cc: Fish Division
Hunt Creek Experiment Station
Institute for Fisheries Research

REPORT NO. 919

THE FEEDING HABITS OF BROOK TROUT IN HUNT CREEK, MONTMORENCY COUNTY, MICHIGAN, DURING THE 1941 FISHING SEASON

By

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B. S.
Michigan State College
1940

A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Science

At

The University of Connecticut

May 30, 1943

ACKNOWLEDGMENTS

The author wishes to acknowledge the invaluable assistance of Dr. J. W. Leonard who directed him throughout his research program. Through Dr. Leonard's efforts this study was originally instituted and to him the author turned when confronted by the many perplexities which arose. The identification of aquatic organisms was checked by him when the author was in doubt. Grateful acknowledgement is due Dr. A. S. Hazzard for his critical review of the manuscript and his suggestions which were responsible for certain revisions of the tables. Also to the creel census clerks who collected the trout, to the many fishermen who willingly contributed the entrails of their catch and to others, too numerous to mention individually, the author expresses his most sincere gratitude.

To the Michigan Department of Conservation the author is indebted for the supply of material which was necessary for the undertaking of this study. Laboratory equipment, financial assistance and permission to proceed with the particular phase of research conducted were contributions of the Department for which appreciation is extended.

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INTRODUCTION

Effort has been directed toward the continuation of a previous study initiated to discover the feeding habits of legal-sized brook trout (seven inches or over) of Hunt Creek (T.29N., R.2E., Sec. 35), Montmorency County, Michigan. This work is one phase of an extensive long-term program dealing with the biology of brook trout, Salvelinus fontinalis, the ultimate aim being to provide information valuable to fisheries management. Fortunately, the experimental area of Hunt Creek is characterized by having several distinct ecological situations which lend themselves well to the adoption of comparative investigations.

An investigation of the feeding habits of brook trout necessarily involves a multiplicity of chemical, physical and biotic relationships. In order to draw logical conclusions regarding important phases of the problem, extensive data are essential. The attempt has been made in this study to obtain sufficient material from all the principal habitats at all periods of the regular fishing season to contribute to such conclusions. Identification of food organisms has been particularized to the extent that each item was determined to its generic and specific name if possible. Thus a record was made of the food accepted by the trout and it becomes possible to assay thereby the various ecological situations which directly contribute items of dietary importance.

Many problems relating to the actual feeding habits of the brook trout remain unsolved. The amount of food secured which is "drift-borne" as compared with the amount obtained through definite foraging activities is unknown. Information regarding the nutritive value of particular food items is lacking. This is a consideration which demands attention when making practical application of the results of such a study as this. And until more is known of the life histories of aquatic organisms and the bionomics involved, little beyond speculation can be expected in the way of definite statements listing order of dietary importance of certain organisms.

Since the inception of the Hunt Creek Experiment Station in 1939, ecological studies of the area have been conducted. This report presents the data and interpretation of one phase of these studies - the feeding habits of the eastern brook trout caught by fishermen between the dates May 23 and September 1, 1941. These trout were taken from the portion of Hunt Creek which lies near or within the boundaries of the Experiment Station. The stream in this area is slightly under two miles long. It supports a fish fauna, beside the brook trout, of occasional specimens of minnows, chiefly fathead minnows (*Pimephales promelas*), red-bellied dace (*Chrosomus eos*) and black-nosed minnows (*Notropis heterolepis*). Muddlers (*Cottus bairdii*) are quite prevalent and rarely present are mud minnows (*Umbra limi*). These smaller fish, with the exception of the muddlers, exist primarily in the tributaries of the main stream. Seven such tributaries, most of which have beaver dams in them, flow into Hunt Creek within the limits of the experimental area and are responsible for the increase in the size of the stream from a width of 4 or 5 feet at the upper end to over 40 feet at the lower end.

The temperature of the water in the summer seldom rises above 65 degrees Fahrenheit, and during the winter does not, except on rare occasions, dip low enough to freeze the surface of the stream, and Then it is only throughout the lower regions of Section A where the stream is broad and the current is not swift.

No plantings of hatchery stock brook trout have been made in the stream since ~~1939~~ 1940 although a very few have been introduced for special experiments, but these were marked by either the jaw-tag method or were fin-clipped.

Thus, for practical purposes, only native fish are present and an experiment such as this deals with conditions which for the most part are unaffected by man. Investigations conducted by various members of the Institute for Fisheries Research staff on trout populations of Hunt Creek and their movements indicate that brook trout tend to remain more or less in restricted areas during the summer, although spasmodic movements of considerable distance are sometimes made by individual fish. This observation is based upon the experience of the author while assisting in tagging and fin clipping trout and in the subsequent recording of the data on recovery records. Thus the feeding habits of trout taken from a certain section of stream are likely to represent the true food conditions of that particular section.

HISTORICAL CONSIDERATIONS

In the past two decades the field of brook trout autoecology has attracted the attention of numerous individuals, a few of whom have directed their attentions to the study of the feeding habits of this highly-prized game fish. Much written information lies hidden in obscure articles, however. Needham (1940) has compiled a great deal of it into one publication which, among other things, describes many common trout food organisms and discusses their biology. He also considers the prevalence of important forms in both the streams and diet of trout. Muttkowski (1925) found a high percentage of stone-flies, particularly the large salmon-colored stonefly (Pteronarcys californica), in the diet of redthroat trout of streams in Yellowstone National Park. Working in Michigan, Metzelaar (1929) pioneered in trout food studies and revealed the predominance of invertebrate organisms, especially insects, in the diet of trout. Eastern mountain streams of New Hampshire were investigated by Hoover (193), who pointed out that only twelve per cent of the food of brook trout originated in the streams while the remainder was of terrestrial origin.

A previous study of the feeding habits of the brook trout of Hunt Creek, Montmorency County, Michigan, was conducted by Leonard (1941a) who reported on the principal food organisms indigenous to the area, their value as dietary items to the trout and certain facts about the natural history of many of them. The present manuscript constitutes a second progress report of the same project and an effort has been made to duplicate the methods established by Leonard and to correlate the data of each report as much as possible.

There is a notable disparity in regard to the interpretation and meaning of the term "terrestrial organisms" as used by Needham and Morofsky and others including Lord (1933), Hazzard and Madsen (1933) and Leonard (1941b). Terrestrial forms, according to Needham, are those not only indigenous to terrestrial habitats throughout their entire life cycle, but those which exist in aquatic situations during their immature stages and emerge as adults to spend their remaining period of life in non-aquatic habitats. Those who have preferred to accept the other viewpoint regard those organisms which are aquaticthroughout their immature stages and emerge as adults to frequent terrestrial habitats as being fundamentally aquatic.

A study of the bionomics of an ecological situation involves all those factors which have played a part, either beneficial or detrimental, in the habitat, and so those semi-aquatic forms which eventually leave the stream have during the course of their early stages utilized a definite supply of nutrition contributed by the stream. This must be considered when attempting to evaluate the productivity of various aquatic habitats. Many aquatic forms after emergence as adults possess vestigial mouthparts and do not feed. May-flies, a classic example, have degenerate mouthparts and live as adults only long enough to complete mating and breeding activities. Stoneflies, according to Frison (1935), may be separated into two groups, those which feed as adults, or the fall and winter emergence forms, and the non-feeders, recruited from the spring and summer emergence forms. On the basis of a study by Leonard (1941b) there is no evidence of winter forms of adult stoneflies being eaten by Hunt Creek brook trout, although immature stages were readily accepted. Summer forms, those with undeveloped mouthparts (a few exceptions), are often taken by trout, as is shown by this report. There are, however, certain groups of aquatic insects whose adult forms are notorious for their particularly vicious feeding habits. Blackflies, deerflies, mosquitoes and no-see-ums are among this group. Dragonflies also are well-known for their predaceous habits.

The method of tabulating data of food items as proposed by Clemens (1928) and later used by Brown (1938) and Leonard (1941b) whereby enumeration of items is given, as well as frequency of occurrence and percentage of total volume has been adopted in the present investigation. The ultimate aim of this study being to produce information which may increase our ability to control or influence trout populations, constant effort has been directed toward including in the tabulation of data all information that may have a bearing upon the problem. Thus by having at hand all aspects of the situation, evaluations of the importance of certain food items may be made with greater impunity.

Recently several investigators have presented reports of a comprehensive nature concerning production and consumption of natural food organisms in streams. Hess and Rainwater (1939) and Hess and Swartz (1941) have devised a method of providing a numerical measure of the dietary preference of trout on the basis of items consumed in relation to items present in the stream. Thus the utility of a particular food organism, according to these authors, may be determined by a ratio of that item's numerical percentage of the total organisms consumed by the fish to the item's numerical percentage of all organisms in a unit area of stream. It is expressed by the term <u>forage ratio</u>. Furthermore a <u>food grade value</u> may be calculated by multiplying the forage ratio figure by the average number of the particular organisms in the unit area (based on several samples), if the forage ratio value is less than 1 per cent. Otherwise the average number of organisms per square foot is taken as the food grade value.

This system of assigning numerical values to food organisms has been challenged by Leonard (1941b) who suggests that it depends upon the assumption that the availability of an organism is in exact relationship to its numerical presence in the stream. Leonard says "it would seem just as logical to conclude that their proposed method for measuring the food preference of trout is actually, instead, a plausible method for measuring availability." Support for the contention of Leonard is revealed in the tables of Surber (1940), who studied the feeding habits of smallmouth bass in certain eastern streams and used the methods of Hess, et al., in tabulating results. For example, the average number of Baetis sp. and Heptagenia sp. nymphs per square feet (Table 5) was 10.76 and 20.48 respectively. The average percentages of total numbers of organism per square feet of these two items were 7.29 and 13.88, while the percentages found in the stomachs were 67.33 and 6.86. These figures by themselves indicate that because of their greater selection the availability of Baetis sp. nymphs must have been higher in spite of greater numbers and higher percentage of the Heptagenia nymphs present. Furthermore, in accordance with the system as proposed by Hess et al., the two organisms would have forage ration values of 9.24 for the Baetis and 0.49 for the Heptagenia. figures which might well represent a numerical expression of availability factors. However, when the food grade value is determined, it is found to be 10.78 for Baetis and 10.04 for Heptagenia, values which obviously do not agree with utilization differences of the food items. The food grade values were determined in the following manner. The forage ratio value of Baetis being 9.24 or over 1 per cent, the average number of food organisms per square feet was accepted at its face value, whereas the forage ratio value of Heptagenia being 0.49 or less than 1 per cent, the average number of organisms per square feet was multiplied by this figure.

