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ZOOLOGICAL SCIENCES SECTION

AGE AND GROWTH OF BROOK TROUT, SALVELINUS FONTINALIS, IN MONTANA*

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INTRODUCTION

The brook trout (Salvelinus fontinalis) was introduced into Montana as early as 1894. Initial plants were made in Glenwood Lake near Jefferson City and in Buffalo and Travis Creeks near Helena (United States Fish Commission Report, 1894). In 1889 and 1890 further introductions were made in the Yellowstone and Madison Rivers in Yellowstone Park. Henshall (1906) reported the stocking of brook trout in many lakes and streams throughout the state. The introduction of brook trout and rainbow trout (Salmo gairdneri) about 1900 into the Centennial Valley (Nelson, 1954) is believed responsible for the decline of native cutthroat trout (Salmo clarki) and American grayling (Thymallus signifer). The replacement of cutthroat trout in the lower parts of its original range by exotic trout is reported by Hanzel (1959). The brook trout has been able to survive and to reproduce so successfully that it now inhabits most river drainages in Montana.

The age and growth of brook trout in Montana have been studied for the Gallatin River drainage (Purkett, 1951 and Holton, 1953) and Prickley Pear Creek (Bishop, 1955). In Western mountain regions, the growth rate for this species is reported for Utah (Hazzard, 1935), Canada (Rawson, 1940), and California (Reimers, 1958). Other important age and growth studies for this species have been made for New York (Hazzard, 1932) and Michigan (Shetter and Leonard, 1943; Cooper, 1953).

The present study was conducted to determine the age and growth of brook trout from various locations in Montana. Data include collections from 13 streams and 8 lakes by state fisheries personnel of the Montana Fish and Game Department over a 10-year period (1950-1959). In addition, the writer studied scales of this species from seven lakes in the Beartooth Mountains during the summer of 1959 (Figure 1).

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METHODS

Fish samples were taken by one or more of the following methods: experimental gill nets, fine mesh gill nets, fish toxicants, electric shocking, seining, and angling. Total lengths were measured to the nearest 0.1 inch and weights to the nearest 0.01 pound. Sex was determined only for mature fish captured from the Beartooth Mountain lakes. Scale samples were taken from the side of each fish anterior to the dorsal fin and above the lateral line, with the exception of specimens from the Beartooth Mountain lakes and Culver pond. Scales from the latter were taken from the area immediately below the lateral line and just anterior to the anal fin.

Scales were prepared for study by making plastic impressions or gum arabic-glycerin mounts. Water mounts were made on some samples where plastic impressions were unsatisfactory.

Annuli were determined with the aid of a microprojector, and measurements were made along the anterior radius of the scale from the center of the focus to the outer edge. Assuming a straight-line relationship of scale length to body length, the length of fish at each year of life was computed by the use of a nomograph. Some difficulty was encountered in distinguishing the first annulus mark, and wherever serious difficulty occurred, scale samples were discarded.

A coefficient of condition (C) was calculated for each fish from the Beartooth Mountain lakes using the formula:

