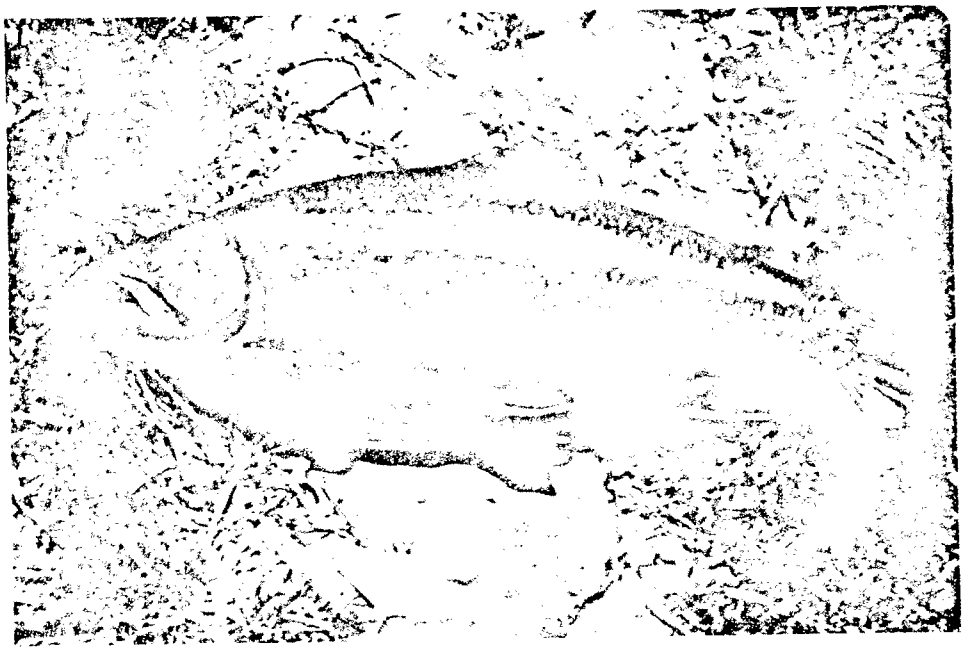

A *Quantitative Analysis of*

Foods Eaten by Eastern Brook Trout

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THE PURPOSE of this paper is to present the quantitative results of an approximate five weeks study of the relation between the foods eaten by the Eastern brook trout (*Salvelinus f. fontinalis* Mitchill) and the available food supply in representative streams of the Snowy Range Area of the Medicine Bow National Forest of Wyoming at elevations ranging from 9,500 feet to 11,000 feet. No detailed observations were made on the lakes within this area, although it should be borne in mind that trout do not confine themselves as strictly stream or lake inhabitants where streams or lakes are connected by accessible waterways. Observations were confined to the Eastern brook trout because it is the prevalent species of trout in the area studied.

Although the results presented in this paper are based on observations covering a relatively short period of time and are confined to a rather limited area, the information gathered may furnish a reasonably good idea of food selection by the Eastern brook trout in this area during a representative summer period. The research incident to this study was conducted in 1946 at the University of Wyoming Summer Science Camp under the direction of Dr. Reed W. Fautin.

Trout and stream samples were collected and observations made during

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AT LEFT: This brook trout photo shows two characteristics of the species by which it can be identified: i. e. the white area on the leading edges of the fins and the wormlike marking on the sides of the fish.

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the period June 29 through August 1, 1946. Areas which were to be studied and which were to serve as collection stations were established at the beginning of this investigation. The stomachs of trout were obtained from various persons and by the writer. Stomachs of these trout, in every case Eastern brook trout and taken at one of the four areas, were removed from the body of the fish and placed in preservative, either 10 per cent formalin or 70 per cent alcohol, until such time as they could be opened and the contents examined in the laboratory.

In collecting representative samples of the stream bottom, a collapsible swift-water net, having a steel frame of 1 square foot, was used. The bottom within this 1 square foot area was agitated to a depth of about 6 inches, using the methods advised by Simon (1938). On some occasions an indestructible-type net was used to collect from the stream bottom, two dips with this net taken as equivalent to one square foot. A plankton net was used to collect samples of material contained in suspension in the stream, a fifty liter sample being taken in each instance.

The available food supply contained in the stream was graded as follows (Simon 1938):

Grade 1—Exceptional richness, volume greater than 2 c.c. (2 grams), more than 50 organisms present.

Grade 2—Average richness, volume 1-2 c.c. (1-2 grams), 50 or more organisms present.

Grade 3—Poor, volume less than 1 c.c. (1 gram), less than 50 organisms present.

Stream bottoms were classified as follows (Simon 1938):

ALTHOUGH Wyoming's Douglas Creek was not included in the author's survey, this section of the stream illustrates a type of environment in which trout food is plentiful.

Photo by Finis N. Mitchell

THIS CATCH of brooks again shows the white fin markings.

