A partial fisheries survey of the Missouri River between Holter Dam and Cascade, Montana, with special emphasis on growth rate of trout and suckers
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A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

Abstract:
A study of the Missouri River between Holter Dam and Cascade, Montana was made during the summers of 1948 and 1949 to determine existing conditions with reference to the trout fishery. The gradient for this part of the river is 3.1 feet per mile.

Water temperature determinations made during 1948 and 1949 showed the average to be within the generally accepted toleration range for trout production.

The presence of large quantities of Chara indicated that turbidity was not sufficient to prevent light penetration necessary for successful plant growth.

Dissolved oxygen, pH, and alkalinity determinations showed dissolved oxygen to be near the saturation point at all stations, the water to be in the alkaline range, and moderately hard.

A partial creel census showed the total catch per hour to be 1.91 in 1948 and 0.97 in 1949. The catch of trout per hour was 0.70 in 1948 and 0.29 in 1949. The catch per hour for all species except whitefish was less in 1949 than in 1948.

Fish collections indicated a predominance of rough fish. The ratio of game fish to rough fish was approximately 1:3; trout to rough fish, 1:86; trout to suckers, 1:76.

Age and growth was determined for 478 rainbow trout, 127 brown trout, 87 longnose suckers, and 223 western white suckers. Age groups of rainbow trout ranged from I to VII; brown trout, I to IX; longnose suckers, III to VIII; western white suckers, I to VIII. Age group II was most predominant in rainbow and brown trout; VI in longnose suckers, and III in western white suckers. Greatest growth was attained during the second year in rainbow and brown trout, and during the first and third years for longnose and western white suckers, respectively. Trout growth is more rapid than sucker growth. The majority of trout were represented in age groups I - III, while suckers were predominately represented in age groups IV - VIII.

Coefficient of condition for 481 rainbow trout was 37.2 and for 117 brown trout was 34.6.

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Submitted to the Graduate Faculty

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partial fulfillment of the requirements

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Master of Science in Fish and Wildlife Management

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Montana State College

Approved:

Head, Major Department

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Bozeman, Montana
June, 1950

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ABSTRACT

A study of the Missouri River between Holter Dam and Cascade, Montana was made during the summers of 1948 and 1949 to determine existing conditions with reference to the trout fishery. The gradient for this part of the river is 3.1 feet per mile.

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Fish collections indicated a predominance of rough fish. The ratio of game fish to rough fish was approximately 1:3; trout to rough fish, 1:86; trout to suckers, 1:76.

Age and growth was determined for 478 rainbow trout, 127 brown trout, 87 longnose suckers, and 223 western white suckers. Age groups of rainbow trout ranged from I to VII; brown trout, I to IX; longnose suckers, III to VIII; western white suckers, I to VIII. Age group II was most predominant in rainbow and brown trout; VI in longnose suckers, and III in western white suckers. Greatest growth was attained during the second year in rainbow and brown trout, and during the first and third years for longnose and western white suckers, respectively. Trout growth is more rapid than sucker growth. The majority of trout were represented in age groups I - III, while suckers were predominately represented in age groups IV - VIII.

Coefficient of condition for 481 rainbow trout was 37.2 and for 117 brown trout was 34.6.

Introduction

During the summer of 1948 a partial fisheries survey, that included certain physical, chemical, and biological determinations, was conducted on the Missouri River between Holter Dam and Cascade, Montana. This project was sponsored by the Cascade County Wildlife Association. Its prime objective was to determine existing conditions which might effect the trout fishery.

Additional observations were made in 1949 emphasizing temperature, creel census, and the securing of trout and sucker scales for age-growth determinations.

No previous fisheries investigations on this part of the river are known to the writer. However, similar unpublished studies have been conducted on other Montana streams.

Age-growth and condition studies were made for rainbow trout (Salmo gairdnerii) and brown trout (Salmo trutta). Age-growth was also determined for the longnose sucker (Catostomus catostomus), and western white sucker (Catostomus commersonnii sucklii). A comparison of growth was made between these species.

Description of the Area

The stream between Holter Dam (T14N, R3W, Section 5, Lewis and Clark County) and Cascade (T18N, R14W, Section 26, Cascade County) comprises a distance of 35 miles. The upper fifteen miles traverses a narrow valley of meadow land. Below this it flows through a canyon for eight miles and then out into an open valley of farm land extending to Cascade.

There are only two major tributaries to this part of the river, Prickley Pear Creek and the Dearborne River. They enter the river three and twelve miles, respectively, downstream from Holter Dam. Several small tributaries also enter this section of the river. These latter streams contribute considerable water during periods of run-off, but very little during the dry season.

