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Production, food consumption and food habits by groups of small, mixed and large sizes of cutthroat trout were studied in enriched and unenriched sections of the Berry Creek Experimental Stream, Oregon State University. Continuous introduction of sucrose and urea to portions of the stream resulted in heavy growth of Sphaerotilus natans which supported large biomasses of benthic insects.

Production was estimated from monthly changes of biomass. Measurements of growth rates of experimental fish and the relationship between rates of growth and rates of food consumption of fish held in aquaria made estimates of food consumption by the stream fish possible.

Analyses were made of the stomach contents of trout removed monthly from the experimental sections. The seasonal contribution to trout food consumption by the important food groups was estimated.

Measurements of benthic biomass showed that insects, especially midge larvae, benefited greatly from the Sphaerotilus in the enriched sections, but organic drift did not increase markedly as a result of enrichment.

In both enriched and unenriched sections trout production and food consumption values were highest for small trout, intermediate for mixed sizes and lowest for large trout. Production and food consumption by all size groups of trout increased greatly as a result of enrichment.

FOOD RELATIONS AND PRODUCTION OF CUTTHROAT TROUT, *SALMO CLARKI CLARKI* RICHARDSON, IN AN EXPERIMENTAL STREAM

by

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FOOD RELATIONS AND PRODUCTION OF CUTTHROAT TROUT, *SALMO CLARKI CLARKI* RICHARDSON, IN AN EXPERIMENTAL STREAM

INTRODUCTION

Studies have been in progress at the Berry Creek Experimental Stream, Oregon State University, since 1960 to determine the pathways by which energy from light, organic debris and dissolved organic matter leads to the production of trout tissue. Enrichment by introduction of sucrose and urea to portions of the experimental stream has resulted in the growth of the bacterium *Sphaerotilus natans*. Warren *et al*. (1964) studied the effects of enrichment on experimental trout populations from 1960 to 1963 and reported great increases in production and food consumption by yearling coastal cutthroat trout, *Salmo clarki clarki* Richardson, in the enriched sections of Berry Creek. They also found greater quantities of trout food organisms in the enriched than in the unenriched portions of Berry Creek.

Studies of the trout growth, production, food consumption and food habits have been continued in the original four experimental sections of Berry Creek since 1963 using experimental populations composed of various sizes of trout. During experiments performed from September 1963 to August 1964 and from September 1964 to August 1965 groups of trout of mixed sizes were used in order to determine whether more complete utilization of the food source by the experimental trout populations would occur than when the populations were of more uniform age and size. In addition to the four original sections, four new sections of the controlled stream were utilized during the summer of 1965 and from September 1965 through May of 1966. This permitted study of the effects of enrichment on additional size-groups. From September 1965 through May 1966 three size-groups of cutthroat trout were studied; (1) a group composed of underyearling trout; (2) a group of mixed sizes to provide a replication of experiments performed from 1963 to 1965; and (3) a group composed of large trout greater than two years old.

It is well known that the large numbers and high growth rates of underyearling trout present in stream trout populations provide the largest portion of the annual production of these populations (Allen, 1951; Horton, 1961; Hunt, 1966). The experiments during 1965-66 were performed to examine some of the factors leading to differences in production, including any differences in food habits, between size-groups in enriched and unenriched sections.

Several sources of trout food appeared to be available to the trout in each section: (1) riffle bottom fauna; (2) drifting terrestrial organisms and adult aquatic insects which had fallen onto the riffle; (3) pool bottom fauna; and (4) terrestrial organisms and adults of aquatic insects which had fallen onto the pool surface. A short term experiment that limited the trout to feeding on various combinations of these food sources was performed during July and August 1965 using groups of mixed sizes of trout.

Analyses of riffle bottom samples and preliminary analyses of drift and pool bottom samples were examined in relation to the kinds and quantities of food consumed by the experimental trout populations.

METHODS AND MATERIALS

Berry Creek and the associated facilities have been described in detail by Warren et al. (1964) and they will be considered only briefly in this thesis. Berry Creek is a small woodland stream located approximately thirteen miles north of the Oregon State University campus. A 1500 foot section of the stream has been brought under complete flow control by means of a diversion dam and a by-pass channel. A 12-inch regulating valve is used to maintain a discharge of 0.5 cubic feet per second through the controlled section of the stream. The lower portion of the controlled part of the stream has been divided into experimental sections, each consisting of a riffle and a pool. Wooden screen boxes at the upstream end of each section have been fitted with Saran screens (32 meshes per inch) designed to prevent the passage of fish, insects and other organisms from one section to another. Four new upstream sections were added during the spring of 1965 bringing the total to eight sections. The sections are designated A, B, C, D, I, II, III, IV proceeding downstream. Although the total section areas differ somewhat between sections, the proportion of riffle and of pool in each section is not greatly different (Table 1).

Nitrogen gas from cylinders fitted with two-stage reduction valves was used to maintain, by displacement, controlled flows of solutions of sucrose and of urea into the stream. Concentrations of these stock solutions were adjusted to maintain stream concentrations of sucrose and urea at approximately 4.0 and 0.5 milligrams per liter, respectively; these levels being adequate for maintaining good growths of *Sphaerotilus*. The solutions were introduced at the upstream end of section III until March 1965 when the point of introduction was moved to the upstream end of section II.

Table 1. Riffle, pool and total section areas, in square meters for each experimental section, at a stream flow of 0.5 cubic feet per second.

Section	Riffle	Pool	Total
A	16.0	15.8	31.8
B	18.4	25.1	43.5
C	16.2	17.9	34.1
D	16.1	20.0	36.1
I	20.1	25.0	45.1
II	19.6	12.4	32.0
III	37.1	23.1	60.2
IV	39.0	9.3	48.3

A V-notch weir at either end of the controlled section of the stream permitted continuous recording of the stream flow. Recordings obtained during 1965-66 are representative of the annual stream flow in Berry Creek (Figure 1). During the summer months, the entire stream flow was passed through the controlled section, but because of low stream flow, maintenance of 0.5 c.f.s. was impossible. A thermograph recorded stream water temperature (Figure 2) throughout each year.

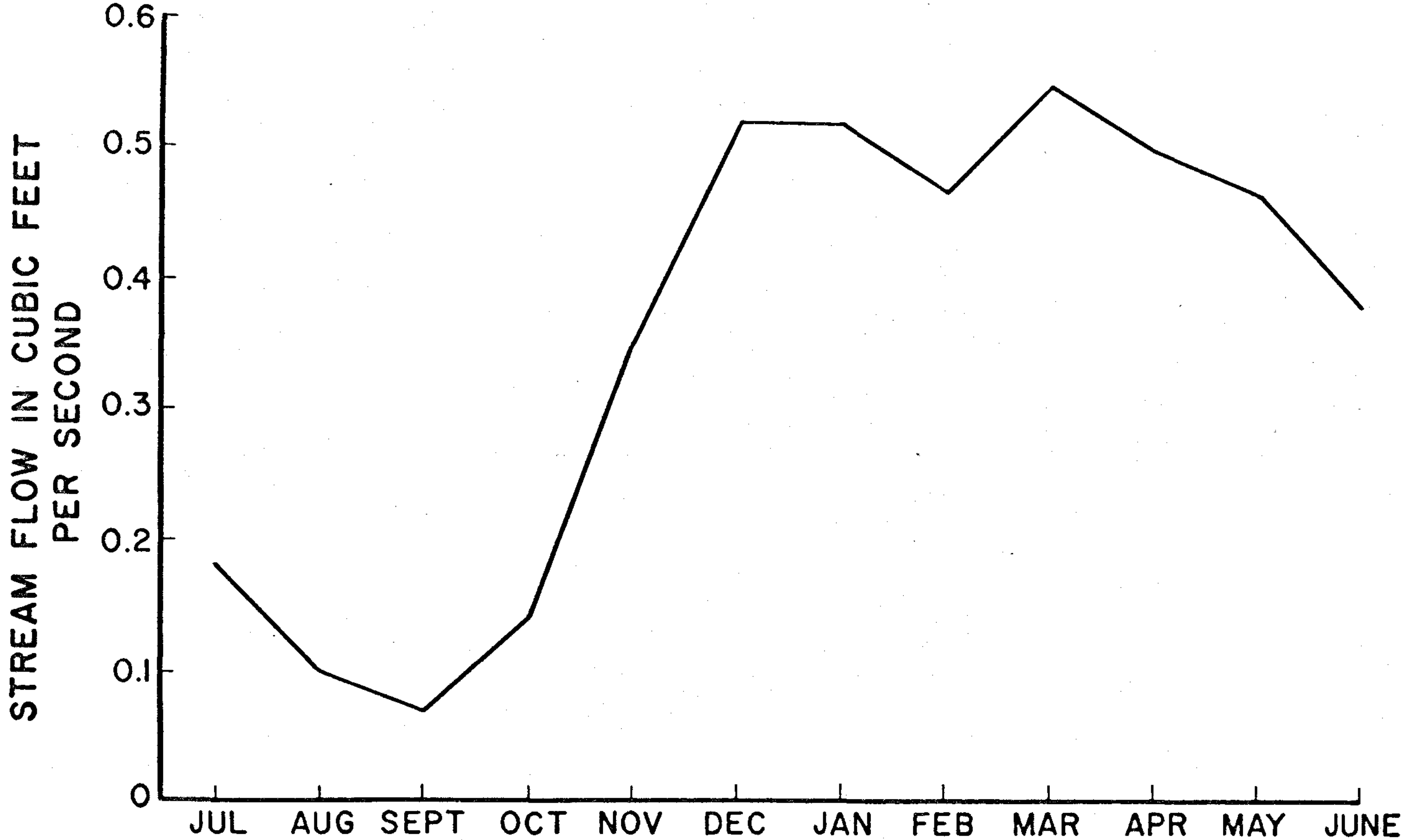

Figure 1. Monthly mean stream flows in the controlled section of Berry Creek from July 1965 to June 1966.

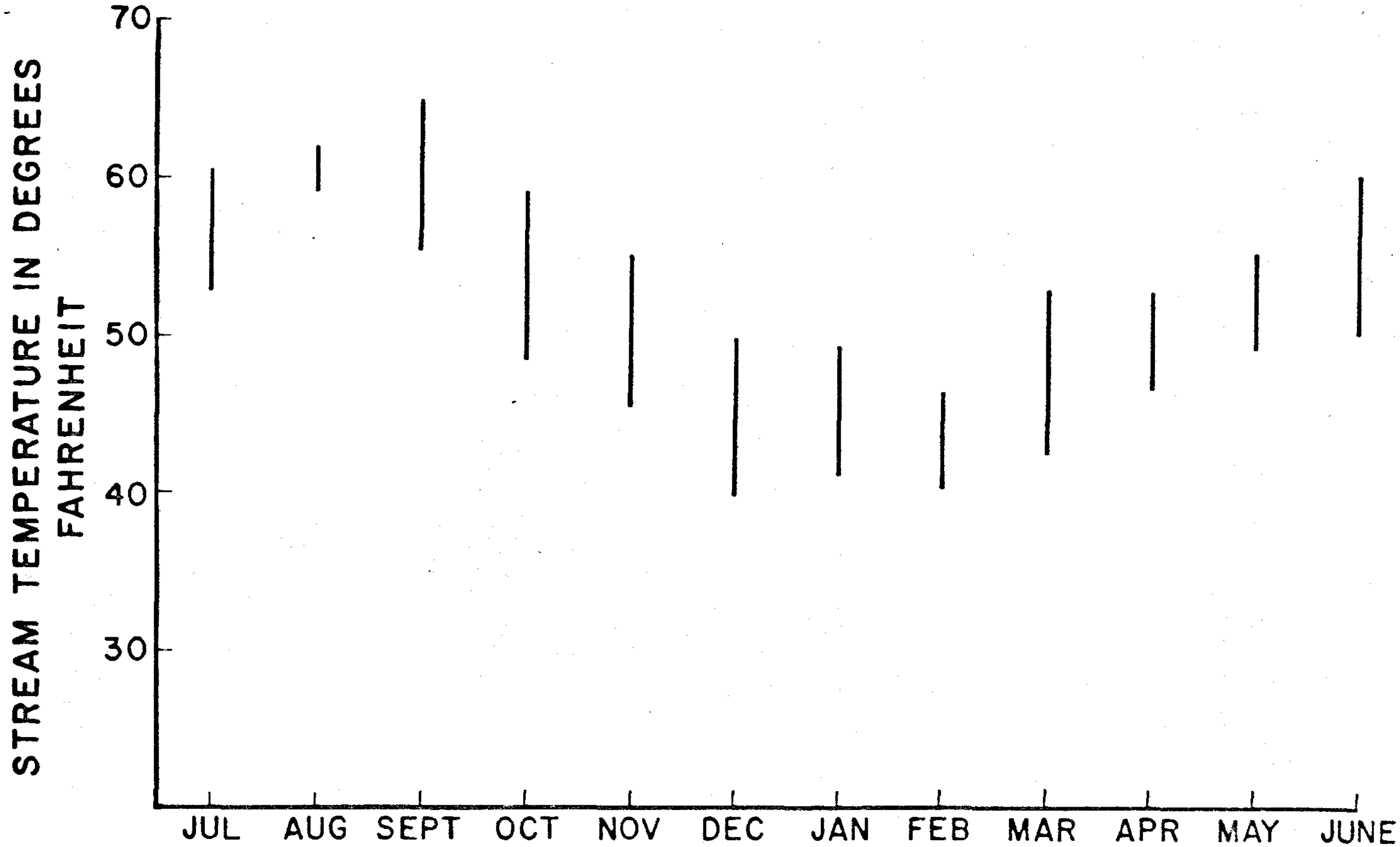

Figure 2. Monthly maximum and minimum stream temperatures in the controlled section of Berry Creek from August 1965 to July 1966.

Stocking, Measurement and Recovery of Trout

The trout used in the experiments were of native stock seined from Berry Creek or other local streams. In most studies the groups of trout stocked in each of the different sections were composed of individuals of several different age-groups. During the 1965-66 experiment, groups of only underyearling trout or groups of trout only greater than two years old were used in some sections.

In all experiments the trout were marked by fin clipping. The underyearling trout were identified only as a single experimental group by removal of the adipose fin from each fish. Each individual of the other size-groups was identified by removal of all or a part of one or two fins. Only when necessary were combinations of two fins used. The pectoral or caudal fins were not removed from experimental fish.

A stocking density of 3.5 grams of trout tissue per square meter of section area was maintained in all sections throughout each experimental period except for the July and August 1965 experiment when a density of 3.0 grams per square meter was used. Maintenance of the stocking density was accomplished by adjustments of the trout biomass on each sampling date. Trout were removed by seining from the experimental sections at two week intervals during the summer 1965 experiment and at monthly intervals in all other experiments. The trout were anesthetized using tricaine methanesulfonate (MS222) to facilitate handling and prevent injury. Trout lengths were recorded to the nearest millimeter and wet weights were obtained using a single pan Mettler balance accurate to 0.01 grams. Stomach contents were removed with alligator ear-forceps using the method described by Wales (1962), which permits removal of stomach contents without sacrificing experimental fish. Stomach contents were immediately preserved in a ten percent formalin solution for future analysis. The trout were held in fresh water until they had completely recovered from the anesthetic, and then returned to their respective stream sections.

In the 1963-64 and 1964-65 experiments, trout in a wide range of sizes were stocked in each section. Size ranges of trout initially stocked during the two successive years were 4.15 to 30.50 and 9.37 to 38.86 grams, respectively.

During the 1965-66 experiment, six sections - enriched sections II, III, and IV and unenriched sections B, C, and I - were stocked with groups of trout of three different size distributions. The three groups used were: (1) age-group 0 trout with individual weights ranging from 2.14 to 5.21 grams; (2) a mixed age-group ranging in size from 9.82 to 28.52 grams; and (3) groups of trout of the largest sizes commonly found in Berry Creek with individuals ranging in weight from 34.22 to 55.50 grams. Scale examinations indicated that most of these large fish were from age-groups II and III. Each of the above treatments was employed in both the unenriched and enriched experimental sections. The small size-group and the large size-group within each treatment were interchanged at regular intervals to take into account any differences between sections.

During July and August 1965 unenriched sections A, B, C and D were modified to examine the ability of trout to exploit food from various sources. At the junction of the riffle and pool of each section a four by four-inch wooden beam was permanently installed in the stream bed from bank to bank. These beams were fitted with two 3/8-inch carriage bolts with which removable screens could be attached. The four experimental treatments were as follows: (1) an open section in which there was no restriction on trout movement; (2) separation of the pool from the riffle by a fine mesh Saran plastic screen (32 meshes per inch) to restrict trout feeding to the pools; (3) pool and riffle separated by a 1/2-inch mesh hardware cloth screen which allowed drifting insects to pass from riffle to pool, but which restricted fish to the pool; and (4) separation of the pool from the riffle by a 1/2-inch mesh hardware cloth screen, but with trout stocked on the riffle above the screen as well as below in the pool. Each treatment was employed for two weeks in each section during the eight week experiment so that any differences associated with particular sections would not affect the results. The experimental fish ranged in weight from 6.75 to 36.20 grams when stocked. Trout biomass was adjusted to three grams per square meter on each sampling date. The trout were handled in the same manner upon removal as in the previous experiments.

Caloric Conversion

Warren et al. (1964) described a method for converting wet weights of trout tissue into caloric values using a relationship established between the condition factor of the trout and the caloric content per gram of their wet weight (Figure 3). This relationship was employed in this study using mean condition factors computed from length-weight measurements recorded for trout removed from the sections.

