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SALMON EGGS AS FOOD FOR STREAM SALMONIDS AND SCULPINS [1]

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Introduction

Coho salmon, Oncorhynchus kisutch, were successfully introduced into the Great Lakes in 1966. Since then, annual plants have been increased to an expected 4.5 million yearling coho salmon in 1971. Survival of salmon to maturity has been excellent, and many planted streams have been the scene of extensive spawning by coho salmon. In addition, straying of planted salmon was widespread and spawning occurred in other streams (Peck, 1970). Extensive spawning by adult salmon in many trout streams has caused much concern about the effect of this activity on brown trout (Salmo trutta), brook trout (Salvelinus fontinalis), and rainbow trout (Salmo gairdneri).

Hildebrand (1971) has shown that fall-spawning coho salmon decimate the bottom organisms that serve as food for trout, with little recovery at least until the following May. On the other hand, it has been postulated that salmon are beneficial to stream trout

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because salmon eggs provide a source of food. My objective here is to ascertain the extent that salmon eggs are utilized as food by small salmon, trout, and slimy sculpins (Cottus cognatus).

Methods

Collections of stream salmonids were made in the Platte River, Benzie County, on 3 November 1970; and in the Anna River, Alger County, on 18 November 1970. Both the Platte and Anna rivers had been stocked heavily with yearling coho salmon in 1969. The plants resulted in large concentrations of spawning salmon in the two streams at the time of collection. A few brown trout were also spawning in the two streams. On the Platte River, salmonids were collected at a point some 5 miles downstream from the hatchery. Anna River collections were made some 3 miles upstream from the mouth. Water temperatures were around 40-50 F in both streams.

Stomachs or whole fish were preserved in 10% formalin immediately after capture. Eggs in the stomachs were classified as either "whole" or "shells," and were counted. The large salmon eggs (0.29-inch diameter; Stauffer, 1970) were easily distinguished from the smaller brown trout eggs (0.18-inch diameter; McFadden, Cooper and Anderson, 1965) in Platte River, but I could not distinguish between salmon and trout eggs from the Anna River. Invertebrates in the stomachs were identified and counted.

Lengths of preserved fish were converted to live lengths by applying conversion factors for shrinkage (1.035 for salmonids, and

1.024 for cottids). Ages of the fish examined were approximated from their lengths, using unpublished data on the Platte and Anna rivers and the state average growth rate.

Daily ration was estimated from data provided by Gaylord Alexander, Hunt Creek Fisheries Research Station. He force-fed fresh salmon eggs (3 or 7) to 21 brown trout 4 to 11 inches long. Trout were held in 35 F water and were killed and examined at intervals after feeding. Whole eggs and shells were found in the stomachs up to 4 and 8 days, respectively, after feeding. After adjusting for differences in water temperature, he estimated that it took an average of 3 days for a trout in the Platte and Anna rivers to digest an egg, at the cold water temperatures which occur during the spawning season. Daily ration (number of eggs eaten per day) was estimated by dividing the number of eggs (whole and shells) in the stomachs by three; this is based on the preliminary rough estimate that daily consumption is about ~~three times~~ one-third the volume present in the stomach at any one time.

Results

Age-0 fish, in general, ate few salmon eggs (Tables 1 and 2). Coho salmon ate more eggs than did the smaller rainbow and brown trout. Average daily ration was less than one egg. Age-I trout fed more on eggs; their average daily ration was 2 to 8, and most were feeding on eggs. Stream-resident, age-II or older brook, brown and rainbow trout ate many eggs; their average daily ration was 9 to 31,

Table 1.--Number of salmon eggs in stomachs, percentage occurrence, and salmon eggs eaten per day, by trout and salmon in Platte River, November 1970

Approximate age and species	Number examined	Total length (inches) Mean	Total length (inches) Range	Average number of eggs [1] per fish	Eggs eaten per day	Percentage frequency of occurrence
Age 0						
Brown trout	3	4.1	3.7-4.6	<1	-	33
Rainbow trout	12	3.3	2.5-3.9	<1	-	16
Coho salmon	21	4.1	3.6-5.0	1	0.3	29
Age I						
Brook trout	4	5.6	4.9-6.7	7	2.3	100
Brown trout	22	8.2	6.7-10.1	25	8.3	91
Rainbow trout	13	5.8	4.6-7.0	11	3.7	100
Age II and older						
Brown trout	12	15.4	10.8-20.7	67	22.3	92
Rainbow trout[2]	9	15.8	12.9-20.3	86	28.7	100

[1] Of all eggs observed, 77% were whole, and 23% were shells.