Methods

Temperature, Transparency, and Chemical Analysis

Morning and evening water temperatures were taken in 1948 and 1949. Most of the temperatures were determined by the use of a pocket thermometer calibrated at two degree intervals. This was checked against a certified chemical thermometer. A maximum-minimum thermometer, and a deep sea reversing thermometer were also used. All temperature determinations were made in the shade, and water temperatures were taken in the current.

Water transparency was determined by means of a Secchi Disk.

Chemical water analyses included dissolved oxygen, pH, phenalphthalein alkalinity and methyl orange alkalinity. Tests were made in accordance with methods described in "Standard Methods for the Examination of Water and Sewage", American Public Health Association (1946). The Winkler Method was used to determine dissolved oxygen, and a Hellige pocket comparator and appropriate indicators were used to determine pH.

Creel Census, Fish Collections, and Scale Studies

Creel census cards were used which requested the following information: Name of fisherman, kinds of fish caught, number of hours fished,

location of catch, average lengths and weights of catch, and type of lure or bait used. These cards were either completed by anglers or by the writer after interviewing fishermen. The time interval covered by any individual report is variable. No special effort was made to get total daily catches. Actual weights and lengths were secured only on those reports completed by the writer. Those taken by fishermen were estimates.

The majority of fish used in this study were collected by angling. Some were secured by gill net, seines, and by the use of dynamite. Common names used in identification of fishes present in the section of the Missouri River studied were taken from American Fisheries Society, Special Publication No. 1 (1948).

Total lengths were determined to the nearest one-tenth of an inch, and weights to the nearest one-tenth of a pound.

Scales were secured from the left side of the fish, between the dorsal fin and the lateral line. They were cleaned and mounted in a glycerine - gum arabic medium. Annuli were determined after projecting the scales on a machine designed for this purpose.

Annual increments on the scales of rainbow and brown trout were measured from the center of the focus along the median-anterior radius. Sucker scale increments were measured along the dorso-ventral diameter as described by Spoor (1938).

Coefficients of condition (K) were calculated for the rainbow and brown trout. The formula used was:

$$K = \frac{W \times 10^5}{L^3}$$

where W = weight in pounds, and L = total length in inches.

Acknowledgements

My sincere appreciation is extended to Dr. C. J. D. Brown, who directed this investigation and assisted in preparation of the manuscript; the Cascade County Wildlife Association and Mr. Harry Prigge, who provided funds for the project, and the Montana Fish and Game Department for their assistance, both in the field and in the laboratory. I also wish to thank Mr. Raymond Hays for his assistance in scale mounting and reading. I am indebted to Dr. Reeve M. Bailey of the University of Michigan for the identification of the suckers.

Physical Characteristics

Gradient and Flow

Stream gradient and volume are factors which may determine the suitability of a stream for trout. In the section of the Missouri River studied there is an average gradient of 3.1 feet per mile (elevation at Holter Dam 3454 feet - Cascade 3345 feet). This gradient is much lower than the average for other major trout streams in Montana.

Stability of flow is a desirable feature of any stream in maintaining high productivity. Holter Dam, at the head of this section of the stream, undoubtedly has a seasonal stabilizing effect on the flow, in that water is impounded during periods of heavy run-off and released when the supply is low. Daily fluctuation is probably greater than it would be if the dam

were not present. A predetermined amount of water is drawn from the bottom of Holter Reservoir once each day (usually during the night) for utilization by four power plants below this section of the Missouri River. The mass of water released at the dam moves downstream as a unit, which results in a marked rise in water level at a particular location in a short period of time. After the mass of water has passed, low water conditions again prevail, making it possible to have low water at each end and high water in the middle of the section. Water released at Holter Dam at midnight often does not reach the lower end of the section at Cascade until 6:00 P.M. of the same day. This daily fluctuation in the water level of the river is probably detrimental to the sport fishery. Several factors may be involved: first, food organisms cannot occupy that zone which is left high and dry each day, and second, fishing conditions are made extremely difficult by the fluctuation in water level, resulting in a reduced harvest of fish. Observations indicate that angling was more successful during periods of low water.

The maximum, minimum, and average actual outflow in cubic feet per second at Holter Dam for the months of June, July, August, and September, 1948 and 1949 is recorded in Table I.

Table I
Measured Actual Outflow Holter Dam
Cubic Feet Per Second*

	June		July		August		September	
	1948	1949	1948	1949	1948	1949	1948	1949
Maximum	35.8	16.3	15.0	4.5	5.3	2.5	4.4	3.7
Minimum	13.6	5.0	3.4	2.2	3.5	1.8	3.5	2.0
Average	25.0	10.0	7.5	3.4	4.3	2.2	4.1	2.8

* Thousands of cubic feet

Flood conditions in 1948 were responsible for the large flow during June and July, while in 1949 a partial drought was responsible for the lesser outflow in July, August, and September.