MATERIALS AND METHODS

A total of 313 brook trout stomachs have been examined, 11 of which were empty. They were collected during the 1941 fishing season by creel census clerks stationed at strategic positions along the stream. The clerks were instructed to weigh and measure the trout caught by fishermen and to remove the stomachs. The stomachs were preserved in a 10 per cent solution of formalin with a label indicating date, time of day, lure used, section of stream from which taken and length and weight of the fish. In the laboratory the stomach contents were removed and placed into vials containing 80 per cent alcohol.

The stomach materials were examined under a binocular microscope and determined to genus and species if possible. For a given stomach food items were recorded on a standard stomach analysis card, Form 5473, provided by the Institute for Fisheries Research. Volumes were obtained by liquid displacement, using a graduated centrifuge tube. Volumes less than 0.10 cubic centimeter were estimated to 0.025 cc. although any less than this amount were recorded as a "trace", and all such materials re-measured collectively and recorded as "traces combined" to provide an accurate figure for the total volume of each stomach's contents.

That portion of Hunt Creek which lies within the boundaries of the experimental area has been divided into five main sections, each division being based upon natural characteristics which in effect tend to separate the area into five distinct ecological habitats. The lower-most of these areas has been designated as Section A, and the remaining sections are successively named in alphabetical order up to Section E. Descriptions of the principal biological and physical characteristics of each have been discussed in another part of this paper in relation to the trout feeding habits.

The data gathered concerning the feeding habits of the 301 trout which contained food are appended to this report in tabular form. Food items found in the stomachs have been summarized in two separate ways, their significance thus being made more readily apparent. More than 150 different food items are listed in Table 4. This table lists by stream sections individual organisms eaten by trout and gives the total numbers of each, the frequency of occurrence, greatest number in any one stomach, average number in stomachs containing the item and percentage of total volume less debris. Table 5 presents a summary of Table 4, listing percentages of taxonomic orders. It is possible from these sets of data to find those organisms which provided substantial portions of the brook trout's bill of fare, and in turn evaluate the habitats which proved more productive than others. By correlating the types of aquatic habitats, the surrounding terrestrial features and the life history of the food organisms prevalent in the fishes' diet, general food conditions of each section of the stream are brought to light.

It is regretted that dates of collection could not be included in Table 4, as this would reveal conditions as they change throughout the season. However, due to the length of this table it was impossible to include this information. Also by the method adopted any unnatural peaks which might occur due to sudden emergencies, or unusual events, cannot appear too conspicuous, because they are reduced to a position nearer their proper level when compared to all other items in the "frequency of occurrence" (number of stomachs with organism) column.

Fig. 1.--Eastern brook trout (Salvelinus fontinalis), a male 210 mm. long, caught October 14, 1942. Photograph by L. C. Hulbert. Courtesy of Institute for Fisheries Research, Michigan Department of Conservation.

DISCUSSION OF FEEDING HABITS BY SECTIONS

Below Section A. - That portion of Hunt Creek which lies below Section A has no definite boundary at the lower extremity, although the line of demarkation is definite where it joins Section A. It is difficult therefore to know the exact type of aquatic situation which trout collected from this area had occupied. Most of the trout checked at the creel census station were caught in the upper portions, which are characterized by adjacent, low-lying meadows of sedges and scattered trees and shrubs (Figure 2). The current of the stream is moderate to swift and flows over a bottom of unstable sand, gravel stretches being uncommon. Undercut banks, sunken logs, log-jams and tangles of submerged brush afford diversified habitats which are attractive to trout and aquatic invertebrates.

Ten trout stomachs collected from this area were examined. As is shown by Table 4 Part 1, aquatic organisms constituted a greater portion by volume of the food consumed than terrestrial organisms. Similar results were obtained from this section the previous year by Leonard (1941a). A correlation can be drawn between the amounts of terrestrial food taken by trout and the density of bank cover along the stream. Thus the percentage of 45.4 as compared with the 54.6 percentage of aquatic organisms may be attributed to the scant supply of vegetative cover along the banks. Naturally these statements can be made only with reservations as the number of stomach specimens available do not warrant conclusive results, however, there is certainly a suggestive trend to indicate that the situation proposed is probably so.

That the food situation in a stream must be a dynamic affair is demonstrated by the often sudden and conspicuous fluctuations in the availability of certain organisms. The burrowing mayfly, *Hexagenia occulta*, lies hidden

Fig. 2.—Hunt Creek, below Section A. Note scarcity of trees and shrubs along banks. Taken October 6, 1942, by L. C. Hulbert. Courtesy of Institute for Fisheries Research, Michigan Department of Conservation.

in the soft silt of the bottom during most of the year, its appearance for emergence in the spring being spectacular and fruitful to trout, although brief. Organisms of this type constitute one category of trout foods, while others may be classified according to regular or irregular availability. The dependable items which provide daily quantities of food in the stream below Section A may be seen in Table 4 Part 1. They are represented by nymphs of the mayfly Baetis vagans, the log-cabin caddis larvae, Brachycentrus americanus, the caddis larvae, Hydropsyche sparna, blackfly larvae, Simulium venustum, and snipe-fly larvae, Atherix variegata. Dragon-fly nymphs Cordulegaster maculatus, accounted for nearly a fourth of the total food consumed, but were taken by only two trout. This item represents a third category of food types. In volume it rates high, but its appearance is infrequent, and organisms of this description should not be considered among the dependable portions of the food supply. One trout from the area below Section A consumed 292 adult mayflies (Tricorythodes allectus). This organism falls under the same general classification as the burrowing mayfly already mentioned, that of spectacular periods of abundance.

The species list of mayflies present in this area is high, if bottom samples taken and the results of stomach analysis are criteria. In this respect this region is similar to Section A. There are other similarities between the two sections, both physical and biological, that will become more evident throughout the discourse to follow.

Ecologists have chosen to classify aquatic associations on the basis of micro-habitats. The study of those associations which provide important contributions to the diet of eastern brook trout is one phase under consideration in this investigation. In the zone below Section A there are three distinct aquatic habitats which supply the greater portion of the food for trout. (1) A gravel-rubble covered bottom in a moderate to rapid current, which contains a wide variety of insects, some existing in great numbers. Here live organisms which, as have been already mentioned, supply the items of the "dependable food" class. (2) Clinging to submerged limbs and sunken logs in fairly swift currents are the immature stages of the caddis flies *Hydropsyche* and *Brachycentrus*, both of which are common, available food items. (3) Those individuals which have been regarded as being important for only brief intervals are inhabitants of slow water areas characterized by a substratum of silt or organic detritus. Into this group fall dragonfly nymphs, *Cordulegaster maculatus*, cranefly larvae, *Tipula* sp. and nymphs of the mayfly *Tricorythodes allectus*. The predominant bottom type of the area below Section A is a loose unstable sand. Few aquatic organisms reside in it and consequently the direct biological benefits to the welfare of the trout can only be small.

Section A. - Flowing through a broad treeless marsh, Hunt Creek throughout Section A is similar in this respect to the section adjacent to it at the lower end (Figure 3.). The stream bed is composed almost entirely of sand or silt, gravel bars being practically non-existent. In rapid water the only objects on the bottom which provide areas of a stable nature are submerged logs, tangles of brush, algal mats and growths of higher vegetation. Silt beds are common along the margins of the stream.

Of the 29 collections totalling 57 trout taken during the 1941 fishing season, 25 collections together accounted for a greater volume of aquatic food than terrestrial (Table 2). Once again limited quantities of terrestrial organisms consumed by trout can be directly related to the paucity of overhanging shore vegetation. Aquatic food items of this section that were accepted by trout in such abundance and frequent occurrence that they may be considered as "staples" included the caddis larvae of *Hydropsyche sparna*, *Brachycentrus americanus*, and a limnephilid,; also included were adult forms of the dance-flies (Empididae), which appear during late July and August in prodigious

Fig. 3.—Section A, showing the surrounding marsh. The men in waders are seining for trout, a monthly procedure done to keep a record of trout populations and movements. Photograph taken July 24, 1942 by L. C. Hulbert, Courtesy of Institute for Fisheries Research, Michigan Department of Conservation.

numbers, many of which fall prey to trout. Midges, dragonflies and beetles, were consumed in significant quantities (Table 4 Part 1). Mayflies, which volumetrically were more important than any other major group, were, nevertheless of questionable significance, for the preponderance of this group is due to the large numbers of Tricorythodes allectus, and this item belongs to the food category characterized by periods of abundance but of brief duration. The species list of mayflies inhabiting Section A is high, but, as is brought out in Table 4 Part 1, few of them provide items of real dietary importance. Some investigators have elected to itemize food organisms by large taxonomic groups such as family or order. This method may lead to conclusions which do not actually reveal the true food situation, for as has already been shown, the predominence of mayflies in Section A, through analysis of the species list and applying a knowledge of the biology of the forms present, is reduced to a position closer to its proper relationship.

One of the perplexities involved in an investigation such as this is correctly evaluating the importance of organisms that live in both aquatic and terrestrial habitats. Earthworms constitute one of these items. It is logical to suppose that under natural conditions earthworms, both of the aquatic and terrestrial varieties are to a certain extent available to trout and eaten. Many trout, whose stomachs were subsequently analyzed in the course of this study, were caught by fishermen using angleworms as bait, thus introducing an additional complicating factor. Trout swallow baitworms, even after a fisherman's hook is imbedded in its jaw. Aquatic and terrestrial earthworms cannot be distinguished from each other by gross examination; microscopic sections, which involve laborious laboratory technics, are necessary for the identification of these forms, as the shape and position of the setae are characters used for separating species.

All earthworms encountered in the stomachs of the trout examined in this investigation have been considered aquatic, and calculations have been based on this assumption, with the exception of the designated column of figures in Table 5 Part I and Part II, in which the attempt was made to separate by arbitrary means those worms which likely were bait worms. Lord (1933), who worked on a Vermont stream on the feeding habits of brook trout, found that earthworms increased as an item of dietary importance to 11.4% in the month of May from a position of negligible importance during the proceeding months. This rise coincided with the opening of fishing season, and it was his belief that the bait-worm angler was directly responsible for the rise.

The importance of caddis flies in the diet of trout of Section A is remarkable considering the scarcity of gravel or rubble beds which are generally believed to be the favorite caddis fly habitat. The origin of the caddis fly specimens consumed by trout is open to speculation. It may be that many of the caddis flies which normally inhabit the gravel areas of Section B are swept downstream by the current, thereby becoming available to trout of Section A, although close inspection of submerged tangles of limbs and brush throughout Section A shows a heavy population of Hydropsyche sparna, Brachycentrus americanus and limnephilids attached to their surfaces. Thus the supply of Trichoptera which constituted the most important group, may have originated from either of two habitats.

