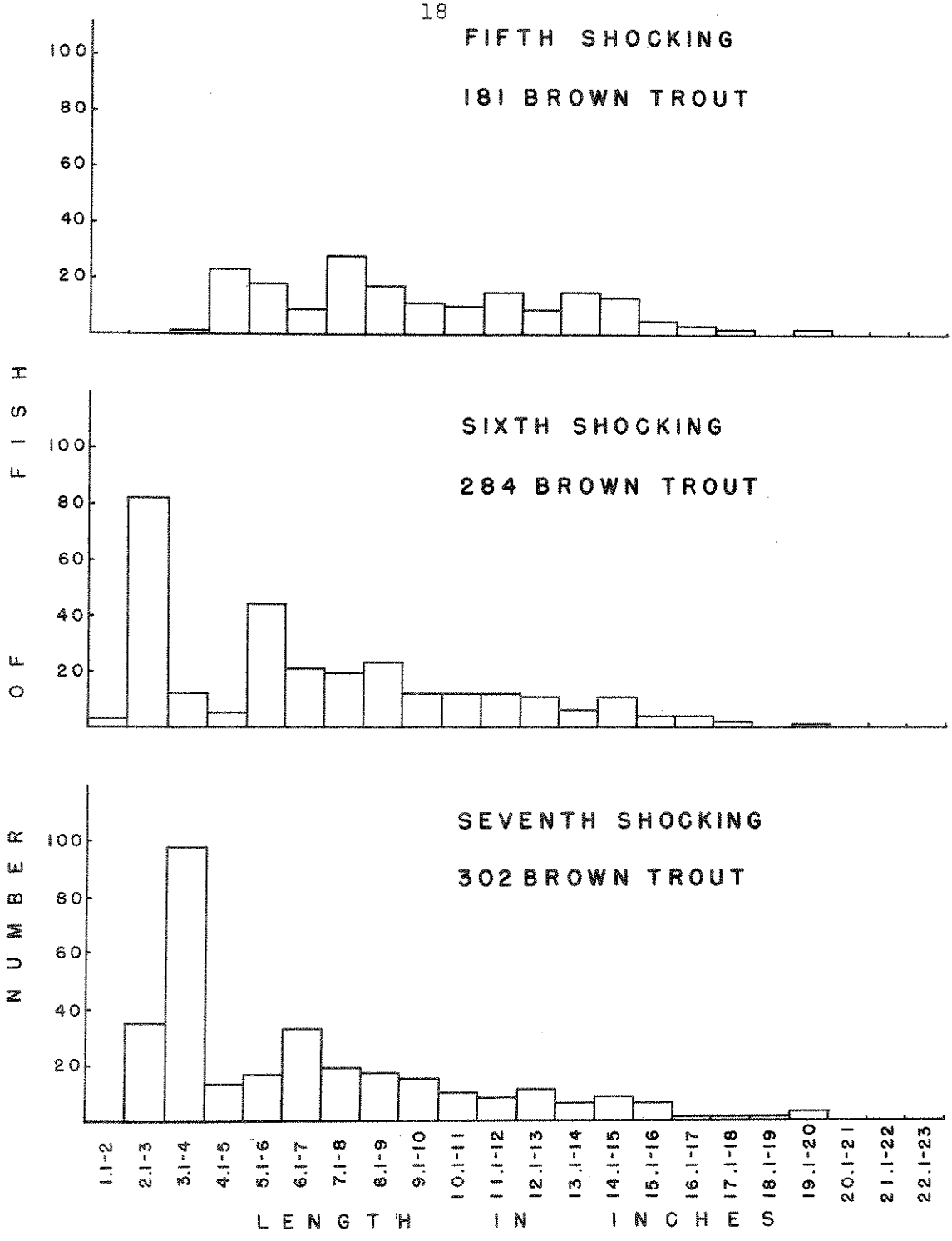


Figure 4. Length frequencies of brown trout for the different shocking periods in 1950.

fourth. The percentages of wild rainbow trout in relation to the total number of all wild trout increased from the first to the fourth shocking periods. When the hatchery rainbow trout (planted after the second shocking period) are included the percentage becomes slightly less in the third shocking period and then increased in the fourth. The total weights of wild rainbow trout was greater in the second than in the first shocking period, and then became progressively less in the third and fourth. The percentages of wild rainbow trout in relation to the total weight of all trout followed the same pattern. The inclusion of the planted rainbow trout in the total weights does not significantly change the above percentages.

In 1950, wild rainbow trout exceeded the number of brown trout only in the seventh shocking period. They showed a marked progressive increase from the fifth to the seventh shocking periods. The percentage of wild rainbow trout in relation to all wild trout followed the same pattern. This does not change when planted rainbow trout are included. The total weights of wild rainbow trout exhibit a marked increase from the fifth to the sixth shocking periods and a slight but still further increase in the seventh. The weights of wild rainbow trout, in relation to the total weight of all wild trout exhibit the same increases whether or not planted rainbow trout are included.