Temperature

Water temperature is possibly the most important physical factor in successful trout production. An attempt was made to determine whether the temperature of the Missouri River was within the accepted range of toleration. Morning and evening temperatures were taken in 1948 as follows: Station 1 (Fig. 1) - Highway bridge 2 miles downstream from Holter Dam; Station 2 - 14-1/2 miles downstream from Holter Dam; Station 3 - County highway bridge at Cascade. Regular morning temperatures were taken twice weekly and evening temperatures four times weekly at Station 1 in 1949.

Maximum, minimum, and average temperatures at each station are presented in Table II.

Table II
Temperature Recordings - Degrees Fahrenheit
Missouri River - 1948 - 1949

	June		July		August		September	
	1948	1949	1948	1949	1948	1949	1948	1949
Station 1								
Maximum	70.0	64.0	71.0	70.0	72.0	73.0	70.0	67.0
Minimum	68.0	61.0	69.0	64.0	67.0	64.0	66.0	55.0
Average	69.3	62.7	69.7	66.1	68.9	67.3	67.0	59.6
Station 2								
Maximum	69.0		71.0		71.0		70.0	
Minimum	67.0		66.0		65.0		62.0	
Average	68.0		68.6		68.9		65.9	
Station 3								
Maximum	71.0		72.0		71.0		68.0	
Minimum	65.0		59.0		61.0		61.0	
Average	68.0		67.0		67.4		64.0	

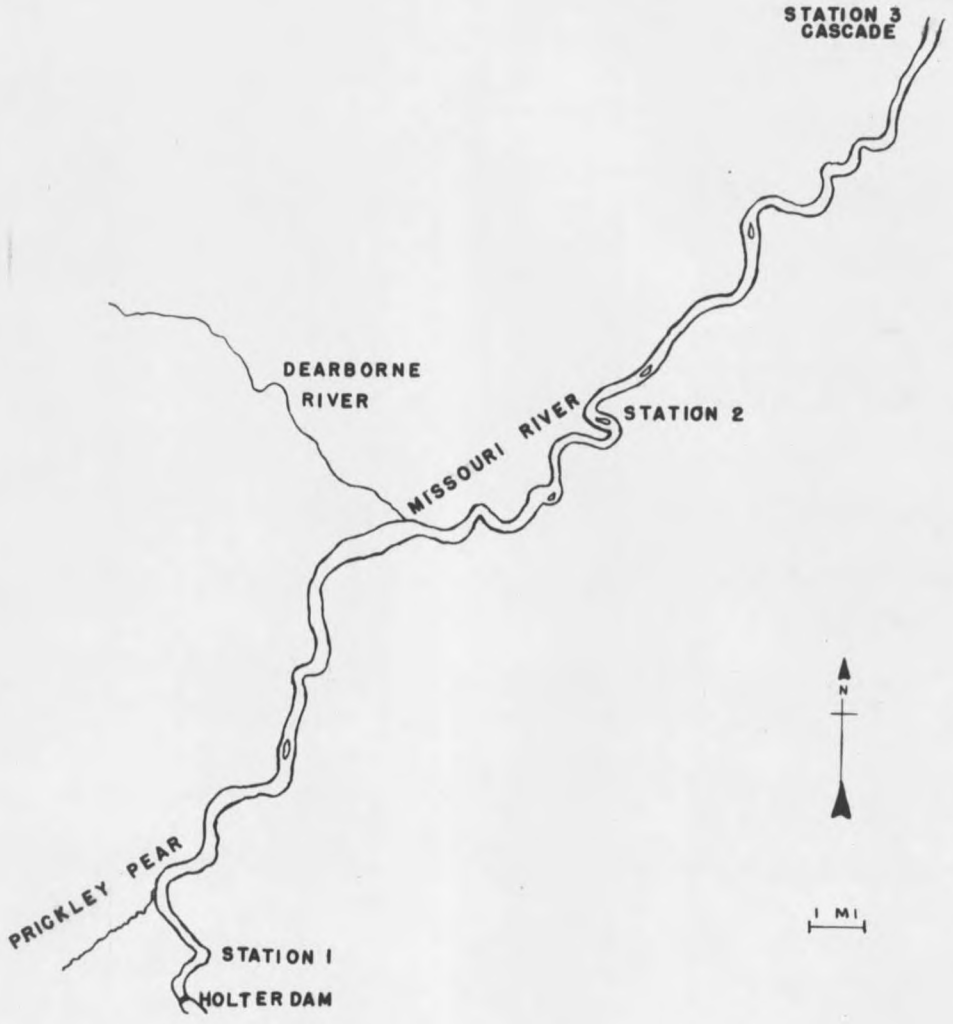

Figure 1
Missouri River
Holter Dam - Cascade, Montana

Maximum-minimum temperatures were taken at Station 3 from July 20 through August 1, 1948. The maximum temperature recorded for the twelve day period was 71.6° F., the minimum 59.1° F., and the average 66.8° F.