Among the terrestrial insects eaten by trout, ants were most numerous, having been taken by over 60 per cent of the trout collected. Volumetrically, however, beetles and grasshoppers totalled higher. The cantharids, or soldier-beetles, were common, as might be expected considering the meadow-like surroundings adjacent to the stream. Also important were rosebugs (Macrodactylus subspinosus). Attention is drawn to the occurrence of rosebugs because these insects have been shown to be toxic to poultry and have been under suspicion as being responsible for mortality of brown trout. Leaf-hoppers, and their close relatives the spittle-bugs, occurred quite frequently in the stomachs, although their probable importance is not evident by the slight volume contributed by them.

In conspectus, the food situation of Section A is probably not as favorable as that of some other areas of the stream due to the dearth of terrestrial organisms available and to the character of the bottom which consists mainly of extensive areas of unstable sand. Moreover, a difference can actually be noted between the amounts of food found in the stomachs from this section, and from other sections which seemingly have more suitable food conditions. In order to make valid comparisons between fish of varying sizes from different stream sections, a numerical expression called a food factor has been devised which represents the ratio of the average amount of food in the stomach of the fish of one section divided by the average amount of all sections combined (stomach content factor) to the average length of the fish of one section divided by the average length of all sections combined (length factor). Thus from Table 6 the food factor is seen to be 0.878 for Section A, a figure significantly lower than, for example 1.175 for Section C. The data of Table 6 have been graphically illustrated in Figure 4.

The desire to determine if a correlation exists between the food situation of a stream and the coefficient of condition of the fish inhabitating the stream has long been held by fisheries biologists. Klak (1940) states that "since the condition of the native fish population appears to depend upon the amount of food available, the average values of their coefficients of condition at any particular period of the year may indicate the abundance of food in a stream." Data compiled for Section A of Hunt Creek have a tendency to support this theory since the condition factor of the trout taken, as well as the food factor, is low (see Figure 4). This data cannot be accepted as conclusive evidence, for the number of specimens is not large, and although the trends in this particular instance are suggestive, similar information compiled for other

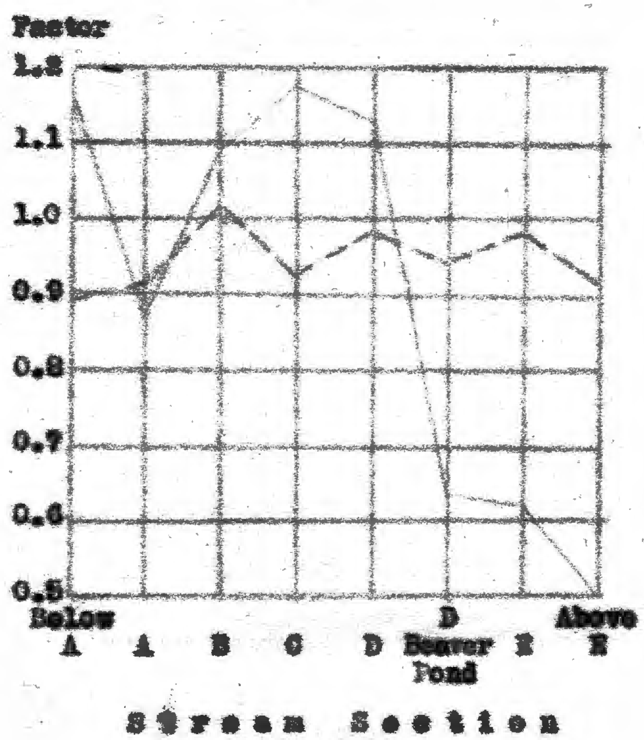

Fig. 4.—Graph of food factors (——), and coefficients of condition (——).

sections does not agree as well.

<u>Section B.</u> - Only 10 trout stomachs were available from Section B. Its unpopularity with fishermen due to lack of good pools and inaccessability, accounts for the small number of specimens collected. This portion of the stream flows through a typical cedar swamp, its borders being lined with overhanging white cedars, tag-alders and tamarack (Figure 5). Unlike many swamp streams, however, the current is rapid and the bottom is composed mostly of gravel. It is possible that the swift current has, during the geological history of the drainage, carried the gravel down from the morainal areas upstream; for in Section B the gravel is rather fine and exists in a thin layer over laying sand and peat depositions many feet in thickness.

The effect of shore vegetation upon the abundance of terrestrial insects available to trout is apparently considerable (Table 5 Part I), for land forms bulked more than those of aquatic origin in this section. Beetles, ants, leaf-hoppers, spittle-bugs, and spiders were taken by trout in about equal amounts. The abundance of these forms can be attributed to the trees and shrubs along the banks in which many insects reside and from which they fall or are blown to the surface of the stream. Also, as suggested by Leonard (1941a) the stream itself creates an opening through the dark, heavy undergrowth of the swamp, and attracts sun-loving insects.

Aquatic habitats through this area vary from gravel beds in swift water to thick beds of silt, and there are consequently a wide assortment of aquatic insects found in this section. Stomach examination revealed that trout were apt to feed on caddisfly larvae, although these organisms were not given exclusive preference, for dragonflies, craneflies and stoneflies provided substantial portions of the diet, Limnephilid larvae were consumed in greater numbers and in greater volume than other forms of caddis flies, however <u>Mystrophora americanana</u>, <u>Hydropsyche sparna</u> and <u>Brachycentrus americanus</u>

Fig. 5.--Section B, looking upstream. Note heavy bank cover and width of stream. Man-made deflectors are also evident. Photograph taken August 14, 1942, by L.C. Hulbert. Courtesy Institute for Fisheries Research, Michigan Department of Conservation.

were taken in appreciable amounts.

Food productivity of Section B seems to be fairly high, for not only are the environs favorable to a wide variety of organisms but there are extensive areas of habitats of the sort which harbor those organisms that due to their abundance and exposure become available to trout. The food factor as well as the coefficient of condition of the trout was high (Figure 4), but little significance can be attached to this fact as the number of specimens examined do not warrant conclusive statements.

<u>Section C.</u> - The portion of Hunt Creek which has been designated as Section C may be divided into two separate units on the basis of physical characteristics. The upper region, which includes about two-thirds of the section, flows through typical morainal material, there being high banks of sand, clay and gravel on either side, while the lower third flows through a cedar swamp much like that of Section B (Figure 6). Tag alder, aspen, birch and many other varieties of trees crowd the banks. The current throughout the entire area is swift (Figure 7), with deep undercut holes beneath banks being quite common. The stream bottom characteristics of the upper zone of the section consist predominantly of gravel-riffle areas, with scattered depositions of silt and organic detritus. The lower portion has a bottom mostly of sand, which in many places is stabilized by luxuriant growths of <u>Vaucheria</u> sp., an alga which grows in conspicuous hummocks over the stream bed, and which, in addition to providing harborage for small food organisms, benefits the productivity of the stream by stabilizing areas of shifting sand.

Examinations were made of 83 trout stomachs from this area. More than half the total volume of food consumed was comprised of terrestrial invertebrates; minnows accounted for slightly more than one-fourth, and aquatic invertebrates for the remainder. Aquatic organisms most frequently consumed were those which inhabit the rapid water associations; baetine mayflies, a

Fig. 6.—Section C, view of lower region showing typical characteristics, Taken March 12, 1940, by J. W. Leonard, Courtesy Institute for Fisheries Research, Michigan Department of Conservation.

Fig. 7.—Section C, typical riffles of upper region. Photograph taken March 12, 1940, by J. W. Leonard, Courtesy of Institute for Fisheries Research, Michigan Department of Conservation.

stonefly of the genus Nemoura, a wide variety of caddisflies including Chimarrha aterrima, Mystrophora americana, Parapsyche sp. and a limnephilid were the common forms. Also occasionally consumed were larvae of the blackfly, Simulium venustum, midge larvae and adult danceflies.

One organism which is well adapted to the gravel bottom (Figure 8) of Section C is the caddisfly Mystrophora americana. This insect occurs in prodigious numbers, often entirely covering the exposed surfaces of rocks. The larva builds a limpet-shaped case of large, sand grains or pebbles which is securely fastened to the stone surface and which serves to protect the larva from predacious enemies. Trout do not find this organism available as a food item in proportion to its occurrence in the stream. This has been demonstrated through data obtained from bottom samples collected in Section C, which have shown a high preponderance of Mystophora larvae in relation to other organisms, and from the data of Table 4 Part I which indicates that this item was not readily accepted by trout. Thus the adequacy of bottom samples as an index to the supply of food organisms in a stream is questionable. A true evaluation of the productivity of trout food items should be made by having not only records of organisms occurring in the stream but of amounts of organisms consumed by trout.

Of the terrestrial organisms consumed by trout in this section grasshoppers and ants comprised the greatest portion. Important also were leafhoppers, spittle-bugs and rose-bugs (Macrodactylus subpinosus). Nearly one-fourth of the stomachs contained minnows, which in the aggregate amounted to a volume greater than all other aquatic items together. The minnows were of the species Pimpephales promelas, the fathead minnow, which thrives ordinarily in impounded waters of the beaver ponds further upstream. Thirty-five collections of trout were taken from Section C during the summer of 1941 and 14 of them contained remains of fish in their stomachs. Leonard (1941a) reports

Fig. 8.--Section C, water drained down, showing bottom features. Photograph taken September 1940, by D. S. Shetter, Courtesy of Institute for Fisheries Research, Michigan Department of Conservation.

that during the summer of 1940 only 2 of 9 fish collections (all fish of one day's catch) had partaken of a fish diet. Obviously a significant difference exists between the amount of fish in the diet of the two years. The sudden change in preference may be directly traced to an event of catostrophic proportions which occurred on May 31, 1941. On that date one of the beaver dams in the upper portion of the stream weakened and broke, releasing the entire contents of the pond and pouring down the stream a huge wall of water which swept along with it, among other things, a large number of fathead minnows.

Food conditions in Section C are probably more than sufficient for the needs of trout. Bottom characteristics are ideal for the production of aquatic organisms and a plentiful supply of terrestrial forms is assured by the profuse growth of trees and shrubs along the banks. Indicative also that food conditions are adequate is the fact that the food factor calculated for this section is the highest of any section in the experimental area. The coefficient of condition of trout from the section was, however, lower than that of other sections having high food factors, as is shown in Figure 4.

Section D. - Section D can be divided into more than one ecological zone on the basis of physical characters; the lower portion has properties similar to Section C, such as a gravel bottom and a moderate to swift current; the central portion consists of deep clay runs and pools overhung by thick growths of tag alders; the upper area is bounded at either end by old, decrepit, nonfunctioning beaver dams which, nevertheless, have resulted in a material change in the stream conditions from their former aspects. The study of the feeding habits of the trout collected from the Section D beaver pond is discussed in another part of this paper.