Length frequencies were determined for wild rainbow trout for each shocking period. In the first and second shocking periods of 1949, no outstanding size or year class could be recognized (Fig. 5). However, in the third shocking period a large number of rainbow trout were in 2.1 -

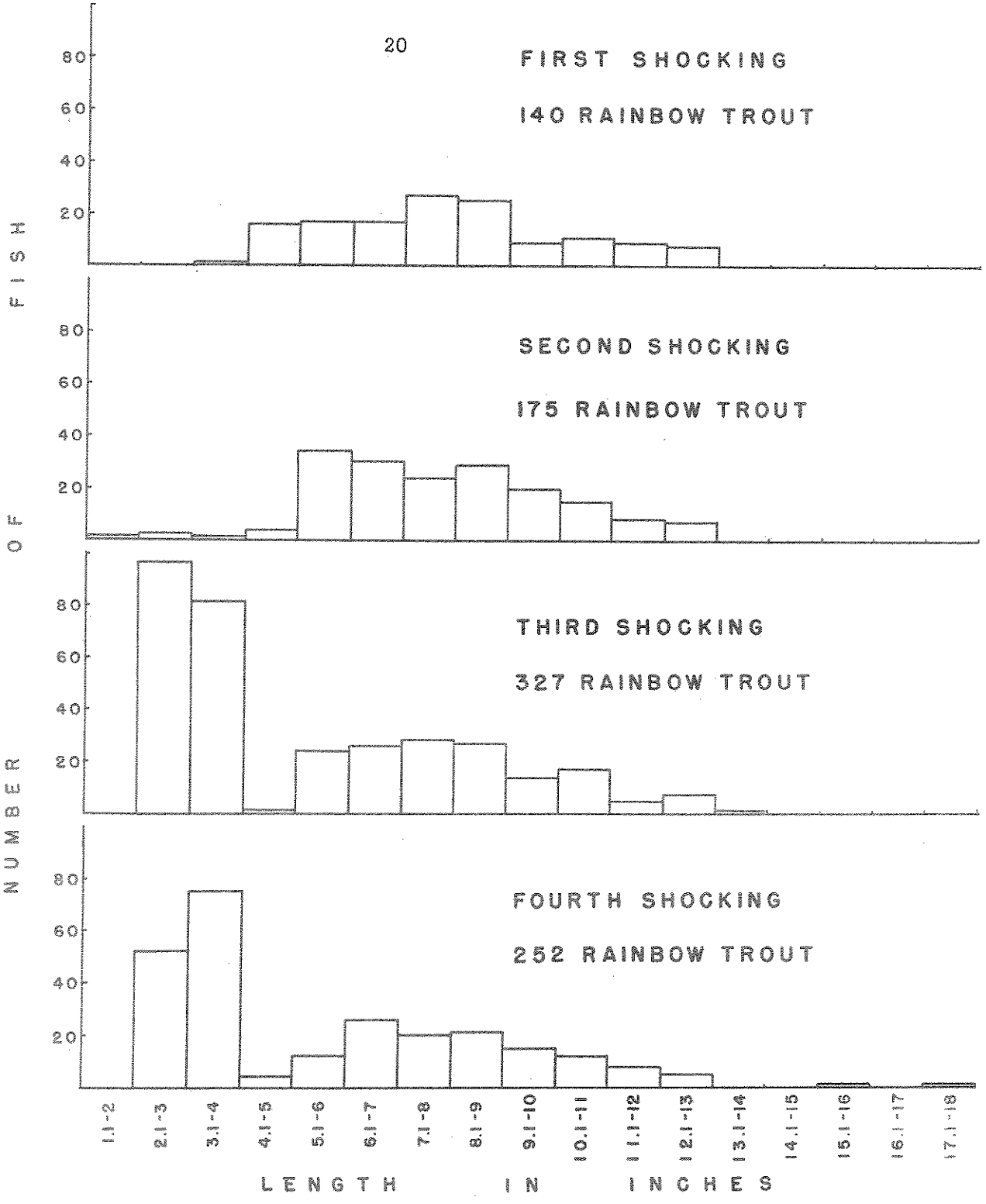


Figure 5. Length frequencies of rainbow trout for the different shocking periods in 1949.

3.0 inch group or the zero year class. The 3.1 - 4.0 inch group or the zero year class stands out in the fourth shocking period. No clear cut groups appear in the fifth shocking period of 1950 (Fig. 6), but the 5.1 - 6.0 inch group or the 1 plus year class appears as a distinct group in the sixth shocking period. Two size groups are distinguishable in the seventh shocking period, the 3.1 - 4.0 inch group or the zero year class and the 6.1 - 7.0 inch group or the 1 plus year class.