In 1948 the maximum temperature recorded was 72° F., and in 1949 73° F. At no time did the maximum temperature remain above 70° F. for a period of more than three consecutive days. In each case, the temperature dropped below 70° F. during the night and again reached this maximum the following day. All temperatures remained within the generally accepted range for trout.

Transparency

Light is known to exert a considerable influence on the growth of plants and consequently animals necessary for successful trout production. Secchi disk readings were made to determine relative transparencies (Table III). These readings were made at the same time and stations as temperatures (Fig. 1). The water was too shallow to use the Secchi disk after July 1 and July 9 at Stations 1 and 3, respectively. Readings were continued through September 10 at Station 2. A maximum reading of 65.5 inches was recorded on August 21. This reading was more or less constant through September 10.

Large numbers of Cladocera were observed in water samples taken in 1948 and 1949. During the months of July, August, and September of 1948 and 1949 great quantities of Chara were present in the river making angling difficult for all except fly fishermen. The presence of Chara in large

quantities indicated that turbidity was not sufficient to prevent light penetration necessary for its growth.

Table III
Secchi Disk Readings - Missouri River 1948

	June	July	August	September
Station 1				
Maximum	23.25 inches	28.75 inches (July 1)		
Minimum	21.5			
Average	21.75			
Station 2				
Maximum	25.75	62.5	65.5 inches	65.5 inches
Minimum	14.0	24.5	57.0	65.5
Average	18.5	46.9	60.0	65.5
Station 3				
Maximum	22.75	26.5		
Minimum	14.5	19.5		
Average	17.4	23.2 (9 days)		

Chemical Characteristics

A limited number of chemical water analyses were made for dissolved oxygen, pH, methyl orange alkalinity, and phenalphthalein alkalinity. These analyses were made at the following locations (Table IV):

1. Retaining wall immediately below Holter Dam.
2. Station 1 (Fig. 1).
3. Hardy Bridge, 2-1/2 miles downstream from Station 2.
4. Station 3.
5. Prickley Pear Creek, 3 miles upstream from its mouth.
6. Dearborne River - 300 feet upstream from its mouth.

Dissolved oxygen content at each station was near the saturation point. The pH determinations were all well within the alkaline range, and methyl orange alkalinity showed the water to be moderately hard. This would appear to be beneficial as moderately hard water is generally more

productive than very soft or very hard water. The chemical determinations made on Prickley Pear Creek and the Dearborne River, with the exception of methyl orange alkalinity and phenalphthalein alkalinity, were nearly identical with those found in the Missouri River.

Table IV
Chemical Water Analyses
Missouri River - Prickley Pear Creek - Dearborne River
1948 - 1949

Location	Date	Time	Water Temp ^{o} F.	D.O. ppm	pH	M.O. Alk. ppm	PhTh Alk. ppm
Retaining wall	7/9/48	11:00 AM	67.6	8.2	8.0	116	
Station 1	9/1/48	10:30 AM	67.6	8.7	8.4	133	7.0
	9/25/49	10:30 AM	59.0	9.0	8.2	144	5.0
Hardy Bridge	7/10/48	10:45 AM	66.6	7.9	8.1	120	4.0
	8/31/48	5:00 PM	67.6	8.4	8.4	134	9.0
Station 3	7/13/48	11:00 AM	64.0	8.5	8.1	120	4.0
	8/31/48	4:00 PM	67.5	8.3	8.4	133	6.0
Prickley Pear Creek	7/10/48	1:45 PM	62.4	8.3	8.4	140	8.0
Dearborne River	7/12/48	2:45 PM	64.2	8.5	8.5	170	8.5

Water temperatures recorded in Table IV are bottom temperatures, and are very similar to surface temperatures (Table II).

Holter Dam

An effort was made to determine what physical and chemical effect, if any, Holter Dam might have on the section of the Missouri River studied. On August 31, 1948 (6:30 - 7:45 P.M.) a series of water temperatures were taken and chemical analysis made on Holter Reservoir at a

point 75 yards above the dam, midway between the east and west shores (Table V). The maximum depth of the reservoir at this location was 102 feet.