The results of analysis of the stomach contents of 88 trout taken from Section D have been tabulated (Table 4 Part II). About half of the food consumed by these trout consisted of minnows, indicating that the effect of the destroyed beaver dam upon the food supply was considerable. It is interesting to note that the percentage of minnows included in the amount of food consumed, from Section D downstream through Section A varies inversely with the distance from the location of the erstwhile beaver dam. This information by itself is only suggestive, however in comparison with the data as obtained by Leonard (1941a) for the previous year, in which no such relationship is evident, its trends become more convincing.

Aquatic invertebrates which provided substantial food supplies in Section D included fresh-water scuds (Gammarus sp.), and the large green caddisfly larva, Rhyacophila sp., beside items mentioned as being important in Section C. This includes larvae of the caddisflies Limnephilidae, Hydropsyche sparna, Mystrophora americana, and Chimarrha aterrima. A wide variety of insects representing the dipterous group were also present, important among them being blackflies, danceflies, crane-flies and midges.

Terrestrial species were plentiful and like Sections B and C, probably were supplied, for the most part, by the heavy vegetation along the stream banks (Figure 9). Large numbers of beetles, tent caterpillars, larch sawflies (Lygaeonematus erichsonii), ants, wasps and true flies contributed to the trout's diet. The number of spiders eaten is also impressive, as well as the volume of grasshoppers.

Brook trout inhabiting Section D probably do not suffer from the lack of food, for both the aquatic and terrestrial environs are well adapted to the high productivity of food items, with the possible exception of the portion which flows through the clay soil and has a bottom quite barren of insect life. Until more information is available on this particular zone, nothing definite can be said about the food conditions there. According to the data compiled in Table 6, not only the food factor but the coefficient of condition factor of this section is high, thus supporting the conclusions already drawn concerning the general food conditions of Section D.

Section D Beaver Pond. - Little resemblance remains between the ecological aspects of the Section D beaver pond in its present description and its former condition when the dam functioned with greater efficiency.

Fig. 9.—Section D, a general view. Note meanders and cover type. Taken January 25, 1939, by A. S. Hazzard. Courtesy Institute for Fisheries Research, Michigan Department of Conservation.

It still maintains impounded characteristics, although in area it has been reduced to within the banks of the original channel. Bottom characteristics consist of silt and finely fragmented organic matter. Few trees or shrubs grow along its banks, and the current is sluggish. Analysis of stomach contents of 27 trout collected from this area provides additional evidence that the amount of overhanging vegetation definitely does influence the supply of terrestrial food available.

Most important items of dietary preference were immature limnephilids (caddisfly larvae), which throughout other sections of the stream have been so common. Other forms, characteristic of a silt or muck substratum, such as haliplid beetles, mollusks, scuds and Molanninae caddisfly larvae were present in significant numbers in the stomachs examined. Adult damselflies and immature midges were consumed in considerable numbers, but were not important when considered on a volumetric basis. The only terrestrial insects of any significance were ants.

Data gathered and conclusions reached agree with the findings of Leonard (1941a) regarding the value of this habitat for brook trout. With the partial failure of the beaver dam and the subsequent lowering of the water level, such items as crayfish, burrowing mayflies and aquatic Hemiptera, which are generally plentiful in beaver ponds, have been discouraged and do not exist in any great numbers. Trout have therefore had to rely on such forms as mollusks and aquatic beetles which do not ordinarily enter into the diet. It is not unlikely that a direct correlation may be drawn between the low food factor for this habitat (Figure 4) and deductions based on general habitat characteristics.

Section E. - Characterized by entirely different ecological conditions, Section E represents the cedar-swamp, head-water type of stream that is common throughout much of northern Michigan. Dense cedar foliage makes a perpetual curtain over the stream and excludes most of the sunlight. The stream itself is divided into innumerable anastomosing channels among the peat deposition that composes the swamp floor. Deep holes in the stream are common. The bottom consists of flocculent silt and sand mixed with organic detritus, fallen limbs and tree trunks.

Twenty-four trout stomachs from this area were examined, most of which were collected during the latter part of the summer (Table 3). Trout apparently found limited amounts of terrestrial food forms available, for nearly 80 percent of their diet consisted of aquatic organisms. The paucity of land insects is probably due to the homogenous aspects of the relatively dark cedar swamp which is attractive to only limited species and quantities.

Minnows, ants, angleworms, grasshoppers and limnephilid larvae accounted for most the volume of food consumed, however snails, aquatic beetles, damselflies and midge larvae appeared often enough to fall within the "dependable food" category. Limnephilid larvae were so prevalent that one-third of the items found in the stomachs consisted of this organism.

Food conditions in Section E are probably not as favorable as in other sections of the stream due to the scant supply of terrestrial forms available and the lack of suitable aquatic habitats for high productivity. Data derived in Table 6 agree with this deduction, for the food factor is 0.633, a figure lower than that for any other section previously discussed.

GENERAL CONSIDERATIONS

In an investigation of the food supply of a trout stream, it is necessary to analyze and catalogue not only food organisms, but each of the aquatic ecological situations, which may then be subdivided into smaller categories, or microhabitats. Approximately 150 species of aquatic insects are known to occur in the waters of Hunt Creek. Others are certain to be added to the list. The many ecological manifestations of each species play important roles in the formation of their biological relationships, and a knowledge of them is desirable. Not much information is on hand concerning the biology of most aquatic organisms, which is a distinct handicap in such an investigation as this; furthermore the classification of many forms has not been completed.

It has been shown in the preceding sections of this paper that certain organisms enter into the diet of trout in greater quantities than others. It is this group which is given primary consideration, but others cannot be entirely neglected, for their participation in the general biology of the stream is no less important, however subtle it may be. Thus the myriads of diatoms and entomostraca, not to mention midge larvae, early instars of mayflies, caddisflies, etc., form the foundations upon which the trout food chain depends.

Those organisms which most nearly fill the dietary requirements of brook trout command attention in a program designed to foster and increase the supply of natural food organisms. This has been one objective of the installation of so-called "stream improvement devices". In Hunt Creek Section B is utilized to test the efficiency of these devices. After three years of normal conditions during which time records were kept on the fish productivity and also on bottom fauna productivity, a number of improvement devices were constructed, and it is the aim of the investigation to continue to keep records and ultimately to decide the actual effects of the improvement program in terms of fish productivity. Bottom samples taken after the installation of devices should indicate if a change in the food situation has taken place.

During the fishing season of 1941 caddisflies were among the most important of food items occurring in Hunt Creek. Of them, limnephilid larvae occupied a position of prominent importance. In the lower sections of the stream Hydropsyche sparna and Brachycentrus americanus were important items, while throughout the upper areas these two species were replaced in the diet by Chimarrha aterrima and Rhyacophila sp. Several species occurred in the diet of brook trout in great enough abundance and with sufficient frequency to be considered dependable sources of food. Midges, blackflies and dance-flies were consumed more often than other Diptera, although on a volumetrical basis others were as significant, such as craneflies and snipeflies.

Mayflies were consumed in less volume than dragonflies. Nevertheless their importance is considerably more due to the greater numbers that were eaten and their higher frequency of occurrence. Mayfly species that live in rapid-water habitats were more consistently accepted than others and are more important than the quiet-water forms. The upper sections of Hunt Creek did not produce mayflies in abundance equal to the lower sections, although the baetine group was common throughout the entire stream and served as a dependable food item.

On the basis of the figures derived in Table I, trout of Hunt Creek consumed an equal amount of aquatic and terrestrial invertebrates. Fish contributed almost as much volume to the supply as each of the invertebrate groups, but in numbers and frequency of occurrence were much less. On a numerical basis aquatic invertebrates were more than twice as prevalent as terrestrial invertebrates. Although grasshoppers and crickets were consumed in greater volumes, ants and wasps accounted for many more items of food and were eaten by two-thirds of all the trout.

Little change can be noted between the difference in amounts of aquatic and terrestrial organisms taken by trout as the season progressed from late spring to late summer. Table 2 indicates that differences in volumes of these two food categories are more related to stream section, ie. habitats, and that fluctuations throughout the seasons varied in a sporadic manner, due probably to weather conditions and sudden emergences of certain insects such as the March fly (Bibionidae) or the larch sawfly

(*Lygaeonematus erichsonii*).

This report on the feeding habits of brook trout constitutes the second in a series of investigations instituted to learn more of the intimate details concerning what trout eat, why they eat it and what can be done to improve natural conditions for their benefit. Certain facts are evident from the data gathered during the course of this investigation, but their interpretation is subject to the fallacy resulting from human prejudice. The need for sufficient data of statistical validity has been demonstrated repeatedly in this investigation. Attempts to assay the importance of certain food items on the basis of amount consumed depends upon information regarding not only the prevalence of that particular item in the stream, but its availability to trout and any tendency toward selection. Also the depredations that the food item itself, as a predacious animal, may inflict upon potential trout food supplies may counterbalance the benefits it affords as a dietary item. These and many more problems remain unsolved. It is hoped that this investigation has augmented to some extent knowledge of the biology of brook trout feeding habits, and at the same time has emphasized the need for more research.

SUMMARY

Aquatic habitats may be divided into various categories based upon the production of available food items, thus silt beds produce significant quantities during limited periods, while riffles produce a continual supply. The value of indirect contributions not immediately obvious from certain aquatic "microhabitats" cannot be estimated from the data at hand. Bottom types of the shifting sand variety, for example, do not contain many organisms, but the possible food producing value is nevertheless problematical.

Food organisms may be classified according to their availability. Three types evident in Hunt Creek are: organisms of dependable supply; organisms which bulk large, but are infrequently available, and those which periodically appear and offer abundant supplies, but are of short duration.

A <u>food factor</u> may be calculated on the basis of a ratio between the amount of food in the stomach of the fish to the length of the fish; this factor is useful in comparing food availability of one ecological situation with another and the factor may vary directly with the coefficient of condition of the fish.

The density and composition of bank vegetative cover directly influences the supply of terrestrial organisms available to trout for consumption

Bottom samples do not indicate true availability of food items. For example <u>Mystrophora americana</u> (caddisfly) larvae were not found in trout stomachs in proportion equal to their abundance in the stream.

Events of catastrophic proportions, which may strike quickly and disappear soon, sometimes leave no conspicuous effects on the physical environment, yet are apt to have very significant effects upon the biological conditions of the stream. Thus a beaver dam which suddenly released its contents into the stream provided a supply of minnows that influenced the diet of trout for most of the summer.

The effect of extraneous factors introduced artificially, such as the addition of bait worms to the food supply, may be of considerable significance when calculating the value of dietary items.