Trout Production and Growth Rates

Trout production in kilocalories per square meter of section area (kcal/m^2) was determined by summing the actual or estimated caloric equivalents of weight change of individual fish over each monthly sampling interval for each square meter of section area. Production in this sense is consistent with the definition of production given by Ricker (1958) as "The total elaboration of new body substance in a stock in a unit of time, irrespective of whether or not it survives to the end of that time." Occasionally the summed values of caloric change were negative. Under these circumstances, production was considered to be negative. The importance of considering negative values of production has been discussed by Warren et al. (1964).

It was necessary to estimate production values when fish disappeared from an experimental section. This loss could often be attributed to predation by birds, but on several occasions the

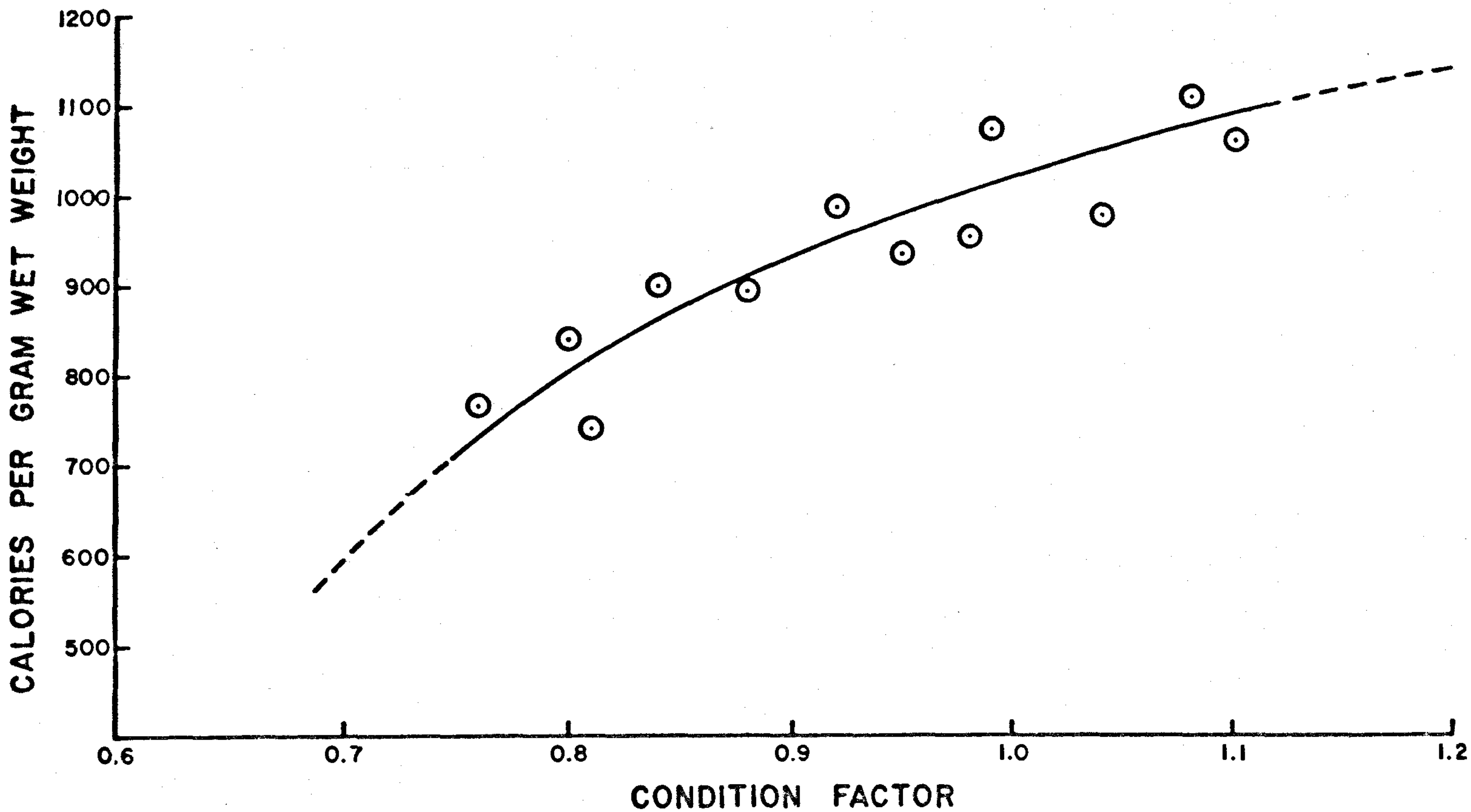

Figure 3. Relation between the caloric values of trout tissue per gram of wet weight and the condition factors of the trout (After Warren *et al*., 1964).

screens separating the sections became obstructed by leaves or Sphaerotilus with subsequent flooding and loss of some fish. If it could not be determined when a fish disappeared from a particular stream section or appeared in an adjoining section, it was considered to have been present in that section for one-half of the time interval. An estimated production value for the missing fish was based upon the growth rate of a fish of similar size within the same section. If all of the fish within a section were of similar size, the mean gain or loss in calories was used to estimate a production value for the missing fish for the period it was present in a given section.

Growth rates were determined by dividing the total monthly gain or loss in calories of the fish in a given section by their mean monthly biomass in kilocalories and by dividing this quotient by the number of days in the interval. This permitted growth rates to be expressed as calories of growth per kilocalories of biomass per day (cal/kcal/day). The biomass of trout present in a stream section during each monthly interval was determined by finding the mean of the amount of trout tissue stocked and the amount recovered each month. The mean biomass could then be divided by the total area of the corresponding stream section and expressed in kilocalories per square meter ($kcal/m^2$).

Trout Food Consumption

The caloric equivalents of food consumed by the trout during a given sampling interval were estimated by comparing the growth rates of trout in the stream with the growth rates of yearling trout held in aquaria and fed different rations of housefly larvae of measured caloric value. The aquarium experiments relating rates of food consumption and growth were performed during the spring of 1964 by Robert W. Brocksen, Department of Fisheries and Wildlife, Oregon State University. Brocksen has provided the data used in fitting the curve shown in Figure 4. Because of the high growth rates obtained for fish in Berry Creek, it was necessary to extrapolate the curve beyond Brocksen's data. Similar data obtained by Robert Carline, Oregon State University, for juvenile coho salmon Onchorhyncus kisutch (Walbaum) fed much higher rations during the spring of 1966 were included in Figure 4 merely to indicate that the relationship between growth and food consumption at these higher rations may be similar to that for cutthroat trout and that the extrapolation of the curve is probably justified.

Total food consumption by the trout per square meter of area in an experimental section during a given interval was computed by multiplying a given consumption rate value obtained graphically from the curve shown in Figure 4 by the average biomass of fish per square meter and the product by the number of days in the interval. Food consumption values could then be expressed in kilocalories per square meter of section area.

Growth-food consumption relationships for cutthroat trout have not been established for all seasons or for all of the size groups used in the studies at Berry Creek, therefore the use of the

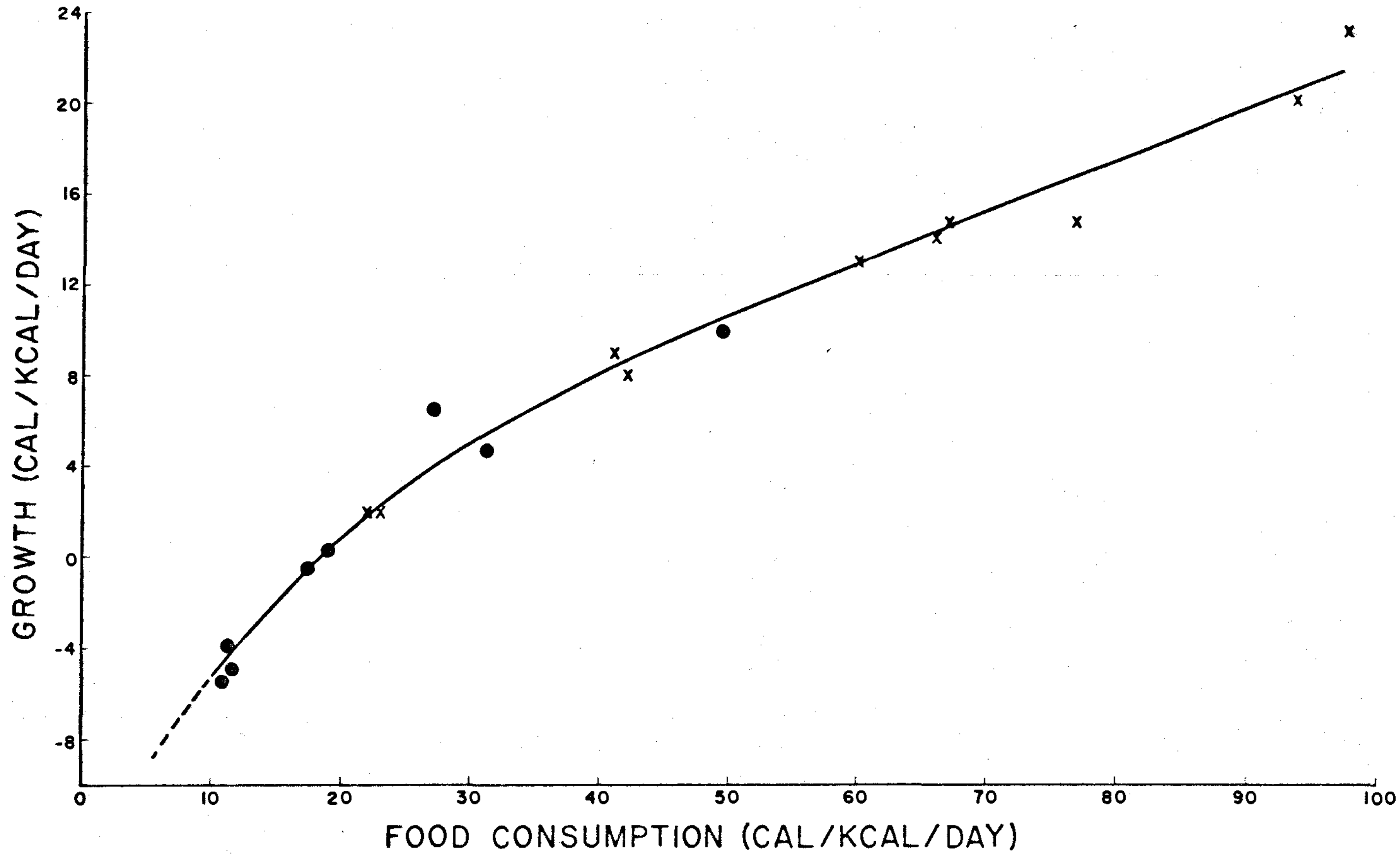

Figure 4. Relation between food consumption rates and growth rates of cutthroat trout held in aquaria and fed different rations of known caloric values. Dots represent data provided by Mr. Robert Brocksen for cutthroat trout and X's represent data provided by Mr. Robert Carline for coho salmon.

curve shown in Figure 4 probably resulted in some errors in estimating food consumption. Dawes (1930) and Brown (1946) have demonstrated that the amount of food necessary to maintain a gram of large fish is less than the amount required to maintain a gram of small fish. Hatanaka and Takahashi (1956), however, presented data for the Pacific mackerel, Pneumotophorus japonicus (Hottuyn) which suggests that values relating rates of food consumption and growth for fish ranging in weight from 6.6 to 56.5 grams at rations above maintenance may be fitted to a single curve. Considering the relatively small range of sizes of trout used in the experimental sections it can probably be assumed that the use of the curve based upon intermediate sized fish (Figure 4) did not result in serious error and provided a reasonable basis for comparison of food consumption values for the different size groups used.

Trout Food Habits

Material removed from trout stomachs for food habits analyses was pooled for each section on each sampling date during the 1964-65 experiments. Whole organisms and recognizable fragments were then examined with the aid of a steroscopic microscope and separated into their respective taxonomic groups. The classification of larvae, pupae and naiads of aquatic insects was taken to family whereas adults of aquatic insects and larvae, and adults of terrestrial insects were classified only to order. For convenience, organisms other than Insecta were placed in more general taxonomic groups which are considered in more detail in the Results and Interpretation section. Individuals in each of the various groups were counted and wet weights of the groups were obtained using a single pan Mettler balance accurate to 0.001 grams. In the 1965-66 experiment, length measurements of each organism were obtained with a one-millimeter grid placed on the stage of the microscope.

Sampling the Bottom Fauna

Monthly benthic samples were routinely taken from each of the riffles of sections I, II, III and IV. Analyses of the samples through September 1964 have been completed. These samples were obtained using a rectangular wire mesh box enclosing 0.23 square meters of riffle bottom. The sides of the box were lined with a Saran screen of 32 meshes per inch and the open downstream end was fitted with a nylon screen-cloth bag having mesh openings of 116 microns. The frame to which the box was fastened was fitted with a four-inch thick layer of foam rubber to ensure a uniform fit to the substrate. After the sampler had been placed on the riffle bottom, the rocks were scrubbed in the water passing through the enclosed area. After thorough agitation of the water contained in the sampler, the net was removed and its contents were preserved in a ten percent formalin solution. The organisms collected were separated to the correct taxonomic group and their wet weights determined. The wet weights were then converted to caloric equivalents using data obtained from oxygen bomb calorimeter determinations at the Oak Creek Fisheries Laboratory, Oregon State University for various kinds of organisms.

The pool bottom fauna for the four numbered sections was sampled, usually monthly, between fall 1964 and summer 1965. These samples were obtained using a foam rubber-based length of aluminum irrigation pipe. This pipe was three feet in length and eight inches in diameter with rubber-stoppered two-inch holes evenly spaced throughout the length of the pipe. After positioning the sampler on the pool bottom, a Gorman-Rupp chemical pump fitted with lengths of 3/4-inch tubing was used to pump the material from the interior of the sampler. Removal of the rubber stopper immediately below the pool surface permitted replacement of the water evacuated by the pump. The contents of the sample were then concentrated using the nylon-cloth bags described earlier and treated in the manner described for materials removed from the riffle benthos.

RESULTS AND INTERPRETATION

Trout Production, Food Consumption and Food Habits

Trout production was greater in the enriched sections than in the unenriched sections during experiments in which mixed age groups of fish were employed (Table 2). During the 1963-64 experiment, annual production values in enriched sections III and IV were 4.62 and 3.88 kcal/m^2, respectively; whereas in section I and II the respective values were only 0.55 and -0.21 kcal/m^2. Similar differences were noted for the 1964-65 experiments, when production values in sections III and IV were 4.94 and 4.88 kcal/m^2, respectively, and that of section I only 0.64 kcal/m^2. Near the midpoint of this latter study, enrichment of previously unenriched section II was begun. The trout production in this section was 2.62 kcal/m^2. The result of enrichment during the second half of the experimental period was an annual production value intermediate between the values for the enriched and the unenriched sections.

Since trout production may decline above some optimal stocking density, production values in themselves may not reveal the capacity of the different experimental sections to produce trout. Estimates of food consumption may provide a better measure of this capacity under the experimental conditions employed at Berry Creek. It may be noted in Table 2 that trout production in the enriched sections during both experiments was usually many-fold that of the unenriched sections; whereas, food consumption in the enriched sections was

Table 2. Mean biomasses, growth rates, production, and food consumption of mixed sizes of cutthroat trout in the four experimental sections for 1963-64 and 1964-65 experiments.

