Original: Fish Division
cc: Education - Game
Inst. for Fish. Res.
H. Gowing
D. S. Shetter
C. T. Yoder
Rifle River Area

INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

ALBERT S. HAZZARD, PH.D.
DIRECTOR

ADDRESS
UNIVERSITY MUSEUMS ANNEX
ANN ARBOR, MICHIGAN

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SEASONAL CHANGE IN CONDITION OF NATIVE BROWN TROUT IN HOUGHTON CREEK, OGEMAW COUNTY, MICHIGAN

By Howard Gowing

Introduction

Coefficient of condition (C) is frequently employed by fisheries investigators as a measure of the heaviness of a fish in relation to its length. In deriving values of condition, weight (W) is considered a function of length (L) and computations are based on this relationship which is expressed as the cube law: $W = CL^3$.

For an eastern trout stream Surber (1937) considered the coefficient of condition as a yardstick to determine when hatchery trout had been overstocked. Klak (1941) emphasized the need for indices of condition of trout to formulate a stocking policy. The present paper describes the seasonal trend in condition of wild brown trout in a stream inhabited almost exclusively by this one species of trout. A few factors related to condition are briefly discussed. The study covered approximately a 13-month period from April, 1953 to May, 1954.

Description of Stream

The site of this study was Houghton Creek, a tributary of the Rifle River, located in the north-central portion of Ogemaw County,

Michigan. The stream is approximately 9.7 miles long and drains an area of about 27 square miles. At the study area, located near the central portion of Houghton Creek, the stream has a mean width of 24 feet and a mean depth of 1.1 feet. The stream bottom consists primarily of gravel, sand, and rubble. A few isolated areas of clay hardpan are present. The fish fauna in this portion of the stream is almost exclusively brown trout (Salmo trutta) and freshwater sculpin (Cottus spp.). White suckers (Catostomus commersoni) and brook trout (Salvelinus fontinalis) are rarely encountered.

Methods

Monthly samples of 100 brown trout were collected by electrofishing during the period, with an additional sample during the spring of 1954. Fish were measured and weighed individually and returned to the stream. Total length was recorded in tenths of inches, and weight was measured in grams on a Chatillon dietary scale. Grams were later converted to hundredths of a pound. Fish less than 5.0 inches in total length were excluded from consideration because, with the Chatillon scale, errors in their individual weights were large percentagewise. The coefficient of condition (C) was based on the English system as expressed by the following relationship between weight in pounds (W) and total length in inches (L):

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

Computation of individual C values was facilitated by the use of a table of reciprocal factors listed by Carlander (1953). Means were computed for the monthly samples.

Records of maximum and minimum water temperatures for the period of the study were furnished by the United States Department of Interior,

Geological Survey, through the courtesy of Mr. D. Pettengill (Grayling, Michigan). Daily water temperatures were recorded on a thermograph housed in a gauging station located approximately 5.5 miles downstream from the fish sampling site. Available water temperature readings taken near the sampling site were generally within two or three degrees of agreement with the thermograph records.

