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FOOD HABITS OF BROWN TROUT IN THE ANNA RIVER,
ALGER COUNTY, MICHIGAN ¹

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Abstract

Food habits of brown trout were studied in a small Lake Superior tributary during May-October 1968 to determine possible effects on production of juvenile rainbow trout. The rainbow in this stream is migratory, and thus a steelhead. Brown trout 1.3 to 11.8 inches (33-300 mm) long and 0, I, II and III years of age, fed primarily on Trichoptera. Larger brown trout, 11.8-20.6 inches (300-522 mm) long (ages IV and V) ate mostly fish, but very few rainbow trout. Stocked coho salmon were the most frequently ingested fish during May, and slimy sculpins were eaten most frequently during June-October. Brown trout selected salmonids over sculpins to eat, even though sculpins were nine times more abundant than salmonids in the stream.

Introduction

Most Michigan tributaries of Lake Superior support spawning runs of rainbow trout (*Salmo gairdneri*), and produce large juvenile

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populations. Young rainbow trout inhabit these streams for their first 1 to 3 years. Certain of these good spawning streams also support sizable populations of brown trout (Salmo trutta), e. g., the Anna River in Alger County, the Chocolay River in Marquette, and the Ontonagon River in Ontonagon. In such streams brown trout may limit rainbow trout production by extensive predation. Studies by Metzelaar (1929), Reimers, Maciolek and Pister (1955), and Sharpe (1957) suggest that brown trout prey extensively on juvenile salmonids. I conducted a study of brown trout food habits in the Anna River, Alger County, Michigan, during May-October 1968 to determine: (1) the extent of brown trout predation on juvenile rainbow trout, (2) the size and age at which brown trout become piscivorous, and (3) whether brown trout are selective in their predation on the fish species present in the Anna River.

The Anna River is approximately 7 miles (11 km) long and is tributary to Lake Superior. The river has substantial populations of slimy sculpins (Cottus cognatus) and juvenile rainbow trout. Brown trout are common and brook trout (Salvelinus fontinalis) are present in lesser numbers. Cyprinids and mudminnows (Umbra limi) are rare. Coho salmon (Oncorhynchus kisutch) smolts (175,000) averaging 5 1/2 inches (137 mm) long, were stocked in the Anna River on 22-23 April and 3 May 1968. Coho smolts were extremely abundant in the stream during May but most had left the stream by June. Naturally produced young-of-the-year coho were also present in the stream (Peck, 1969).

Methods

Each month, during May-October 1968, brown trout were collected from three 1,000-foot (300-meter) sections approximately 1 1/2 miles (2.5 km) upstream from the mouth. Physical characteristics of the three sections were similar. Average widths were 20-23 feet (6-7 m), average depth 1 1/2 feet (0.5 m), and flows were 30-40 cubic feet per second (0.9-1.2 m³/sec). The principal bottom types were sand (52-77%) and gravel (13-25%). Water temperatures ranged from 42 to 51 F (5.5 to 10.5 C), and conductivities from 175 to 208 μ mhos per cubic centimeter.

Fish were collected on 7-8 May, 12-13 June, 15 August and 17 October in one section, on 15-16 July in a second section, and on 26 September in a third section. It was necessary to use the three sections to obtain adequate samples. Since the areas were similar, there was no reason to believe that food habits or fish populations were different. Because brown trout have nocturnal feeding habits (Brynildson, Hacker, and Klick, 1963), collecting with a d-c shocker began soon after sunrise and continued for 4 to 7 hours. Fish were netted as seen, regardless of species. All fish were anesthetized (M.S. 222) and total length was measured to the nearest millimeter. Fish not stomach sampled were released midway in the section from which they had been captured. Brown trout that were stomach sampled were measured, weighed to the nearest 0.1 g, sexed and scale sampled.

The contents of most stomachs were centrifuged and weighed to the nearest 0.001 g. Stomach contents too bulky to centrifuge were blotted dry and weighed. Fish in the stomachs were identified to family or species as described by Hubbs and Lagler (1947), and invertebrates to order (Pennak, 1953; Ross, 1965). Weights were obtained for each ingested fish, and individuals in each invertebrate group were counted. Total lengths of partially digested prey fish were estimated from measurements of undigested parts.

Scales of stomach-sampled brown trout were aged with a microprojector at a magnification of 107X (Lagler, 1956).

The numbers of salmonids and slimy sculpins present during each of the collecting periods were estimated by the following methods. In September the populations were estimated by the mark-and-recapture method (Shetter, 1957; Bailey, 1951). I assumed that collecting efficiency (percentage of total population caught) was the same during May-August and October as during the marking run of the September population estimate. Using this known collecting efficiency for September, the populations of fish present during the other months were estimated by applying the expansion factor for September. For example, if 20% of the estimated salmonid population was captured during the September marking run, then the expansion factor used for the other months was five.

Results and discussion

Food in brown trout stomachs was mostly fish by weight or volume, although numerically it was mostly invertebrates (Table 1). The 135 brown trout stomachs contained 24 fish which constituted 62.3% of the weight of food ingested. Thirteen salmonids made up 54.8% of the weight, and nine slimy sculpins represented 7.4%. Of the salmonids ingested, six were stocked coho salmon, one was a rainbow trout, and six could not be identified to species. The measurable coho salmon (5) in brown trout stomachs were 3.6-5.7 inches (91-145 mm) long and the measurable slimy sculpins (3) were 1.8-3.3 inches (46-85 mm) long.