Month	1963-64 Mean biomass (kcal/m²)	1963-64 Growth rate (cal/kcal/day)	1963-64 Production (kcal/m²)	1963-64 Consumption (kcal/m²)	1964-65 Mean biomass (kcal/m²)	1964-65 Growth rate (cal/kcal/day)	1964-65 Production (kcal/m²)	1964-65 Consumption (kcal/m²)	1963-64 Mean biomass (kcal/m²)	1963-64 Growth rate (cal/kcal/day)	1963-64 Production (kcal/m²)	1963-64 Consumption (kcal/m²)	1964-65 Mean biomass (kcal/m²)	1964-65 Growth rate (cal/kcal/day)	1964-65 Production (kcal/m²)	1964-65 Consumption (kcal/m²)
	Section I (unenriched)								Section II (enriched beginning March, 1965)							
September	2.35	2.84	0.22	1.89	2.57	2.95	0.22	1.83	2.72	-1.89	-0.17	1.36	1.61	0.64	0.03	0.92
October	2.67	1.10	0.08	1.50	2.92	1.77	0.15	1.86	2.46	-8.43	-0.56	0.40	3.08	-0.56	-0.05	1.56
November	2.85	-0.65	-0.05	1.35	2.83	0.00	0.00	1.78	3.07	-1.81	-0.15	1.28	2.83	0.10	0.01	1.79
December	3.16	0.57	0.05	1.73	2.17	0.00	0.00	1.16	3.38	0.85	0.08	1.89	1.93	1.25	0.07	1.18
January					1.56	-0.85	-0.04	0.80					2.23	0.90	0.06	1.35
February	3.11	0.55	0.05	1.76	2.68	0.53	0.03	1.10	2.98	0.93	0.08	1.75	2.87	-0.33	-0.02	1.08
March	2.90	1.49	0.13	1.86	3.12	1.40	0.14	2.12	2.94	2.61	0.23	2.09	3.75	1.08	0.13	2.46
April	3.13	0.00	0.00	1.56	2.84	-0.63	-0.05	1.38	3.86	2.40	0.25	2.44	4.78	7.17	0.96	4.95
May	3.03	1.65	0.16	2.09	2.80	3.88	0.25	1.74	3.68	2.04	0.24	2.65	3.87	9.66	0.86	4.14
June	2.78	0.72	0.05	1.38	3.11	-0.58	-0.06	1.80	2.70	1.48	0.10	1.44	3.52	1.81	0.21	2.58
July	1.68	0.54	0.03	1.08	2.62	-0.99	-0.07	1.18	2.45	-1.73	-0.14	1.25	3.44	1.94	0.18	2.08
August	2.40	-2.53	-0.17	0.96	3.32	0.68	0.07	2.03	2.20	-2.76	-0.17	0.85	2.73	2.13	0.18	1.93
Totals			0.55	17.16			0.64	18.78			-0.21	17.40			2.62	26.02
Means	2.73				2.71				2.95				3.05			
	Section III (enriched)								Section IV (enriched)							
September	3.60	4.97	0.59	3.56	2.48	4.31	0.31	2.01	3.15	3.27	0.34	2.64	1.88	6.24	0.34	1.85
October	3.08	0.60	0.05	1.61	3.30	2.30	0.22	2.20	2.89	1.03	0.08	1.59	2.38	1.16	0.08	1.44
November	3.96	7.29	0.78	3.99	3.78	0.54	0.07	2.51	2.32	-1.44	-0.09	1.00	2.86	1.65	0.16	2.12
December	3.16	-2.94	-0.26	1.19	2.65	3.90	0.30	2.09	3.44	-0.93	-0.09	1.61	2.88	5.99	0.50	2.76
January					2.75	2.55	0.21	1.96					2.53	11.33	0.86	4.04
February	3.52	2.74	0.28	2.48	3.43	8.47	0.61	2.97	3.48	1.59	0.16	2.17	3.80	2.88	0.23	1.96
March	3.83	4.35	0.50	3.23	3.87	5.01	0.62	3.75	3.07	4.13	0.38	2.55	3.94	4.68	0.59	3.69
April	3.66	9.11	0.90	4.32	4.68	10.68	1.40	6.62	4.83	7.21	0.94	4.89	4.70	4.26	0.56	3.68
May	4.36	6.88	0.96	5.01	4.16	10.87	1.04	4.90	4.77	6.35	0.97	5.22	5.82	9.26	1.24	5.96
June	3.70	4.65	0.43	2.71	3.38	2.33	0.26	2.59	3.47	5.76	0.50	2.82	3.01	3.32	0.33	2.53
July	3.44	0.88	0.10	2.28	3.68	-1.61	-0.16	1.56	2.81	2.91	0.27	2.30	3.14	0.24	0.02	1.59
August	2.42	4.28	0.29	1.90	3.28	0.59	0.06	1.98	2.33	6.44	0.42	2.25	3.52	-0.92	-0.10	1.83
Totals			4.62	32.28			4.94	35.14			3.88	29.04			4.81	33.45
Means	3.52				3.45				3.32				3.37			

approximately twice that of the unenriched sections. An exception to this is noted for section II, which was enriched during March 1965, in that annual food consumption in this section was intermediate between that of the enriched and unenriched sections. The very low production values in the unenriched sections even though food consumption was about one-half that of the enriched sections was primarily a result of most of the food consumed being required merely to maintain the stock of fish, very little being left over to permit growth.

Results of food habit analyses for the 1964-65 experiment are summarized (Appendices 1 through 4) as the percentage each individual group contributed to the total weight of identified material. The food organisms are listed under two major headings; aquatic and terrestrial. Aquatic groups include immature insects, oligochaetes, snails, crayfish, springtails and infrequently, young reticulate sculpins Cottus perplexus Gilbert and Evermann and sculpin eggs. Terrestrial groups include aquatic adults, terrestrial adult and larval insects, isopods and spiders.

For purposes of graphical presentation of the results of the trout stomach analyses, the weights of the different food groups (Appendices 1 through 4) were combined into the following categories: aquatic insect adults; Chironomidae and Ephemeroptera; other aquatic organisms; and terrestrial organisms. The percentages by weight of animals in each of the categories of the total identified stomach contents were applied to the values of total monthly food consumption by trout in each section. Terrestrial insects were an important part of the trout diet in all experimental sections (Figures 5, 6, 7 and 8) and formed the greatest part of the diet in unenriched section I (Figure 5) during the spring months when most of the trout growth occurred (Table 2). In the enriched sections (Figures 7 and 8), the terrestrial component remained high during the optimum growth period, but the relative importance of the aquatic groups, especially ephemeropteran nymphs and chironomid larvae and pupae was greatly increased.

Aquatic organisms make up the largest portion of the diet during the winter months in all sections. During this period there is a paucity of terrestrial organisms. Food consumption in the enriched sections (Figure 7 and 8) was considerably higher than in the unenriched sections during the period of low temperatures, and this can be related to the greater quantities of aquatic food organisms consumed. The increased consumption of aquatic forms by trout under conditions of enrichment was also demonstrated in section II (Figure 6). After enrichment of this section began in March 1965 the consumption of aquatic stages of Ephemeroptera and Chironomidae by trout increased markedly and remained high throughout the spring period of trout growth.

Aquatic organisms other than insects occasionally formed a large percentage by weight of the food consumed by trout. The large contribution of aquatic organisms to the diet of trout in section I in May and July (Figure 5) was due to the consumption of crayfish,

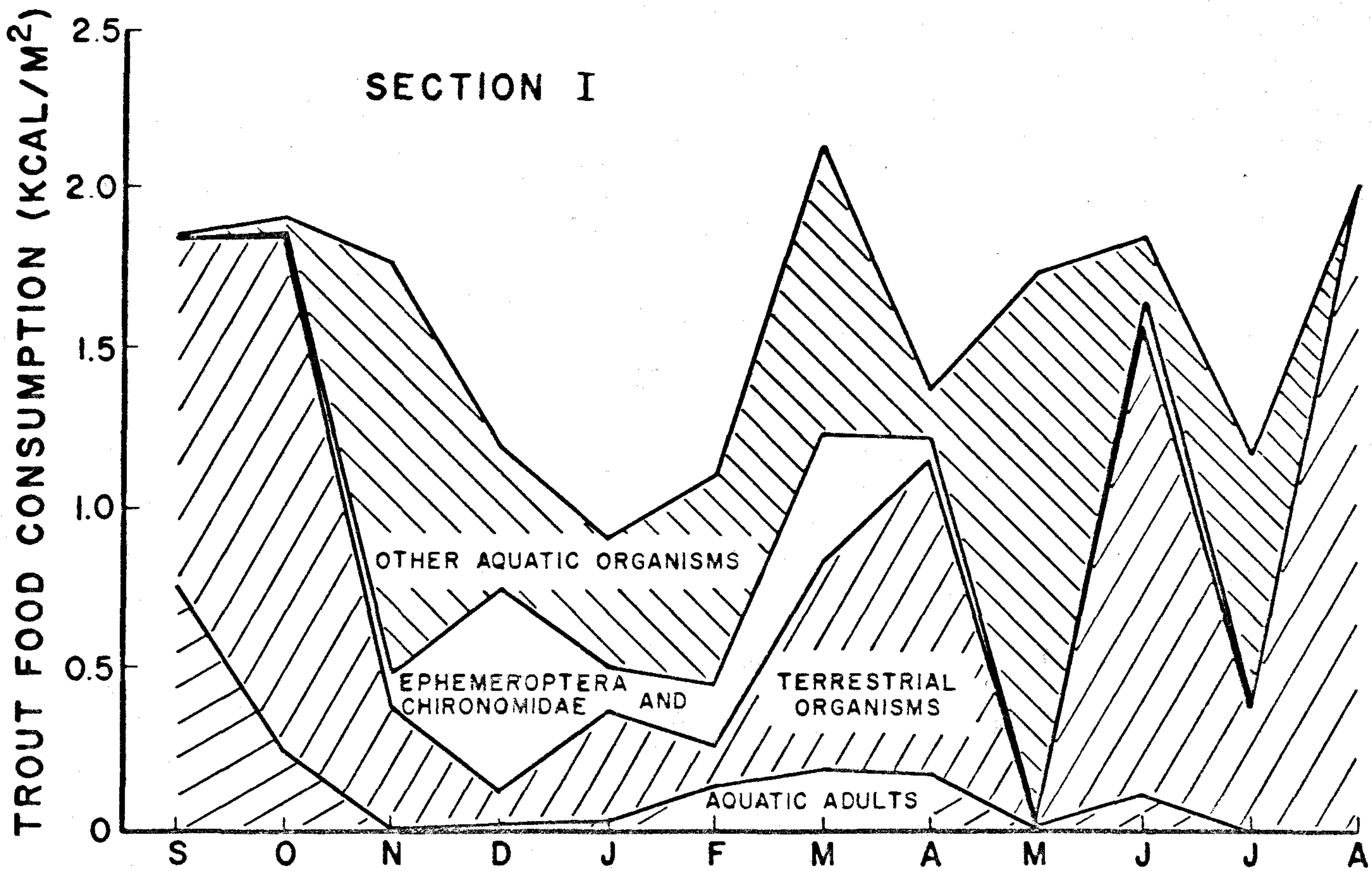

Figure 5. The relative contribution of various food organisms to the total food consumption of mixed size groups of cutthroat trout in unenriched section I during the 1964-65 experiment.

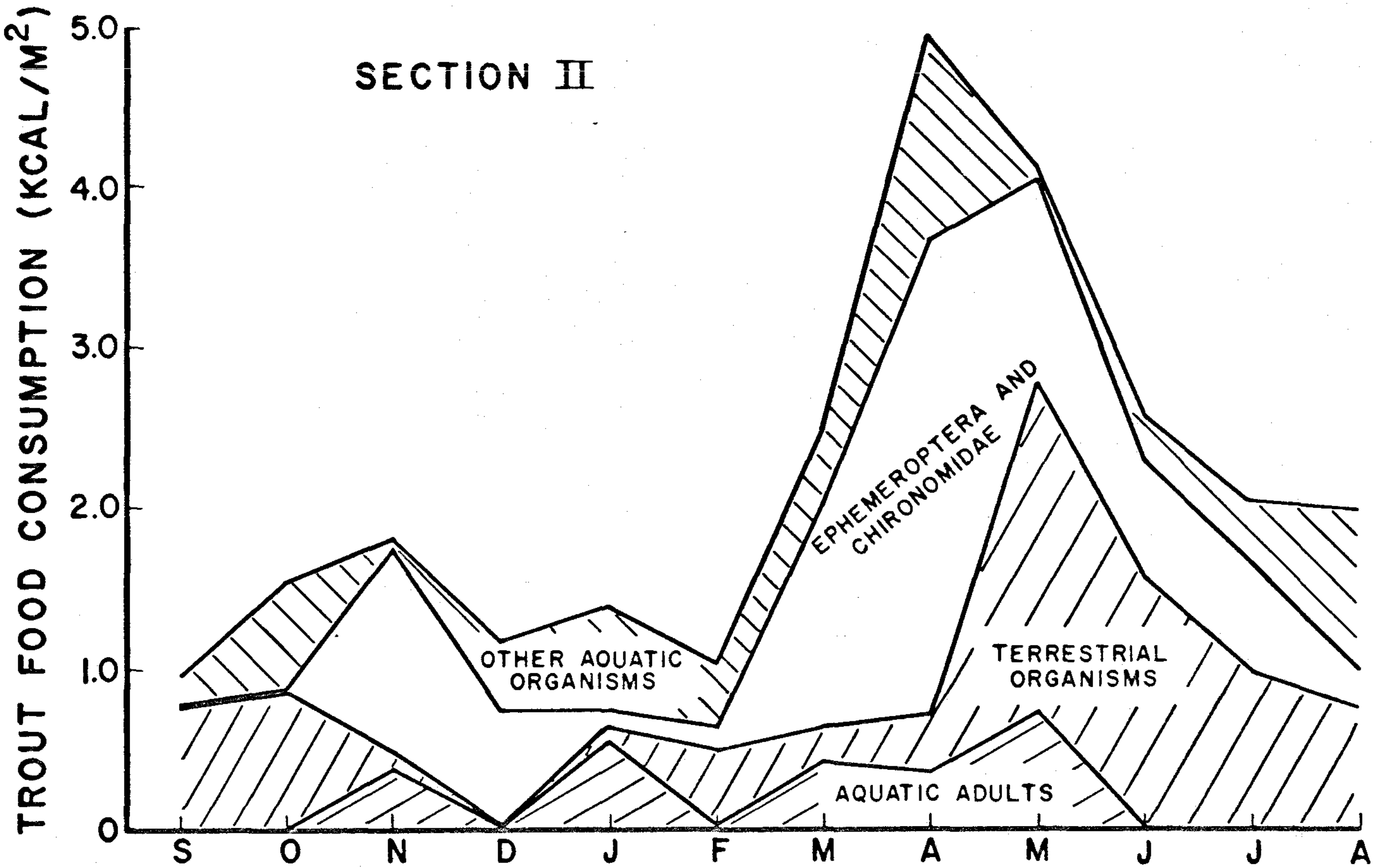

Figure 6. The relative contribution of various food organisms to the total food consumption of mixed size groups of cutthroat trout in section II during the 1964-65 experiment. Section II was enriched beginning in March 1965.

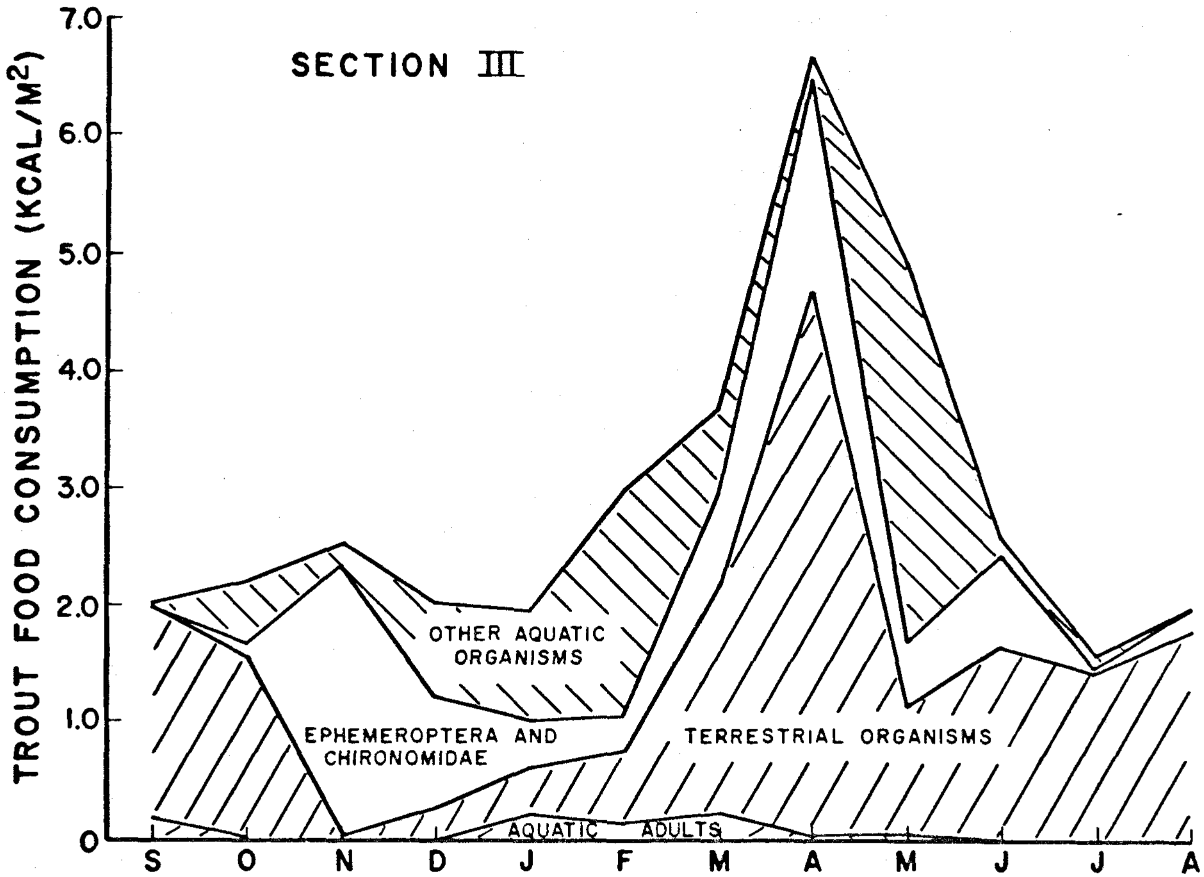

Figure 7. The relative contribution of various food organisms to the total food consumption of mixed size groups of cutthroat trout in enriched section III during the 1964-65 experiment.