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

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

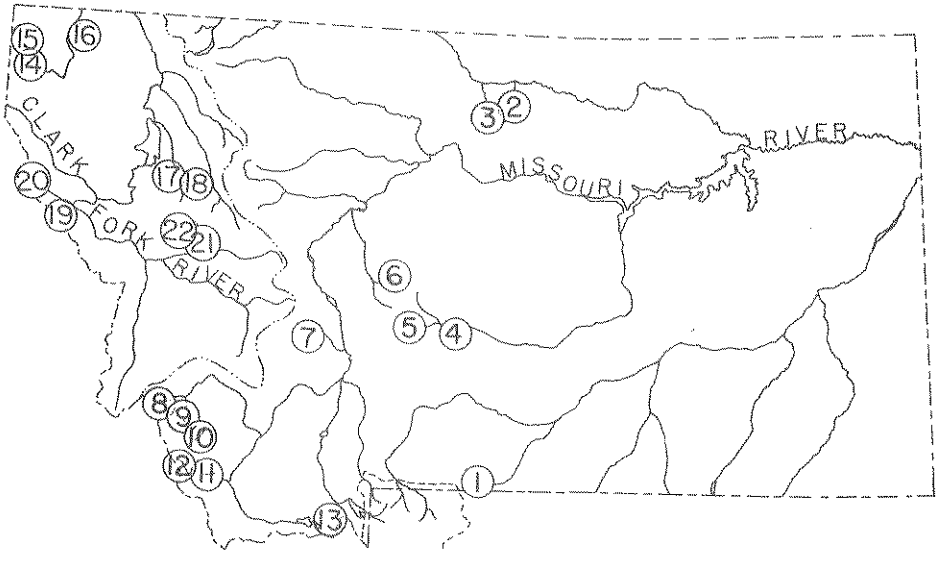

Figure 1. Locations of Brook Trout Collections in Montana

Missouri River Drainage

1. Beartooth Mountain lakes
2. Clear Creek
3. Beaver Creek
4. Big Elk Creek
5. Allabaugh Creek
6. Sheep Creek
7. Upper and Lower Tizer lakes
8. Trail Creek
9. Big Hole River, Section 1
10. Big Hole River, Section 2
11. Reservoir Lake
12. Bloody Dick Creek
13. Culver Pond

Clark Fork River Drainage

14. O'Brien Creek
15. Kilbrennan Lake
16. Pinkham Creek
17. Lost Lake
18. Smith Creek
19. Moore Lake
20. Silver Lake
21. Placid Lake
22. Placid Creek

STUDY OF TROUT IN BEARTOOTH MOUNTAIN LAKES

Area Description

The seven Beartooth Mountain lakes studied (Table I) are located in South-Central Montana in the Cooke City-Red Lodge region. They lie at elevations from 8,000 to 10,500 feet above sea level and vary in size from 15 to 160 acres and in depth from 30 to 65 feet. Most are fed by small streams averaging 3 to 4 feet in width. Melting snow supplies water for these streams, which probably dry up during the winter. Lake bottom materials in shallow areas consist of rubble and boulders except for alluvial deposits near the inlets. The shoreline varies from steep escarpments to gently sloping meadows. Surface temperatures varied between 42° and 62° F. (July 9--September 10). Vegetation surrounding these lakes is either sub-alpine forest or alpine tundra formation (alpine meadow and barren rock). Methyl orange alkalinity was low, ranging from 15 to 28 ppm.

TABLE I. Some Physical and Chemical Characteristics of Beartooth Mountain Lakes

Lake	Elevation (feet)	Approximate size (acres)	Approximate maximum depth (feet)	Methyl orange alkalinity (ppm)
Crow	9,064	20	40	-
Glacier	9,702	160	50	15
Kersey	8,070	100	65	15
Round	9,280	20	30	28
Russell	8,800	40	50	-
Ship	10,480	15	-	15
Timberline	9,660	15	50	18

Although no attempt was made to secure quantitative food samples, Diptera, Ephemeroptera, Trichoptera, and Plecoptera were known to be common. In addition to brook trout, cutthroat trout were found in Glacier and Round Lakes and lake chub, *Hybopsis plumbea*, were taken from Kersey Lake.

Age and Growth of Trout in Beartooth Mountain Lakes

It is believed that the young of certain brook trout in the Beartooth Mountain lakes fail to form scales during the first year and, therefore, have no annulus. Brown and Bailey (1952) reported that a considerable number of cutthroat trout from Yellowstone Lake passed the first winter without scales. Robertson (1947) found the same condition to exist for cutthroat trout taken from Upper and Lower No Name Lakes, Wyoming. Curtis (1934) indicated that 50 to 75 per cent of golden trout, Salmo aqua-bonita, from Cottonwood Lakes, California, failed to develop scales during their first growing season. In the present study, 40 per cent of the brook trout scales from Round Lake and 16 per cent from Timberline Lake were judged to lack the first annulus (Figure 2a). These fish had 8 to 12 circuli, while the usual number before the first annulus ranged from 4 to 7 (Figure 2b). In addition, the scales of these fish differ from others in having a larger focus, and the first 3 or 4 circuli were wider apart.