Planted rainbow trout

The first lot of hatchery rainbow trout was planted on September 8, 1949, eight days before the third shocking period. This group made up 25.6 per cent of the total number of all trout at this time and 12.2 per cent of all trout in the fourth shocking period. In 1950, this lot of planted fish constituted less than 2 per cent of the total number of trout captured in any of the shocking periods.

The second lot of rainbow trout was planted on May 13, 1950, 41 days before the fifth shocking period. It made up 20.8 per cent of the total number of all trout in the fifth shocking period, 7.0 per cent in the sixth, and 1.7 per cent in the seventh.

The third lot of rainbow trout was planted on September 17, 1950, one day before the seventh shocking period. The fish in this lot comprised 35.6 per cent of the total number of all trout in the seventh shocking period. The weight of these trout was only 4.5 per cent of the total weight of all trout.

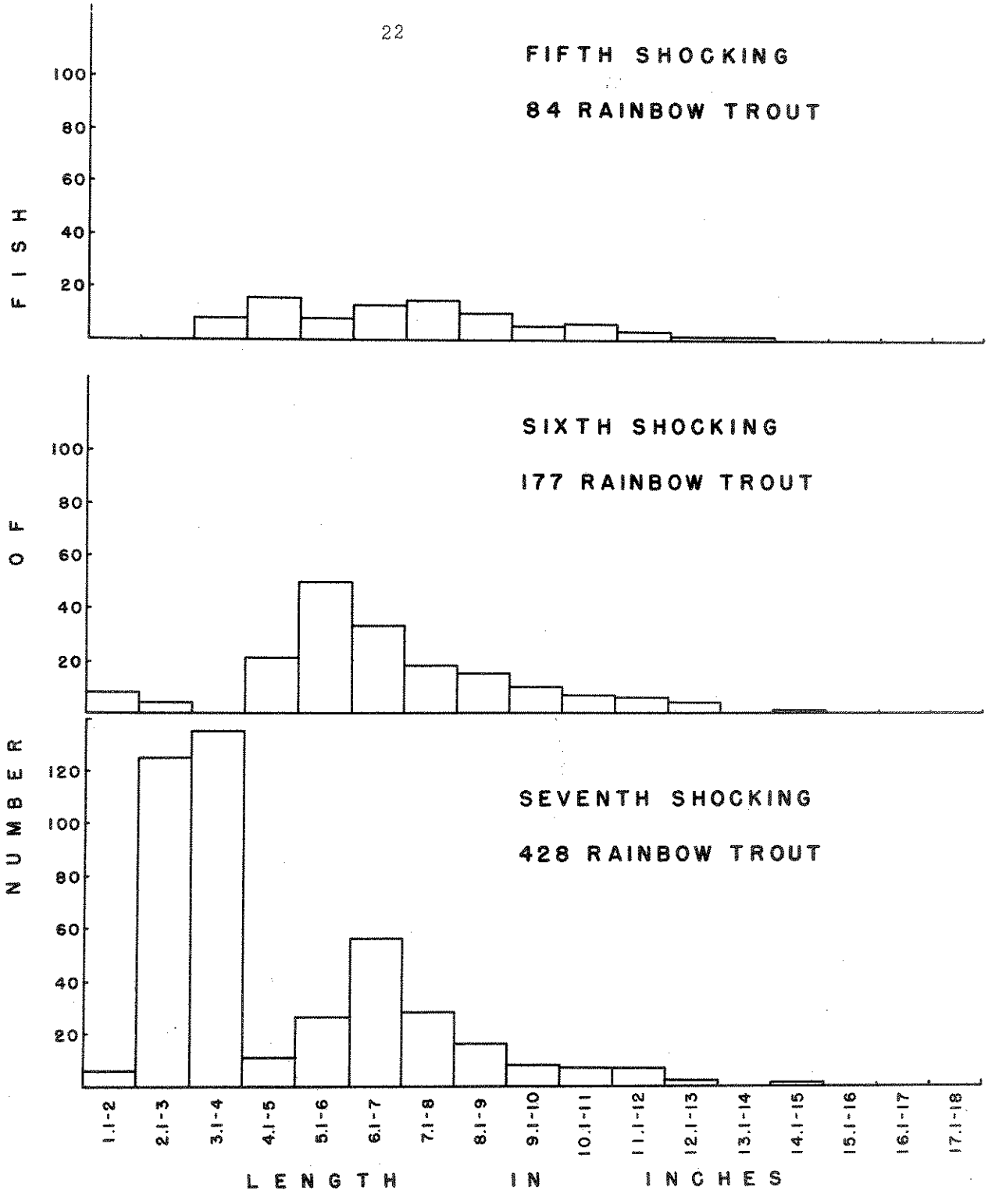


Figure 6. Length frequencies of rainbow trout for the different shocking periods in 1950.

