5-1951

Age and Growth of the Brown Trout *Salmo trutta fario* Linnaeus in Logan River, Utah

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Abstract

The Logan River flowing southwesterly through the mountains of Cache County, Utah is comparatively cold to the mouth of Logan Canyon. The stream is characterized by steep gradient, a high velocity and relatively few pools. A total of 1053 brown trout were examined during the course of this study; 286 were retained for age and growth determinations. The body-scale relationship is $L = 40.46$ mm. $+ 0.44185R + 0.01908R^2$ where L equals standard length in millimeters, and R equals scale radius times 80. The relationship of standard length to weight is described by the formula $W = 0.000022\ L^{2.96}$. The rate of growth in length of Logan River brown trout is comparable to that of several other populations. The relative weight is somewhat higher.

Introduction

In 1948 a comprehensive fishery investigation on Logan River was initiated by the Department of Wildlife Management, Utah State Agricultural College, and the Utah Cooperative Wildlife Research Unit.[1]

1. Utah Fish and Game Department, Wildlife Management Institute, Utah State Agricultural College and U.S. Fish and Wildlife Service, cooperating.

One phase of this study is the life history of the brown trout Salmo trutta fario Linnaeus.

Native fish in Logan River above the lowest impoundment dam include cutthroat trout Salmo clarki Richardson, mountain whitefish Prosopium williamsoni (Girard), Utah sculpin Cottus bairdi semiscaber (Cope), and rarely the smallfin redside shiner Richardsonius balteatus hydrophlox (Cope). Introduced fish, in addition to the brown trout, are the eastern brook trout Salvelinus fontinalis fontinalis (Mitchell), and coast rainbow Salmo gairdneri irrideus Gibbons.[2] There is no up-

2. Since the introduction of rainbow trout, the hybrid, rainbow x cutthroat has appeared.

stream passage of fish over the lowest impoundment dam.

Fish were collected largely with the aid of an electric shocking machine. A few were collected with experimental gill nets and by hook and line. A total of 1053 fish were examined during the course of this study; 286 were retained for age and growth determinations. Scales and other data were taken according to standard procedure from June 1948 through February 1951.

Carlander (1950) lists over 100 articles and reports which contain some reference to brown trout. However, detailed information on the rate of growth of wild brown trout is quite limited.

Description of the Area

Logan River heads in Franklin County in Southern Idaho and flows southwesterly through Cache County, Utah, until it empties into Bear River. The rugged mountainous area of the Logan River watershed covers 225 square miles of weathered Paleozoic Age limestone, dolomite and shale. The main branch of the river enters Utah at an elevation of 8,500 feet and drops to 4,500 feet where it enters Cache Valley; a distance of approximately 36 stream miles. Brown trout are most abundant below elevations of 6,800 feet. The average gradient for the Logan River is approximately 70 feet per mile (Brown, 1935). In general, the higher elevations have much steeper gradients than the lower sections of the river. There are three artificial impoundments above 4500 feet which supply power and irrigation water to Cache Valley. These impoundments, none of which exceeds 22 feet in depth or 4 acres in size, have a rich bottom layer of silt and extensive shoal areas.

The stream bottom is composed largely of coarse gravel, rubble, and boulders. Sand and gravel beds are scarce due to the steep gradient and high velocity of the river. Silting is slight in the stream bed except during the spring run-off. Turbidities, based on silicon dioxide equivalents, range from 25 to 32 parts per million in the spring, but drop to 6 parts per million in September and October. There is virtually no pollution except from soil erosion. The average velocity of the river over a series of stations, between April and October in 1948 and 1949, was 2.6 feet per second.

Table 1. Body-scale Relationship (L/Sc) of 286 Brown Trout from Logan River, Arranged in 20 Millimeter Standard Length Groups with All Age Groups Combined.

Actual mean standard length	Actual mean scale measurement	Calculated mean scale radius	L/Sc ratio	Number of fish
51.4	19	15	2.70	9
68.6	26	28	2.64	16
89.7	36.6	40.5	2.45	11
113.4	51.4	51	2.21	29
129.6	53.4	53	2.43	41
150.0	65.0	65	2.31	35
170.7	71.0	72	2.40	44
189.5	82.1	77.5	2.31	30
210.5	82.8	83.5	2.54	25
229.6	91.0	88.7	2.52	10
249.6	92.8	94.0	2.69	12
268.4	97.1	98.3	2.76	8
293.4	97.4	104.0	3.01	5
311.0	103.0	108.0	3.02	6
332.5	119.5	112.7	2.78	2
384.6	129.0	123.2	2.98	3

$L = 40.46 \text{ mm.} + 0.44185R + 0.01908R^2$

The major source of water during the summer and fall months is springs. This, coupled with a high water velocity and an abundance of bank shade, keeps the temperature comparatively low to the mouth of Logan Canyon. Temperatures taken between April and October, 1948 and 1949, from the Idaho line down to the upper (third) dam, averaged about 48 degrees and did not exceed 60. The average monthly mean discharge at the junction of the Cache National Forest and Cache Valley, based on the 1946-1949 water seasons, was 247 cubic feet per second. The greatest flow occurred in May (717) and the least in February (108).

The habitat of the mountain whitefish, which is similar to that of the brown trout, is described in more detail by Sigler (1951).