Figure 2a. Scale of a 5.2 Inch Brook Trout from Round Lake Believed to Lack a First Annulus Mark

Figure 2b. Scale of a 6.2 Inch Brook Trout from Round Lake with a Definite First Annulus Mark

The average calculated total lengths of brook trout for the seven Beartooth Mountain lakes (Yellowstone drainage) are shown in Table II. Round Lake produced brook trout with the greatest average calculated total length at the fourth annulus (12.0 inches), while Timberline Lake had the least (7.9 inches). The average calculated total lengths of trout for all seven lakes at annuli 1-4 were 2.5, 5.3, 7.6, and 9.4 inches respectively. These fish had a maximum of four annuli, with the exception of Glacier Lake, where the maximum was six. Greatest growth increments occurred during the second year of life and decreased gradually through the third and fourth.

Since no significant difference in growth rate of males and females was found, data for both sexes were combined.

TABLE II. The Average Calculated Total Length (inches) of Brook Trout from the Beartooth Mountain Lakes (Number of specimens in parentheses)

Locality	Year of life					
	I	II	III	IV	V	VI
Crow Lake	2.7 (116)	5.5 (110)	7.8 (107)	9.2 (28)	- -	- -
Glacier Lake	3.2 (57)	5.9 (46)	8.1 (40)	10.1 (32)	11.9 (4)	14.2 (1)
Kersey Lake	2.8 (121)	5.2 (101)	7.2 (65)	8.6 (19)	- -	- -
Round Lake	2.7 (60)	6.7 (38)	9.8 (12)	12.0 (8)	- -	- -
Russell Lake	2.3 (133)	5.2 (101)	7.7 (60)	10.2 (6)	- -	- -
Ship Lake	3.1 (92)	5.3 (86)	7.3 (65)	9.2 (26)	- -	- -
Timberline Lake	2.0 (76)	4.5 (61)	6.5 (53)	7.9 (11)	- -	- -
Grand averages	2.5 (655)	5.3 (543)	7.6 (408)	9.4 (130)	11.9 (4)	14.2 (1)

The actual total length of brook trout from these lakes ranged from 2.1 to 17.4 inches, and weight varied between 0.01 and 2.29 pounds. Based on the catch from experimental gill nets only (Table III), Glacier Lake showed the largest average size of fish (11.3 inches; 0.74 pounds) and Timberline Lake the smallest (7.9 inches; 0.17 pounds). Timberline Lake produced the greatest average catch (41.0) per 12-hour night set and Round Lake the least (13.7).

TABLE III. Summary of Brook Trout Catch Taken by Experimental Gill Nets from Beartooth Mountain Lakes

Lake	Number of fish	Number of 12-hour net sets	Catch per set	Average weight (pounds)	Average total length (inches)
Crow	82	5	16.4	0.35	10.3
Glacier	47	3	15.7	0.74	11.3
Kersey	182	6	30.3	0.22	8.3
Round	41	3	13.7	0.42	7.9
Russell	75	3	25.0	0.27	8.7
Ship	88	3	29.3	0.26	9.2
Timberline	82	2	41.0	0.17	7.9

The average weight of brook trout was lowest in lakes where the largest number of brook trout was caught per 12-hour set (Figure 3).