Eastern brook trout

In 1949, the number of eastern brook trout comprised less than 4 per cent of the total trout in any shocking period. Their weight in relation to the total weight of all trout did not exceed 1.6 per cent for the same periods.

The total number in 1950 is about the same as for 1949 but the percentage in relation to all trout increased to 7.2 per cent. However, this percentage decreased progressively from the fifth to the seventh shocking periods.

Cutthroat trout

Only one cutthroat trout was captured and this was during the seventh shocking period.

Populations of all fish

The populations and relationships of the different species of trout have been discussed. Data now presented concerns the entire population of all fish with the trout included. The numbers and weights of trout, mountain whitefish, suckers, carp and American burbot are given for each shocking period.

Trout

In 1949 the total number of trout increased from the first to the third shocking period and then decreased in the fourth (Table III). The number in relation to all fish increased progressively from the first to the third shocking periods and then remained about the same in the fourth. However, the total weight of trout decreased from the first to the fourth shocking periods while the weight in relation to that of all fish increased

Table III

Numbers, weights and pounds per acre of fish captured during each shocking period in Prickley Pear Creek

Group of fish	Number	Percentage of total number	Total weight	Percentage of total weight	Pounds per acre
		First shocking, June 22 to July 13, 1949			
Trout	464	57.2	162.65	28.2	67.91
Whitefish	75	9.2	40.98	7.1	17.11
Suckers	260	32.1	348.86	60.4	145.66
Carp	9	1.1	24.26	4.2	10.13
Burbot	3	0.4	0.70	0.1	0.29
Total	811		577.45		241.10
		Second shocking, August 11-17, 1949			
Trout	573	82.4	149.70	56.4	62.51
Whitefish	21	3.0	21.60	8.1	9.02
Suckers	90	13.0	89.59	33.7	37.41
Carp	1	0.1	2.24	0.8	0.94
Burbot	10	1.5	2.51	1.0	1.05
Total	695		265.64		110.93
		Third shocking, September 16-23, 1949			
Trout	1096	93.6	154.45	69.9	64.49
Whitefish	20	1.7	11.71	5.3	4.89
Suckers	52	4.4	53.75	24.3	22.44
Burbot	3	0.3	1.18	0.5	0.49
Total	1171		221.09		92.31
		Fourth shocking, November 24-27, 1949			
Trout	672	91.1	146.25	74.7	61.06
Whitefish	36	4.9	22.18	11.3	9.26
Suckers	27	3.7	26.82	13.7	11.20
Burbot	2	0.3	0.56	0.3	0.23
Total	737		195.81		81.75
		Fifth shocking, June 22-30, 1950			
Trout	375	62.0	107.71	30.4	44.97
Whitefish	46	7.6	23.90	6.7	9.98
Suckers	182	30.1	222.36	62.7	92.84
Burbot	2	0.3	0.61	0.2	0.25
Total	605		354.58		148.04

Table III (continued)

Group of fish	Number	Percentage of total number	Total weight	Percentage of total weight	Pounds per acre
		Sixth shocking, August 7-15, 1950			
Trout	532	73.2	104.85	31.3	43.78
Whitefish	10	1.3	2.74	0.8	1.14
Suckers	181	24.9	220.03	65.8	91.87
Carp	2	0.3	5.40	1.6	2.25
Burbot	2	0.3	1.60	0.5	0.67
Total	727		334.62		139.71
		Seventh shocking, September 18-25, 1950			
Trout	1207	89.5	111.67	79.2	46.63
Whitefish	8	0.6	1.91	1.4	0.80
Suckers	133	9.9	27.40	19.4	11.44
Total	1348		140.98		58.87

progressively through the four shocking periods.

In 1950, the total number of trout increased from the fifth to the seventh shocking period. The percentage of all trout in relation to total numbers of all fish followed the same pattern. Total weights of trout varied less than seven pounds in all three shocking periods and the weight in relation to the total weight of all fish increased slightly from the fifth to the sixth shocking period with a marked increase in the seventh.

Mountain whitefish

The number of whitefish fluctuated considerably in 1949. A marked decrease occurred in the second shocking period, remained about the same in the third and then increased in the fourth. The percentage of whitefish progressively decreased in relation to the total number of all fish from the first to the third shocking periods and then increased slightly in the fourth. Total weights follow the same pattern while the total weight in relation to that of all fish increased from the first to the second shocking period, decreased in the third and then increased in the fourth.

In 1950, both the total number of whitefish and their numbers in relation to all other fish decreased progressively from the fifth to the seventh shocking periods. The total weight also decreased in the same periods. This decline was pronounced from the fifth to the sixth and less in the seventh. The total weight in relation to all fish decreased from the fifth to the sixth shocking periods and then increased in the seventh.

Suckers

The number and weight of suckers in 1949 decreased from the first to the fourth shocking periods. The most pronounced decrease in numbers and weights occurred between the first and second shocking periods. While suckers were fewer in 1950 than in 1949, their numbers and weight in relation to other fish show the same general pattern except that the drop occurs between the last two shocking periods.