Seasonal Trend in Condition

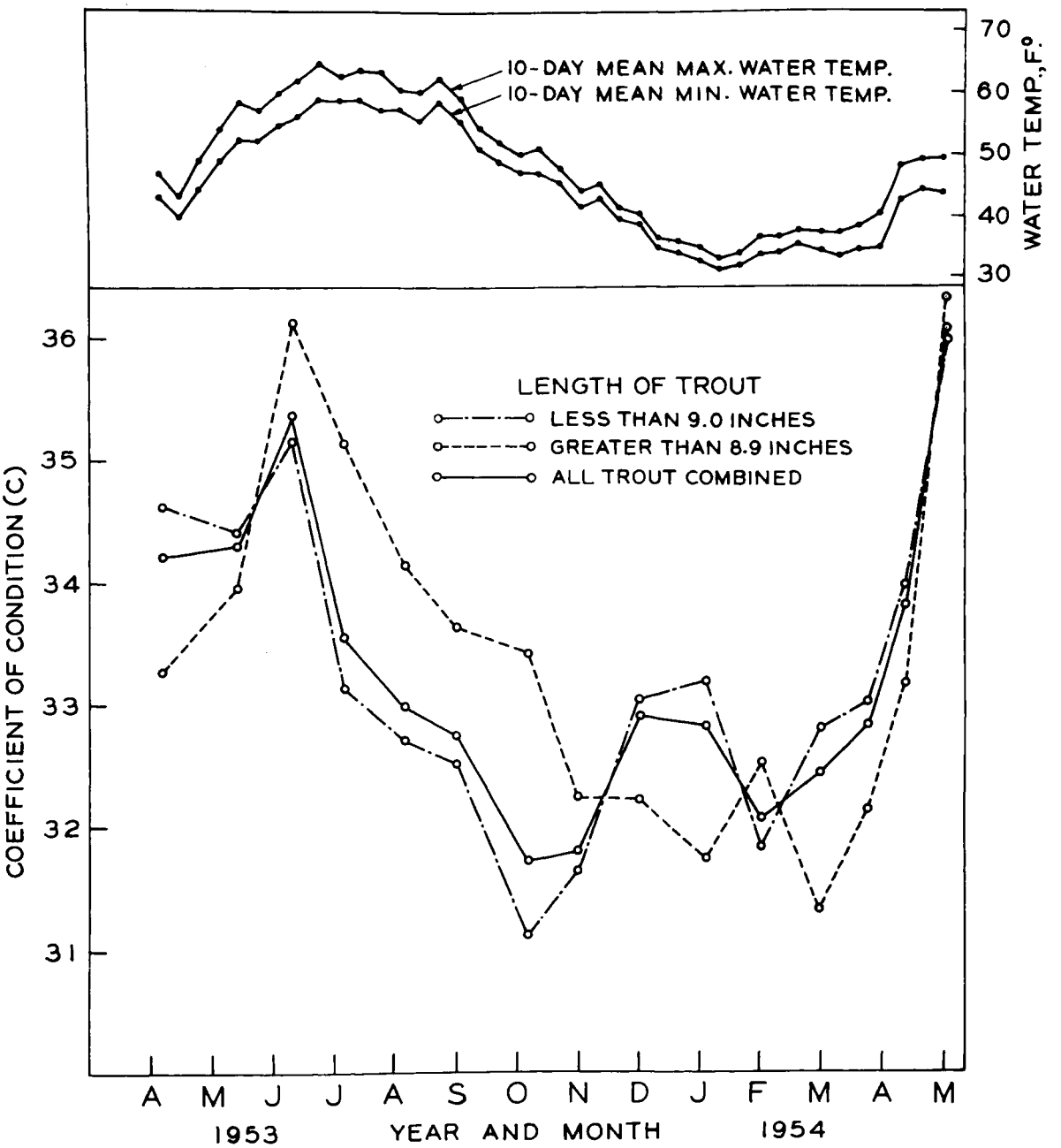
Based on the means of the monthly samples (Table 1), illustrated in Figure 1, the condition of trout increased negligibly from April to May and then rose abruptly to a peak by about the second week in June. Condition then decreased during the succeeding summer months until a low point was reached in early October.

In order to discern the general seasonal trend in condition with respect to sexual maturity, 9.0 inches was selected as a point for separating mature from immature fish. There was some overlapping with respect to maturity, particularly among males. Mean monthly samples based on this division indicated that the large trout entered the spring season in poorer condition than the small trout, but the large fish reached a significantly higher peak of condition in June than did the smaller fish (t = 1.99, p = 95.3 percent). Condition of trout in both groups steadily decreased from July to October, with the large fish maintaining a superiority in condition during this period (t = 2.54 to 5.17, p = 98.9 to 99.9+ percent). The large trout exhibited a precipitous drop in condition during October, presumably associated with spawning, and they finally reached a low by late winter. Some evidence as to the extent of weight loss following spawning was reported by Mottley (1938). He found that a run of

Table 1. Average values of coefficient of condition (C) of wild brown trout in Houghton Creek based on monthly samples of 100 fish.