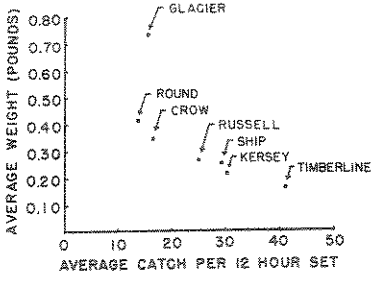

Figure 3. The Average Weight of Brook Trout Compared to the Average Number of Brook Trout Caught per 12-hour Night Set in Seven Beartooth Mountain Lakes

Five adult brook trout ranging from 15.5 to 17.7 inches total length and weighing between 2.0 and 2.8 pounds were caught in Bald Knob Lake. All had five annuli. A few young of the year were also taken in the outlet of this lake. It is believed that poor spawning conditions prevent over-population and account for these larger fish.

Using the fourth annulus as a basis, a comparison was made between the average calculated total lengths of brook trout from the Beartooth Mountain lakes with other lakes in the Western mountain region. Hazzard (1935) showed that brook trout from Fish Lake (elevation 8,800 feet), Utah, were 12.9 inches at this annulus, while Rawson (1940) reported 11.2 and 11.7 inches respectively for Maligne and Beaver Lakes (elevation 5,500 feet), Alberta, Canada. In both instances, the average calculated total lengths exceeded those of the Beartooth Mountain lakes. Reimers (1958) showed that the size of brook trout from Bunny Lake (elevation 10,900 feet), California, was considerably less at the fourth annulus (5.9 inches) than those of the Beartooth lakes.

Condition Factors of Trout in Beartooth Lakes

Coefficients of condition of brook trout for the Beartooth Mountain lakes were calculated only on fish exceeding 6 inches total length. Smaller fish were not weighed because adequate field equipment was not available. The average coefficient of condition (C) for the seven lakes ranged from 32.0 (Ship Lake) to 45.5 (Glacier Lake). Average coefficients of condition were determined for each lake by four-inch size groups. With the exception of Glacier and Kersey Lakes, a progressive decline in condition was noted as the fish increased in size (Table IV). Shetter and Leonard (1943) reported that larger brook trout had better condition (C) than the smaller individuals in Hunt Creek, Michigan.

TABLE IV. Average Condition Factors (C) of Brook Trout from Beartooth Mountain Lakes

Lake	Average (C) for 4-inch length intervals						Average (C) for each lake
	Number	6.0-9.9	Number	10.0-13.9	Number	14.0-17.9	
Glacier	8	40.8	36	45.9	4	50.4	45.5
Crow	64	34.7	56	33.6	-	-	34.2
Kersey	99	33.2	17	33.3	2	45.7	33.4
Round	27	39.8	35	37.4	1	35.0	38.4
Russell	97	37.6	17	36.9	1	38.2	37.2
Ship	86	34.3	33	27.3	-	-	32.0
Timberline	80	32.8	1	27.0	-	-	32.7

STUDY OF TROUT IN OTHER MONTANA LAKES AND DRAINAGES

The lakes and streams from which brook trout were taken are located on both sides of the Continental Divide and include the Clark Fork River of the Columbia River and the Missouri River drainages. The primary tributaries of these two rivers originate in the mountains at elevations from 5,000 to 8,000 feet. They descend through steep canyons to cultivated valleys and range land below. Most of the scale samples were taken from fish which inhabit secondary and tertiary tributaries of these drainages. The lakes and streams where samples were taken are treated by drainages beginning at the mouth and going toward the source (Figure 1).

Milk River Drainage

Clear Creek (No. 2) is tributary to the central part of the Milk River. Samples were restricted to a 5-mile portion located approximately 25 miles southeast of Havre; Beaver Creek (No. 3) is also tributary to the central part, and samples were confined to a 2-mile portion located about 20 miles south of Havre.

Musselshell River Drainage

Big Elk Creek (No. 4) is tributary to the upper Musselshell River. Samples were secured from a 10-mile section of this stream located 8 miles south of Two Dot. Allabaugh Creek (No. 5) drains into the South Fork of the Musselshell River, and samples came from a 10-mile section located 1 mile west of Lennep.

Smith River Drainage

Sheep Creek (No. 6) drains into the central portion of the

Smith River, and samples were from a 10-mile section located approximately 20 miles southeast of the King's Hill Ranger Station.