A total of 313 brook trout caught by fishermen from the five main experimental sections of Hunt Creek were examined to find out what organisms and the amounts of each that had been selected by trout as food items. A special effort was made to identify food items to genus and species, in order to clarify the necessity of such detailed determinations. In some cases specific identification revealed that large taxonomic groups assumed positions of undue importance because of certain items, which had swelled the volumetrical and numerical quantities, but definitely could not be included in the dependable food classification.

TABLE 1

FEEDING HABITS OF 301 LEGAL-LENGTH EASTERN BROOK TROUT TAKEN DURING THE 1941SEASON FROM HUNT CREEK, ALL SECTIONS COMBINED. ARRANGED BY MAJOR TAXONOMIC GROUPS IN ORDER OF VOLUMETRIC IMPORTANCE.

Organism	No. of Stomachs Containing Organism	Total No. of Organisms	% of Total Volume	% of Total Volume Less Bait-worms
(Aquatic Invertebrates)				
Trichoptera (Caddisflies)	258	2,285	11.4	(12.3)
Diptera (Midges, blackflies,etc)	199	2,407	3.9	(4.2)
Odonata (Dragonflies)	29	31	3.3	(3.6)
Ephemeroptera (Mayflies)	127	1,863	3.3	(3.5)
Coleoptera (Beetles)	69	106	2.6	(2.8)
Annelida (Worms)	12	16	8.5	(1.5)
Malacostraca (Scuds)	43	67	1.3	(1.4)
Mollusca (Snails and clams)	25	36	0.8	(0.8)
Plecoptera (Stoneflies)	48	86	0.4	(0.4)
Hemiptera (Water bugs)	26	35	0.3	(0.4)
Neuroptera (Alderflies, etc.)	3	3	0.1	(0.1)
Hydracarina (Watermites)	12	26	...	...
Entomostraca (Water fleas)	3	4	...	...
TOTAL, AQUATIC INVERTEBRATES		6,965	35.9	(31.0)
(Terrestrial Invertebrates)				
Orthoptera (Grasshoppers, etc.)	86	100	11.1	(12.0)
Hymenoptera (Ants,bees, wasps)	202	1,476	9.2	(9.9)
Coleoptera (Beetles)	126	286	5.6	(6.1)
Lepidoptera (Moths)	35	54	2.2	(2.3)
Homoptera (Leafhoppers)	118	543	1.8	(1.9)
Diptera (True flies)	65	266	1.7	(1.8)
Araneae (Spiders)	46	60	1.0	(1.1)
Diplopoda (Millipeds)	18	18	0.7	(0.8)
Hemiptera (True bugs)	37	50	0.4	(0.4)
Gordiacea (Hair worms)	6	6	0.3	(0.3)
Isopoda (Sow bugs)	3	3	0.1	(0.1)
Mecoptera (Scorpion flies)	2	2	...	...
Psocoptera (Psocods)	4	8	...	...
Neuroptera (Trash-carriers)	6	6	...	...
Pseudoscorpioneae	1	1	...	...
TOTAL, TERRESTRIAL INVERTEBRATES		2,879	34.1	(36.7)
(Vertebrates)				
Pisces (Fish)	52	63	28.3	(30.5)
Amphibia (Frogs)	4	4	1.7	(1.8)
TOTAL FOOD CONSUMED		9,911	100.0	(100.0)

TABLE 2

FEEDING HABITS OF 313 LEGAL BROOK TROUT FROM HUNT CREEK, 1941 FISHING SEASON, ACCORDING TO DATE AND SECTION OF COLLECTION; ORGANISMS GROUPED AS TO VERTEBRATE OR INVERTEBRATE, TERRESTRIAL OR AQUATIC ORIGIN

Date of collection	No. of fish	Per cent diet of aquatic invertebrates	Per cent diet of terrestrial invertebrates	Per cent diet of fish
		BELOW SECTION A		
June 22	1	57.1	42.9	0.0
June 28	1	59.5	40.5	0.0
June 29	2	55.9	44.1	0.0
July 1	1	75.0	25.0	0.0
Aug. 18	1	31.0	69.0	0.0
Aug. 21	3	75.0	25.0	0.0
Aug. 27	1	100.0	———	0.0
		SECTION A		
May 28	2	84.6	15.4	0.0
May 30	2	97.1	2.9	0.0
May 31	2	80.0	20.0	0.0
June 1	1	4.5	1.5	94.0
June 5	4	34.0	27.0	24.0
June 8	2	57.4	42.6	0.0
June 19	4	49.3	21.3	29.4
June 20	1	———	100.0	0.0
June 22	4	62.5	37.5	0.0
June 25	1	100.0	———	0.0
June 27	4	54.3	45.7	0.0
June 29	2	100.0	———	0.0
July 4	2	70.0	30.0	0.0
July 8	2	70.6	29.4	0.0
July 24	1	71.4	28.6	0.0
July 28	1	56.3	43.7	0.0
July 30	1	100.0	———	0.0
Aug. 3	2	25.0	75.0	0.0
Aug. 5	2	4.8	95.2	0.0
Aug. 7	1	54.5	45.5	0.0
Aug. 10	2	69.0	31.0	0.0
Aug. 11	2	75.0	25.0	0.0
Aug. 13	2	45.5	54.5	0.0
Aug. 14	1	100.0	———	0.0
Aug. 17	1	100.0	———	0.0
Aug. 20	1	100.0	———	0.0
Aug. 25	1	100.0	———	0.0
Aug. 30	5	71.9	28.1	0.0
Aug. 31	1	78.9	21.1	0.0
		SECTION B		
June 5	1	21.1	15.8	63.1
June 22	1	33.3	66.7	0.0
June 27	2	28.6	71.4	0.0
July 27	1	64.5	35.5	0.0
Aug. 10	2	26.3	10.5	63.2
Aug. 11	3	45.7	54.3	0.0

TABLE 2 - <u>continued</u>

Date of collection	No. of fish	Per cent diet of aquatic invertebrates	Per cent diet of terrestrial invertebrates	Per cent diet of fish
		SECTION C		
May 27	1	20.9	41.8	37.3
May 29	3	54.5	45.5	0.0
May 30	1	100.0	0.0	0.0
May 31	1	100.0	0.0	0.0
June 2	1	18.4	29.0	52.6
June 10	1	31.6	68.4	0.0
June 11	3	17.0	2.0	81.0
June 16	3	39.5	60.5	0.0
July 4	2	6.7	93.3	0.0
July 5	6	26.5	71.7	1.8
July 6	10	12.1	69.9	2.9
July 9	1	100.0	0.0	0.0
July 11	1	100.0	0.0	0.0
July 12	1	0.0	2.5	97.5
July 16	1	100.0	0.0	0.0
July 23	4	9.5	90.5	0.0
July 26	1	0.0	100.0	0.0
July 29	2	25.0	75.0	0.0
July 31	3	3.0	97.0	0.0
Aug. 1	2	3.1	9.4	87.5
Aug. 2	6	6.7	31.9	61.4
Aug. 6	2	0.0	100.0	0.0
Aug. 10	2	17.2	41.4	41.4
Aug. 11	2	25.0	18.8	56.2
Aug. 12	1	0.0	0.0	0.0
Aug. 13	1	25.0	75.0	0.0
Aug. 14	2	50.0	50.0	0.0
Aug. 15	2	0.0	100.0	0.0
Aug. 23	2	4.9	65.9	29.2
Aug. 24	1	0.0	0.0	100.0
Aug. 25	2	50.0	50.0	0.0
Aug. 29	1	50.0	50.0	0.0
Aug. 30	2	0.0	100.0	0.0
Aug. 31	3	12.0	52.0	36.0
Sept. 1	3	12.0	54.1	33.7
		SECTION D		
May 29	3	85.7	14.3	0.0
June 1	2	12.8	7.6	79.6
June 6	1	———	11.1	88.9
June 7	3	3.5	12.8	83.7
June 9	2	2.0	10.0	88.0
June 10	3	6.6	21.1	72.2
June 11	3	5.1	19.2	75.7
June 13	1	0.0	0.0	100.0
June 22	2	40.6	21.66	37.8
June 29	1	13.3	86.7	0.0
July 2	4	13.0	87.0	0.0

TABLE 2 - continued

Date of collection	No. of fish	Per cent diet of aquatic invertebrates	Per cent diet of terrestrial invertebrates	Per cent diet of fish
		SECTION D (CONT'D)		
July 3	3	56.0	40.0	4.0
July 4	2	20.0	80.0	0.0
July 5	2	84.6	15.4	0.0
July 6	8	38.3	50.6	11.1
July 11	1	100.0	0.0	0.0
July 12	1	12.5	87.5	0.0
July 16	1	100.0	0.0	0.0
July 22	1	100.0	0.0	0.0
July 23	2	100.0	0.0	0.0
July 25	5	29.6	70.4	0.0
July 26	1	66.7	33.3	0.0
July 31	3	14.0	38.0	48.0
Aug. 1	2	18.8	81.2	0.0
Aug. 2	2	24.6	0.0	75.4
Aug. 3	1	100.0	0.0	0.0
Aug. 6	2	75.0	25.0	0.0
Aug. 8	1	100.0	0.0	0.0
Aug. 9	3	6.8	58.1	35.1
Aug. 10	1	100.0	0.0	0.0
Aug. 11	2	77.8	22.2	0.0
Aug. 12	1	55.6	44.4	0.0
Aug. 13	1	0.0	0.0	100.0
Aug. 14	2	57.1	42.9	0.0
Aug. 17	2	100.0	0.0	0.0
Aug. 21	2	80.0	20.0	0.0
Aug. 23	2	3.1	84.8	12.1
Aug. 24	1	100.0	0.0	0.0
Aug. 25	1	50.0	50.0	0.0
Aug. 26	2	13.0	87.0	0.0
Aug. 27	2	37.5	12.5	50.0
Aug. 31	9	70.1	4.6	25.0
Sept. 1	1	61.5	38.5	0.0
		SECTION D - BEAVER POND		
June 22	4	23.7	20.0	0.0
June 26	7	69.4	30.6	0.0
June 27	7	70.0	30.0	0.0
July 4	1	84.2	15.8	0.0
July 13	1	44.4	55.6	0.0
Aug. 10	3	50.0	50.0	0.0
Aug. 24	1	0.0	13.3	86.7
Aug. 26	1	0.0	66.7	33.3
Aug. 27	1	100.0	0.0	0.0
Sept. 1	1	20.0	80.0	0.0