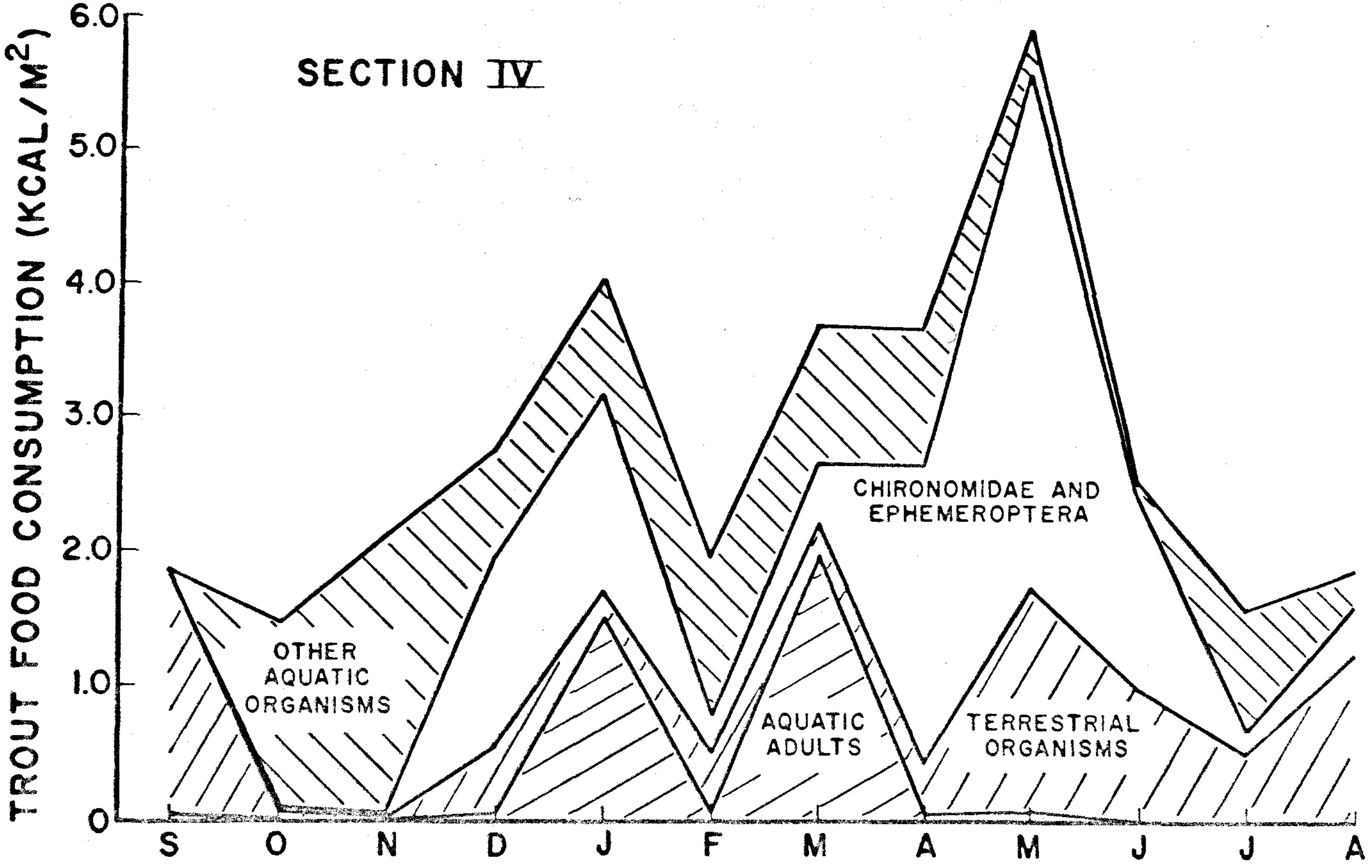

Figure 8. The relative contribution of various food organisms to the total food consumption of mixed size groups of cutthroat trout in enriched section IV during the 1964-65 experiment.

oligochaetes and fish, which percentage-wise contributed greatly to the stomach contents of the trout. The apparently large contribution of aquatic organisms to trout food consumption in section III (Figure 7) during February and May resulted from the presence in the stomach contents of Cottus eggs during February and crayfish during May. The winged stages of aquatic insects, which were included in the terrestrial category, formed a large portion of the trout diet in section IV (Figure 8) in January and March, when the other terrestrial forms were not abundant.

Results of the experiments with trout populations of different size composition (Appendix 5) showed that in both enriched (Figures 9 and 10) and unenriched (Figures 11 and 12) sections production and food consumption were highest for the trout of age-group 0, intermediate for the mixed age-groups and lowest for the large trout (age groups II and III). Total food consumption values over the eight month period for all size groups of trout were consistently higher in the enriched sections (Figure 10) than in the unenriched sections (Figure 12). These were approximately 3, 2 and 1.3 times greater in the enriched sections for the small, mixed and large size-groups, respectively. The differences in consumption for the three different experimental groups indicated a reduced ability of the large fish to utilize the increased food resource in the enriched sections since consumption estimates for the large groups were only slightly higher in enriched than in unenriched sections.

The high consumption values recorded for the small fish may be

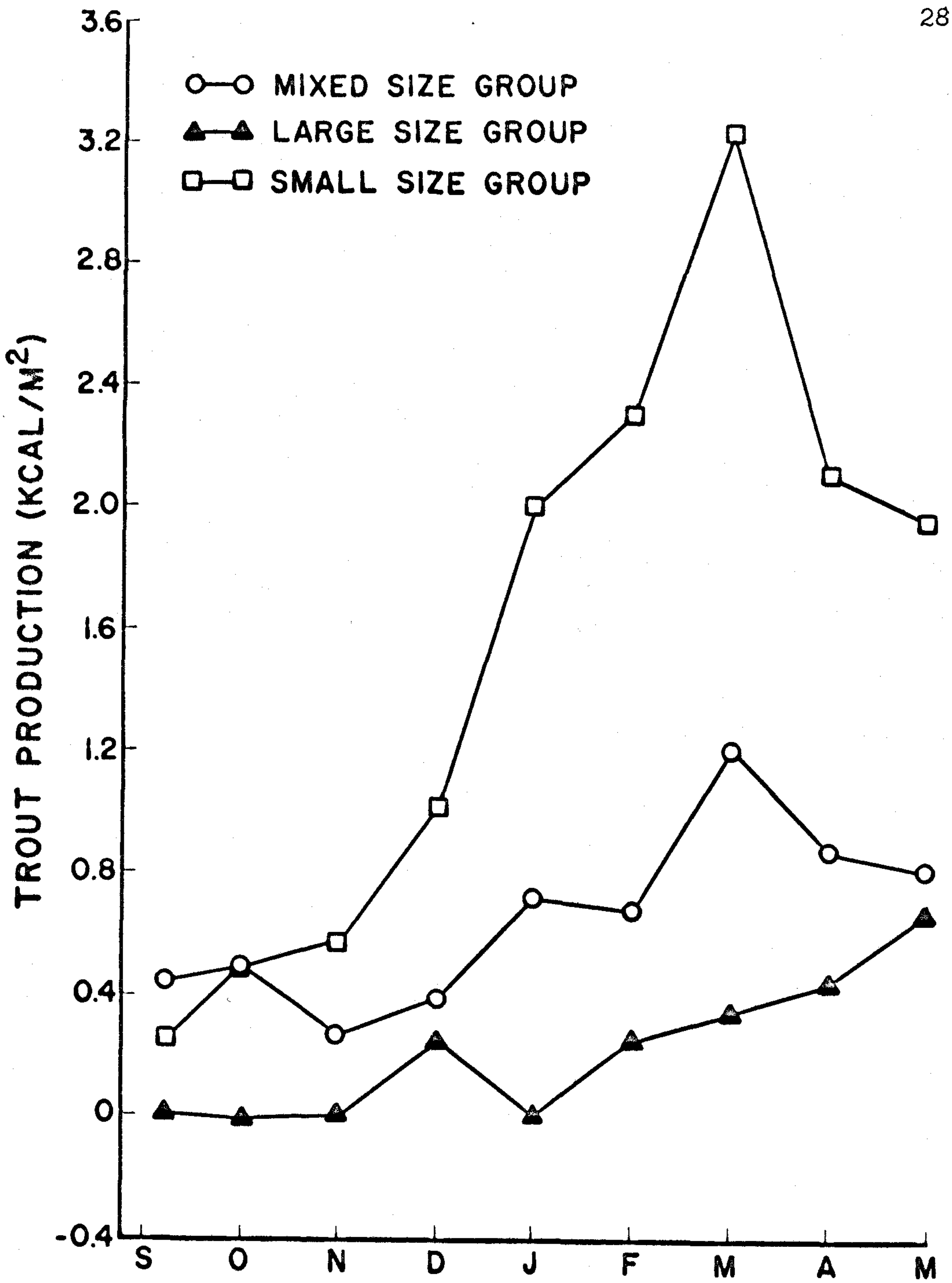

Figure 9. Production values for small, mixed and large sizes of trout in enriched sections II, III and IV for the September 1965 to May 1966 experimental period.

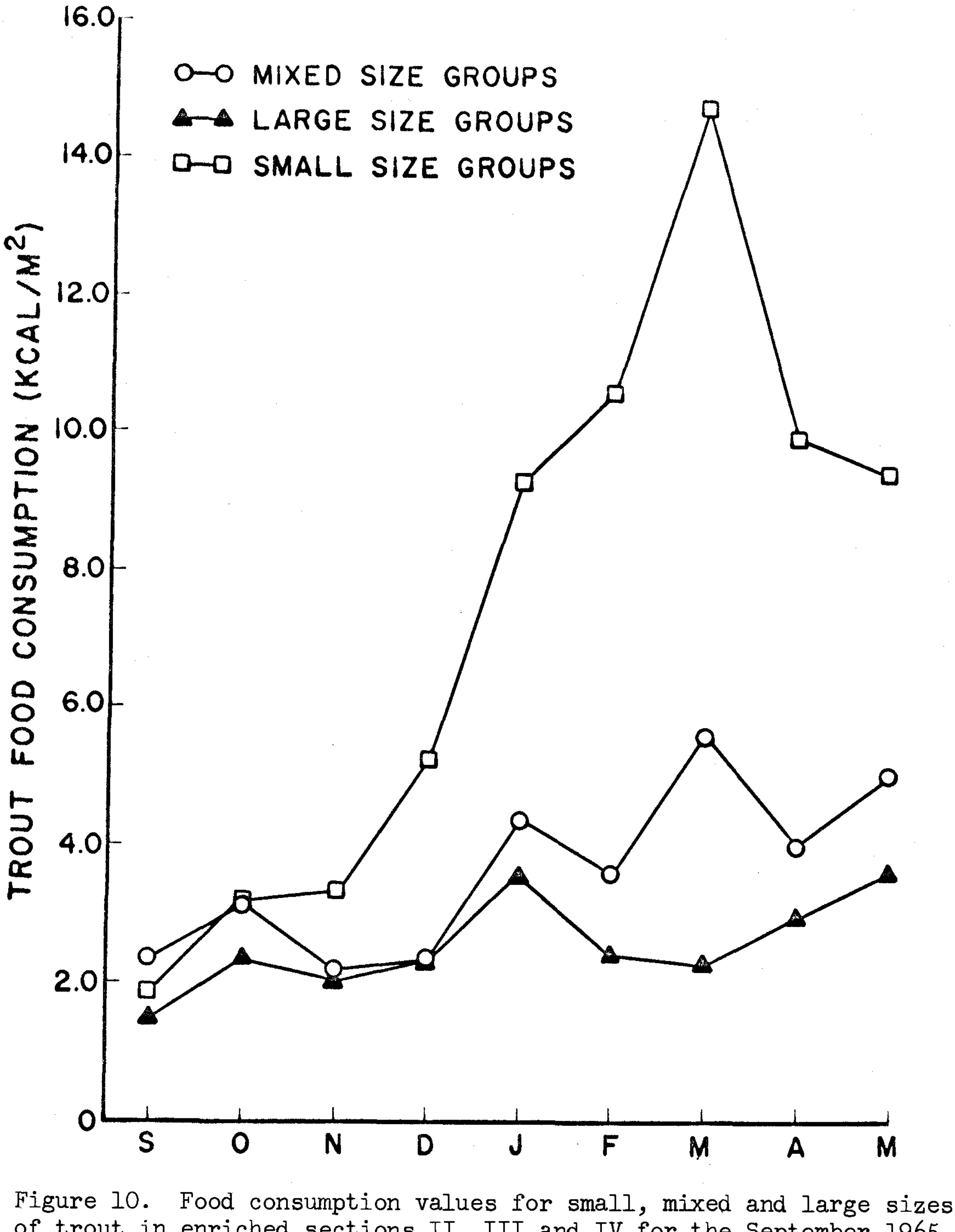

Figure 10. Food consumption values for small, mixed and large sizes of trout in enriched sections II, III and IV for the September 1965 to May 1966 experimental period.

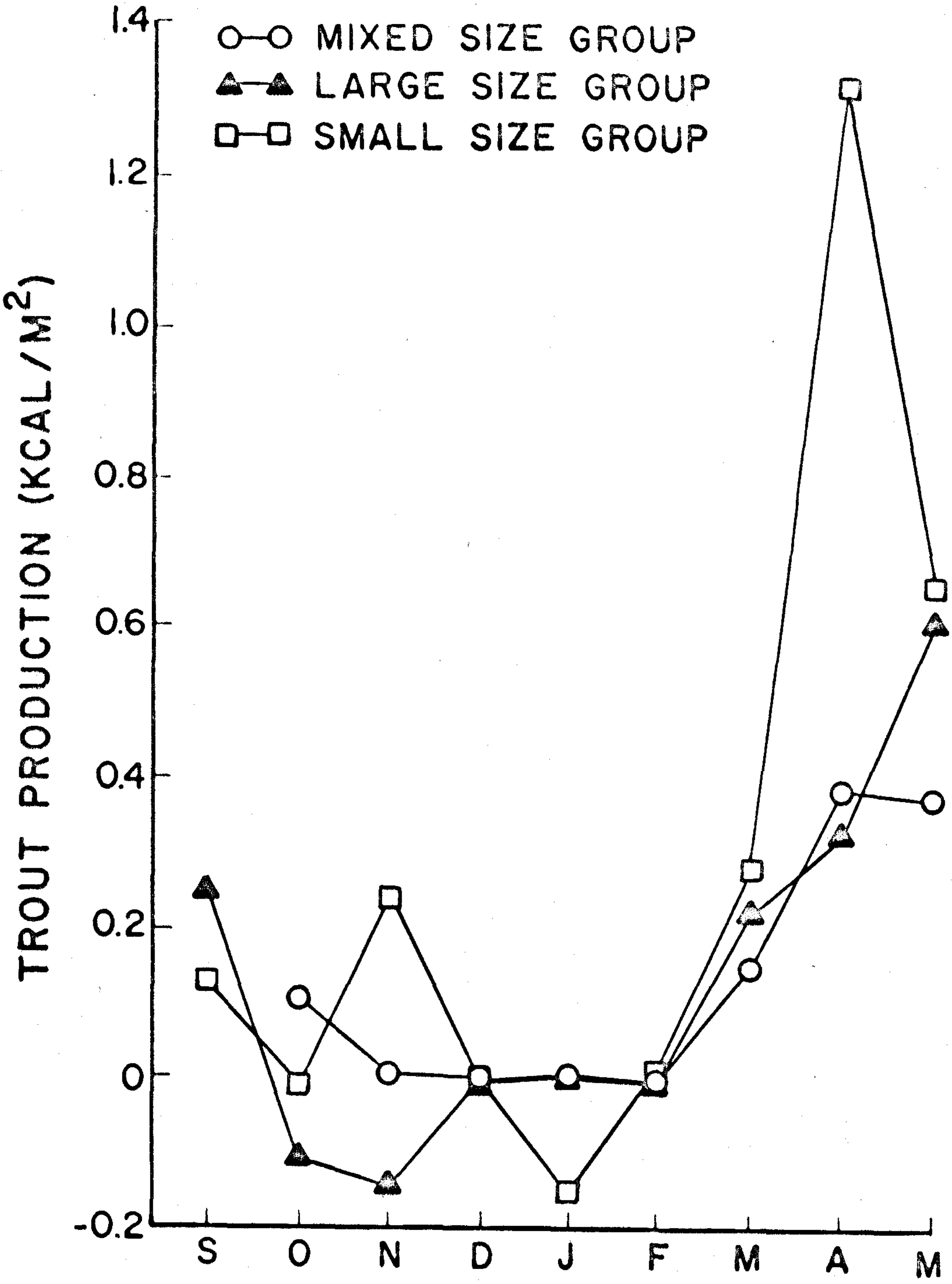

Figure 11. Production values for small, mixed and large sizes of trout in unenriched sections B, C and I for the September 1965 to May 1966 experimental period. No data were obtained for mixed sizes for September 1965.