Table V
Water Temperatures and Chemical Analysis
Holter Reservoir, August 31, 1948

Depth	Water Temperature Degrees F.	Dissolved Oxygen ppm	pH	Phenalphthalein Alkalinity ppm	Methyl Orange Alkalinity ppm
Surface	68.1	8.4	8.7	10.0	127
5 ft.	68.1				
10 ft.	68.0				
15 ft.	68.0				
20 ft.	67.6				
25 ft.	67.2				
30 ft.	66.9				
50 ft.	66.2	5.9			
60 ft.	65.8				
70 ft.	63.3	1.6			
75 ft.	61.9				
80 ft.	60.4				
90 ft.	60.1				
100 ft.	58.6	0.7	7.2	0.0	115

There was no marked thermal stratification in the reservoir. The difference in water temperature between the surface and 100 feet was 9.5° F. Since the water utilized for power generation is drawn from the bottom of the lake, it would seem that the water temperature below the dam would be considerably lower than the average river temperature. Temperatures taken in July, 1948 from the retaining wall immediately below the dam averaged 67.6° F. The average temperatures in August at Station 1, two miles downstream from the dam were 68.9° F. in 1948 and 67.3° F. in 1949. There was a constant spill of surface water from the reservoir over the dam 24 hours a day, which probably offset any temperature variation that would

have been caused by the water being drawn from the bottom of the reservoir. The mixing of surface and bottom waters was undoubtedly sufficient to prevent any lowering of the water temperature in an area immediately below the dam.

The condition with reference to dissolved oxygen, pH, and alkalinity in the reservoir probably has no great influence on chemical conditions of the river below the dam.

Creel Census

A partial creel census was undertaken by the writer in 1948 and continued during the summer of 1949 (Table VI). U. S. HighwayNo. 91 closely follows the river from Station 1 (Fig. 1) to Cascade making the stream easily accessible to anglers and the creel census taker. Time did not permit a complete census of the entire area every day. About one-half of the reports secured in 1948 were actual interviews and the other half were voluntary reports of fishermen. The 1949 census includes only actual interviews.

Of 802 creel census records secured in 1948, 88 (11 percent) reported no catch, while in 1949, 87 (22 percent) of the 381 records reported taking no fish. Anglers reporting "no catch" fished a total of 296 hours in 1948 and 152 hours in 1949. The probable reason for this difference in "no catch" results from the fact that fishermen are hesitant to report when they take no fish. In final analysis, however, the total catch per hour was not appreciably affected by the records of anglers reporting "no catch".

The total catch per hour, which included all species reported, was 1.91 in 1948 and 0.97 in 1949. The catch per hour for all species of trout

was 0.70 in 1948 and 0.29 in 1949. The 1949 catch per hour was less for all species, except the mountain whitefish, than it was in 1948. The average angler fished 3.7 hours in 1948 and 2.5 hours in 1949, and for his effort took home 2.06 trout in 1948 and 0.55 trout in 1949.

Although the yellow perch is not considered a game fish in the Montana fishing regulations, it plays an important role in the fishery of this section of the Missouri River, and is considered a game fish for the purposes of this study. Yellow perch were reported more frequently than any of the fish taken in 1948, comprising 31.67 percent of the total catch. Fewer perch were reported in 1949 than in 1948, and made up only 20.2 percent of the total catch.

Rainbow trout is the most important trout species in the river, and was reported more frequently than either the brown or eastern brook trout. Rainbow trout made up 29.13 percent of the total catch in 1948 and 22.83 percent in 1949, while brown and brook trout combined only comprised 7.36 percent of the 1948 catch and 7.68 percent of the 1949 catch. Brown trout showed a slight increase in percent of the total catch in 1949 over 1948. All of the eastern brook trout reported were caught within a short distance of the mouths of small tributaries.

Mountain whitefish was the predominant fish reported in 1949, comprising 27.22 percent of the total catch, while in 1948 it made up only 8.85 percent of the catch. Creel census was taken only during the summer months and so does not include the winter fishery which is largely whitefish. If the winter fishery had been included, whitefish would undoubtedly be

Table VI
Missouri River Creel Census
1948 - 1949

	1948	1949	Percent of Total 1948	1949
Number of fishermen	802	381		
Number taking no fish	88	87	11.0	22.83
Number of fish taken	5675	911		
Total hours fished	2966	938		
Catch per hour	1.91	0.97		
Ave. hours per fisherman day	3.7	2.5		
Trout per hour	0.70	0.29		
Whitefish	0.17	0.27		
Perch	0.61	0.20		
Suckers	0.30	0.18		
Carp	0.11	0.02		
Others	0.02	0.01		
Catch				
Rainbow trout	1653	208	29.13	22.83
Brown trout	365	66	6.43	7.24
Eastern brook trout	53	4	0.93	0.44
Mountain whitefish	502	248	8.85	27.22
Yellow perch	1797	184	31.67	20.20
Suckers	886	182	15.61	19.98
Carp	322	15	5.68	1.65
Others (Burbot, Channel catfish, Brown bullhead, Flathead chub, Cottus, Bass, Sunfish)	97	4	1.70	0.44
Number of trout per fisherman for the season	2.06	0.55		

the predominant game fish for both years in this section of the Missouri River.