TABLE E - <u>continued</u>

Date of collection	No. of fish	Per cent diet of aquatic invertebrates	Per cent diet of terrestrial invertebrates	Per cent diet of fish
		SECTION E		
July 4	1	100.0	0.0	0.0
July 22	1	100.0	0.0	0.0
Aug. 1	1	100.0	0.0	0.0
Aug. 2	2	100.0	0.0	0.0
Aug. 3	1	16.7	83.3	0.0
Aug. 5	1	100.0	0.0	0.0
Aug. 8	1	100.0	0.0	0.0
Aug. 10	1	100.0	0.0	0.0
Aug. 11	2	100.0	0.0	0.0
Aug. 12	1	12.5	0.0	87.5
Aug. 13	1	50.0	50.0	0.0
Aug. 15	1	15.4	84.6	0.0
Aug. 16	1	100.0	0.0	0.0
Aug. 19	4	47.8	34.8	17.4
Aug. 23	1	100.0	0.0	0.0
Aug. 25	1	0.0	100.0	0.0
Aug. 26	1	0.0	100.0	0.0
Aug. 31	1	100.0	0.0	0.0
Sept. 1	1	100.0	0.0	0.0
		ABOVE SECTION E		
June 30	3	82.6	17.4	0.0
Aug. 29	2	20.0	0.0	80.0

TABLE 3

NUMBER OF TROUT STOMACHS COLLECTED FROM HUNT CREEK DURING THE 1941 FISHING SEASON, ARRANGED ACCORDING TO SECTIONS AND WEEKLY INTERVALS

Date 1941	Below Sec. A	Sec. A	Sec. B	Sec. C	Sec. D	Sec. D Beaver Pond	Sec. E	Above Sec. E
May 23–May 29		2		4	3			
May 30–June 5		9	1	3	2			
June 6–June 12		2		4	12			
June 13–June 19		4		3	1			
June 20–June 26	1	6	1		2	11		3
June 27–July 3	4	6	2		8	7		
July 4–July 10		4		19	12	1	1	
July 11–July 17				3	3	1		
July 18–July 24		1		4	3		1	
July 25–July 31		2	1	6	7			
Aug. 1–Aug. 7		5		10	7		5	
Aug. 8–Aug. 14		7	5	8	11	3	6	
Aug. 15–Aug. 21	4	2		2	4		6	
Aug. 22–Aug. 28	1	1		5	8	3	3	
Aug. 29–Sept. 1		6		9	5	1	2	2
TOTALS	10	57	10	80	88	27	24	5

TABLE 4 PART I

SUMMARY OF FEEDING HABITS OF 301 LEGAL-LENGTH EASTERN BROOK TROUT COLLECTED DURING THE 1941 SEASON FROM HUNT CREEK, ARRANGED BY STREAM SECTIONS AND PRESENTING OCCURRENCE OF FOOD ITEMS ON A FREQUENCY, NUMERICAL AND VOLUMETRICAL BASIS
(PART I, INCLUDING FROM BELOW SECTION A TO SECTION C)

Organism	Below Section A 10 Stomachs					Section A 57 Stomachs					Section B 10 Stomachs					Section C 80 Stomachs				
	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume
(AQUATIC ORIGIN)																				
Annelida (Worms and leeches)																				
Oligochaeta	1	1	1	1	1.12	5	5	1	1	9.34	1	1	1	1	0.66	5	6	2	1.2	7.25
Hirudinea						1	1	1	1	0.12										
Mollusca (Snails and clams)																				
Gastropoda	1	2	2	2	tr.[2]	1	1	1	1	0.12						5	6	2	1.2	0.44
Pisidium sp.						1	1	1	1	tr.						1	1	1	1	tr.
Malacostraca (Crayfish and scuds)																				
Gammarus sp.						4	4	1	1	0.46	1	1	1	1	1.32	6	9	2	1.5	0.31
Hyalella sp.	1	1	1	1	tr.	1	1	1	1	tr.	1	1	1	1	tr.	1	1	1	1	tr.
Cambarus sp.						1	1	1	1	2.46						1	1	1	1	0.5[illegible]
Ephemeroptera (Mayflies)																				
Hexagenia occulta - A						1	1	1	1	0.12						2	7	5	3.5	1.0[illegible]
Hexagenia occulta - N	1	1	1	1	0.56	2	2	1	1	0.62						3	3	1	1	0.12
Stenonema sp. - A																1	1	1	1	tr.
Stenonema sp. - N						1	1	1	1	tr.										
Paraleptophlebia sp. - A											1	3	3	3	tr.					

1 A - Adult; P - Pupa; L - Larva; N - Nymph
2 tr. - trace

TABLE 4 PART I - Continued

Organism	Below Section A 10 Stomachs: No. of stomachs with organism	Below Section A: Total no. of organisms	Below Section A: Greatest no. in any stomach	Below Section A: Ave. no. in stom. containing them	Below Section A: % of total volume	Section A [illegible] Stomachs: No. of stomachs with organism	Section A: Total no. of organisms	Section A: Greatest no. in any stomach	Section A: Ave. no. in stom. containing them	Section A: % of total volume	Section B 10 Stomachs: No. of stomachs with organism	Section B: Total no. of organisms	Section B: Greatest no. in any stomach	Section B: Ave. no. in stom. containing them	Section B: % of total volume	Section C 50 Stomachs: No. of stomachs with organism	Section C: Total no. of organisms	Section C: Greatest no. in any stomach	Section C: Ave. no. in stom. containing them	Section C: % of total volume
Ephemerella invaria - A						1	7	7	7	0.49						1	12	12	12	0.75
Ephemerella invaria - N	2	4	2	2	1.12	1	2	2	2	0.12										
Ephemerella lata - N	1	4	4	4	0.56	1	1	1	1	tr.										
Ephemerella bicolor - A	1	1	1	1	tr.	1	9	9	9	0.85										
Ephemerella bicolor - N	3	6	3	2	0.56	2	5	3	2.5	0.85										
Ephemerella sp. - A						3	16	9	5.3	0.37										
Ephemerella sp. - N	3	3	1	1	tr.	1	8	8	8	0.12										
Tricorythodes allectus - A	1	292	292	292	4.49	8	1,121	565	140	8.85										
Tricorythodes allectus - N	3	5	2	1.7	0.56	2	7	6	3.5	tr.										
Baetis vagans - A	4	22	12	5.5	0.56															
Baetis vagans - N	5	17	6	3.4	1.12	3	5	3	1.6	tr.						5	8	3	1.6	tr.
Baetis pygmaeus - A																1	1	1	1	tr.
Baetis sp. - A						5	27	23	5.4	0.62						1	2	2	2	tr.
Baetis sp. - N						8	15	6	1.8	0.12						5	9	4	1.8	0.06
Baetidae - A						1	1	1	1	tr.						2	4	2	2	tr.
Baetidae - N											1	1	1	1	tr.	4	4	1	1	tr.
Family (?) - A	2	42	21	21	1.12	9	31	10	3.4	0.74	2	21	13	10.5	1.97	6	6	1	1	tr.
Family (?) - N						1	1	1	1	tr.	1	1	1	1	tr.					

TABLE 4 PART I - Continued

Organism	Below Section A 10 Stomachs					Section A 57 Stomachs					Section B 10 Stomachs					Section C 80 Stomachs				
	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume
Odonata (Dragonflies)																				
Ophiogomphus rupinsulensis - A											1	2	2	2	11.55					
Boyeria vinosa - A						3	3	1	1	0.12						1	1	1	1	tr.
Cordulegaster maculatus - A						2	2	1	1	4.66										
Cordulegaster maculatus - N	2	2	1	1	22.45						1	1	1	1	0.66					
Tetragoneuria sp. - A						1	1	1	1	0.40	1	1	1	1	1.32					
Tetragoneuria sp. - N																1	1	1	1	tr.
Plathemis lydia - A						2	2	1	1	3.20										
Plathemis lydia - N						1	1	1	1	0.12										
Sympetrum sp. - A																1	1	1	1	0.06
Libellulidae - N						1	1	1	1	tr.										
Anisoptera - A						1	1	1	1	0.12										
Family (?) - A						1	1	1	1	0.46						1	1	1	1	tr.
Plecoptera (Stoneflies)																				
Nemoura sp. - A											1	3	3	3	tr.	3	6	4	2	0.12
Nemoura sp. - N	1	1	1	1	tr.	2	3	2	1.5	tr.	1	2	2	2	tr.	11	24	10	2.2	0.[illegible]
Leuctra sp. - A						1	1	1	1	tr.						1	1	1	1	tr.
Allocapnia sp. - N																1	1	1	1	tr.
Acroneuria sp. - A																3	4	2	1.3	0.[illegible]
Isogenus frontalis - A						1	1	1	1	0.12										
Isogenus frontalis - N											3	3	1	1	0.66	1	3	3	3	0.06
Isoperla sp. - N																2	2	1	1	tr.
Family (?)						2	2	1	1	tr.	1	1	1	1	tr.	3	4	2	1.3	tr.
Neuroptera (Fish flies, etc.)																				
Sialis sp. - L																1	1	1	1	0.06
Chauliodes sp. - A											1	1	1	1	1.97					
Hemiptera (Water bugs)																				
Corixidae						6	6	1	1	0.12						3	3	1	1	0.19
Gerridae	2	2	1	1	1.12	1	1	1	1	tr.										
Coleoptera (Beetles)																				
Haliplidae - A						1	1	1	1	tr.										
Dytiscidae - A	1	1	1	1	tr.	5	7	2	1.4	1.48	1	1	1	1	tr.	5	6	3	1.2	0.87
Dytiscidae - L																1	1	1	1	0.06
Gyrinidae - A						5	5	1	1	0.88						3	5	3	1.7	0.19
Hydrophilidae - A						1	1	1	1	tr.						2	2	1	1	0.06