Crow Creek Drainage

Upper and Lower Tizer Lakes (No. 7), located about 32 miles northwest of Toston, at the headwaters of Crow Creek, were sampled.

Jefferson River Drainage

Trail Creek (No. 8) is tributary to the Big Hole River. Samples were taken from the lower part of this creek near the site of the Big Hole Battlefield National Monument. Two areas were sampled on the Big Hole River proper: one (No. 9) was three miles south of Jackson and the other (No. 10) upstream in the vicinity of Skinner Meadows. Bloody Dick Creek (No. 12) flows into the upper part of Horse Prairie Creek, which, in turn, is a tributary to the Beaverhead River. Brook trout were taken four miles south of Skinner Meadows in this creek. Reservoir Lake (No. 11) drains into Bloody Dick Creek about four miles south of Skinner Meadows. Culver Pond (No. 13) is tributary to Elk Springs Creek and Upper Red Rock Lake on the eastern border of the Red Rock Migratory Bird Refuge.

Kootenai River Drainage

O'Brien Creek (No. 14) is tributary to the central part of the Kootenai River, and samples were secured from the lower portion of this stream--located three miles west of Troy--and from Kilbrennan Lake (No. 15) which drains into the upper part of O'Brien Creek--10 miles east of Leopia. Pinkham Creek (No. 16), which is also tributary to the middle portion of the Kootenai River, was sampled 17 miles southeast of Rexford.

Saint Regis River Drainage

Samples were secured from Moore Lake (No. 19)--located in the headwaters of Saint Joe Creek 12 miles southwest of Saint Regis--and Silver Lake (No. 20) which drains into Silver Creek, tributary to the Saint Regis River--six miles southwest of Saltese.

Flathead River Drainage

Brook trout were collected from a location five miles upstream from the Condon Ranger Station on Smith Creek (No. 18) which empties into Condon Creek, a tributary of the Swan River and from Lost Lake (No. 17) which drains into Little Salmon Creek--located five miles east of the Condon Ranger Station. This creek is tributary to the South Fork of the Flathead River.

Blackfoot River Drainage

Placid Lake (No. 21) is located 5 miles south of the Seeley Lake Ranger Station. Placid Creek (No. 22) is tributary to the Blackfoot River. Samples came from a 6-mile section of stream immediately above Placid Lake.

AGE AND GROWTH OF TROUT IN VARIOUS LAKES AND DRAINAGES

The average calculated total lengths of brook trout are presented for the various lakes and streams described above. Since most fish had a maximum of three annuli, comparisons among average calculated total lengths were made for this annulus. Those from the Musselshell River drainage had only two annuli. In addition to average calculated total lengths, comparisons were made of growth increments and actual total lengths and weights.

The average calculated total length of brook trout from the Milk River drainage was 7.6 inches (Table V). Those from Beaver Creek had an average calculated total length of 8.0 inches and from Clear Creek, 7.3 inches. In these instances, the greatest growth increment occurred during the first year of life. Actual total lengths ranged from 3.9 to 10.7 inches, and weights varied between 0.02 and 0.45 pounds.

The average calculated total length of brook trout from the Musselshell drainage at the second annulus was 5.7 inches (Table V). Fish from Big Elk Creek were 5.9 inches at this annulus, while trout from Allabaugh Creek were only 5.1 inches. In each case, the growth increment was greatest during the first year of life. These fish ranged in actual total length from 3.2 to 10.6 inches and varied in weight from 0.02 to 0.46 pounds.

The Smith River drainage is represented by one collection from Sheep Creek, where the average calculated total length was 10.0 inches at the third annulus (Table V). The greatest growth was exhibited during the third year of life. The range of actual total lengths was from 3.9 to 13.7 inches, and the weights varied from 0.03 to 1.16 pounds.