Date	Size range	Coefficient of condition (C)		
		Mean	Standard deviation	Standard error of mean
4-7-53	5.0-11.7	34.17	2.29	0.229
5-11-53	5.1-13.8	34.25	2.91	0.291
6-10-53	5.0-14.0	35.37	2.18	0.218
7-7-53	5.0-12-3	33.52	3.38	0.338
8-6-53	5.1-12.1	32.94	2.50	0.250
9-3-53	5.1-11.5	32.71	2.39	0.239
10-9-53	5.1-14.5	31.67	2.38	0.238
11-3-53	5.1-13.1	31.73	2.82	0.282
12-2-53	5.0-11.6	32.84	2.59	0.259
1-8-54	5.0-11.6	32.80	2.37	0.237
2-5-54	5.0-14.5	32.00	2.68	0.268
3-5-54	5.0-12.3	32.42	2.76	0.276
3-29-54	5.0-12.1	32.79	2.36	0.236
4-15-54	5.0-13.0	33.79	2.78	0.278
5-4-54	5.0-11.9	36.11	2.54	0.254

Figure 1. Seasonal trend in maximum and minimum water temperatures, and in coefficient of condition of wild brown trout in Houghton Creek based on means of monthly samples of 100 fish.


10-DAY MEAN MAX. WATER TEMP.
10-DAY MEAN MIN. WATER TEMP.
WATER TEMP.,F°
70
60
50
40
30
LENGTH OF TROUT
LESS THAN 9.0 INCHES
GREATER THAN 8.9 INCHES
ALL TROUT COMBINED
COEFFICIENT OF CONDITION (C)
36
35
34
33
32
31
A M J J A S O N D J F M A M
1953
YEAR AND MONTH
1954

mature rainbow trout had a weight loss of 16.7 to 25.2 percent, based on weight lost by each fish computed as a percentage of weight before spawning.

In contrast to the large (mature) trout, the small (immature) trout increased significantly in condition from early fall to midwinter before falling off to a late winter low.

The immature and mature trout entered April of 1954 in poorer condition than at the onset of April of the previous year. However, during April, 1954, the condition of trout improved considerably and by early May reached a level of condition that exceeded that of May, 1953.

Water Temperatures

The early spring rise in water temperature was coincident with an increase in condition of trout. The monthly mean minimum and maximum water temperatures during this period in 1953 were: April, 42°-46° F.; May, 50°-55° F.; and June, 56°-61° F. (Table 2). For the month of June, daily maximum water temperatures ranged between 58° and 67° F.

Through the months of July and August monthly mean maximum and minimum water temperatures varied only two degrees above that of June, but the condition of trout steadily fell.

Water temperatures began to fall during September, and the trend in condition continued downward. During October, when spawning was most intense, mean water temperatures were: maximum, 50° F.; minimum 47° F. The condition of trout was much lower prior to the spawning period than in June when the 1953 peak in condition was reached (Figure 1).

The rise in condition of the small (immature) trout began in October and extended over a period of approximately three months. The

Table 2. Ten-day and monthly mean maximum and minimum water temperatures of Houghton Creek during the period of April 1, 1953 to May 10, 1954

Period	Water temperature (°F.)			
	Ten-day mean		Monthly mean	
	Maximum	Minimum	Maximum	Minimum
April 1-10, 1953	46	42		
April 11-20	42	39	46	42
April 21-30	48	43		
May 1-10	53	48		
May 11-20	57	51	55	50
May 21-31	56	51		
June 1-10	59	54		
June 11-20	61	55	61	56
June 21-30	64	58		
July 1-10	62	58		
July 11-20	63	58	63	57
July 21-31	63	57		
August 1-10	60	57		
August 11-20	60	55	61	57
August 21-31	62	58		
September 1-10	59	55		
September 11-20	54	51	55	52
September 21-30	52	49		
October 1-10	50	47		
October 11-20	51	47	50	47
October 21-31	48	46		
November 1-10	44	42		
November 11-20	45	43	43	42
November 21-30	41	40		
December 1-10	40	39		
December 11-20	36	35	37	36
December 21-31	36	34		
January 1-10, 1954	35	33		
January 11-20	33	32	34	32
January 21-31	34	32		
February 1-10	37	34		
February 11-20	37	34	37	35
February 21-28	38	36		
March 1-10	38	35		
March 11-20	38	34	38	35
March 21-31	39	35		
April 1-10	41	35		
April 11-20	49	43	47	41
April 21-30	50	45		
May 1-10	50	44		

greatest increment in condition (C) occurred during the month of November when daily maximum water temperatures ranged between 38° and 47° F.