TABLE 4 PART I - Continued

Organism	Below Section A 10 Stomachs					Section A 57 Stomachs					Section B 10 Stomachs					Section D 80 Stomachs				
	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume
Elmidae	2	2	1	1	0.56	1	1	1	1	tr.										
Donacia sp. - A						4	9	5	2.25	0.74	2	2	1	1	1.32					
Family - A						1	1	1	1	0.12										
Trichoptera (Caddisflies)																				
Rhyacophila sp. - P											1	1	1	1	1.32	2	2	1	1	0.05
Rhyacophila sp. - L						1	1	1	1	tr.						8	12	5	1.5	0.23
Mystrophora americana - A	2	6	5	3	1.12	1	1	1	1	tr.	2	3	2	1.5	tr.	1	1	1	1	tr.
Mystrophora americana - P	1	1	1	1	tr.											1	1	1	1	tr.
Mystrophora americana - L	2	2	1	1	tr.						1	4	4	4	0.65	7	7	1	1	tr.
Hydroptilidae - A	1	3	3	3	tr.	2	4	3	2	tr.										
Hydroptilidae - L	1	4	4	4	tr.	9	18	3	2	tr.	1	1	1	1	tr.	6	18	10	3	0.06
Philopotamus sp. - P						1	1	1	1	tr.						2	2	1	1	0.06
Chimarrha aterrima - P																2	2	1	1	tr.
Chimarrha aterrima - L						1	1	1	1	tr.	1	1	1	1	tr.	19	67	37	3.5	0.37
Philopotamidae - A	1	1	1	1	tr.	4	11	8	2.7	0.86						1	1	1	1	tr.
Philopotamidae - P	1	2	2	2	0.56											3	3	1	1	0.12
Philopotamidae - L																1	1	1	1	tr.
Parapsyche sp. - A																1	1	1	1	tr.
Parapsyche sp. - L																15	28	7	1.9	0.62
Hydropsyche sparna - A						8	14	5	1.8	0.62	1	6	6	6	1.97	4	4	1	1	0.19
Hydropsyche sparna - P						1	1	1	1	tr.						1	1	1	1	0.05
Hydropsyche sparna - L	4	11	4	2.8	0.56	16	34	4	2.1	1.36	1	1	1	1	tr.	6	11	3	1.9	0.12
Molannidae - P																1	1	1	1	0.28
Leptoceridae - L						2	2	1	1	0.12										
Stenophylax sp. - A						1	1	1	1	tr.										
Limnephilidae - A	2	3	2	1.5	tr.	2	2	1	1	0.42						1	1	1	1	tr.
Limnephilidae - P						3	6	4	2	0.12						1	1	1	1	tr.
Limnephilidae - L						26	141	44	5.2	6.26	6	12	4	2	6.56	35	151	13	4.3	2.76

TABLE 4 PART I - Continued

Organism	Below Section A, 10 Stomachs: No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	Percentage of total volume	Section A, 57 Stomachs: No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	Percentage of total volume	Section B, 10 Stomachs: No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	Percentage of total volume	Section C, 80 Stomachs: No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	Percentage of total volume
Brachycentrus americanus - A											2	2	1	1	0.66					
Brachycentrus americanus - P	1	1	1	1	0.56															
Brachycentrus americanus - L	6	12	4	2	0.56	15	36	8	2.4	0.99	2	3	2	1.5	0.66	3	3	1	1	tr.
Micrasema sp. - A																1	1	1	1	tr.
Sericostomatidae - A						2	2	1	1	tr.										
Sericostomatidae - P						1	1	1	1	tr.						1	1	1	1	0.06
Goera sp. - A																1	1	1	1	0.06
Goera sp. - P																1	3	3	3	0.12
Olemira costalis - A	1	1	1	1	tr.	2	2	1	1	tr.										
Olemira costalis - L						1	1	1	1	0.12										
Mormomyia (?) sp. - A																1	1	1	1	tr.
Lepidostomatinae - L																1	1	1	1	tr.
Family (?) - A						4	4	1	1	tr.	4	5	2	1.[illegible]	0.66	12	18	3	1.5	0.31
Family (?) - P						8	19	6	2.4	0.37	2	10	9	5	1.3[illegible]	12	18	5	1.5	0.44
Family (?) - L											1	1	1	1	tr.	3	3	1	1	tr.
Diptera (Midges, blackflies, etc.)																				
Ptychoptera sp. - A																1	1	1	1	tr.
Antocha sp. - L																1	1	1	1	tr.
Dicranomyia sp. - L																1	1	1	1	tr.
Limnophora aprilina - A																1	1	1	1	tr.
Eriocera sp. - L																1	1	1	1	tr.
Pedicia sp. - L						1	2	2	2	0.2[illegible]						1	1	1	1	tr.
Rhaphidolabis sp. - L						1	1	1	1	tr.						1	1	1	1	tr.

TABLE 4 PART I - Continued

Organism	Below Section A 10 Stomachs: No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	Section A 57 Stomachs: No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	Section B 10 Stomachs: No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	Section C 80 Stomachs: No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume
Tanyptera frontalis - A						1	1	1	1	0.49	1	1	1	1	1.32					
Tipula ignobilis - L											1	1	1	1	0.66					
Tipula abdominalis - L																				
Tipula sp. - A	1	2	2	2	3.74	2	2	1	1	0.62						1	1	1	1	0.81
Tipula sp. - L	3	3	1	1	0.56	2	2	1	1	1.35						2	2	1	1	tr.
Tipulidae - A						2	2	1	1	0.37						1	1	1	1	tr.
Tipulidae - L						2	2	1	1	0.25										
Dixinae - L	1	1	1	1	tr.											3	4	2	1.3	tr.
Simulium venustum - A	5	109	56	[illegible]	2.25	2	2	1	1	tr.						2	2	1	1	tr.
Simulium venustum - P	1	1	1	1	tr.															
Simulium venustum - L	4	10	3	3.3	tr.	8	12	2	1.5	1.12						8	10	2	1.3	tr.
Stratiomyiidae - L						5	6	2	1.2	1.25	1	1	1	1	1.32	2	2	1	1	tr.
Atherix variegata - A						1	1	1	1	tr.						1	1	1	1	0.06
Atherix variegata - L	5	10	3	2	2.81															
Chrysops sp. - L						4	5	2	1.2	0.12										
Empididae - A	4	34	19	8.5	1.69	32	789	131	24.5	7.64	3	10	5	2	0.66	7	45	19	6.4	0.37
Empididae - P						1	5	5	5	tr.										
Limnophora sp. - L						1	1	1	1	tr.										
Anthomyiidae - A						1	2	2	2	tr.						5	6	2	1.2	0.25
Brachycera - L	1	1	1	1	1.12	1	1	1	1	0.12						1	1	1	1	0.06
Chironomidae - A						2	2	1	1	tr.	1	1	1	1	tr.	3	4	2	1.3	tr.
Chironomidae - P	4	15	10	35	tr.	16	73	42	4.6	0.12	2	3	4	3.5	tr.	3	5	2	1.7	tr.
Chironomidae - L	2	2	1	1	tr.	19	67	9	2.5	0.25	2	2	1	1	tr.	18	59	14	3.2	0.12
Ceratopogonidae - P	1	1	1	1	tr.	3	4	2	1.5	tr.						1	1	1	1	tr.
Ceratopogonidae - L						4	5	2	1.2	tr.						5	6	2	1.2	tr.
Hydracarina (Water mites)						1	2	2	2	tr.						1	1	1	1	tr.
(TERRESTRIAL ORIGIN)																				
Orthoptera (Grasshoppers etc.)																				
Ceuthophilus sp.						1	1	1	1	0.12						2	2	1	1	1.99
Gryllidae	4	5	2	1.5	3.43	3	3	1	1	0.86	1	1	1	1	3.56	2	2	1	1	0.37

TABLE 4 PART I - Continued

Organism	Below Section A 10 Stomachs					Section A 57 Stomachs					Section B 10 Stomachs					Section C 80 Stomachs				
	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume
Locustidae						8	8	1	1	2.9[illegible]	4	4	1	1	4.61	34	38	6	1.3	[illegible]
Blattidae						1	1	1	1	0.74						2	2	1	1	tr.
Family (?)						1	1	1	1	0.90										
Neuroptera (Trash carriers)																				
Hemerobiidae	1	1	1	1	tr.	2	2	1	1	tr.	1	1	1	1	tr.					
Psocoptera (Psocids)																1	1	1	1	tr.
Hemiptera (True bugs)																				
Miridae						2	3	2	1.5	tr.	1	1	1	1	tr.					
Nabidae						1	1	1	1	tr.										
Reduviidae						1	1	1	1	tr.	1	1	1	1	0.66					
Tingidae						2	3	2	1.5	tr.	1	1	1	1	tr.	1	2	2	2	tr.
Lygaeidae																1	1	1	1	tr.
Neididae																1	1	1	1	tr.
Pentatomidae						5	5	1	1	0.49						4	7	3	1.8	0.58
Family (?)						3	3	1	1	tr.						3	3	1	1	tr.
Homoptera (Plant lice, leaf hoppers, etc.)																				
Cercopidae						8	17	4	2.1	0.3[illegible]	4	5	2	1.3	1.97	11	35	10	3.4	0.56
Membracidae																2	2	1	1	0.19
Cicadellidae	6	62	[illegible]	8.4	4.4[illegible]	13	34	12	2.6	0.6[illegible]	5	5	1	1	tr.	22	107	35	4.9	[illegible]
Scolops sp.																1	1	1	1	tr.
Aphidoidea	[illegible]	13	9	6.5	tr.	11	46	18	4.2	0.37						4	5	2	1	tr.
Family (?)																2	2	1	1	tr.
Coleoptera (Beetles)																				
Cicindellidae - L																1	1	1	1	0.2[illegible]
Hydrophilinae	[illegible]					14	1[illegible]	[illegible]	1	0.73	1	1	1	1	5.2[illegible]	2	2	1	1	1.46
Carabidae	[illegible]	1	1	1	0.52	2	2	1	1	0.12	1	1	1	1	tr.	7	7	1	1	0.75
Staphylinidae						2	3	1	1	tr.						1	5	5	5	0.06
Lampyridae	1	1	1	1	tr.															

TABLE 4 PART I - Continued

Organism	Below Section A 10 Stomachs					Section A [illegible] Stomachs					Section B 10 Stomachs					Section C [illegible] Stomachs				
	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stom. containing them	% of total volume
Calopteron reticulatum						1	1	1	1	tr.										
Cantharidae						8	22	10	2.8	1.3[illegible]	2	4	2	2	2.63	7	16	5	2.3	0.62
Elateridae						5	5	1	1	0.25	1	1	1	1	3.9[illegible]	4	5	2	1.3	0.40
Agrilus sp.																1	1	1	1	tr.
[illegible] sp.																1	1	1	1	tr.
Coccinellidae						4	6	2	1.5	tr.	1	1	1	1	tr.	3	3	1	1	0.37
Aphodius sp.						1	1	1	1	0.37										
Phyllophaga sp.						1	1	1	1	1.97						1	1	1	1	0.12
Macrodactylus subspinosus	1	4	4	4	2.25	2	7	6	3.5	1.3[illegible]	1	1	1	1	0.63	11	27	7	2.5	2.95
Scarabaeidae																2	2	2	1	0.12
Cerambycidae						1	1	1	1	0.49						2	2	1	1	0.75
Chrysomelidae	2	2	1	1	0.55	5	7	3	1.4	0.12	2	3	2	1.5	0.63	4	4	2	2	0.06
Curculionidae						2	3	2	1.5	tr.						2	2	1	1	0.06
Rhynchophora						1	1	1	1	tr.						2	2	1	1	tr.
Family (?)						10	12	2	1.2	0.12						8	10	3	1.2	0.06
Mecoptera (Scorpion flies)						2	2	1	1	0.12										
Lepidoptera (Moths)																				
Family (?) - A	[illegible]	4	[illegible]	1.5	[illegible]	2	2	1	1	0.0[illegible]	1	1	1	1	1.32	3	3	1	1	0.12
Family (?) - P																2	2	1	1	0.37
Family (?) - L						1	1	1	1	0.12						13	20	6	1.7	2.31
Diptera (True flies)																				
Cecidomyiidae						1	1	1	1	tr.										
Bibionidae						2	34	30	17	0.42						7	84	36	12	0.75
Tabanidae						1	1	1	1	tr.										
Stratiomyiidae						1	1	1	1	tr.						1	2	2	2	tr.
Asilidae	2	4	3	2	5.06	5	5	1	1	1.3[illegible]						3	3	1	1	0.81
Dolichopodidae	3	3	1	1	tr.	8	10	3	1.3	tr.						5	6	2	1	0.06
Phoridae																1	1	1	1	tr.
Syrphidae	1	1	1	1	tr.											1	1	1	1	0.06
Sciomyzidae						1	1	1	1	tr.										
Ottidae	1	1	1	1	tr.															