Carp

Nine carp were present in the first shocking period and one in the second in 1949. They constituted 1.1 per cent or less of the total number and 4.2 per cent or less of the total weight of all fish. Two carp were present in the sixth shocking period. These comprised 0.3 per cent of the total number and 1.6 per cent of the total weight of all fish.

American burbot

Burbot were present in all shocking periods in 1949. The numbers were 1.5 per cent or less and their weights were 1.0 per cent or less of the total fish population. In the fifth and sixth shocking periods they comprised 0.3 per cent of the total number and 0.5 per cent of the weight of all fish.

Standing fish populations in Prickley Pear Creek

The total weight of all fish collected from the six sampling sections during each shocking period were used in calculation of the pounds of fish per acre. The weight of all fish in Prickley Pear Creek varied from 81.75 to 241.10 pounds per acre in 1949 and from 58.87 to 148.04 pounds in 1950 (Table III). This decrease in weight is due primarily to a decline in the

number of suckers which disappeared from the study area. In 1949 this decrease occurred chiefly between the first and second shocking periods and in 1950 between the sixth and seventh. At least some suckers moved into the Missouri River as evidenced by two tag returns.

The weight of trout as calculated from all shocking periods decreased from an average of 63.99 pounds per acre in 1949 to 45.13 pounds in 1950. Trout populations remained relatively stable in the shocking periods of each year but showed a significant difference between years. The reason for this is unknown but may result from mortality, catch or movement into the Missouri River.

The weight of the trout population remained more or less constant during each year even though many trout moved out of the study sections. Each time a section was shocked some untagged or "new" trout were captured. Some marked trout did move outside the sections as evidenced by random sampling. When trout move out of a section they are replaced by "new" or unmarked trout of equivalent weight.

Standing populations in comparison with other studies

Shuck (1945) estimated the average weight of brown trout in Crystal Creek, New York, to be 13.85 pounds per acre based on September samples over a four year period. The September samples from Prickley Pear Creek show the average weight of brown trout to be 37.5 pounds per acre. Smith et al (1949) reports an average of 251.1 pounds of trout and other fish per acre in the Root River system in Minnesota. The average for Prickley Pear Creek was 131.52 pounds per acre in 1949 and 115.54 pounds in 1950. Shetter and Leonard (1943) give 94.40 pounds per acre as the total weight of

brook trout (only trout species present) in Hunt Creek, Michigan. This figure is considerably higher than the 1.4 to 40.0 pounds per acre of trout reported for other Michigan streams (Shetter and Hazzard, 1939). The weight of trout in Prickley Pear Creek for the two year period varied from 43.78 pounds per acre to 67.91 pounds. The total weight of fish per acre in six primitive streams in New Hampshire (Hoover 1938) varied from 29.7 to 158.4 pounds per acre, as compared to Prickley Pear Creek which showed a variation of 58.87 to 241.10 pounds of fish per acre at the different shocking periods.

Movement

Information on the movement of tagged fish was secured from three sources as follows: by regularly scheduled sampling of the six shocking sections, by shocking selected sections taken at random within the study area, and by creel census.

Movements as determined by regularly scheduled shockings

The movement of tagged fish recovered in the population studies was noted. In considering this information the number of fish caught by anglers is substracted from the number tagged which is then described as the number available for recovery (Table V, VI). The number described as showing no movement are fish that were recaptured in the same sub-section where tagged or recaptured in the same sub-section they occupied in the preceding shocking period. The number moving within a section are fish that moved from one sub-section to another in the interim between two successive shocking periods.

Brown trout

Nine hundred forty-four brown trout were tagged including 100 in the last shocking period which were, for the purpose of this study, unavailable for recapture. In subsequent shocking periods 398 or 47 per cent of the 844 available were recaptured at least once. Many brown trout were recovered more than once and then were recaptured six times (Table IV).

Table IV

Number of fish marked and times recaptured

Species	Number tagged	Number of fish and times recaptured 1	2	3	4	5	6
Brown trout	844	181	114	44	29	20	10
Rainbow trout	528	153	53	21	6	8	1
Eastern brook trout	87	10	1	3	1		
Whitefish	155	7					
Suckers	767	26	8	0	1		
Carp	11						
American burbot	3						

The tagged brown trout in each shocking period showed a marked decrease in recaptures in the next subsequent shocking period. The rate of recovery thereafter exhibited a more or less gradual decline for the remaining shocking periods (Fig. 7). The disturbance of the fish population at the time of shocking and tagging may have caused the fish to move out of the section and mortality resulting from handling and tagging may have reduced the numbers somewhat. There is evidence of movement out of a section. This was observed when the areas immediately above and below section 5 was sampled 22 days after the second shocking period. Five tagged brown trout were found within 200 feet of the lower boundary of the section.