A large number of suckers were taken by bait fishermen in 1948 and 1949. Many fishermen did not report their sucker catch. Two species of suckers, with possible hybrids between them, were present in the catch. No attempt was made in the creel census to distinguish between them.

Although a considerable number of carp are present in this part of the river they are not commonly taken by fishermen.

In 1948 an attempt was made to determine the type of lure or bait used. Two hundred three anglers reported using only artificial flies; 75 used spinners, spoons, and plugs; 459 used bait, which included angleworms, sucker meat, grasshoppers, and maggots; 64 did not report the type of lure or bait used. Bait fishing was the most popular method. The high, muddy waters in 1948 provided ideal conditions for the bait fisherman, while in 1949 low water conditions were more satisfactory for the fly fisherman.

The following fish were observed to be present in the section of the Missouri River studied:

Rainbow trout (Salmo gairdnerii)
Brown trout (Salmo trutta)
Eastern brook trout (Salvelinus fontinalis)
Mountain whitefish (Prosopium williamsoni)
Yellow perch (Perca flavescens)
Burbot (Lota lota)
Brown bullhead (Ameiurus nebulosis)
Channel catfish (Ictalurus lacustris)
Carp (Cyprinus carpio)
Flathead chub (Platygobio sp.)
Longnose Dace (Rhinichthys sp.)
Freshwater sculpin (Cottus sp.)
Pumpkinseed (Lepomus gibbosus)
Largemouth black bass (Micropterus salmoides)
Western white sucker (Catostomus commersonnii sucklii)
Longnose sucker (Catostomus catostomus)

Fish Collections

Seining was attempted at several locations on July 31, 1948. Ten trout, 16 suckers, and 5 carp were taken in six seine hauls. A graded gill net (125 ft.) was set at 11:00 A.M. July 11 and lifted at seven o'clock the following morning. The catch included 24 suckers, 2 yellow perch, and 1 brown bullhead. The use of seines and gill nets was considered to be impractical because of the size of the river, the amount of current, the nature of the bottom, and the large amount of floating debris.

The use of dynamite was resorted to in an effort to obtain a reasonable sample of fish. On August 29-30, 1948 collections were made at three selected locations, as follows: (1) Lone Pine - 6 miles downstream from Holter Dam; (2) 7 - 9 Ranch - 2 miles upstream from Station 2 (Fig. 1); (3) Barrett Ranch - 3 miles upstream from Station 3. Recovery of fish was the most important factor considered in selecting the locations. Each consisted of an upstream riffle followed by a deep hole. Bottom and surface charges of five, six, and ten sticks of ten percent dynamite were exploded at these three locations. Two man crews, equipped with dip nets, in motor boats passed back and forth in and below the dynamited area picking up the fish as they floated to the surface. It was not possible to recover all of the fish that surfaced as some were swept away by the current. The air bladders of others were ruptured by the explosion and some of these did not come to the surface immediately. The areas dynamited were checked daily for dead fish. On September 1 a number

of floating fish were observed at Lone Pine. A total of 92 suckers, 11 carp, and 1 yellow perch were counted on the bank and floating in a back water. The following day, September 2, 40 unidentified fish were counted floating in the river at the same location. Since sea gulls were present in the area it is likely that many dead fish were eaten before being counted. The fish collected after dynamiting are recorded in Table VII. Those counted on September 1 and 2 are not included in the table.

Table VII
Fish Collections - Missouri River
August 30 - 31, 1948

	Lone Pine			7-9 Ranch			Barrett Ranch		
Species	No.	Ave. Length Inches	Ave. Weight Pounds	No.	Ave. Length Inches	Ave. Weight Pounds	No.	Ave. Length Inches*	Ave. Weight Pounds
Rainbow trout	0			3			2		
Brown trout	0			0			1		
Yellow perch	42			0			3		
Mountain whitefish	13	12.5	0.61	96	12.4	0.64	10	10.6	0.52
Carp	18	17.4	2.56	10	18.3	3.21	60		
Western white sucker	147	13.7	0.98	41	14.0	1.04	73		
Longnose sucker	37	13.3	1.00	114	14.0	1.27	73		
Total	257			264			166		

* All lengths are total length

Game fish (trout, whitefish, and perch) comprised 24.7 percent, and rough fish (suckers and carp) 75.3 percent of the total collected by the use of dynamite. The ratio of game fish to rough fish was 1:3, trout to rough fish, 1:86, and trout to suckers, 1:76.