TABLE 4 PART I - Continued

Organism	Below Section A 10 Stomachs					Section A 57 Stomachs					Section B [illegible]0 Stomachs					Section C [illegible]0 Stomachs				
	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stms containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stms containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stms containing them	% of total volume	No. of stomachs with organism	Total no. of organisms	Greatest no. in any stomach	Ave. no. in stms containing them	% of total volume
Muscidae	2	2	1	1	tr.															
Family (?)	3	3	1	1	tr.	3	4	2	1.3	tr.	1	1	1	1	tr.	7	9	2	1.3	0.56
Hymenoptera (Ants, bees and wasps)																				
Cimicidae						1	1	1	1	tr.						1	1	1	1	0.02
Lygaeonematus erichsonii						4	4	1	1	0.12	2	3	2	1.5	tr.	8	11	2	1.4	0.37
Tenthridinidae																2	2	1	1	tr.
Ichneumonoidea						5	11	7	2.2	0.12						1	1	1	1	tr.
Cynipoidea						1	1	1	1	tr.						1	1	1	1	0.06
Calcidoidea	2	6	4	3	0.36															
Formicidae	6	49	16	8	3.32	35	222	55	6.3	4.43	7	44	14	6.3	6.58	44	476	67	10.8	8.29
Vespa maculata	1	2	2	2	2.25	4	4	1	1	0.74	1	1	1	1	tr.	11	13	3	1.2	2.49
Vespidae	3	5	3	1.7	0.56	4	4	1	1	0.49	1	1	1	1	1.97	11	26	11	2.4	0.19
Sphecidae											3	4	2	1	tr.	2	2	1	1	0.12
Family (?)						6	6	1	1	0.37	2	2	1	1	tr.	7	7	1	1	tr.
Isopoda (Sow bugs)																2	2	1	1	0.12
Diplopoda (Millipeds)	1	1	1	1	1.12	1	1	1	1	tr.	2	2	1	1	1.32	8	8	1	1	1.43
Araneae (Spiders)	2	3	2	1.5	0.56	12	15	2	1.3	1.11	3	3	1	1	5.92	6	10	4	1.7	1.68
Pseudoscorpiones						1	1	1	1	tr.										
Gordiacea (Hair worms)	2	2	1	1	5.06	1	1	1	1	0.12						2	2	1	1	0.12
Pisces (Fish)						4	5	2	1.2	11.88	2	2	1	1	15.79	17	19	3	1.1	21.76
Amphibia (Frogs)	1	1	1	1	tr.											1	1	1	1	2.24

Table 4, Part II and Table 5, Part II not included in this copy.

TABLE 5 PART I

SUMMARY OF FEEDING HABITS OF 201 LEGAL-SIZED EASTERN BROOK TROUT COLLECTED DURING THE 1941 SEASON, ORGANISMS LISTED BY MAJOR GROUPS IN PHYLOGENETIC ORDER
(PART I, INCLUDING FROM BELOW SECTION A TO SECTION C)

Organism	Below Section A 10 Stomachs				Section A 57 Stomachs				Section B 10 Stomachs				Section C 80 Stomachs			
	No. of stomachs with organism	Total no. of organisms	% of tot. vol. less bait worms	% of total volume	No. of stomachs with organism	Total no. of organisms	% of tot. vol. less bait worms	% of total volume	No. of stomachs with organism	Total no. of organisms	% of tot. vol. less bait worms	% of total volume	No. of stomachs with organism	Total no. of organisms	% of tot. vol. less bait worms	% of total volume
(AQUATIC ORIGIN)																
Annelida (Worms and leeches)	1	1	1.1	1.1	2	2	0.4	9.4	1	1	0.7	0.7	3	4	0.7	7.8
Mollusca (Snails and clams)	1	2	...	...	2	2	0.1	0.1					6	7	0.4	0.4
Malacostraca (Crayfish and scuds)	1	1	...	...	6	6	3.2	3.0	2	2	1.3	1.3	8	11	0.4	0.4
Ephemeroptera (Mayflies)	10	397	10.7	10.7	34	1220	14.8	13.4	4	26	2.0	2.0	28	58	2.1	1.9
Odonata (Dragonflies)	2	2	22.5	22.5	11	12	10.2	9.2	3	4	12.5	12.5	4	4	0.1	0.1
Plecoptera (Stoneflies)	1	1	...	...	6	7	0.1	0.1	5	9	0.7	0.7	21	42	1.0	0.9
Neuroptera (Fishflies, alderflies, etc.)									1	1	2.0	2.0	1	1	0.1	0.1
Hemiptera (Water bugs)	2	2	1.1	1.1	7	7	0.1	0.1					3	3	0.2	0.2
Coleoptera (Beetles)	2	3	0.6	0.6	13	25	3.2	3.0	3	3	2.0	2.0	11	14	1.2	1.2
Trichoptera (Caddisflies)	10	47	3.4	3.4	49	302	12.6	11.5	10	50	13.8	13.8	63	366	7.2	6.7
Diptera (True flies)	10	189	15.2	15.2	47	967	13.7	12.4	5	21	3.9	3.9	36	157	1.8	1.7
Hydracarina (Water mites)	1	1	...	...	1	2	...	...					1	1	...	...
Total, aquatic invertebrates		644	54.6	54.6		2615	58.4	62.0		117	36.9	36.9		671	15.2	21.8
(TERRESTRIAL ORIGIN)																
Orthoptera (Grasshoppers, etc.)	4	5	8.4	8.4	14	14	7.3	6.7	5	5	11.2	11.2	29	33	20.6	19.2

TABLE 5 PART I - Continued

Organism	Below Section A 10 Stomachs				Section A 57 Stomachs				Section B 10 Stomachs				Section C 80 Stomachs			
	No. of stomachs with organism	Total no. of organisms	% of wt. vol. less bait worms	% of total volume	No. of stomachs with organism	Total no. of organisms	% of wt. vol. less bait worms	% of total volume	No. of stomachs with organism	Total no. of organisms	% of wt. vol. less bait worms	% of total volume	No. of stomachs with organism	Total no. of organisms	% of wt. vol. less bait worms	% of total volume
Neuroptera (Trash carriers)	1	1	...	...	2	2	...	...	1	1	...	...				
Psocoptera (Psocids)													1	1	...	...
Hemiptera (True bugs)					12	16	0.5	0.5	3	3	0.7	0.7	10	14	0.5	0.5
Homoptera (Plant lice, leaf hoppers)	5	55	4.5	4.5	22	97	1.5	1.4	7	10	2.0	2.0	31	152	1.9	1.8
Coleoptera (Beetles)	4	8	3.4	3.4	25	72	7.6	6.9	6	12	13.1	13.1	35	91	8.7	8.1
Mecoptera (Scorpion flies)					2	2	0.1	0.1								
Lepidoptera (Moths)	3	4	10.7	10.7	3	3	1.2	1.1	1	1	1.3	1.3	14	25	3.0	2.8
Diptera (True flies)	6	14	5.0	5.0	17	37	2.2	2.0	1	1	...	...	17	106	2.4	2.3
Hymenoptera (Bees and wasps)	5	62	6.7	6.7	41	253	6.9	6.3	9	55	9.8	9.8	56	540	13.0	12.2
Isopoda (Sow bugs)													2	2	0.1	0.1
Diplopoda (Millepeds)	1	1	1.1	1.1	1	1	...	...	2	2	1.3	1.3	8	8	1.5	1.4
Araneae (Spiders)	2	3	0.6	0.6	12	15	1.2	1.1	3	5	5.9	5.9	6	10	1.8	1.7
Pseudoscorpioneae					1	1	...	...								
Gordiacea (Hair worms)	2	2	5.0	5.0	1	1	0.1	0.1					2	2	0.2	0.1
Total, terrestrial invertebrates		155	45.4	45.5		534	28.6	26.2		93	45.3	46.3		909	55.7	50.3
Pisces (Fish)					4	6	13.0	11.6	2	2	15.8	15.8	17	19	28.7	26.8
Amphibia (Frogs)	1	1	...	...									1	1	2.4	2.2
Total food consumed		800	100.0	100.0		3152	100.0	100.0		212	100.0	100.0		1680	100.0	100.0

TABLE 6

GENERAL DATA ON SIZE, WEIGHT AND FOOD FACTORS OF 313 BROOK TROUT EXAMINED. MATERIAL GROUPED ACCORDING TO STREAM SECTIONS

Section of stream	No. of trout	Range total length mm.	Ave. length mm.	Length factor[1]	Average volume stomach content cc.	Stomach content factor[2]	Ave. wt. trout gm.	Coef. of cond.[3]	Food factor[4]
Below A	11	174-220	184.65	0.934	0.405	1.086	56.7	0.896	1.163
A	59	175-232	189.00	0.956	0.313	0.840	61.6	0.912	0.878
B	10	171-200	183.30	0.928	0.380	1.019	62.4	1.018	1.098
C	83	167-304	203.77	1.030	0.451	1.209	78.7	0.927	1.175
D	93	177-282	199.62	1.010	0.427	1.145	76.5	0.981	1.134
D-Beav. Pond	27	177-236	192.00	0.972	0.226	0.602	66.7	0.943	0.638
E	25	177-232	192.92	0.976	0.231	0.620	70.7	0.984	0.635
Above E	5	171-217	196.80	1.004	0.190	0.509	72.5	0.920	0.506
	313		197.70		0.375				

1- Length factor = $\frac{\text{ave. length of fish of one section}}{\text{average length of all fish}}$

2- Stomach content factor = $\frac{\text{ave. vol. of stom. contents of one sect.}}{\text{ave. vol. of stom. contents of all fish}}$

3 - Coefficient of condition = $\frac{\text{weight} \times 100{,}000}{\text{length}^3}$

4 - Food factor = $\frac{\text{stomach content factor}}{\text{length factor}}$

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