The average calculated total length of brook trout from the Crow Creek drainage was 6.9 inches (Table V). All the fish studied came from Upper and Lower Tizer Lakes. The greatest growth increment occurred during the first year. Their actual total lengths ranged from 5.1 to 8.9 inches, and weights varied from 0.04 to 0.25 pounds.

Brook trout collected from the Jefferson River drainage had an average calculated total length of 8.8 inches (Table V). Trout from Culver Pond had the greatest average calculated total length (14.4 inches) in this drainage. Others from this drainage were as follows: Reservoir Lake--8.9 inches; Trail Creek--7.8 inches; Big Hole

River (Section 1)--7.7 inches; Big Hole River (Section 2)--6.5 inches; Bloody Dick Creek--5.8 inches. Brook trout from this drainage showed the greatest increment during the first year of life, except in Culver Pond where the increment occurred during the second year. Fish from this drainage ranged in actual total length from 4.2 to 21.9 inches, and weights varied from 0.03 to 5.50 pounds.

The average calculated total length of brook trout from the Kootenai River drainage was 8.2 inches at the third annulus (Table V). Those from Kilbrennan Lake attained the greatest length (9.1 inches), while those from O'Brien and Pinkham Creeks were 7.5 and 6.0 inches respectively. Growth increments were the greatest during the third year of life. The range in actual total length was 2.7-13.2 inches, and the range in weight was 0.01-0.93 pounds.

Brook trout from the Flathead River drainage, represented by collections from Smith Creek and Lost Lake, had an average calculated total length of 9.5 inches (Table V). Smith Creek showed the greatest growth--9.5 inches--and Lost Lake the least--8.9 inches. In both instances, the greatest growth increment occurred during the first year of life. The actual total length varied from 4.8 to 15.5 inches, and weights ranged from 0.04 to 1.56 pounds.

The average calculated total length for brook trout from the Saint Regis River drainage was 7.9 inches (Table V). Fish from Moore Lake displayed the greatest growth (10.1 inches) at the third annulus. Those from Silver Lake had the least growth (7.7 inches). The largest growth increments occurred during the first year of life for fish from Moore Lake, while in Silver Lake the increment came in the second year. The actual total lengths of these fish ranged from 6.1 to 12.5 inches, and weights ranged from 0.08 to 0.59 pounds.

Placid Creek and Placid Lake are in the Blackfoot River drainage. The average calculated total length of fish from the drainage was 8.1 inches (Table V). Placid Creek samples had the greatest growth (8.8 inches), while fish from Placid Lake were only 7.2 inches. Brook trout from Placid Lake showed the greatest increment during the first year of life, while fish from Placid Creek grew most in the fifth year. Fish varied in actual total length from 2.7 to 24.0 inches, and in weight ranged from 0.01 to 5.01 pounds.

The grand average calculated total lengths of brook trout for all nine river drainages at annuli 1-5 were 3.2, 5.8, 8.4, 13.6, and 16.9 inches respectively. Comparisons between drainages showed that brook trout from the Flathead River drainage had the greatest average calculated total length (9.5 inches) at the third annulus, except for one fish from the Smith River drainage. Specimens from the Crow Creek drainage showed the least average growth (6.9 inches) at this annulus. The greatest average growth increment of brook trout for the nine river drainages usually occurred during the first year of life. The exceptions to this condition involve very small samples and may be disregarded.

TABLE V. The Average Calculated Total Lengths (inches) of Brook Trout from Some Streams and Lakes in Montana (Numbers of specimens in parentheses)