Brown trout tagged and recaptured during 1949 and 1950

Month tagged	Month recaptured	Number available for recapture	Number recaptured	Number showing no movement	Number moving within section
June 1949	August 1949	278	131	93	38
	Sept. 1949	275	109	60	15
	Nov. 1949	274	83	38	13
	June 1950	267	66	29	11
	August 1950	261	48	18	13
	Sept. 1950	257	38	21	7
August 1949	Sept. 1949	150	88	68	20
	Nov. 1949	150	53	33	11
	June 1950	149	31	8	5
	August 1950	147	23	10	7
	Sept. 1950	145	16	12	2
Sept. 1949	Nov. 1949	172	31	13	17
	June 1950	168	5	0	3
	August 1950	168	9	2	1
	Sept. 1950	168	6	2	1
Nov. 1949	June 1950	97	5	4	1
	August 1950	97	5	C	1
	Sept. 1950	96	4	2	1
June 1950	August 1950	62	16	6	10
	Sept. 1950	60	15	3	4
August 1950	Sept. 1950	77	34	22	12

Table VI

Rainbow trout tagged and recaptured during 1949 and 1950

Month tagged	Month recaptured	Number available for recapture	Number recaptured	Number showing no movement	Number moving within section
June 1949	August 1949	122	63	43	19
	Sept. 1949	120	54	29	10
	Nov. 1949	120	37	21	8
	June 1950	114	11	4	3
	August 1950	113	14	3	2
	Sept. 1950	113	8	5	2
August 1949	Sept. 1949	103	48	31	17
	Nov. 1949	102	15	6	5
	June 1950	95	6	3	0
	August 1950	94	6	0	0
	Sept. 1950	94	2	0	0
Sept. 1949	Nov. 1949	65	15	9	6
	June 1950	62	4	2	1
	August 1950	58	3	1	1
	Sept. 1950	58	3	1	2
Nov. 1949	June 1950	69	6	2	4
	August 1950	66	4	2	0
	Sept. 1950	65	3	2	0
June 1950	August 1950	47	16	10	6
	Sept. 1950	46	17	7	5
August 1950	Sept. 1950	110	55	30	25