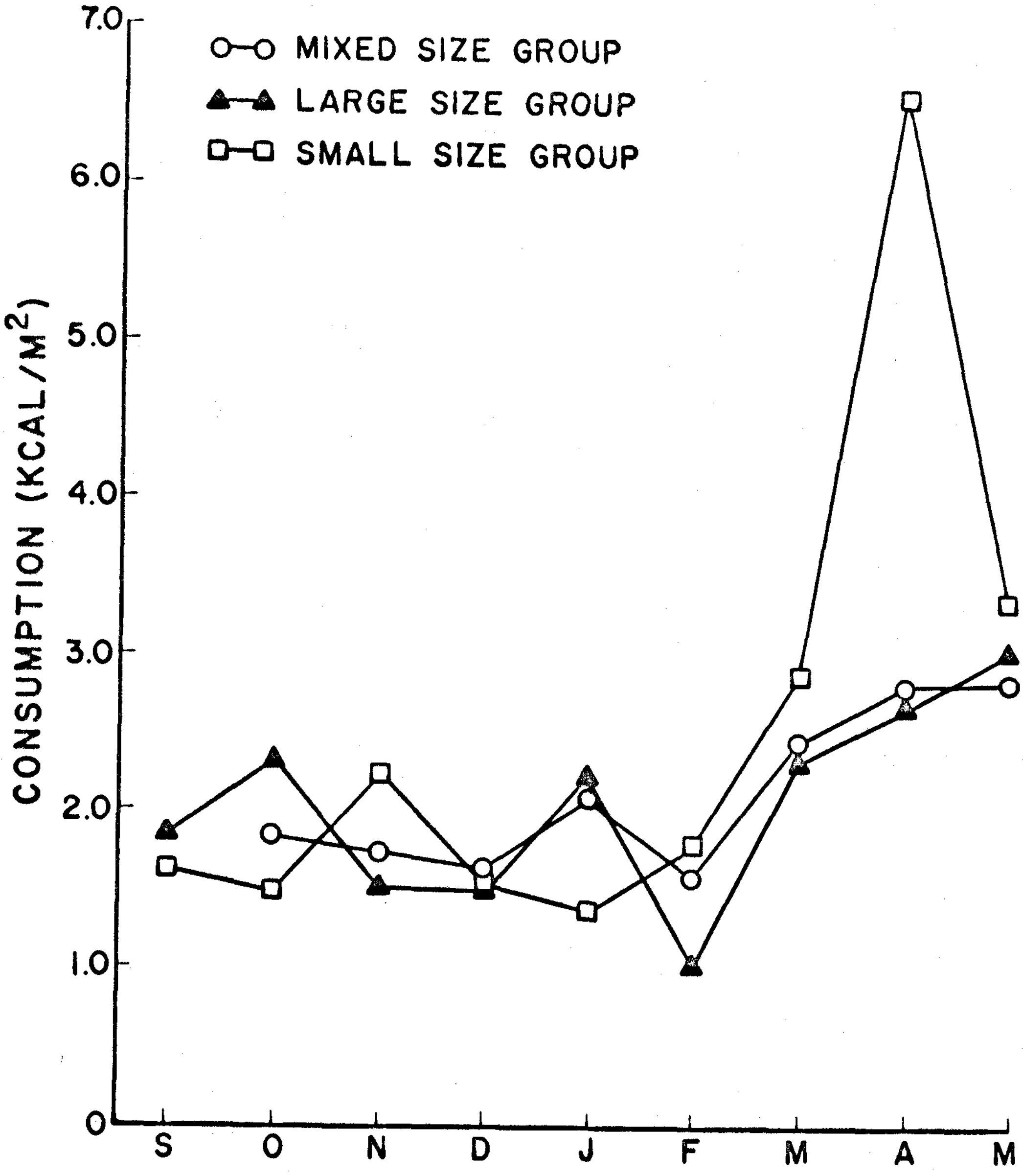

Figure 12. Food consumption values for small, mixed and large sizes of trout in unenriched sections B, C and I for the September 1965 to May 1966 experimental period. No data were obtained for mixed sizes for September 1965.

related to the greater numbers of small fish that could be stocked in the experimental sections consistent with the stocking density (3.5 grams per square meter) imposed by the experimental design. Large numbers of trout contained within a limited area can probably exploit the available food resource more efficiently than can smaller numbers. The low, medium and high production and consumption estimates for the three size groups used corresponds to low, medium and high numbers since the stocking densities were essentially equal in all sections.

Analyses of food habits (Appendices 6 through 11) for the small, mixed and large size groups demonstrate a similarity between the kinds and sizes of food organisms utilized by the three groups. Measurements of the food organisms showed that the 1-4 millimeter length-group was utilized predominantly by both the small and large trout in all sections.

The seasonal contribution by aquatic and terrestrial organisms to the total amount of food consumed by each of the three size-groups of trout used during the 1965-66 experiment (Figures 13, 14 and 15) was similar to that recorded for the mixed size-groups during 1964-65 (Figures 5 through 8). For each of the three size-groups of trout, the terrestrial organisms generally decreased in importance during the late fall months and increased again in the early spring months. The greater food consumption in the enriched sections can be attributed to increased consumption of aquatic forms, especially members of the dipteran family Chironomidae.

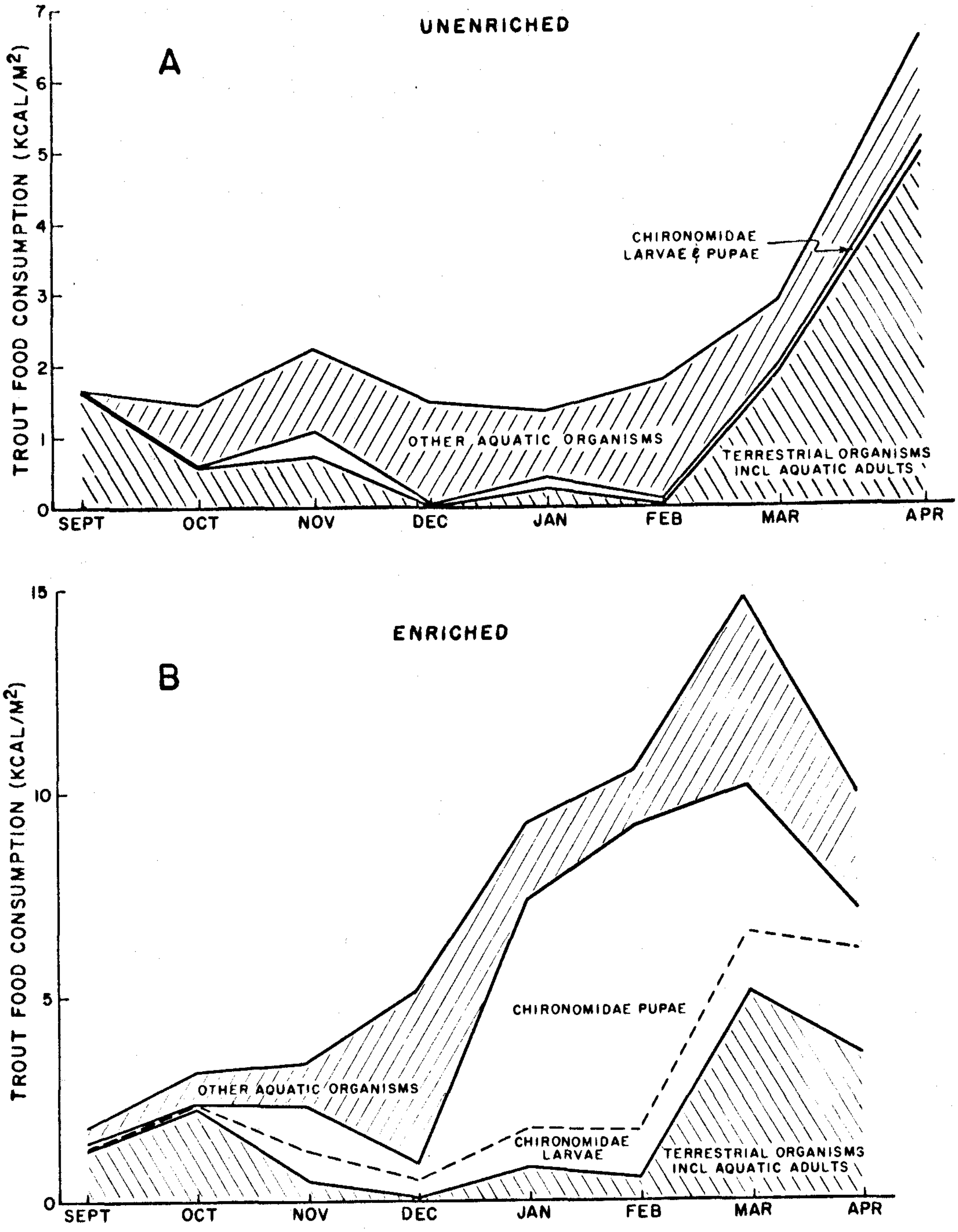

Figure 13. The relative contribution of various food organisms to the total food consumption of small cutthroat trout in (A) unenriched sections B and C, and (B) enriched sections III and IV during the 1965-66 experiment.

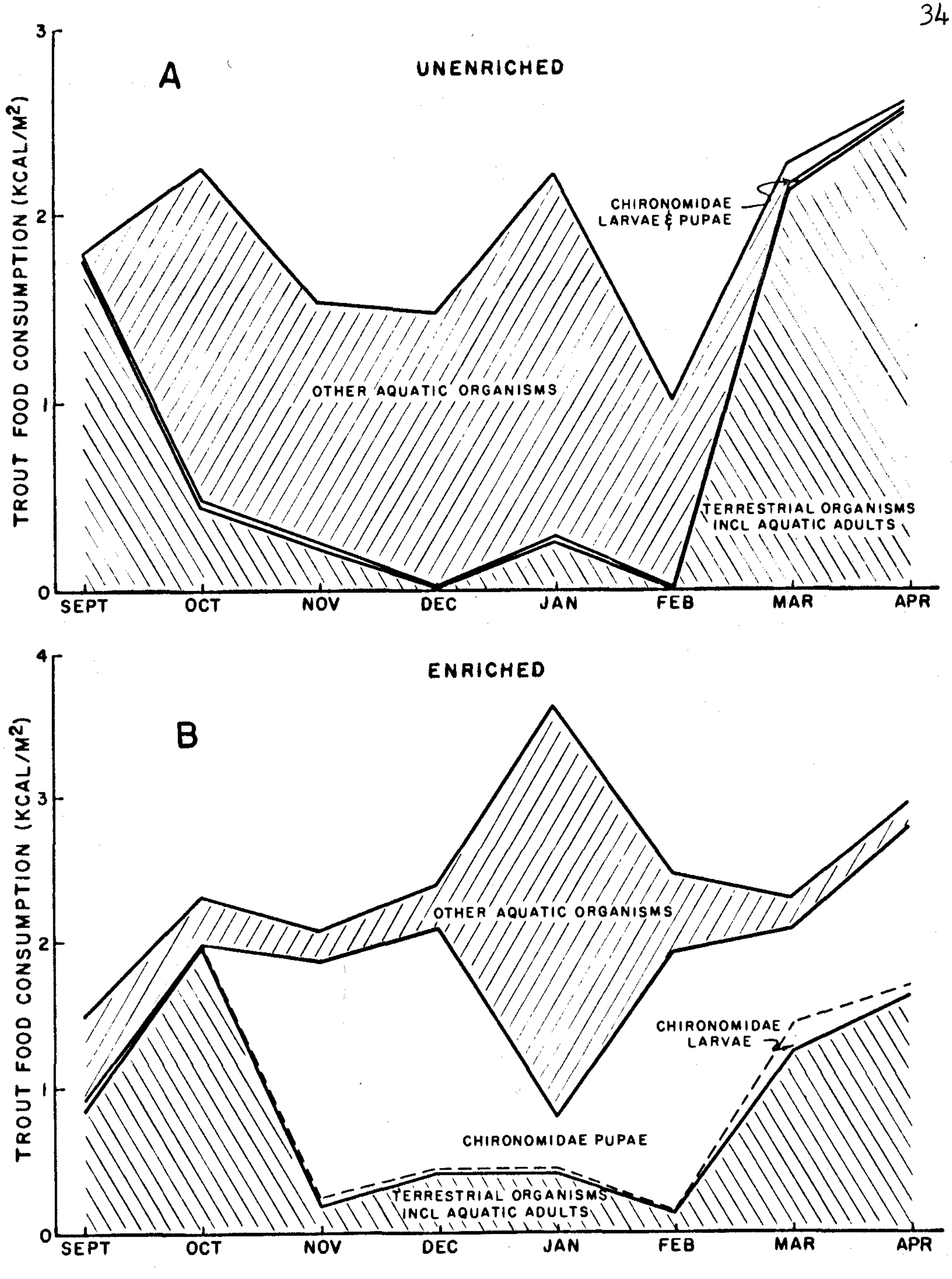

Figure 14. The relative contribution of various food organisms to the total food consumption of large cutthroat trout in (A) unenriched sections B and C, and (B) enriched sections III and IV during the 1965-66 experiment.

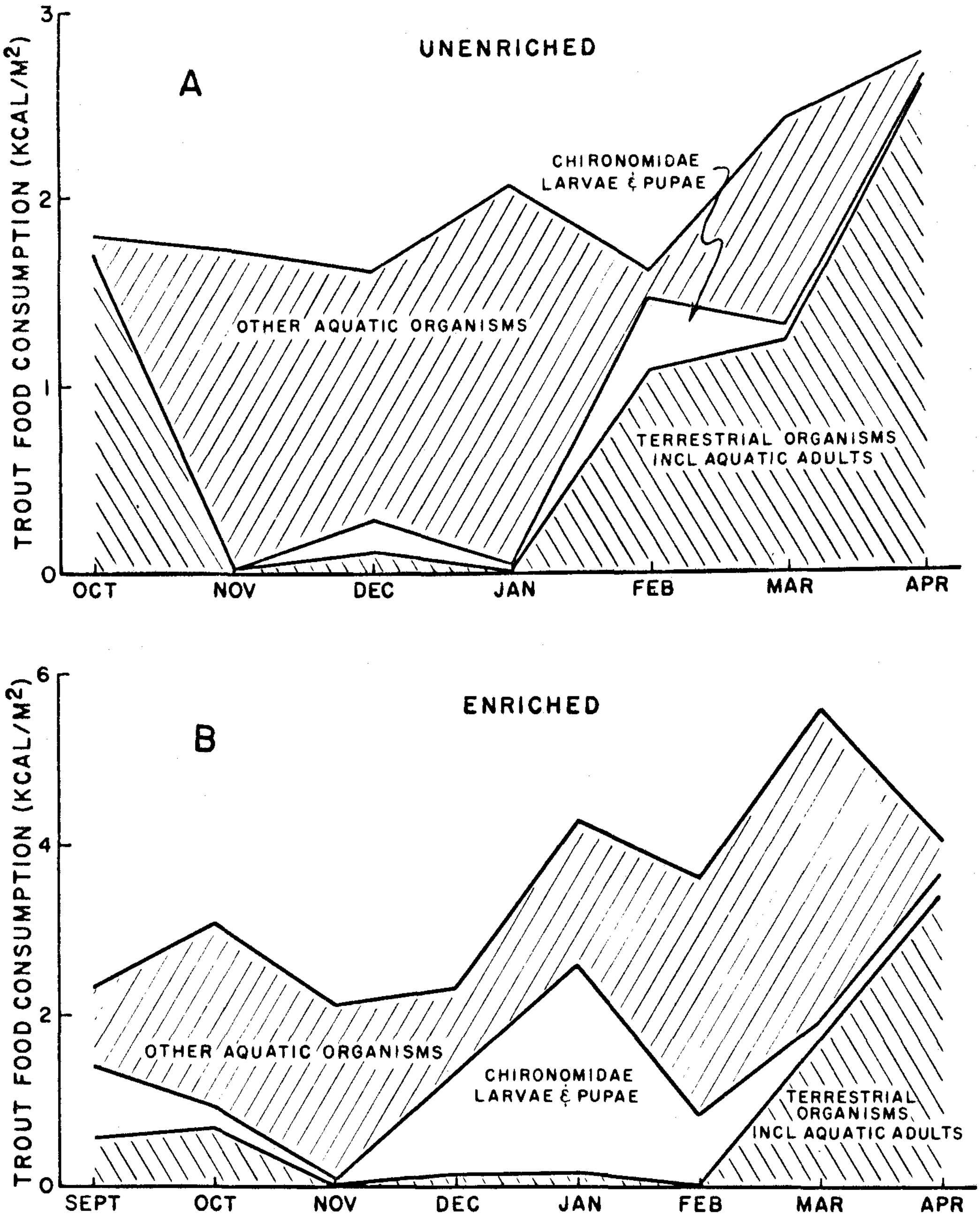

Figure 15. The relative contribution of various food organisms to the total food consumption of mixed size groups of cutthroat trout in (A) unenriched section I and (B) enriched section II during the 1965-66 experiment.

Higher food consumption values for the small fish in the unenriched sections compared with those of the large fish apparently were not a result of greatly increased consumption of aquatic organisms. The small trout were able to obtain somewhat greater quantities of terrestrial organisms than were the larger trout. This advantage can probably be related to the larger numbers of small trout.

The Food Resource

The increased consumption by trout in the enriched sections over that in the unenriched sections can be related to the greater quantities of food present in the enriched sections. Although production of the food organisms has not been measured, data are available for comparing the biomasses of insects in the different sections (Table 3). Diptera, primarily the Chironomidae, benefited greatly from enrichment. The biomasses of the Plecoptera and Megaloptera (Sialidae) were also greater in the enriched sections. The plecopterans were largely of the family Nemouridae which along with the Chironomidae are herbivorous. The *Sphaerotilus* produced in the enriched sections undoubtedly formed an important food source for these herbivores. The Sialidae are carnivorous and their increased biomass probably resulted from the increase in herbivores that they utilized for food.

Table 3. Mean biomasses of benthic insects in the four experimental stream sections for the period September 1963 through August 1964, in kilocalories per square meter of riffle area.

	SECTION			
	Unenriched		Enriched	
	I	II	III	IV
Ephemeroptera	23.90	22.14	19.24	21.07
Plecoptera	6.14	11.76	25.42	24.02
Megaloptera	0.18	0.97	6.49	11.77
Trichoptera	6.97	16.95	7.98	8.50
Coleoptera	3.70	7.23	3.25	4.48
Diptera				
Chironomidae	6.44	9.32	46.33	38.27
Others	3.63	7.21	5.88	11.17
Insecta Total	50.96	75.58	114.59	119.28
Monthly Mean	4.25	6.30	9.54	9.94

Preliminary analyses of the pool bottom samples taken from enriched and unenriched sections suggest that the benthic fauna was greater in the pools of the enriched sections than in the pools of the unenriched sections. Although these data were based upon rather small samples and should be considered tentative, they do provide some estimate of the differences resulting from enrichment (Table 4). The abundant insects, especially chironomids in the enriched sections may have been an important source of fish food. The chironomid pupae, upon emergence, would have become readily available to the feeding fish.

Table 4. Mean biomasses of insects and other invertebrates in the benthic fauna of the pools of unenriched and enriched sections during each season between fall 1964 and summer 1965. Each seasonal value is a mean of monthly samples. Values are in kilocalories per square meter of pool area.