Rubble—rocks 2 inches to 1 foot diameter.

Boulder—rocks 1 foot in diameter and larger.

Coarse gravel—rocks 2 inches to ½ inch diameter.

Fine gravel—coarse sand to rocks ½ inch diameter.

Hardpan—shale or hard clay.

Silt—soft flocculent material.

Detritus—principally organic material.

The average width of the stream at areas studied was determined by measuring width at several points within the area and taking the average. The average stream depth was determined by taking the depth of the center and the depth one-half way from the center on either side and dividing by four.

Some difficulty was encountered in making exact counts, as well as exact identifications, of some of the organisms removed from the trout stomachs, due to the degree of maceration of the organisms after their ingestion by the fish.

Area "A" was located approximately 200 feet upstream from the point of entry of the stream into Middle Pond. At this location one edge of the stream is at the border of spruce-fir forest; the other edge, a boggy meadow. The average width of the stream within this area was three feet with an average depth of ten inches. The stream bottom consisted mainly of rubble, but numerous larger rocks were present. These created many small pools at their bases, providing excellent shelter for fish and some other forms of aquatic life, while serving also to keep the water well aerated. The stream drop was marked, rate of flow averaging 2.7 feet per second but varying in direct proportion to the snow melt. Very little silt was noted in the stream bottom except that in small back-water eddies in quiet places near the edge of the stream. Decaying organic material, such as fallen trees, dead aquatic grasses, etc., was noted in small amounts only, and phytoplankton, including filamentous algae, was not observed to occur in any abundance on the bottom rocks. The

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water was sparkling clear with an average temperature of 49 degrees Fahrenheit and an average pH of 7.9 (alkaline). Numerous clumps of willow were scattered throughout the boggy meadow side of the stream. A few amphibians were observed, many Eastern brook trout fry and parr were present, and evidence of the work of beaver in past years was extensive in the meadow adjacent to the area.

Area "B" was located approximately 200 feet downstream from the outlet of the stream from Middle Pond. At this point the edge of the spruce-fir forest was about 35 feet distant from either side of the stream. Here the stream was larger than at area "A", the average width being 4½ feet and the average depth 12 inches. The stream in this area cut a distinct groove through the boggy meadow, its edges cutting under the overhanging bank, which was extensively covered with sedges. Numerous willow clumps followed the course of the stream. The stream bottom was composed mainly of rubble, large rocks being infrequent as compared to area "A". Much more silt and decaying organic material was present although restricted mainly to the areas of dead water in the more extensive eddies. The stream followed a distinct channel, flowing at an average of 2.5 feet per second. The average water temperature at the area was 51 degrees Fahrenheit; average pH 7.6. Here the water has spread over a greater area and stream flow decreased, affording a greater absorption time/area for the sun's rays. At this area there was practically no vegetation of sufficient size to furnish stream shade. Numerous parr of the Eastern brook trout were observed.

Area "C" was located on Nash's Fork Creek at the edge of the spruce-fir forest approximately one-quarter mile downstream from the location of the University of Wyoming Science Camp and approximately 75 feet from the entry of the creek into a boggy marsh which has been built up by years of extensive beaver activity. At this point the average width of the stream was 5½ feet and average depth 18 inches. Stream flow was swift, averaging 2.5 feet per second, and the bottom mostly rubble with abundant quantities of gravel occurring near the edges of the stream and interspersed with some silt. Numerous willow clumps and sedges followed the course of the stream along with an abundance of fallen trees and other vegetation. The average temperature of the water was found to be 53 degrees Fahrenheit and the average pH of the water 7.4. Fry and parr of the Eastern brook trout were observed in abundance, and two parr of the cutthroat trout were taken by the writer.

Area "D" was located on Sally (Blepharacera) Creek approximately one-half mile upstream from its point of entry into Nash's Fork Creek. The stream at this location was narrow, the average width 30 inches, running through a relatively narrow and steep-walled gulch in the midst of the spruce-fir forest. Rate of stream flow was not rapid, amounting to only about 1 foot per second. The average stream depth was seven inches, the stream bottom consisting principally of gravel, and the average pH of the water was 7.9. Varying amounts of grass and sedge were noted occurring to the stream edges, and there was only a moderate amount of dead vegetation in and along the stream. The larvae of net-winged midges (Blepharaceridae) were found in abundance on the upper surfaces of the smoother rocks in the swifter parts of the water. Some willow clumps were present along the stream and, as a whole, this stream was extensively shaded. Sufficient Eastern brook trout were obtained for study purposes from the pools formed at the bases of the larger rocks. These fish were small, averaging but four inches in length. Sally Creek is fed by springs and melting snow, and the volume of water de-

Available Aquatic Food Supply

AREA "A"—Average number of organisms per square foot of bottom sample was 99.75 (Grade 1)

Diptera larvae	43.36% (173)
Ephemeroptera nymphs	35.59% (142)
Other aquatic invertebrates	21.05% (84)