Although water temperatures were similar during April of both years, it was only in 1954 that there was a marked improvement in condition of trout during April.

Other stream studies have also revealed a seasonal trend in the condition of trout. The average condition of brown trout in the River Liffey, Ireland, fell from the bi-monthly period July/August until winter, and then rose rather rapidly and reached a maximum in July/August (Went and Frost, 1942). These authors also observed a comparable seasonal trend in condition of salmon smolts and parr in the River Liffey.

Needham and Slater (1945), in their investigations at Convict Creek, California, determined the coefficient of condition of hatchery rainbow trout and wild brown trout each month for two summer seasons beginning in May and ending by early fall (October and November). During both years the condition of wild brown trout was highest during May and it decreased thereafter until fall. The drop in condition was attributed in part to (1) experimental handling of trout, (2) competition as a result of the planting of hatchery rainbow trout (planted in May), and/or (3) the result of rapid growth in length during the summer months.

Cooper and Benson (1951) demonstrated a seasonal change in the coefficient of condition of brown trout in the Pigeon River, Michigan, similar to the one observed in Houghton Creek. Brook and brown trout in the Pigeon River exhibited a similar trend in condition. The pricipal difference between these species was that brook trout showed

a greater fluctuation in condition during a year. According to Cooper (1953), brook trout in three Michigan streams gained an average of 22 to 35 percent of their March weight by early June, exclusive of weight attributable directly to growth in length. Over a comparable period of time in 1953, Houghton Creek brown trout gained approximately 4 percent of their late-winter weight. In the spring of 1954, Houghton Creek brown trout gained about 10 percent of their late-March weight by early May. Brown trout in Houghton Creek did not reach the extreme winter low in condition as that reached by brook trout in the three streams cited by Cooper. However, the Houghton Creek brown trout attained the same approximate June level of condition as did brook trout in two of these streams.

Certain factors related to condition of trout have been discussed by other fisheries workers. Cooper (op. cit.), in his study of the periodicity of growth of brook trout, observed a correlation between condition and growth. Periods of rapid growth were associated with high condition values, and periods of little or no growth were associated with low condition coefficients. This correlation was also cited in earlier studies on growth of brown trout by Went and Frost (op. cit.) and by Brown (1946a).

Under controlled laboratory conditions, Brown (1946b) observed the effect of temperature on the growth of brown trout. Two-year-old brown trout, living (1) at different constant temperatures and (2) in water of changing temperature, showed two growth-rate maxima. Specific growth rates were high at temperatures between 7° and 9° C. (45° and 48° F.) and between 16° and 19° C. (61° and 66° F.). Above, between and below these temperatures, specific growth rates were low. Maximum activity occurred at temperatures between 10° and 12° C. (50° and 54° F.),

and food consumption was greatest at temperatures between 10° and 19° C. (50° and 66° F.).

These optimal temperature ranges, determined experimentally, are corroborated to a considerable degree by the increase in condition of Houghton Creek brown trout during May and June (daily maximum water temperature range: 44°-67° F.) and the rise in condition of small (immature) trout during the fall, particularly in November when daily maximum water temperatures averaged 43° F.

The drop in condition of trout, especially during July and August, cannot be explained solely on the basis of water temperature. Average minimum and maximum water temperatures were 57°-63° F. and 57°-61° F. for July and August, respectively, while those of June were 56°-61° F.

Benson (1954) considered the relationship between condition and mean volume of stomach contents of angler-caught brook trout, and found that condition and mean volume of stomach contents were highest in May and June and then decreased during the remainder of the angling season.

The decline in condition of trout during the summer months might be attributed in part to a seasonal decrease in volume of bottom fauna following late spring emergence of adult insects.

Acknowledgments

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By Howard Gowing

Report approved by: G. P. Cooper

Report typed by: A. D. Waterbury