[2] Lake-run fish.

and practically all had eaten eggs. All lake-run rainbow trout (steelheads) fed heavily on eggs; their average daily ration was as high as 71.

Sculpins fed but little on salmon eggs. Age-0 fish ate none, and older sculpins consumed about one egg per day. About half of the older sculpins contained eggs.

A few brown trout eggs were also eaten by fish. Four brown trout from the Platte River contained 110 brown trout eggs, and three rainbow trout had eaten 27 eggs.

Some invertebrates were eaten, but their proportion in the diet was small, as compared to eggs. Only 974 invertebrates were found in salmonid stomachs, as compared to 4, 692 salmon eggs. Invertebrates were practically all aquatic, and may or may not have been dislodged by spawning salmon. Salmonids from the Platte River ate (in order of importance): caddis nymphs, sow bugs, midge larvae, mayfly nymphs, and earthworms. Salmonids and cottids from the Anna River ate (in order of importance): caddis fly nymphs, springtails, mayfly nymphs, midge larvae, and horsefly larvae.

Discussion

I conclude that salmon eggs become available to stream fish during the spawning act or when spawning salmonids dig up previously constructed redds. Several researchers have observed that practically all eggs normally lodge in the redd when shed (Briggs, 1953; Shapovalov

Table 2.--Number of salmon eggs in stomachs, percentage occurrence, and salmon eggs eaten per day, by trout, salmon and sculpins, Anna River, November 1970

Approximate age and species	Number examined	Total length (inches) Mean	Total length (inches) Range	Average number of eggs per fish [1]	Eggs eaten per day	Percentage frequency of occurrence
Age 0						
Rainbow trout	7	2.6	1.9- 3.7	1	0.3	29
Coho salmon	20	3.5	2.7- 4.7	2	0.7	70
Age I						
Brook trout	4	5.0	4.3- 6.2	11	3.7	75
Brown trout	11	5.2	4.3- 6.9	8	2.7	73
Rainbow trout	29	5.2	4.1- 7.0	10	3.3	97
Slimy sculpin	9	2.2	1.7- 2.7	0	-	0
Age II and older						
Brook trout	3	10.1	7.7-13.0	75	25.0	100
Brown trout	9	11.0	9.1-13.3	92	30.7	100
Rainbow trout	23	8.9	7.5-11.4	26	8.7	96
Rainbow trout [2]	1	20.4	-	214	71.3	100
Slimy sculpin	11	3.7	2.9- 4.5	3	1.0	55

[1] Of all eggs observed, 60% were whole, and 40% were shells.

[2] Lake-run fish.

and Taft, 1954; Greeley, 1932). Foerster (1968) noted that late spawners in large runs of sockeye salmon (Oncorhynchus nerka) dig up areas used by earlier spawners and dislodge the eggs already deposited. He further stated: "These eggs become (1) subject to damage by being exposed to the light, particularly sunlight, and (2) readily available for consumption by predator fishes and birds."

During the present study on the Platte and Anna rivers, the salmon spawning areas were heavily used (C. M. Taube, personal communication; and my observations). Therefore, digging up of previously constructed redds probably provided most of the eggs eaten by trout and salmon. Consumption of these eggs presumably did not affect egg survival, since most of these eggs would have died anyway (Foerster, 1968).

Age-I and older trout were eating large numbers of salmon eggs about the time of my collections, in November. No doubt, eggs were readily available as early as mid-October, when spawning salmon were abundant in the Platte and Anna rivers (C. M. Taube, personal communication; and my observations). If stream salmonids fed during much of the period that salmon were spawning, and fed to the extent indicated by the present food study, then salmon eggs provided an appreciable portion of the annual diet. This may compensate, to a substantial degree, for the destruction of bottom fauna by spawning salmon.

Brown trout eggs were eaten by salmonids in the Platte River. Presumably these eggs were dislodged from a redd by spawning brown trout or coho salmon, most likely by salmon which were exceptionally numerous.

The daily consumption of eggs by age-0 sculpins is probably minimal. Reed (1967) reported that prickly sculpins, Cottus asper, smaller than 2.4 inches, had difficulty swallowing whole salmon eggs, but were very successful in breaking the egg membrane and ingesting the yolk. I could not have detected yolks in the stomachs of my sculpins.

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