AREA "B"—Average number of organisms per square foot of bottom sample was 157.00 (Grade 1)

Dipetra larvae	56.69% (445)
Ephemeroptera nymphs	27.26% (214)
Other aquatic invertebrates	16.05% (126)

AREA "C"—Average number of organisms per square foot of bottom sample was 96.75 (Grade 1)

Diptera larvae	52.45% (203)
Ephemeroptera nymphs	21.13% (105)
Other aquatic invertebrates	20.41% (79)

AREA "D"—Average number of organisms per square foot of bottom sample was 69.75 (Grade 2)

Diptera larvae	44.80% (125)
Ephemeroptera nymphs	29.75% (83)
Other aquatic invertebrates	25.45% (71)

ALL AREAS: Average number of organisms per square foot of bottom sample was 108.80 (Grade 1)

Diptera larvae	51.13% (946)
Ephemeroptera nymphs	29.41% (544)
Other aquatic invertebrates	19.46% (360)

creases steadily as the summer season approaches its peak.

The available aquatic food supply, determined by stream bottom sampling, was found to be as shown above.

The results of the quantitative food counts of the stomach contents of the trout examined are as shown on Page 17.

Summary and Conclusions

The larvae of Diptera (true flies) were found to constitute 51.13 per cent of the available aquatic food supply as determined by samples of the stream bottoms of all areas. No reliable quantitative count could be made on the numbers of adult Diptera since they are essentially terrestrial in habitat, trout securing them as food when they alight on or fall to the surface of the water and/or during their emergence. Mayfly nymphs (Ephemeroptera) constituted 29.41 per cent of the available aquatic food supply. The remainder, 19.46 per cent, consisted of other aquatic invertebrates, including annelid worms, adult Gyrinidae (whirligig beetles), caddis-worms (Trichoptera), Hydracarina (water-mites), et cetera. It is doubtful if the Eastern brook trout actually feeds on such minute organisms as water-mites, but engulfs them along with other foods.

Examination of the stomach contents of fish from all areas revealed that Diptera larvae made up 39.7 per cent of the foods eaten. Diptera adults constituted 38.45 per cent, Ephemeroptera nymphs and adults 8.20 per cent, and 13.63 per cent being composed of a miscellany of other basically aquatic invertebrates including Trichoptera nymphs and adults, stonefly nymphs and adults (Plecoptera), Coleoptera (beetles) and Crustacea.

This investigation lends credence

Results of Quantitative Food Counts

AREA "A"—(15 fish): Average number of organisms per stomach was 25.20

Diptera larvae	34.66%	(131)
Diptera adults	46.03%	(174)
Ephemeroptera nymphs and adults	11.37%	(43)
Plecoptera nymphs and adults	1.06%	(4)
Other invertebrate organisms	6.88%	(26)

AREA "B" (19 fish): Average number of organisms per stomach was 30.58

Diptera larvae	32.19%	(187)
Diptera adults	43.37%	(252)
Ephemeroptera nymphs and adults	8.78%	(51)
Plecoptera nymphs and adults	2.75%	(16)
Other invertebrate organisms	12.91%	(75)

AREA "C" (17 fish): Average number of organisms per stomach was 29.94

Diptera larvae	54.22%	(276)
Diptera adults	30.84%	(157)
Ephemeroptera nymphs and adults	4.52%	(23)
Plecoptera nymphs and adults	2.55%	(13)
Other invertebrate organisms	7.86%	(40)

AREA "D" (13 fish): Average number of organisms per stomach was 19.31

Diptera larvae	35.46%	(89)
Diptera adults	31.07%	(78)
Ephemeroptera nymphs and adults	9.56%	(24)
Plecoptera nymphs and adults	5.98%	(15)
Other invertebrate organisms	17.93%	(45)

ALL AREAS (64 fish): Average number of organisms per stomach was 26.86

Diptera larvae	39.73%	(683)
Diptera adults	38.45%	(661)
Ephemeroptera nymphs and adults	8.20%	(141)
Plecoptera nymphs and adults	2.80%	(48)
Other invertebrate organisms	10.82%	(186)

to the generally accepted impression that brook trout are "opportunists" (Needham 1938), eating available foods in direct proportion to their availability. This is not, however, to deny that trout show definite selectivity in feeding. Among other factors there is some evidence to indicate that the oil content of organisms, especially those that are terrestial (e.g. adult insects) may exert some influence on food selectivity.

The volume of water in streams of the area studied recede or "drop" progressively as the summer season lengthens, due to the melting of snow banks which feed the streams, to the longer daylight period, and to the increased daily temperature which promotes faster evaporation. Observations were that a considerable proportion of the trout population tend to follow this decrease in stream volume, seeking the deeper and cooler pools where daily temperature fluctuations are not so marked, and where they are assured of a more uniform oxygen supply.

Literature Cited

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