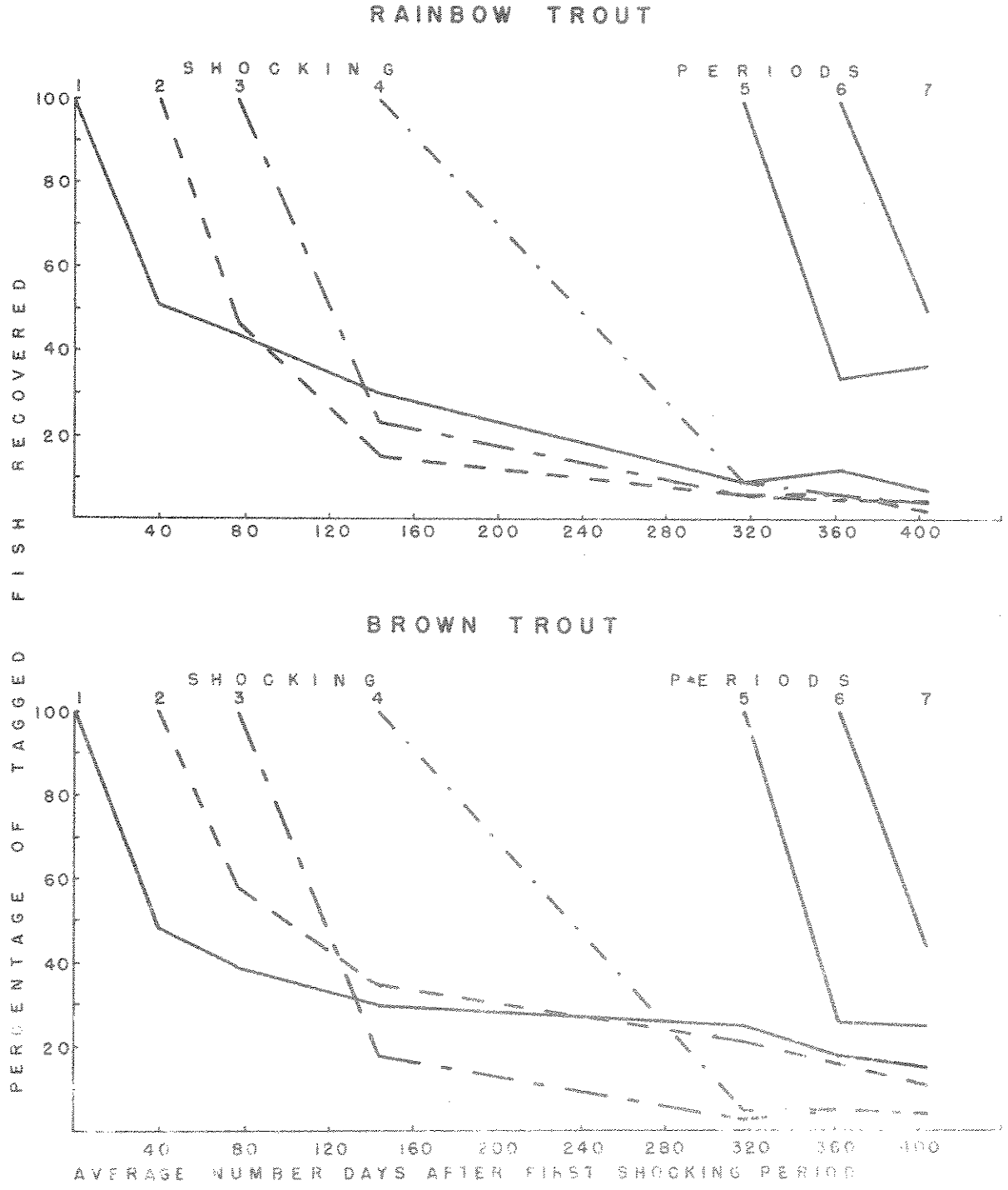


Figure 7. The percentages of tagged rainbow trout and brown trout recovered in subsequent shocking periods for 1949 and 1950.

Three tagged brown trout were found within 500 feet of the upper boundary of section 5. This accounted for only 5 per cent of the brown trout that were missing from section 5 in the second shocking period; however, further demonstration of movement out of a section is exhibited by one brown trout that moved downstream 2.3 miles between September 22 and November 26, 1949.

The number of trout that were found in the same sub-section from one shocking period to the next was remarkably high (Table V). The movement from one sub-section to another within the section shows no discernable pattern. A considerable number of brown trout in Prickley Pear Creek demonstrated the same "home site" phenomena as described by Shuck (1945).

Rainbow trout

Of 638 rainbow trout tagged, 528 were available for recovery (Table IV). During subsequent shocking periods 242 or 46 per cent were recaptured at least once. About 1/3 were recovered more than once and one was recovered 6 times. The percentages of rainbow trout recovered in the different shocking periods was about the same as that exhibited by the brown trout (Fig. 18). The percentage of rainbow trout recovered after one winter at large was less than brown trout. Some rainbow trout also demonstrated the "home site" phenomenon while others showed definite movements between sections as follows:

6.9 miles upstream between July 12 and August 13, 1949,
4.6 miles downstream between August 12 and November 27, 1949,
4.6 miles upstream between September 18, 1949 and June 30, 1950,
6.9 miles downstream between September 20, 1949 and June 22, 1950,

2.3 miles downstream between November 24, 1949 and August 11, 1950. Although the sample is small the data secured on movement from one regular section to another demonstrates that rainbow trout move more than brown trout.

Eastern brook trout

Only 88 eastern brook trout were tagged and of these 76 were available for recapture (Table IV). All of the 15 specimens recaptured were taken in the sections where tagged.

Mountain whitefish

Only 7 of the 156 whitefish marked and available for recovery were recaptured and each was found in the section where marked.

Suckers

A total of 767 suckers were marked during this study. Fifteen were tagged in the last shocking period. Of the 752 suckers available for recovery 35 were recaptured at least once and one of these was recovered 4 times. Only two were recaptured in a section other than where tagged. These had moved downstream as follows: 6.9 miles between June 30 and August 15, 1949, 6.9 miles between June 23 and 29, 1950. This last movement is close to one mile per day.

None of the tagged American burbot or carp were recovered in subsequent shocking of the regular sections.

Movements determined by sampling random sections

In 1950, sampling areas chosen at random as described by Snedecor (1946) were shocked in order to determine the movement of tagged fish outside the regular sections. Eleven random sections (Fig. 1) each 300 feet

in length were sampled by regular shocking methods between July 5 and 13, 1950. One random section coincided with part of the regular section six and one bordered the lower boundary of section five. No fish were marked during this operation.

Of the 24 tagged brown trout recovered only 6 were found outside a regular section. All had moved downstream. Four of these were captured in a random section that bordered section five. One brown trout was captured in another random section 500 feet from section 5 and one was captured in a random section 1,300 feet from the same section. The average distance these six brown trout moved away from place of tagging and release was 700 feet, with a maximum distance of 1,900 feet. All were tagged in 1949.

Of the five tagged rainbow trout recovered, only three were found outside of a regular section. One was recovered in a random section 1,300 feet from section 5, having moved downstream 1,500 feet from place of tagging and release. Two were recovered in the random section that bordered section 5. The average distance moved was 780 feet downstream. These trout were tagged in 1949. Only two eastern brook trout were recovered and these were in the random section in regular section 6. One mountain whitefish was recovered in a random section downstream from section 5. It had moved 1,500 feet.