Rate of Growth

The body-scale relationship of 286 brown trout is described by the formula $L = 40.46 \text{ mm.} + 0.44185R + 0.01908R^2$; where L = standard length in millimeters and R = scale radius in millimeters times 80 (table 1 and figure 1). The assessment of age and the calculation of growth were accomplished by reading the scales. The validity of the method was tested according to practices described by Van Oosten (1929) and Hile (1941). Actual calculation of past growth was made with the aid of a nomograph similar to that described by Carlander and Smith (1944) and Hile (1950).

Brown trout in Logan River grow approximately three inches per year after the first year (table 3). They attain a legal length of seven inches early in their third year of life. According to this

Table 2. Length-weight Relationship of 286 Brown Trout from Logan River.

Mean standard length in millimeters	Weight in grams		Difference in actual & calculated weight	Mean K	Number of fish
	Actual mean	Calculated mean			
51	2	2	0	1.938	9
69	6	6	0	1.912	16
90	12	13	+1	1.720	11
113	25	26	+1	1.737	29
130	40	40	0	1.842	41
150	62	61	-1	1.845	35
171	90	90	0	1.814	44
190	127	122	-5	1.860	30
210	170	165	-5	1.834	25
230	204	215	+11	1.688	10
250	267	276	+9	1.728	12
268	329	339	+10	1.692	8
293	400	440	+40	1.574	5
311	512	526	+14	1.712	6
332	634	638	+4	1.347	2
385	868	989	+121	1.546	3

$W = 0.000022\ L^{2.96}$

study, fish in advanced year groups do not grow faster than those in younger groups, but simply live longer. Based on age, Logan River brown trout apparently grow in length at about the same rate as many other populations (Eddy and Carlander, 1939; Bean, 1902, and others).

A series of one-tenth mile sections of stream were sampled with an electric shocking machine. A total of 1053 fish from these sections were measured to the nearest inch and recorded on a length-frequency basis. Normally the numbers of fish in length groups decrease as the size of the fish increase. Fish less than four inches long represented only eight percent of the total, and did not follow the expected length-frequency ratio. This is believed to be a sampling bias rather than a representation of actual conditions. The number of fish in length groups between 7 and 20 inches dropped steadily and rapidly as the size increased. Forty-seven percent of the legal-sized fish were less than 10 inches long, and 61 percent of them were less than 15 inches long. Fish between 4 and 9.7 inches long in the age and growth sample (table 3) represent 95 percent of the total; fish from these same length groups total 76 percent of the entire population studied.

The conversion factors, based on the fish in table one, are as follows: standard length times total length equals 1.173; total length times standard length equals 0.852; fork length times standard length equals 0.887.

Length-Weight Relationship

The relationship of weight in grams to standard length in milli-

Table 3. Summary of the Mean Calculated Standard Lengths and Annual Increments of Lengths in Millimeters for the Logan River Brown Trout with Sexes Combined, Collected in 1948, 1949, and 1950.

Age class	Number of fish	Standard length at capture	Calculated lengths at end of year of life							
			1	2	3	4	5	6	7	8
I	124	138.7	86							
II	92	188.8	88	149						
III	32	255.9	91	155	218					
IV	6	316.0	72	128	201	269				
V	2	395.5	75	128	169	253	317			
VI	1	420.0	62	116	188	240	300	372		
VII	1	670.7	84	124	170	276	404	470	600	
VIII	2	654.5	79	119	211	252	341	377	528	600
Grand averages and total	260		87	148	211	262	337	399	552	600
Increments of growth			87	61	64	70	82	52	144	72
Equivalent total length in inches			4.0	2.8	2.9	3.2	3.8	2.4	6.6	3.3
Number of fish			260	136	44	12	6	4	3	2
Equivalent total length in inches			4.0	6.9	9.7	12.1	15.6	18.3	25.5	27.7

meters is described by the formula $W = 0.000022\ L^{2.96}$ (table 2). The agreement between actual and calculated weights is good for groups of fish containing over six individuals. The weight increases approximately as the 2.96 power of the length of the fish. Schuck (1942) gives a somewhat lower value for wild brown trout from New York. However, this in part is accounted for by the fact that the total length was used instead of standard length in calculating the formula.

The condition factor, K, of brown trout from Logan River was calculated from the following $K = \frac{W \times 10^5}{L^3}$; when W equals weight in grams, and L equals standard length in millimeters. The highest K value of 1.938 was recorded for the smallest fish; K decreases somewhat with the increase in length. The condition factor of the Logan River fish is somewhat higher than that of several other populations. (Schuck, 1945; Carlander, 1944).

According to Needham (1938) few brown trout over five pounds are taken from streams. Bean (1902) lists as maximum a weight of 22 pounds and a length of 35 inches, but states that 5 or 6 pounds is a good average. Although Logan River has yielded some very large brown trout, including the world's record, accurate data on them are scarce. In 1929 a 39 inch brown trout weighing 35 pounds was taken from the lowest impoundment. Almost every year two or more ranging in weight from 12 to 18 pounds are caught from the lower part of the river.

Acknowledgements

I am grateful for the assistance received from graduate and undergraduate students in the department of Wildlife Management, Utah State

Agricultural College. Special thanks are due to students Sam Jackson and George Fleener.

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