Age-growth

Age and growth was determined for 478 rainbow trout, 127 brown trout, 87 longnose suckers, and 223 white suckers. Since the samples were taken at various times during the growing season, calculations were made to determine lengths at the end of each year of life. Tabulations include the average calculated total length in inches at each annulus for each age group, the grand average of calculated lengths, the number of samples considered in each age group, and the average actual lengths of the fish at the time they were collected.

Rainbow Trout

The average calculated lengths for rainbow trout at the end of each year of life (Table VIII) are as follows: First year, 3.2 inches; second year, 7.9 inches; third year, 11.1 inches; fourth year, 13.5 inches; fifth year, 15.9 inches; sixth year, 16.6 inches; seventh year, 18.5 inches. The averages beyond the fourth year may not be significant due to the small size of the sample.

While growth was greatest in the second year, it was also considerable in the first and third years. Ninety-two percent of all rainbow trout were represented in age groups I-III, with the largest number in age group II. The remaining eight percent were in age groups IV - VII.

Average actual total lengths of rainbow trout from three Michigan streams, in age groups I and II, as shown by Shetter and Hazzard (1939) are less than in the same age groups of Missouri River rainbow trout.

Table VIII
Average Calculated Total Lengths and Increments of
Rainbow Trout Collected in 1948 and 1949

Group	No. of Fish	Ave. Actual Length	Calculated total lengths (inches) at end of year of life 1	2	3	4	5	6	7
I	107	8.8	3.6						
II	202	11.7	3.2	8.3					
III	129	13.3	3.2	7.6	10.9				
IV	36	15.1	3.3	7.1	11.0	13.4			
V	2	18.5	4.1	7.7	11.6	15.3	17.6		
VI	1	18.1	4.3	7.7	11.4	15.2	15.9	17.1	
VII	1	19.7	3.7	6.5	8.5	10.0	12.5	16.0	18.5
Grand Average Calculated Length			3.2	7.9	11.1	13.5	15.9	16.6	18.5
Increment			3.2	4.7	3.2	2.4	2.4	0.7	1.9
Number of fish			478	371	168	40	4	2	1

Brown Trout

The average calculated lengths for brown trout at the end of each year of life are as follows (Table IX): First year, 3.9 inches; second year, 8.1 inches; third year, 12.0 inches; fourth year, 15.3 inches; fifth year, 18.2 inches; sixth year, 20.0 inches; seventh year, 21.7 inches, eighth year, 22.2 inches; ninth year, 21.6 inches.

Growth was rapid during the first three years of life, with the greatest growth occurring during the second year. There was a gradual decrease in growth increments for each year of life beyond the second year.

Sixty-two percent of the sample was represented in age groups I - III, and twenty-eight percent was in age groups V - IX. The largest number was represented in age group II, closely followed by age groups III and IV.

Average actual lengths of brown trout from the Missouri River were greater than those of brown trout taken in Crystal Creek, New York as shown by Schuck (1945).

Table IX
Average Calculated Total Lengths and Increments of Brown Trout Collected in 1948 and 1949

Age Group	No. of Fish	Ave. Actual Length	Calculated total length (inches) at end of year of life 1	2	3	4	5	6	7	8	9
I	17	8.3	4.9								
II	36	11.0	3.6	8.5							
III	26	13.7	3.8	8.2	12.0						
IV	29	16.2	3.9	8.0	12.0	14.9					
V	14	19.1	3.8	7.9	12.8	15.0	18.1				
VI	2	21.4	3.7	8.0	12.3	16.4	18.7	20.4			
VII	1	23.5	5.0	8.4	12.3	16.3	19.2	21.5	22.5		
VIII	1	24.4	3.8	7.8	11.6	16.8	20.3	22.0	23.3	24.2	
IX	1	21.6	3.4	5.3	9.5	12.4	15.1	17.0	19.0	20.2	21.6
Grand Average Calculated Length			3.9	8.1	12.0	15.3	18.2	20.0	21.7	22.2	21.6
Increment			3.9	4.2	3.9	3.3	2.9	1.8	1.7	0.5	
Number of Fish			127	103	71	47	19	5	3	2	1

Rainbow and brown trout both showed their greatest growth during the second year of life. Brown trout growth increments were progressively less after the second year of life, while there was no progressive decrease exhibited for rainbow trout. Growth rate for brown trout was greater than rainbow trout in all years except the fifth and seventh. The samples representing these two years were small for both species, and may not be representative. Brown trout were more numerous in the older age groups than rainbow. The growth of both rainbow and brown trout in this section of the Missouri River is as good or better than that of the same species in certain other trout streams of Montana.