Locality	Average lengths for year of life				
	I	II	III	IV	V
Milk River drainage					
Clear Creek	3.2 (107)	5.7 (44)	7.3 (4)	-	-
Beaver Creek	3.3 (60)	5.7 (29)	8.0 (3)	9.1 (1)	-
Average calculated length	3.3 (167)	5.7 (73)	7.6 (7)	9.1 (1)	-
Musselshell River drainage					
Big Elk Creek	3.4 (77)	5.9 (34)	-	-	-
Allabaugh Creek	2.8 (77)	5.1 (13)	-	-	-
Average calculated length	3.1 (144)	5.7 (47)	-	-	-
Smith River drainage					
Sheep Creek	3.3 (66)	5.6 (25)	10.0 (1)	12.3 (1)	-
Crow Creek drainage					
Upper and Lower Tizer lakes	3.2 (48)	5.3 (24)	6.9 (5)	7.4 (1)	-
Jefferson River drainage					
Trail Creek	2.8 (79)	5.7 (37)	7.8 (14)	9.3 (3)	-
Big Hole River (Section 1)	2.9 (48)	5.4 (25)	7.7 (10)	9.4 (2)	-
Big Hole River (Section 2)	2.2 (58)	4.2 (35)	6.5 (17)	-	-
Reservoir Lake	4.3 (58)	7.2 (41)	8.9 (4)	-	-
Bloody Dick Creek	2.3 (38)	4.3 (27)	5.8 (9)	-	-
Culver Pond	4.7 (89)	10.0 (48)	14.4 (21)	17.4 (9)	20.6 (1)
Average calculated length	3.4 (370)	6.5 (213)	8.8 (75)	14.5 (14)	20.6 (1)

TABLE V. (continued)

Locality	Average lengths for year of life				
	I	II	III	IV	V
Kootenai River drainage					
O'Brien Creek	3.0 (261)	5.3 (93)	7.5 (4)	-	-
Kilbrennan Lake	3.5 (45)	6.0 (36)	9.1 (17)	-	-
Pinkham Creek	2.5 (42)	4.2 (22)	6.0 (5)	-	-
Average calculated length	3.0 (348)	5.3 (151)	8.2 (26)	-	-
Flathead River drainage					
Smith Creek	3.7 (54)	6.8 (51)	9.5 (20)	-	-
Lost Lake	4.2 (48)	6.9 (17)	8.9 (1)	-	-
Average calculated length	3.9 (102)	6.8 (68)	9.5 (21)	-	-
Saint Regis River drainage					
Moore Lake	3.8 (46)	7.3 (29)	10.1 (3)	-	-
Silver Lake	2.4 (52)	5.5 (52)	7.7 (22)	-	-
Average calculated length	3.1 (98)	6.2 (81)	7.9 (25)	-	-
Blackfoot River drainage					
Placid Lake	2.9 (32)	5.2 (32)	7.2 (23)	8.8 (4)	10.2 (1)
Placid Creek	2.8 (293)	5.0 (174)	8.8 (34)	11.4 (10)	16.0 (4)
Average calculated length	2.8 (325)	5.0 (206)	8.1 (57)	10.7 (14)	14.8 (5)
Grand average calculated length	3.2 (1678)	5.8 (888)	8.4 (217)	13.6 (31)	16.9 (6)

Most brook trout attained a maximum of three annuli, but four were frequent. Those trout from the Blackfoot and Beaverhead River drainages had a maximum of five, while those from the Musselshell River drainage had a maximum of two.

The growth rates for brook trout reported in previous Montana studies were greater than that of the present study. Brook trout from Bridger and Spring Creeks of the Gallatin River drainage (Purkett, 1951) showed an average calculated total length of 10.9 inches at the third annulus, while those from Prickley Pear Creek, which is tributary to the Missouri River, had an average calculated total length of 9.8 inches at this annulus (Bishop, 1955). Holton (1953) studied the growth of brook trout from Trout Creek of the Gallatin River drainage and gave 8.8 inches as the average actual total length at the second annulus.

DISCUSSION

The combined data on brook trout for all the lakes and streams in this study showed a grand average calculated total length at annuli 1-6 of 3.0, 5.6, 7.9, 10.3, 14.4, and 14.2 inches respectively. The average calculated total lengths of the combined age and growth data at annuli 1-3 along with maximum (Culver Pond) and minimum (Bloody Dick Creek) growth rates are shown in Figure 4. The growth rate of brook trout from the Beartooth Mountain lakes was only slightly less than the over-all state average.