Group	Fall	Winter	Spring	Summer
		Unenriched		
Chironomidae	2.2	7.0	2.9	8.5
Sialidae	2.0	2.5	1.3	6.9
Other insects	2.1	5.0	1.8	0.0
Oligochaeta	0.6	0.0	0.0	0.0
Totals	6.9	14.5	6.0	15.4
		Enriched		
Chironomidae	59.4	51.4	21.4	13.3
Sialidae	1.1	2.4	0.0	9.2
Other insects	0.2	0.6	0.6	0.2
Oligochaeta	0.8	0.5	0.0	0.0
Totals	61.4	54.9	22.0	22.7

Results of the experiments carried on in sections A, B, C and D during July and August 1965 were not satisfactory for evaluating the contribution of food from different sources to the diet of the trout. Aquatic insects were not abundant during this experiment and the trout subsisted at near-maintenance levels on food mainly of terrestrial origin (Table 5).

Estimates of biweekly mean food consumption by fish restricted to different portions of these experimental sections were as follows: 19.8 kcal for fish held in the pools of the different sections in which drift was removed by screens positioned at the foot of the riffles; 13.4 and 6.1 kcal (total 19.5) for fish restricted to the pools and riffles respectively; 21.1 kcal for fish confined to the pools but which had access to insects drifting from the riffles; and 22.1 kcal for fish given free access to both the riffles and pools.

The amounts of food consumed by the trout were not greatly different between the different treatments and further interpretation of the results was considered unjustified. The use of this experimental design should provide valuable information for evaluating different sources of trout food during seasonal periods when aquatic insects are abundant and trout growth occurs.

Table 5. Percentages by weight of different food organisms of the total stomach contents of trout limited to food from different sources during the summer 1965 experiment. Column headings are designated as follows: (1) pool without drift; (2) pool with drift; (3) riffle alone; (4) pool with fish on riffle; and (5) open section.

Food group	Treatment				
	(1)	(2)	(3)	(4)	(5)
Aquatic groups					
Collembola				0.2	0.1
Ephemeroptera	1.1	8.8	1.9	1.4	0.2
Trichoptera	0.3		0.2	1.4	
Plecoptera	0.1		0.1		
Hemiptera	16.7	1.8	2.2	5.0	
Diptera	0.9	6.8	2.1	0.6	1.1
Chironomidae	(0.4)	(5.7)	(0.8)	(0.2)	(0.4)
Others	(0.5)	(1.1)	(1.3)	(0.4)	(0.7)
Crayfish		13.3		1.4	
Hydracarina			0.8	0.7	
Pisces					2.3
Miscellaneous	0.2	0.9			
Terrestrial groups					
Isopoda	41.1	35.8	18.4	19.5	58.6
Arachnida	1.5	1.0	8.7	38.4	2.8
Terrestrial insects	34.0	31.8	39.7	31.2	34.9
Myriapoda	4.2		25.8		
Totals	100.1	100.2	99.9	99.8	100.0

DISCUSSION

Increased production and food consumption by trout in enriched sections over that recorded for trout in unenriched sections during the 1963-64 and 1964-65 experiments when mixed size-groups of trout were used has confirmed the results reported by Warren et al. (1964) for experiments performed between 1960 and 1963. The effect of enrichment on trout production and food consumption was further demonstrated by the results obtained in section II after enrichment was begun in March 1965. Comparison of the annual production (2.62 $kcal/m^2$) and consumption (26.02 $kcal/m^2$) values in newly enriched section II with the production (-0.21 $kcal/m^2$) and consumption (17.40 $kcal/m^2$) values in the same section during the 11 month experiment in 1963-64 showed that considerable increases of production and consumption resulted from enrichment.

In all instances during the 1965-66 experiment when groups of small trout, mixed sizes of trout and large trout were used, higher production and food consumption values were recorded for trout in the enriched sections. Production and consumption values for small trout were higher in both enriched and unenriched sections than for either the mixed sizes or the large trout. The differences in production and consumption values for fish in the unenriched and in the enriched sections however, were much greater for the small trout than for either the mixed sizes or large trout.

High production values for stream populations of trout in their first and second years have been reported from field studies utilizing standard sampling techniques (Allen, 1951; Horton, 1961; Hunt, 1966). High growth rates and comparatively large numbers of trout in their first and second years have resulted in a high proportion of the annual total trout production being the result of production of these age groups. In the Horokiwi Stream of New Zealand, Allen (1951) reports that about 95 percent of the production of an individual year-class of brown trout occurs by the end of its second year. Hunt (1966), in a five-year study of brook trout in Lawrence Creek, Wisconsin, found that the production by age-groups 0 and I was equivalent to 88.2 percent of the total production by all age-groups.

High numbers and growth rates for trout in their first year of life during the 1965-66 experiment also resulted in this group having the highest production values for the three size-groups tested. Growth rates for the large fish were much lower than for the other size-groups. In all cases the use of mixed size-groups resulted in a production value intermediate between the large and small size-groups.

The higher consumption values obtained for the small trout than for the large trout in both enriched and unenriched sections suggests that they could better exploit the available food supply than could the larger fish. Estimates of food consumption (Figures 10 and 12) and results of food habit analyses (Figures 13 and 15) for the small and large trout indicated that there were large differences only in the quantities, but not in the kinds and sizes of food organisms utilized. Consumption of organisms from one to four millimeters in length by all experimental fish in Berry Creek indicates that all size-groups of trout depended upon similar sized food organisms.

The use of trout of even larger sizes than those employed in this study might have resulted in greater consumption of large organisms, such as sculpins and crayfish which were abundant in the stream. Tebo and Hasler (1963) have reported that large brook, brown and rainbow trout selected larger food organisms than did smaller trout in North Carolina streams. The results of Horton (1961), however, indicated that organisms of two to eight millimeters in length were utilized by all sizes of brown trout present in Walla Brook.

Data collected from Berry Creek during the 1963-64 experimental period have made possible an examination of various trout food sources. Samples of organic drift were taken at three-week intervals during this period by Dr. Norman H. Anderson, Department of Entomology, Oregon State University. On each sampling date, the contents of drift nets were removed at three-hour intervals over a 24-hour period. These data were used for determining monthly amounts of aquatic and terrestrial drift from the riffles and to provide a basis for estimating the quantity of terrestrial organisms which fell on the surface of the pools. Estimates of the amounts of terrestrial organisms which fell upon the surface of the pools were made by multiplying the terrestrial drift per square meter of riffle area times the area of the pool in each section. These quantities were then added to the aquatic and terrestrial drift from the riffle resulting in an estimate of total food reaching the pool which was then compared with computed values of total trout food consumption per month in each section (Figure 16). In making this comparison it was assumed that the trout did not consume significant quantities of drift in the shallow riffles. Total trout food consumption for each month was computed by multiplying the consumption per square meter of section area (Table 2) times the area of the respective section. Comparison of these values for each section suggests that there was usually an insufficient supply of food from the different estimated food components available to the trout to account for the quantity of food estimated to have been consumed. Comparison of food consumption by brown trout and the amount of drift in Walla Brook (Horton, 1961) also indicated that some food source other than drifting organisms was utilized by the trout.

During the summer months in Berry Creek when the terrestrial component of the trout diet was high, the total amount of drift was usually higher than consumption. This may indicate that food consumption by trout during the summer is reduced by factors other than the quantity of food. The decrease in growth when the quantity of drifting organisms was high may be related to some endogenous factor which restricts trout growth during the warmer summer months. Seasonal differences in growth of bluegills in Michigan have been reported by Anderson (1959), but the factors involved are not well understood.

It is worthy of note that the amount of food organisms

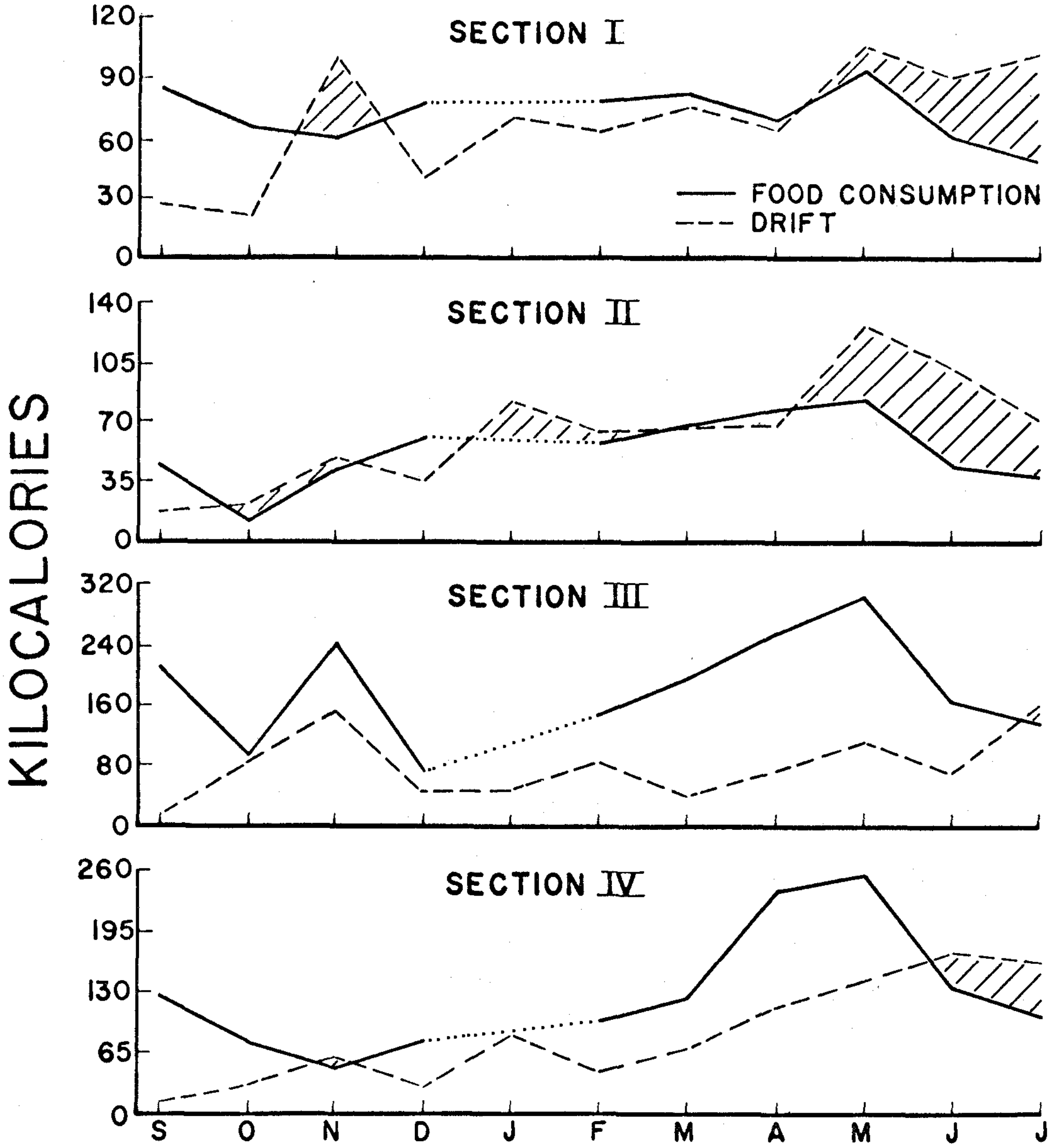

Figure 16. Comparison of the total monthly organic drift and total monthly food consumption in unenriched sections I and II and enriched sections III and IV during the 1963-64 experiment. No data were obtained for estimating food consumption during January 1964 (dotted line). Cross hatched areas represent period when drift was greater than total food consumption.

occurring in the drift (Figure 17) was not significantly greater in enriched sections III and IV than in unenriched sections I and II. Similar results were reported by Warren et al. (1964). The filtering action of the heavy mats of Sphaerotilus growing on the riffles of the enriched sections may have reduced the amount of organic drift. The additional food source provided by Sphaerotilus may have reduced competition for food by insects in enriched sections. Competition for food has been suggested to be a major cause of the drift phenomenon (Müller, 1954).

The biomass of drifting organisms in Berry Creek reached its highest levels during the summer and fall (Figure 17), when large amounts of terrestrial organisms appeared in the drift, and was at the lowest levels during the winter. The amount of drift generally increased after water temperatures began to increase during the spring.

The biomasses of riffle benthic organisms in enriched and unenriched sections were generally lowest during the summer months when values of drift were generally highest (Figure 18). Although trout growth was usually at relatively low levels during the summer months (Table 2), it tended to increase throughout the spring and early summer months which corresponded to the general increase in drifting organisms during the same period.

The increased drift and increased trout growth during the spring when riffle biomass declined suggests that the food organisms entered the drift and were utilized by the trout during this period. The riffle insects may be subject to increased predation

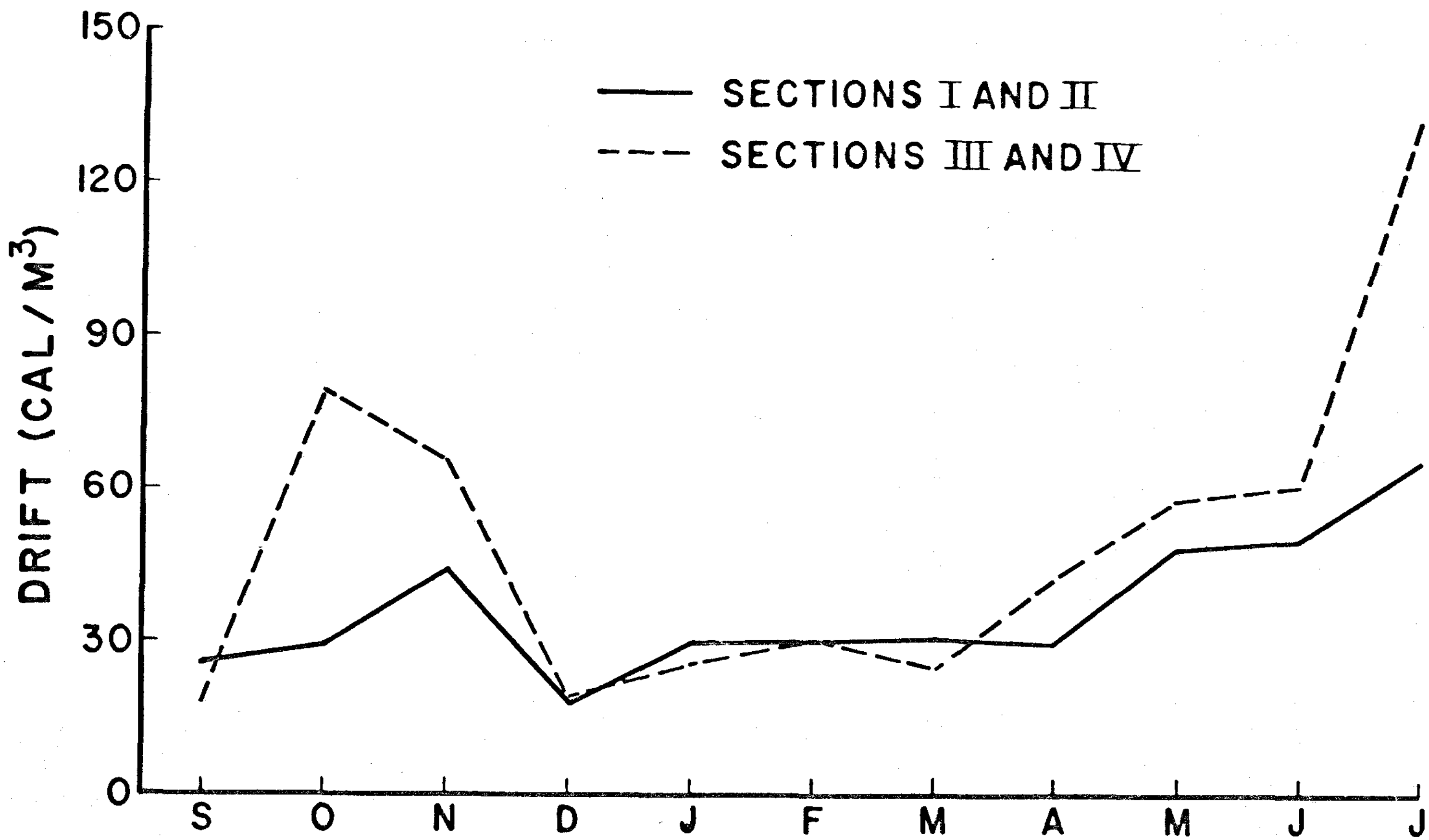

Figure 17. Comparison of mean values of drift from the riffles of unenriched sections I and II with mean values of drift from the riffles of enriched sections III and IV during the 1963-64 experiment.