In the random sections 14 suckers were recaptured. One was recovered in the random section in section 6. The remainder were scattered in nearly all of the other random sections. Six of these were found upstream for an average of 1.3 miles from the place of tagging. The maximum dist-

ance moved was 2.3 miles. Seven suckers moved downstream for an average of 2.3 miles. The maximum distance was 9.1 miles. One sucker moved downstream 5.0 miles between June 30 and July 6, 1950. Three of the recovered suckers were tagged in 1949 and the remainder in 1950.

No tagged carp or burbot were found in the sampling of the random sections.

Movement determined by creel census

A partial creel census was made in the summer of 1949 and an intensive creel census during the summer of 1950. This project was given publicity in the local newspapers and many signs were posted along the creek instructing anglers to report all information on fish caught, especially marked fish. Although much information was collected in this manner, it is known that the returns were not complete.

A total of 36 marked brown trout were caught by anglers, and reliable information on the location of catch was available on 27. Thirteen were caught in the sections where tagged, one was captured 0.1 miles upstream from the point of tagging, and the other 13 moved downstream for an average of 5.2 miles (minimum 0.1, maximum 27). Of the downstream migrants, five were captured in the Missouri River. One of these had moved approximately 27 miles between July 8, 1949 and May 2, 1950.

Accurate location information was secured on 32 of the 44 rainbow trout caught by anglers. Sixteen were caught in the section where tagged. Five moved upstream between June 30, 1949 and August 27, 1950 for an average distance of 4.4 miles (minimum 0.1 miles, maximum 11.5 miles). Nine moved downstream between June 23, 1949 and December 1950 for an average of

0.3 miles (minimum 0.1 miles, maximum 10.2 miles).

Seven marked eastern brook trout were reported by anglers. Only one of these was caught outside the section in which tagged. It had moved 2.3 miles upstream between June 22 and July 4, 1950.

Ten of the 14 suckers caught by anglers had accurate location data. Six of these were tagged in 1949 and the remainder in 1950. Two were caught where tagged while two moved upstream for an average of 1.4 miles. The maximum distance moved upstream was 2.4 miles between September 23, 1949 and May 21, 1950. Of the six suckers that moved downstream two were caught in the Missouri River. The average distance moved was 2.2 miles downstream (minimum 0.4 mile) with the greatest distance being 5.6 miles between June 23 and August 9, 1950.

No returns were obtained on mountain whitefish, carp and American burbot by creel census.

While there is some movement of trout in Prickley Pear Creek, it does not show any recognizable pattern. This is in contrast to the observations of Needham and Cramer (1943) who reported that most of the brown trout moved downstream. The drastic reduction of suckers in the summer suggests a mass exodus of this species out of the study area. There is indication that some suckers move rapidly downstream as demonstrated by one which moved 6.9 miles in 7 days. At least some move into the Missouri River.

Summary

1. A two-year study was made of fish populations and movements at six sampling sections in Prickley Pear Creek, Montana.

2. Brown trout, rainbow trout and longnose suckers were the predominate species considered. A small number of eastern brook trout, mountain whitefish, American burbot, carp and western white suckers were present as well as numerous sculpins. Only one cutthroat trout was found.

3. The number of brown trout comprised approximately 60 per cent of all trout in 1949 and 54 per cent in 1950. Their numbers increased from June through September in both years, but their weights decreased slightly in the same periods. The weight of brown trout in relation to that of all trout was about 74 per cent for both years.

4. The number of rainbow trout in relation to that of all trout was 35 per cent in 1949 and 41 per cent in 1950. They increased in numbers from June through September in both years. Their weights remained relatively constant in 1949 and increased during the summer in 1950. Their weight in relation to all other trout was about 24 per cent for both years.

5. Planted rainbow trout did not exceed 8.9 per cent of the total weight of all trout at any time.

6. The number of all trout in relation to that of all fish except freshwater sculpins was about 80 per cent in 1949 and 78 per cent in 1950, and their weight 58 per cent in 1949 and 47 per cent in 1950.

7. There was a variation of 43.78 to 67.91 pounds per acre of trout during the two year period. The weight of trout decreased from an average

of 63.99 pounds per acre in 1949 to 45.13 pounds in 1950. Weights remained relatively constant for the sampling periods each year but showed a significant difference between years.

8. Suckers made up about 13 per cent of the number and 33 per cent of the weight in 1949 and 22 per cent of the number and 49 per cent of the weight in 1950.

9. The total weight of all fish (freshwater sculpins not included) varied from 58.87 to 241.10 pounds per acre at the different sampling periods.

10. No discernable pattern was observed in the movement of trout. A large number were recaptured in the same areas where tagged. Eleven were recovered six times in the same area.

11. The drastic reduction of suckers in the summer suggests a mass exodus of this species out of the study area, probably into the Missouri River.

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