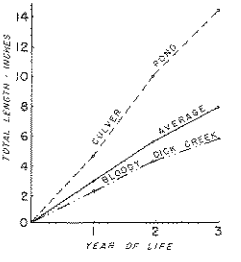

Figure 4. The Average Calculated Total Length of Brook Trout Showing the Maximum (Culver Pond), Over-All Average (average), and Minimum (Bloody Dick Creek) Growth Rates at Annuli 1-3

The average calculated total lengths for 13 streams in New York (Hazzard, 1932) at annuli 1-3 were 3.5, 5.3, and 6.6 inches respectively. Shetter and Leonard (1943) reported the average calculated total lengths at annuli 1-3 of 3.0, 5.0, and 6.8 inches respectively for a limited section of Hunt Creek, Michigan. Brook trout from New York streams were larger at the first annulus than the over-all Montana average of the present study, while those from Hunt Creek were about the same as the Montana average. However, the

Montana brook trout exceeded the average calculated total length of both New York and Michigan collections at the second and third annuli.

LITERATURE CITED

Bean, Tarleton H. "Report on the Propagation and Distribution of Food Fishes," Report of the United States Commission on Fish and Fisheries, pp. 20-80. Washington: Government Printing Office, 1894.

Bishop, Clinton G. "Age, Growth and Condition of Trout in Prickley Pear Creek, Montana," Trans. Am. Micros. Soc., 74:134-145, 1955.

Brown, C. J. D., and Jack E. Bailey. "Time and Pattern of Scale Formation in Yellowstone Cutthroat Trout Salmo clarkii lewisii," Trans. Am. Micros. Soc., 71:120-124, 1952.

Cooper, Edwin L. "Periodicity of Growth and Change of Condition of Brook Trout Salvelinus fontinalis in Three Michigan Trout Streams," Copeia, 1953, pp. 107-114.

Curtis, B. "Golden Trout of Cottonwood Lakes (Salmo aqua-bonita Jordan)," Trans. Am. Fish. Soc., 64:259-265, 1934.

Hanzel, Delano A. "The Distribution of Cutthroat Trout Salmo clarki in Montana," Proc. Mont. Acad. Sci., 19:32-71, 1959.

Hazzard, A. S. "A Preliminary Study of an Exceptionally Productive Trout Water, Fish Lake, Utah," Trans. Am. Fish. Soc., 65:122-128, 1935.

_____. "Some Phases of the Life History of Eastern Brook Trout, Salvelinus fontinalis Mitchell," Trans. Am. Fish. Soc., 62: 344-350, 1932.

Henshall, James A. A List of the Fishes of Montana (University of Montana Bulletin, Vol. XI, No. 34) Missoula, Montana: University of Montana Press, 1906. 12 pp.

Holton, George D. "A Trout Population Study on a Small Creek in Gallatin County, Montana," J. Wildl. Mgmt., 17:62-82, 1953.

Nelson, Perry H. "Life History and Management of the American Grayling (Thymallus signifer tricolor) in Montana," J. Wildl. Mgmt., 18:324-342, 1954.

Purkett, Charles A., Jr. "Growth Rate of Trout in Relation to Elevation and Temperature," Trans. Am. Fish. Soc., 80:251-259, 1951.

Rawson, Don. "The Eastern Brook Trout in the Maligne River System, Jasper National Park," Trans. Am. Fish. Soc., 70:221-235, 1940.

Reimers, Norman. "Conditions of Existence, Growth and Longevity of Brook Trout in a Small High Altitude Lake of the Eastern Sierra Nevada Mountains," Calif. Fish and Game, 4:319-333, 1958.

Robertson, O. H. "An Ecological Study of Two High Mountain Lakes in the Wind River Range, Wyoming," Ecology, 4:87-112, 1947.

Shetter, David S., and Justin W. Leonard. "A Population Study of a Limited Area in a Michigan Trout Stream," Trans. Am. Fish. Soc., 72:35-51, 1943.

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