Longnose Suckers

The average calculated lengths for longnose suckers at the end of each year of life are as follows (Table X): First year, 3.0 inches; second year, 5.5 inches; third year, 8.1 inches; fourth year, 10.4 inches; fifth year, 12.3 inches; sixth year, 13.7 inches; seventh year, 14.7 inches; eighth year, 15.5 inches.

Growth was greatest during the first year and progressively decreased as the fish grew older, except in the third year.

Table X
Average Calculated Total Lengths and Increments of Longnose Suckers Collected in 1948 and 1949

Age Group	No. of Fish	Ave. Actual Length	Calculated total length (inches) at end of year of life 1	2	3	4	5	6	7	8
I	0									
II	0									
III	3	12.9	2.6	6.5	11.0					
IV	10	13.4	3.0	6.1	9.2	12.0				
V	19	14.7	3.4	6.5	9.0	11.5	13.6			
VI	28	15.3	3.2	5.5	8.0	10.5	12.5	14.2		
VII	19	15.7	2.6	4.7	7.2	8.9	11.4	13.4	15.0	
VIII	8	16.3	2.8	4.4	6.3	8.4	10.5	12.4	14.1	15.5
Grand Average Calculated Length			3.0	5.5	8.1	10.4	12.3	13.7	14.7	15.5
Increment			3.0	2.5	2.6	2.3	1.9	1.4	1.0	0.8
Number of Fish			87	87	87	84	74	55	27	8

Ninety-five percent of all samples are in age groups IV - VIII, with the largest number in age group VI. No small fish were taken which accounts for the lack of age groups I and II.

Western White Sucker

The average calculated lengths for white suckers at the end of each year of life are as follows (Table XI): First year, 2.6 inches; second year, 5.3 inches; third year, 8.2 inches; fourth year, 10.1 inches; fifth year, 12.2 inches; sixth year, 13.7 inches; seventh year, 14.3 inches; eighth year, 15.2 inches. The most rapid growth occurs in the third year of life. There is a considerable difference in growth rate of the older fish.

Table XI
Average Calculated Total Lengths and Increments of Western White Suckers Collected in 1948 and 1949

Age Group	No. of Fish	Ave. Actual Length	Calculated total length (inches) at end of year of life 1	2	3	4	5	6	7	8
I	9	5.6	2.5							
II	22	7.4	2.6	5.2						
III	62	10.9	2.5	5.8	9.2					
IV	42	11.9	2.4	5.1	7.5	10.0				
V	40	13.4	2.6	5.0	7.2	9.7	12.0			
VI	32	15.0	3.0	5.9	8.7	11.0	12.6	14.2		
VII	11	14.8	2.5	4.9	6.9	9.0	11.8	13.8	14.1	
VIII	5	16.0	2.6	4.4	6.8	8.9	11.0	12.6	14.1	15.2
Grand Average Calculated Lengths			2.6	5.3	8.2	10.1	12.2	13.7	14.1	15.2
Increment			2.6	2.7	2.9	1.9	2.1	1.5	0.4	0.9
Number of Fish			223	214	192	131	90	49	17	5

Fifty-eight percent of all samples were represented in age groups IV - VIII with the largest number in age group III.

Growth increments were greater for the longnose sucker than the white sucker in the first year. After the first year the average calculated lengths at the end of each year of life were very nearly identical.

Rainbow and brown trout grew more rapidly than the suckers. Trout were mostly in age groups I - III, while the suckers were predominant in age groups IV - VIII.

Coefficient of Condition

The coefficient of condition (K) was calculated for each speciman of rainbow and brown trout for which weights were available (Table XII).

Table XII
Average Coefficient of Condition for Rainbow and Brown Trout Collected in 1948 and 1949

	Average value of K per age group							
Species	I	II	III	IV	V	VI	VII	VIII
Rainbow trout	36.9	37.7	37.1	35.5	34.2	29.5		
No. of Fish	113	205	125	35	2	1		
Brown trout	36.3	33.6	33.4	34.6	36.6	37.0	37.4	19.8
No. of Fish	21	30	24	26	12	2	1	1

Condition (K) of rainbow trout was higher than that of brown trout in age groups I - IV, while brown trout showed a higher K value in age groups V and VI. The average K value for rainbow trout is 37.2, for brown trout 34.6, and for the combined trout sample is 36.7. The condition (K) of rainbow trout appeared to follow a definite trend of decreasing slightly as the fish grew older, while the rather inadequate sample of brown trout showed the opposite to be true.

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