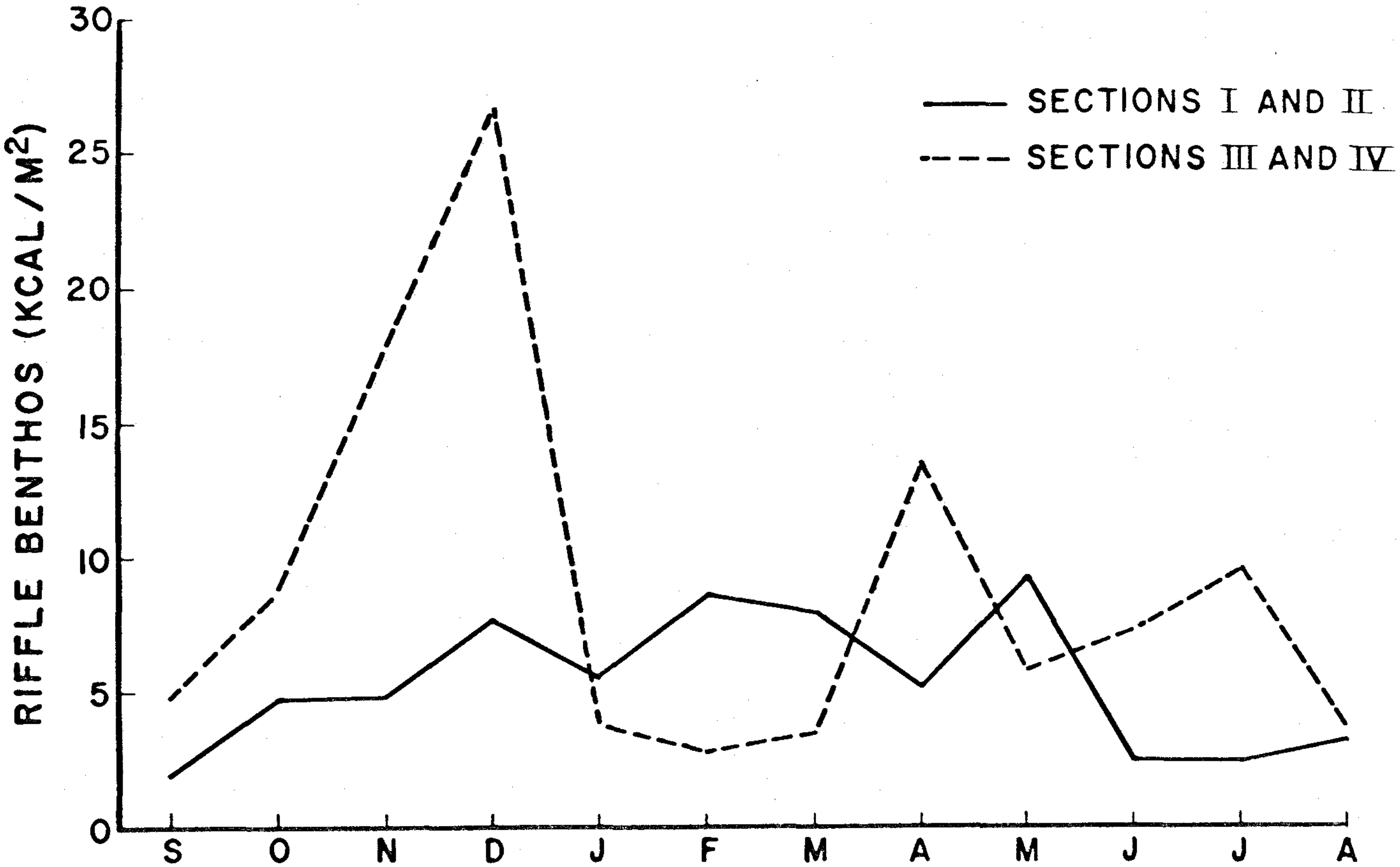

Figure 18. Comparison of mean values of riffle benthos in unenriched sections I and II with mean values of riffle benthos in enriched sections III and IV during the 1963-64 experiment.

during metamorphosis from pupal to adult or from naiad to adult stages. Increasing amounts of insects in the drift during the period of increasing trout growth may indicate that measurements of the amounts of drifting organisms would be a more meaningful measure of the trout food resource, in that it probably provides a better measure of the quantity of organisms which are available to the trout from the riffle.

Growth of trout in unenriched sections of Berry Creek appeared to be dependent upon the terrestrial insects which live in the canopy of the surrounding woodland. In the unenriched sections, trout growth remained near the maintenance level until the consumption of terrestrial organisms increased during the early spring months. In the enriched sections, the increased abundance of aquatic forms allowed for greater growth rates throughout the year. Growth rates were further enhanced after the terrestrial groups became an important part of the trout diet in the spring.

The forest canopy has been removed over sections II and IV, however, the abundant shrubbery along these sections creates a favorable insect habitat. The importance of terrestrial insects as food organisms for the trout may have been related to the relatively small size of Berry Creek. Demory (1961) presented data which permitted comparison of the food habits of juvenile coho salmon in two small Oregon coastal streams, Deer Creek and Needle Branch, which had low summer flows of 1.0 and less that 0.1 cfs, respectively. He found that the stomach contents of the salmon from the smaller stream, Needle Branch, contained a greater percentage of terrestrial food than did the stomach contents of the fish from Deer Creek.

High chironomid biomass in the pool benthos and a high occurrence of these organisms in the trout diet, especially in the enriched sections, may indicate that a considerable part of trout food was obtained in the pools. Chironomid pupae were separated from the larvae in trout stomach samples examined during the 1965-66 experiment. The large quantities of pupae consumed by the trout during the late winter and spring months appear to show a high availability of these forms during the pre-emergence period (Figures 13, 14 and 15). Data have been obtained using floating emergence traps positioned over the pools of the four numbered sections by Richard K. Eppley, Department of Entomology, Oregon State University, for the chironomid populations, but analysis of this material is not complete at the present time. Had this information been available, perhaps a measure of the availability of these pool insects as a trout food source could have been obtained.

The large biomasses of organisms present in the pools of enriched sections in which there were large accumulations of leaves and Sphaerotilus probably do not exist in uncontrolled streams having a natural flow regime, but even in the uncontrolled streams accumulation of silt and organic matter in the pools after the spring freshets may create conditions favorable to the growth of trout food organisms.

Results for the 1965-66 experiment, when all three size groups of trout could be compared during the same experimental period, indicate that for each group approximately the same amount of terrestrial organisms (Figures 13, 14 and 15) were consumed in both the enriched and unenriched sections. Small differences, however, were found in the amount of terrestrial food consumed between the various size groups within each treatment; the small fish consuming more terrestrial forms than did the large fish. The greater consumption and production values found for trout of all size groups in the enriched sections can probably be attributed to the increased food resource created by the Sphaerotilus for aquatic organisms which were important in the trout diet. The much greater values of production and food consumption for experimental populations of small trout in the enriched sections indicate that low levels of organic enrichment leading to higher biomasses of aquatic insects, especially chironomids, may create an environment capable of supporting large numbers of trout in their first year of life. As the trout become larger and their numbers decrease, the increased food supply resulting from enrichment does not bring about great increases in production and food consumption.

Growths of Sphaerotilus, even though they enhance the environment for small trout, may decrease the suitability of streams for spawning areas. Heavy growths of Sphaerotilus over spawning areas could bring about reductions of oxygen concentrations in stream bed gravels, thus resulting in unfavorable conditions for the survival of embryos. A judgment as to whether the effects of enrichment are beneficial or deleterious must be based upon a rational evaluation of the factors contributing to the success of populations valuable to man.

APPENDICES

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Appendix 1. Percentages by weight of the identified food organisms found in stomachs of cutthroat trout in unenriched section I between September 1964 and August 1965. Only those groups contributing at least 0.1 percent by weight each month are included.

Aquatic Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Collembola			4.4	8.3	1.9	4.6	2.3					
Ephemeroptera			2.9	53.6	13.7	8.9	16.7	1.1	0.2			
Plecoptera				2.2	0.6		5.6				0.7	
Hemiptera					13.8	37.4		12.5	0.4	8.1		
Megaloptera							9.4					
Trichoptera	0.3	1.4			5.1	17.0	7.7	0.1	0.1	1.3		0.1
Coleoptera							15.5					
Diptera												
Chironomidae	0.5	0.7	2.3	0.3	4.1	7.4	2.7	2.4		3.3		
Miscellaneous	1.0		1.7	0.8	0.1	0.4	1.3					
Gastropoda					13.9							
Crustacea									97.5			
Pisces			65.9	24.8							35.3	
Oligochaeta											30.1	
Acarina												
Terrestrial Groups												
Isopoda										26.4	21.4	
Hymenoptera		5.5	0.3		28.2	0.1	0.1	17.4			0.7	0.2
Hemiptera		7.7				0.1		1.2	0.2	16.0	2.9	4.7
Homoptera		5.9										0.1
Coleoptera	43.2	1.8			9.0	8.6	26.3	5.7	0.2	22.8	5.3	65.1
Lepidoptera				6.8				35.4	0.2		2.7	26.6
Diptera	13.4	37.2				0.1	0.2	9.6	0.8	16.3	0.7	3.2
Misc. Insecta	0.7		1.6									
Aquatic adults	40.8	12.7	0.3	3.3	8.1	15.4	9.2	13.1	0.3	5.9	0.1	
Myriapoda											0.1	
Arachnida		27.1	20.5		1.6		2.9	1.4				
Totals	99.9	100.0	99.9	100.1	100.1	100.0	99.9	99.9	99.9	100.1	100.0	100.0
Total Aquatic	1.8	2.1	77.2	90.0	53.2	75.7	61.2	16.1	98.2	12.7	66.1	0.1
Total Terrestrial	98.1	97.9	22.7	10.1	46.9	24.3	38.7	83.8	1.7	87.4	33.9	99.9

Appendix 2. Percentages by weight of the identified food organisms found in stomachs of cutthroat trout in section II between September 1964 and August 1965. This section was enriched beginning in March 1965. Only those groups contributing at least 0.1 percent by weight each month are included.

Aquatic Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Collembola	2.2		5.2	25.0	5.2					0.1		
Ephemeroptera		0.9	18.6	51.8		15.3	49.5	38.5	28.7	1.3		
Plecoptera		37.1				19.7	10.6	25.3	0.1	0.7		
Hemiptera	6.6				4.6		0.1					
Megaloptera												53.3
Trichoptera		8.5		12.5	36.0	9.5	0.1		0.1		0.4	
Coleoptera									0.2			
Diptera												
Chironomidae	0.9		50.3	7.1	7.6	2.2	4.7	20.0	4.2	25.3	34.0	7.6
Miscellaneous	10.1	1.3					6.8	0.6	0.3	11.5	21.6	
Vertebrate eggs						12.5						
Acarina							0.1					
Terrestrial Groups												
Isopoda							4.3	1.9		36.3		
Hymenoptera	6.1		0.4				0.1	1.1	3.6	0.1	38.8	
Hemiptera		37.7			3.1			0.3	1.9	0.6		
Homoptera		1.6	0.8					0.2	8.4			
Coleoptera	13.2	1.3	1.1			35.7	3.1	1.2	12.2		5.3	10.1
Lepidoptera			1.9				1.4		7.6	21.3		
Diptera	56.1	11.6	1.9	3.6	0.4	1.4	1.9	2.2	9.0	2.7		0.4
Aquatic adults	4.8		19.9		42.4	3.8	15.9	6.2	17.4			
Arachnida					0.7		1.5	2.3	6.4	0.2		28.6
Totals	100.0	100.0	100.1	100.0	100.0	100.1	100.1	99.8	100.1	100.1	100.1	100.0
Total Aquatic	19.7	47.8	74.1	96.4	53.5	59.1	71.9	84.4	33.6	38.8	55.9	60.9
Total Terrestrial	80.3	52.2	26.0	3.6	46.5	41.0	28.2	15.4	66.5	61.3	44.2	39.1

Appendix 3. Percentages by weight of the identified food organisms found in stomachs of cutthroat trout in section III (enriched) between September 1964 and August 1965. Only those groups contributing at least 0.1 percent by weight each month are included.

Aquatic Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Collembola		3.0	1.6		0.9	0.4	0.9					
Ephemeroptera	0.9	5.3	0.7	13.9	6.1	3.5	1.6	0.9	0.4	3.6		2.9
Plecoptera		6.7			13.3	0.6		0.1	1.5			
Hemiptera		7.5							0.5		0.6	
Megaloptera							7.8					
Trichoptera			5.0	39.6	13.8	3.8		0.1				
Coleoptera		6.5								6.6		
Diptera												
Chironomidae	0.2	0.1	90.9	30.4	15.5	7.4	19.2	26.5	11.9	27.0	2.2	6.4
Miscellaneous			0.1	1.9	0.4	0.4	0.4		0.3		6.1	
Crustacea				0.1	0.2			1.0	62.5			
Pisces					16.0		12.5					
Vertebrate eggs						57.9		0.2				
Annelida					2.1							
Terrestrial Groups												
Isopoda									4.6		17.3	
Hymenoptera	2.6	3.6	0.6		6.9	4.9	1.5	0.3	6.9	5.1	1.5	24.1
Hemiptera	6.1	12.7			4.7	1.3	1.2	0.2	0.4	6.9	1.6	31.2
Homoptera	2.1	0.4							0.2			0.2
Dermaptera	30.4											
Coleoptera	10.5	2.4	0.4		0.3	7.5	5.8	0.6	4.0	29.2	6.0	22.3
Lepidoptera			0.6			4.6	40.1	66.0	0.3			
Diptera	37.0	47.6	0.1		2.0	0.3	2.0	2.4	4.3	13.1	1.2	12.9
Aquatic adults	10.1	0.4			11.8	4.7	6.0	0.9	1.5		0.4	
Myriapoda		3.2										
Arachnida		0.6		14.0	6.0	2.7	1.3	0.6	0.8	8.5	63.2	
Totals	99.9	100.0	100.0	99.9	100.0	100.0	100.3	99.8	100.1	100.0	100.1	100.0
Total Aquatic	1.1	29.1	98.3	85.9	68.3	74.0	42.4	28.9	77.1	37.2	8.8	9.4
Total Terrestrial	98.8	70.9	1.7	14.0	31.7	26.0	57.9	70.9	23.0	62.8	91.3	90.6

Appendix 4. Percentages by weight of the identified food organisms found in stomachs of cutthroat trout in enriched section IV between September 1964 and August 1965. Only those groups contributing at least 0.1 percent by weight each month are included.

Aquatic Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Collembola		1.3		0.4	1.5	0.4	4.0					
Ephemeroptera	0.3	0.4	2.0	2.7	25.7	7.5	2.3	5.9	5.1			0.1
Plecoptera				6.8	2.8	5.4	5.4	1.2				
Hemiptera	0.1	0.9		0.4				3.7	0.3			
Megaloptera		4.5				4.8	18.2	2.2	3.9		38.3	
Trichoptera	1.5		2.9	21.3	16.5	3.7		1.9	0.1		0.5	
Coleoptera								1.2	0.2			
Diptera												
Chironomidae		1.5	7.9	48.6	12.5	8.8	9.5	54.2	59.5	56.0	9.2	18.9
Miscellaneous	1.6		2.4	0.3	0.3	3.9	0.1	1.8	2.0	4.7	18.5	12.5
Pisces			82.6			38.6	1.0	16.3				
Vertebrate eggs						3.1						
Oligochaeta		83.7										
Terrestrial Groups												
Isopoda							0.7	0.9	3.8	22.2	26.8	
Hymenoptera	3.6	6.0					4.5	0.7	0.3		3.4	67.7
Hemiptera		0.4				0.5	0.2		0.1	11.8	1.7	
Homoptera	17.4	0.2						0.5				0.1
Coleoptera	0.2					5.9	0.7	2.4	7.8			
Lepidoptera		0.7				2.9		1.1	6.9			
Diptera	69.3	0.4	0.3		0.2	0.2	1.5	0.8	3.4	5.3	1.7	0.2
Aquatic adults	6.0		2.1	19.1	36.6	14.2	51.9	4.7	6.6			0.5
Arachnida				0.3	3.9			0.4				
Totals	100.0	100.0	100.2	99.9	100.0	99.9	100.0	99.9	100.0	100.0	100.1	100.0
Total Aquatic	3.5	92.4	97.7	80.5	59.3	76.2	40.5	88.4	71.1	60.7	70.2	31.5
Total Terrestrial	96.5	7.6	2.5	19.4	40.7	23.7	59.5	11.5	28.9	39.3	29.9	68.5

Appendix 5. Mean biomasses, growth rates, production, and food consumption of cutthroat trout populations composed of only small, of only large, or of individuals of differing sizes in unenriched and enriched experimental stream sections during the 1965-66 experiment.

Month	1965-66 (Small) Mean biomass ($kcal/m^2$)	1965-66 (Small) Growth rate (cal/kcal/day)	1965-66 (Small) Production ($kcal/m^2$)	1965-66 (Small) Consumption ($kcal/m^2$)	1965-66 (Large) Mean biomass ($kcal/m^2$)	1965-66 (Large) Growth rate (cal/kcal/day)	1965-66 (Large) Production ($kcal/m^2$)	1965-66 (Large) Consumption ($Kcal/m^2$)	1965-66 (Mixed) Mean biomass ($kcal/m^2$)	1965-66 (Mixed) Growth rate (cal/kcal/day)	1965-66 (Mixed) Production ($kcal/m^2$)	1965-66 (Mixed) Consumption ($kcal/m^2$)
						Unenriched						
September	2.87	1.55	0.12	1.67	3.52	3.55	0.25	1.84				
October	2.68	-1.21	-0.11	1.49	3.94	-0.75	-0.10	2.29	2.62	1.23	0.11	1.85
November	2.95	2.54	0.24	2.23	2.86	-1.63	-0.14	1.54	2.81	0.80	0.07	1.74
December	3.21	-0.24	-0.02	1.50	3.08	-0.25	-0.02	1.44	3.55	0.11	0.01	1.68
January	2.43	-1.71	-0.15	1.36	3.21	0.26	0.03	2.20	3.03	0.46	0.05	2.10
February	3.54	0.54	0.05	1.79	2.27	-0.85	-0.05	1.00	3.41	-0.01	-0.02	1.63
March	4.29	2.25	0.28	2.86	3.30	2.22	0.22	2.28	4.02	1.20	0.14	2.42
April	5.07	7.89	1.32	6.59	3.36	2.98	0.32	2.66	3.56	3.56	0.38	2.80
May	2.91	7.21	0.65	3.34	2.45	7.90	0.60	3.00	3.71	2.87	0.33	2.82
Totals			2.38	22.83			1.11	18.25			1.07	17.04
Means	3.33				3.11				2.97			
						Enriched						
September	3.32	3.29	0.24	1.86	3.82	0.52	0.04	1.49	3.03	6.60	0.44	2.33
October	3.37	4.10	0.47	3.15	3.84	-0.46	-0.06	2.31	3.22	4.38	0.48	3.12
November	3.32	5.37	0.57	3.32	3.58	0.37	0.04	2.07	2.82	2.97	0.26	2.16
December	5.31	7.39	1.02	5.22	4.02	2.20	0.23	2.39	3.04	4.93	0.39	2.37
January	4.22	13.16	2.00	9.27	5.18	0.48	0.09	3.62	3.98	4.96	0.71	4.33
February	4.42	19.93	2.29	10.52	4.33	2.22	0.24	2.47	4.35	6.07	0.66	3.62
March	5.78	19.21	3.22	14.75	2.93	3.88	0.33	2.29	3.41	12.13	1.20	5.61
April	5.72	11.90	2.11	9.93	3.27	4.49	0.44	2.94	2.62	11.07	0.87	4.07
May	7.18	8.40	1.93	9.48	3.50	5.71	0.64	3.62	5.21	4.65	0.80	5.03
Totals			13.85	67.50			1.99	23.20			5.81	32.64
Means	4.74				3.83				3.52			

Appendix 6. Percentages by weight of identified food organisms taken from the stomachs of underyearling cutthroat trout kept in the unenriched sections between September 1965 and April 1966. Only those groups which contribute at least 0.1 percent by weight each month are included.