Invertebrates made up 37.7% of the weight of food ingested by brown trout; Trichoptera were the most numerous.

In May, stocked coho salmon were the principal fish (5 of 9) eaten by brown trout in the Anna River. Since other investigators (Metzelaar, 1929; Reimers et al., 1955; Sharpe, 1962) have shown that brown trout prey readily on native trout, it seems likely that stocked coho salmon acted as a buffer between brown trout and native salmonids during May. During June-October, one coho salmon and one rainbow trout were identified among the five salmonids ingested by brown trout. Overall, it did not appear that brown trout predation had much effect on production of juvenile rainbow trout.

As brown trout increased in length, the amount of fish in their diet also increased (Table 2). Brown trout 1.3-11.8 inches (33-300 mm) long (age 0, I, II and III) ate few fish, but brown trout 11.8-20.6 inches

(300-522 mm) long (age IV and V) were primarily piscivorous. This agrees with Metzelaar (1929) and Reimers et al. (1955) who found that brown trout become primarily piscivorous at 15 and 14 inches (381 and 350 mm), respectively.

There was some evidence that brown trout were selective in their food habits (Table 3). The principal prey fish available to brown trout (based on length of the largest fish ingested, 5.7 inches or 145 mm) were salmonids under 5.9 inches (150 mm) long and all slimy sculpins. Population estimates revealed that slimy sculpins composed 90% of the available prey during June-October, and salmonids under 5.9 inches long represented the remaining 10%. The May data were excluded because of the unnatural presence of large numbers of recently stocked coho salmon smolts. Brown trout stomachs (109), collected during June-October, contained five salmonids and eight slimy sculpins.

A difference-between-proportions test (Dixon and Massey, 1957) was used to determine if a difference existed between the proportion of slimy sculpins in brown trout stomachs (.6154) and this proportion in the stream (.895). The limits of $-.5440 < \bar{P}_1 - \bar{P}_2 < .0152$ do not overlap zero at the 95% confidence level. The proportion of sculpins in brown trout stomachs was significantly lower than the proportion of sculpins available in the stream indicating that brown trout did feed selectively upon salmonids in the Anna River.

Differences in behavior of salmonids and slimy sculpins probably caused the selective feeding by brown trout. Beyerle and Williams (1968) observed that northern pike, Esox lucius, in aquaria fed selectively on rapidly moving cyprinids that schooled in the center of the aquarium. Centrarchids that hovered motionless in the corners of the aquarium were eaten much less frequently. Beyerle and Williams concluded that the greater accessibility of cyprinids was the reason for their selection by northern pike. The feeding selectivity of Anna River brown trout was also probably due to the greater accessibility of salmonids. Coho salmon smolts, the most frequently eaten salmonid, were stocked about 1 1/2 miles (2.5 km) above the study sections and subsequently migrated downstream in schools to Lake Superior. Vulnerability to brown trout during downstream migration was presumably high. In contrast, slimy sculpins are solitary benthic fish and are usually well hidden; this behavior probably protects them from extensive brown trout predation.

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Table 1. -- Food eaten by 135 brown trout from the Anna River,
Alger County, May-October 1968

Food item	Number eaten		Weight eaten	
	Actual	Percent	Grams	Percent
Fish	24	1.3	118.6	62.3
Salmonidae	13	0.7	104.4	54.8
Cottidae	9	0.5	14.0	7.4
Unidentified fish	2	0.1	0.2	0.1
Invertebrates	1,796	98.7	71.9	37.7
Trichoptera	1,338	73.5	-	-
Diptera	174	9.6	-	-
Ephemeroptera	121	6.6	-	-
Miscellaneous	163	9.0	-	-

Table 2. --Weight of fish and invertebrates ingested by brown trout of different lengths in the Anna River, Alger County, May-October 1968

Brown trout examined				Stomach contents			
Length (mm)		Num-ber	Number with food	Fish		Invertebrates	
Range	Average			Weight (g)	Weight %	Weight (g)	Weight %
33-100	69	30	13	0	0	0.8	100
101-200	149	62	53	0.8	3	25.9	97
201-300	240	28	26	13.3	34	26.6	66
301-400	341	9	8	102.8	87	15.4	13
401-500	417	5	3	1.7	36	3.1	64
501-522	522	1	0	0	0	0	0

Table 3. --Small salmonids (under 5.9 inches or 150 mm) and slimy sculpins in 1,000-foot (300-meter) study sections of the Anna River, and in brown trout stomachs from the same sections, May-October 1968

Month	Number in stream sections				Number in stomachs			
	Salmonids		Sculpins		Salmonids		Sculpins	
	Num- ber	%	Num- ber	%	Num- ber	%	Num- ber	%
May	1,975	32	4,185	68	8	89	1	11
June	605	9	6,475	91	2	100	0	0
July	606	8	7,425	92	0	0	1	100
Aug.	800	12	5,980	88	2	100	0	0
Sept.	1,031 ^a	13	6,662 ^a	87	0	0	5	100
Oct.	817	11	6,811	89	1	33	2	67

^a Based on mark-and-recapture population estimate:
 95% confidence limits on slimy sculpins are 4,221-11,255.
 95% confidence limits on salmonids are 892-1,199.