Food Organisms	Percentages by weight for indicated dates							
Aquatic Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Collembola		0.3	3.4	4.4	6.7	2.3	1.2	1.9
Ephemeroptera								
Heptageniidae			4.0	42.5	5.5	0.3	3.5	0.2
Baetidae		0.2	0.2	4.5	4.6	0.4	4.0	0.3
Leptophlebiidae	0.1	0.4	10.8	20.0	3.5		3.8	0.4
Miscellaneous								0.2
Plecoptera								
Nemouridae		0.1	1.2	12.7	9.3	0.2		
Perlidae							0.4	0.4
Chloroperlidae				0.6				
Perlodidae				0.4		0.3	0.9	0.1
Hemiptera								
Saldidae								0.5
Megaloptera								
Sialidae			10.8	1.7				
Trichoptera								
Philopotamidae	0.2		1.7	0.2	0.2		0.2	0.1
Lepidostomatidae	0.8	0.4	0.4	0.5	5.9			
Brachycentridae		0.1		1.1	1.8			
Miscellaneous				1.6			1.1	0.4
Coleoptera								
Dytiscidae		0.4			2.0			0.2
Elmidae	0.4	0.1			13.9			
Miscellaneous					2.0		0.4	
Diptera								
Dixidae	0.1	0.4	0.3	0.3	0.4	0.1	0.1	0.1
Simulidae larvae		0.1	2.0	2.0	2.8	0.1	8.3	0.2
Simulidae pupae							1.1	
Chironomidae larvae	0.9	1.0	6.1	5.2	8.5	0.4	1.1	2.5
Chironomidae pupae	0.6	0.4	8.8	0.1	1.7	0.2	2.5	0.3
Miscellaneous	0.2		15.3	0.3	0.2		0.2	
Crustacea	0.2	0.1					2.6	
Gastropoda		0.2	0.6		9 8			
Annelida		56.2				92.5		17.3
Acarina		0.1			0.6			0.1
Vertebrate eggs							2.1	

Appendix 6. Continued

Food Organisms	Percentages by weight for indicated dates							
Terrestrial Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Isopoda			3.5					
Arachnida		5.7	12.2	1.4		0.3	6.3	0.6
Hemiptera		1.6				0.1	1.0	
Homoptera	0.3	5.7	0.9		0.1		0.1	1.6
Dermaptera	3.9	4.0						
Coleoptera	3.7	5.0	1.1		3.0	0.8	2.4	6.3
Diptera	54.8	3.6	8.8	0.4	3.1	1.5	34.7	12.7
Lepidoptera	2.1	8.2			0.9	0.2	6.1	31.8
Hymenoptera	28.6	3.5	1.8		11.9		0.4	17.8
Ephemeroptera		0.9			0.5	0.1	6.2	0.3
Plecoptera		1.4	2.6				7.1	0.5
Trichoptera	2.7		3.7		1.1		2.2	3.4
Misc. Insecta	0.5	0.1						
Total	100.1	100.2	100.2	99.9	100.0	99.8	100.0	100.2
Total Aquatic	3.5	60.5	65.6	98.1	79.4	96.8	33.5	25.2
Total Terrestrial	96.6	39.7	34.6	1.8	20.6	3.0	66.5	75.0

Appendix 7. Percentages by weight of identified food organisms taken from the stomachs of various sizes of trout kept in unenriched section I between October 1965 and April 1966. Only those groups contributing at least 0.1 percent by weight each month are included.

Food Organisms	Percentages by weight for indicated dates						
Aquatic Groups	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Collembola	0.3	4.0	2.0	2.5	3.4	1.3	2.6
Ephemeroptera							
Heptageniidae	1.7		48.4		5.2	4.0	
Baetidae		1.1	3.0	7.9	2.3	0.7	
Leptophlebiidae			1.1				
Miscellaneous			7.4			1.6	
Plecoptera							
Nemouridae			0.7				
Perlidae	0.5		9.3				
Perlodidae	3.6		1.8			1.0	
Miscellaneous			1.7				
Hemiptera							
Gerridae				22.0			
Saldidae				0.1			
Megaloptera							
Sialidae				2.4			
Trichoptera							
Philopotamidae	0.7					0.4	
Lepidostomatidae			1.4	21.1	0.4		
Brachycentridae			0.7	1.5			
Miscellaneous				30.8			
Coleoptera							
Dytiscidae		0.7					0.4
Elmidae				6.6			
Diptera							
Dixidae		0.2	0.2		0.3		0.5
Simulidae larvae	0.1	0.4	0.6		0.2	0.1	0.8
Chironomidae larvae		0.1	13.3	0.9	1.8	0.4	0.5
Chironomidae pupae	0.1	0.2	0.1	3.4	13.5	1.7	1.0
Miscellaneous		0.1	0.6	0.1	0.1	0.3	0.4
Crustacea					0.1	25.9	
Gastropoda		90.6					
Annelida						8.7	

Appendix 7. Continued

Food Organisms	Percentages by weight for indicated dates						
Terrestrial Groups	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Isopoda			2.6				
Myriapoda		0.1					
Arachnida	32.1	0.1			0.8	1.3	1.6
Hemiptera	7.8					0.2	1.4
Homoptera	19.0						0.5
Coleoptera	3.9	1.8				5.3	10.6
Diptera	5.7	0.1	0.1	0.8	58.4	17.4	45.1
Lepidoptera	4.7						26.3
Hymenoptera	3.6	0.1			9.8	1.2	1.3
Ephemeroptera	0.3	0.3			3.7	20.6	3.6
Plecoptera	15.7		2.0			7.8	3.5
Trichoptera	0.3		3.0				
Misc. Insecta		0.3					
Total	100.1	100.2	100.0	100.1	100.0	99.9	100.1
Total Aquatic	7.0	97.4	92.3	99.3	27.3	46.1	6.2
Total Terrestrial	93.1	2.8	7.7	0.8	72.7	53.8	93.9

Appendix 8. Percentage by weight of identified food organisms taken from the stomachs of large trout kept in the unenriched sections between September 1965 and April 1966. Only those groups contributing at least 0.1 percent by weight each month are included.

Food Organisms	Percentages by weight for indicated dates							
Aquatic Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Collembola		0.1	5.8	5.7	0.8		0.1	0.4
Ephemeroptera								
Heptageniidae			5.7	25.4	2.1	2.3	1.9	
Baetidae			1.6	3.4	0.3	0.6		
Leptophlebiidae				39.4	4.0			
Plecoptera								
Nemouridae			2.2	12.7	0.9	1.0		
Perlidae						0.3	0.4	
Perlodidae							1.4	
Hemiptera								
Gerridae		1.2	63.9		72.3	94.0		1.0
Megaloptera								
Sialidae							0.9	
Trichoptera								
Philopotamidae		0.1						
Lepidostomatidae					4.1			
Brachycentridae				0.9				
Miscellaneous				4.5			2.3	
Diptera								
Dixidae		0.1		0.4				
Simulidae larvae			0.9	0.7				
Chironomidae larvae	2.8		0.2	1.1	0.2	1.5	0.2	
Chironomidae pupae	1.7		4.8	0.1	2.6	0.3	0.7	0.3
Crustacea		78.0						
Terrestrial Groups								
Isopoda							7.7	30.1
Arachnida		1.8	1.3	0.7			4.7	0.5
Hemiptera		1.4					1.3	
Homoptera	13.6	3.6	1.2					2.2
Coleoptera	20.6	3.8	3.2	2.6	0.8		7.2	2.4
Diptera	29.5	0.1	4.3	0.1			34.3	28.0
Lepidoptera	18.5	0.8	4.3				21.9	34.0
Hymenoptera			0.7		11.9		0.8	0.3
Ephemeroptera							6.8	
Plecoptera	13.3	4.4		0.9			7.1	
Trichoptera		0.1		1.4			0.5	0.9
Misc. Insecta		4.3						
Total	100.0	99.8	100.1	100.0	100.0	100.0	101.1	100.1
Total Aquatic	4.5	79.5	85.1	94.3	87.3	100.0	7.9	1.7
Total Terrestrial	95.5	20.3	15.0	5.7	12.7		93.2	98.4

Appendix 9. Percentages by weight of identified food organisms taken from the stomachs of underyearling cutthroat trout kept in the enriched sections between September 1965 and April 1966. Only those groups contributing at least 0.1 percent by weight each month are included.

Food Organisms	Percentages by weight for indicated dates							
Aquatic Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Collembola		2.7	8.5	5.1	5.9	1.3	0.1	0.3
Ephemeroptera								
Heptageniidae				1.9			0.8	
Baetidae				2.3	1.6	2.7	4.9	0.5
Leptophlebiidae	1.5	0.4	1.2	9.7	3.3	0.5		0.1
Miscellaneous								1.0
Plecoptera								
Nemouridae		5.4	3.0	13.8	1.5	0.8		
Perlidae							1.9	7.9
Miscellaneous					0.2		0.3	0.6
Hemiptera								
Gerridae		0.9						
Saldidae				2.1				0.2
Megaloptera								
Sialidae	16.0		5.3			3.7	6.0	
Trichoptera								
Philopotamidae			0.1				0.2	
Lepidostomatidae	1.4	0.5	0.8		0.5			
Miscellaneous			0.7	0.1				
Coleoptera								
Dytiscidae							0.1	
Elmidae	1.1	0.5						
Diptera								
Dixidae	0.1	1.4	1.1	0.2				1.0
Simulidae larvae		5.5	1.9	28.2	0.2	0.9	1.6	0.7
Simulidae pupae		2.2	5.5	0.8		0.3		
Chironomidae larvae	0.8	2.3	22.6	7.3	10.7	7.9	14.7	26.6
Chironomidae pupae	7.5	1.0	31.0	9.0	59.9	70.9	24.1	8.8
Miscellaneous	1.7	0.6			1.0	0.4	2.1	1.7
Vertebrate eggs					6.7			
Crustacea				0.1				
Gastropoda			1.3	2.8		1.4		
Pelecypoda	0.4							
Acarina							0.1	
Annelida		3.3		13.8		3.9	8.5	13.5

Appendix 9. Continued

Food Organisms	Percentages by weight for indicated dates							
Terrestrial Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Isopoda		0.5						16.6
Myriapoda				0.1				
Arachnida	8.4	1.2	0.7		0.1	1.0	0.8	
Hemiptera		0.5					0.1	
Homoptera	3.2	12.4	1.9					0.3
Dermaptera	2.4	7.0						
Coleoptera	17.0	5.7	0.3	0.2	0.4		0.7	6.1
Diptera	26.0	12.8	9.5	0.5	2.1		16.5	9.9
Lepidoptera	3.4	0.2			2.4			
Hymenoptera	2.2	4.2					0.1	0.8
Ephemeroptera	4.7	0.1	2.6	1.7	1.8	0.5	8.4	1.5
Plecoptera	2.2	27.7	1.7		1.8	3.5	8.1	1.8
Trichoptera			0.1					
Misc. Insecta		0.7						
Total	100.0	99.7	99.8	99.7	100.1	99.7	100.1	99.9
Total Aquatic	30.5	26.7	83.0	97.2	91.5	94.7	65.4	62.9
Total Terrestrial	69.5	73.0	16.8	2.5	8.6	5.0	34.7	37.0

Appendix 10. Percentages by weight of identified food organisms taken from the stomachs of various sizes of cutthroat trout kept in enriched section II between September 1965 and April 1966. Only those groups contributing at least 0.1 percent by weight each month are included.

Food Organisms	Percentages by weight for indicated dates							
Aquatic Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Collembola		0.4	0.1	1.2	1.6	0.8		1.0
Ephemeroptera								
Heptageniidae						0.5	18.9	3.4
Baetidae				2.7	2.9	0.5	1.5	0.8
Leptophlebiidae					0.6	0.6	4.1	
Miscellaneous			0.1			0.2	5.4	0.2
Plecoptera								
Nemouridae					1.9	4.2	3.7	
Perlidae		51.6	2.8	6.4	0.5	0.8		0.6
Perlodidae		1.0		3.1	0.6	0.2	1.9	
Miscellaneous		2.3		1.0	0.8			
Megaloptera								
Sialidae			89.7				26.9	
Trichoptera								
Lepidostomatidae	1.5	5.3	0.6	14.0	21.4	0.6		
Brachycentridae			0.3	13.4	1.6	0.9		
Miscellaneous					1.9		1.5	
Coleoptera								
Dytiscidae	23.0							
Elmidae						1.3		
Diptera								
Dixidae			0.3			0.2		
Simulidae larvae	7.9	7.4	0.7	4.3	3.8	8.7	1.1	
Simulidae pupae								3.1
Chironomidae larvae	6.3	6.1	0.9	20.5	6.0	1.1	3.1	3.4
Chironomidae pupae	28.8	3.0	2.0	25.8	49.9	22.6	0.7	2.4
Miscellaneous	7.1		0.7		2.0	0.6		
Vertebrate eggs						3.1		
Acarina		0.1			0.2			
Annelida						52.3		

Appendix 10. Continued

Food Organisms	Percentages by weight for indicated dates							
Terrestrial Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Isopoda		3.5						
Arachnida		2.5		1.0	0.1			
Hemiptera		16.1						
Homoptera		0.4						0.2
Coleoptera	25.0		0.4	1.0			1.0	2.9
Diptera		0.3	0.6	2.5	0.9	0.2	8.1	12.0
Lepidoptera						0.3		67.2
Hymenoptera	0.4		0.3					0.1
Ephemeroptera				3.1	0.4	0.3	11.6	
Plecoptera			0.5		2.7		10.5	
Trichoptera					0.4			2.9
Total	100.0	100.0	100.0	100.0	100.2	100.0	100.0	100.2
Total Aquatic	74.6	77.2	98.2	92.4	95.7	99.2	68.8	14.9
Total Terrestrial	25.4	22.8	1.8	7.6	4.5	0.8	31.2	85.3

Appendix 11. Percentages by weight of identified food organisms taken from the stomachs of large trout kept in the enriched sections between September 1965 and April 1966. Only those groups contributing at least 0.1 percent by weight each month are included.

Food Organisms	Percentages by weight for indicated dates							
Aquatic Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Collembola		1.7	6.0	3.3	1.8	0.6	0.6	1.7
Ephemeroptera								
Heptageniidae			2.1		0.4	7.8	0.3	
Baetidae		1.5		1.0	1.5		3.1	1.3
Leptophlebiidae		0.3	1.6	3.5				
Plecoptera								
Nemouridae	0.1	3.3		3.4	15.2	3.2		
Perlidae							4.2	
Chloroperlidae				0.4				
Perlodidae							0.2	
Hemiptera								
Gerridae	36.7				29.4			
Megaloptera								
Sialidae		2.7				3.1	7.5	
Trichoptera								
Philopotamidae							0.7	
Lepidostomatidae	1.1							
Miscellaneous				0.1				
Coleoptera								
Dytiscidae					0.3			
Elmidae				0.2				
Diptera								
Dixidae			0.2	0.3	3.0	0.3		
Simulidae larvae			0.3	0.2	19.8	0.1	0.2	
Simulidae pupae	0.1	4.9			2.4			
Chironomidae larvae	0.2		2.6	1.4	0.9	0.3	6.7	2.1
Chironomidae pupae	6.0	0.7	78.4	68.8	13.7	77.8	22.2	29.6
Miscellaneous						1.6	0.7	0.3
Acarina				0.1				

Appendix 11. Continued

Food Organisms	Percentages by weight for indicated dates							
Terrestrial Groups	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Isopoda		41.6						
Arachnida	1.7		0.1					0.2
Hemiptera	1.2							
Homoptera	14.0	7.0	0.5	0.5				0.8
Dermaptera		25.4						
Coleoptera	0.2	3.1	2.0	1.4	5.3		3.8	17.3
Diptera	26.9	3.8	0.5	5.9	2.5	2.1	8.3	42.9
Lepidoptera			4.8	1.0		0.8	4.5	
Hymenoptera	11.8	2.7	1.1	2.6			2.6	0.2
Ephemeroptera				4.0			11.6	
Plecoptera		1.3		2.1	3.9	2.4	22.9	3.5
Total	100.0	100.0	100.2	100.2	100.1	100.1	100.1	99.9
Total Aquatic	44.2	15.1	91.2	82.7	88.4	94.8	46.4	35.0
Total Terrestrial	55.8	84.9	9.0	17.5	11.7	5.3	53.7	64.9